BACHELOR THESIS
ME-141502

TECHNICAL AND ECONOMICAL OVERVIEW OF HOMOGENIZER INSTALATION ON PT. PERTAMINA TANKER SHIP'S FUEL SYSTEM

MUHAMMAD LUTFI PRAGOLA PUTRA
NRP. 4212101032

Supervisors :
Semin, S.T., M.T., Ph.D.
Dr. I Made Ariana, S.T., M.T.

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TUGAS AKHIR
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TINJAUAN TEKNIS DAN EKONOMIS PEMASANGAN HOMOGENIZER PADA SISTEM BAHAN BAKAR KAPAL TANKER PT. PERTAMINA

MUHAMMAD LUTFI PRAGOLA PUTRA
NRP. 4212101032

Dosen pembimbing :
Semin, S.T., M.T., Ph.D.
Dr. I Made Ariana, S.T., M.T.

PROGRAM DOUBLE DEGREE
JURUSAN TEKNIK SISTEM PERKAPALAN
FAKULTAS TEKNOLOGI KEMARITIMAN
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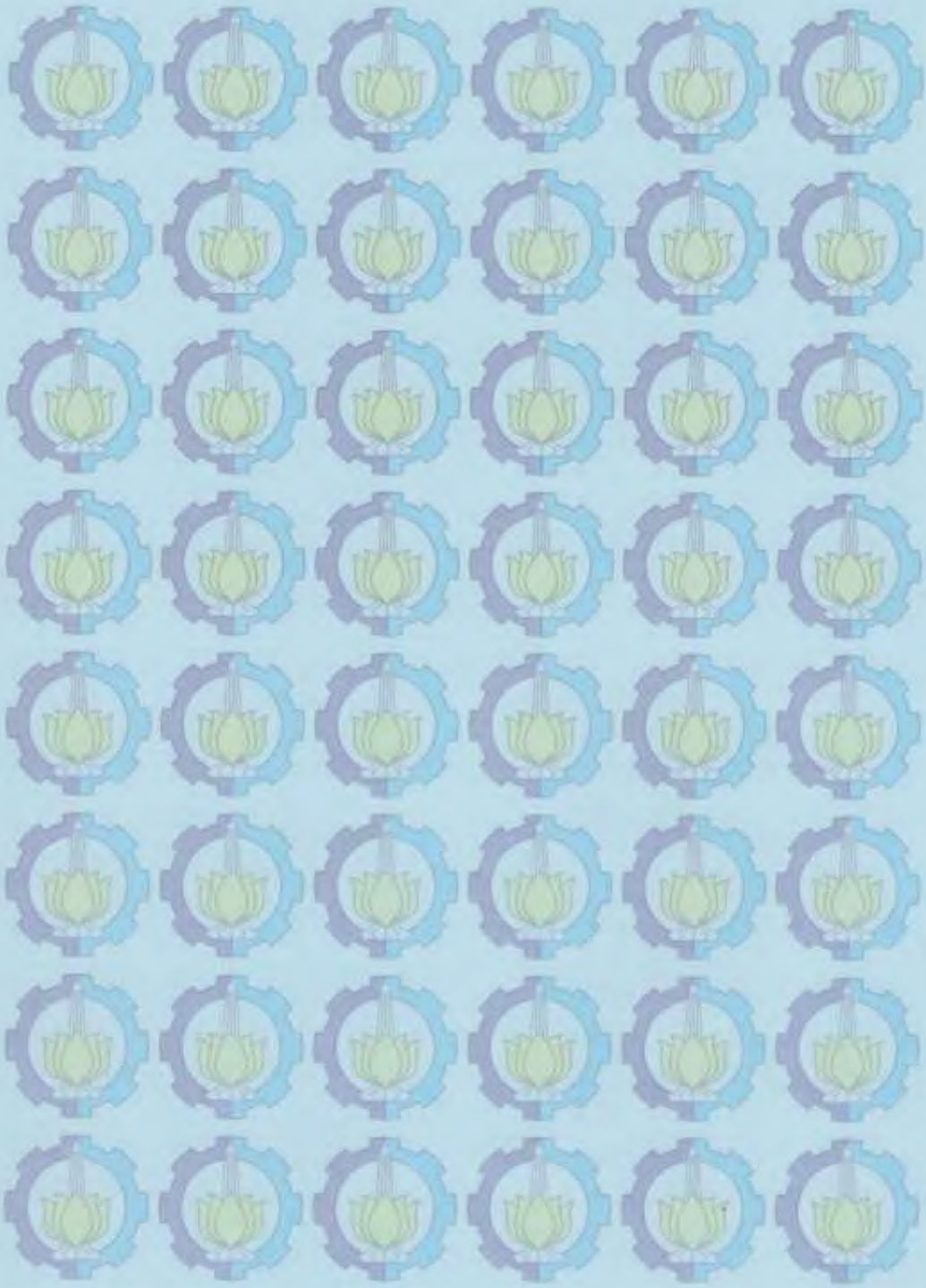

APPROVAL SHEET

TECHNICAL AND ECONOMICAL OVERVIEW OF HOMOGENIZER INSTALATION ON PT. PERTAMINA TANKER SHIP'S FUEL SYSTEM

BACHELOR THESIS

Proposed to fulfill One of Requiremens Acquired Bachelor
Engineering in Marine Power Plant Field Study
Double Degree Program of Marine Engineering Department
Faculty of Marine Technology
Institut Teknologi Sepuluh Nopember

Proposed by :
Muhammad Lutfi Pragola Putra
NRP : 4212101032

Approved by Supervisors :

1. **Semin, S.T., M.T., Ph.D.**
   NIP : 1971 0110 1997 02 1001

2. **Dr. I Made Ariana, S.T., M.T.**
   NIP : 1971 0610 1995 12 1001

SURABAYA
JULY, 2016

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Proposed by :
Muhammad Lutfi Pragola Putra
NRP : 4212101032

Approved by Head Department Marine Engineering

Dr. Eng. Muhammad Badrus Zaman, ST. MT.
1972 0830 2000 03 1001

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Muhammad Lutfi Pragola Putra
NRP : 4212101032

Approved by
Representative Hochscule Wismar in Indonesia

Dr. -Ing Wolfgang Busse

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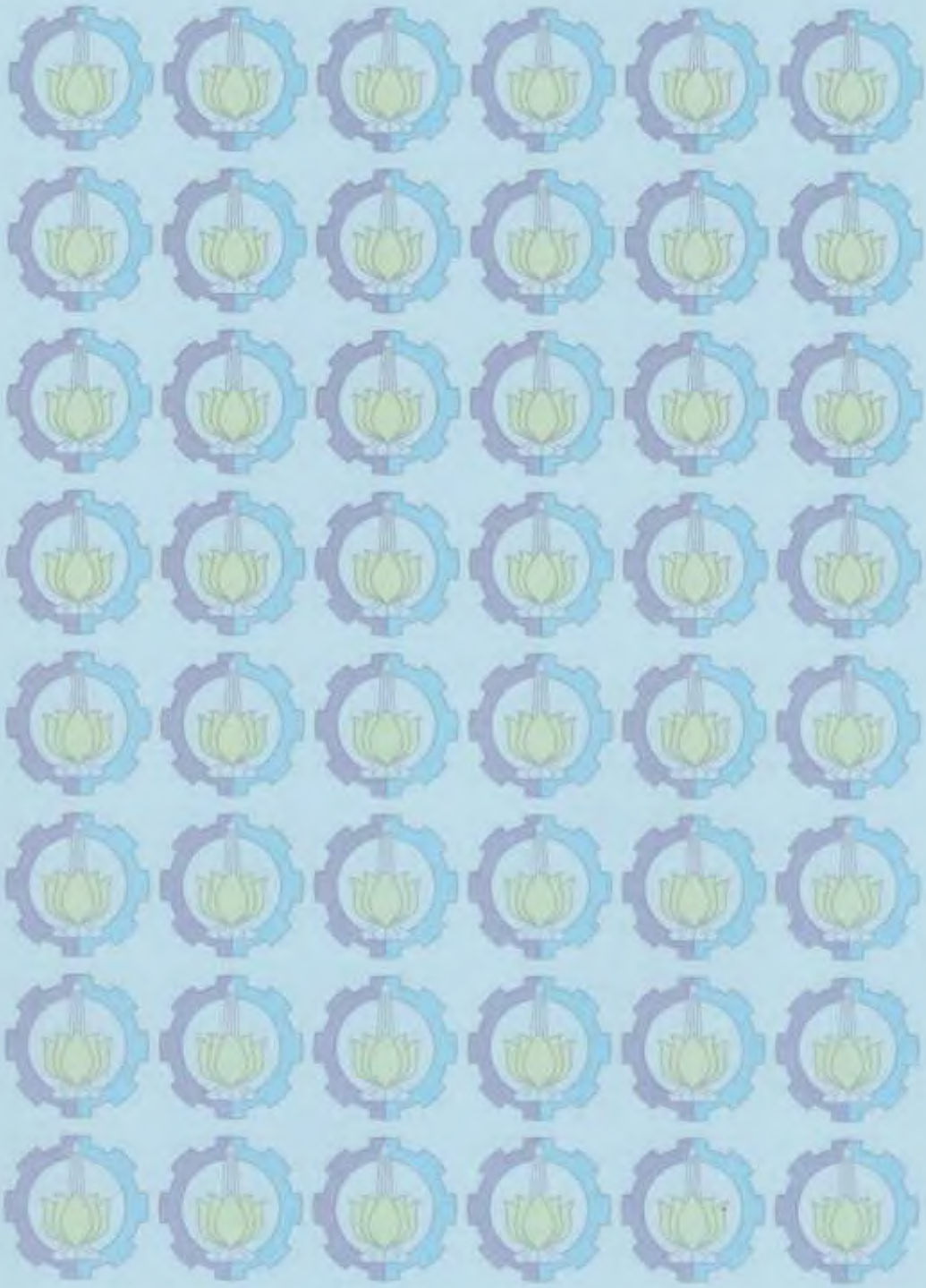


TECHNICAL AND ECONOMICAL OVERVIEW OF HOMOGENIZER INSTALATION ON PT. PERTAMINA TANKER SHIP'S FUEL SYSTEM

Name : Muhammad Lutfi Pragola Putra
NRP : 4212101032
Supervisors :
1. Semin, S.T., M.T., Ph.D.
2. Dr. I Made Ariana, S.T., M.T.

Abstract

HFO has become one of fuel choice for engine on board because it has a relatively cheaper price compared to HSD and MDO. However, unlike HSD which is can be used directly, HFO must have system of preparation before it flowed into ship's engine. HFO system generally includes storage tanks, transfer pumps, settling tanks, separators, service tank, booster pump.

Because of more advanced refining process, HFO has changes in terms of quality and quantity. HFO currently has a higher concentration of asphalt content and also experiencing a change in fuel properties, such as viscosity and density. This low quality fuel may lead to several complication on main engine and fuel treatment system components. To reduce the impact, fuel can be homogenized by process called Homogenization process.

Homogenization process becomes important for fuel especially HFO. By performing homogenization of fuel, fuel waste can be reduced, quality of combustion can be better, and also able to provide a positive influence for the reduction of emissions and a reduction in NOx levels. Homogenization process is done with a tool called a homogenizer.

In this bachelor thesis, author intends to study the effect of homogenizer instalation on PT. Pertamina tanker's fuel system. Research will study fuel oil cost difference between PT. Pertamina tankers MT. Pangkalan Brandan which equipped with homogenizer and MT. Palusipat which are not equipped with homogenizer. Research is be done by comparing FOC two similiar ships and calculate it's fuel benefit reduction cost.

Due to fuel oil price fluctuation, fuel oil price will be simulated with five different scenario which are decrease 2,93% annually, decrease 1,47% annually, constant price, increase 6,7% annually, and increase 13,41% annually. Through ecomonic calculation, the result for homogenizer instalation are effect on reducing fuel oil consumption cost whithin 10 years. Fuel oil consumption cost reduction are ; $47.462,1 with fuel oil price decrease 2,93% annually, $52.615,9 with fuel oil price decrease 1,47% annually, $58.185,0 with constant fuel oil price, $89.928,0 with fuel oil price increase 6,7% annually, and $134.975,1 with fuel oil price increase 13,41% annually. Payback period will be obtained within 4 years after operation.

Key words : Fuel conversion, fuel cost reduction, homogenizer, ship fuel system.

TINJAUAN TEKNIS DAN EKONOMIS PEMASANGAN HOMOGENIZER PADA SISTEM BAHAN BAKAR KAPAL TANKER PT. PERTAMINA

Nama : Muhammad Lutfi Pragola Putra
NRP : 4212101032
Dosen Pembimbing :
1. Semin, S.T., M.T., Ph.D.
2. Dr. I Made Ariana, S.T., M.T.

Abstrak

HFO menjadi salah satu pilihan bahan bakar untuk mesin kapal karena harganya yang relatif lebih murah dibandingkan dengan HSD dan MDO. Namun demikian, tidak seperti HSD yang dapat digunakan secara langsung, HFO harus harus menjalani perlakuan pada sistem bahan bakar sebelum memasuki mesin. Sistem perlakuan HFO diantaranya meliputi *storage tanks, transfer pumps, settling tanks, separators, service tank*, dan *booster pump*.

Dikarenakan semakin berkembangnya proses penyulingan minyak, HFO telah berubah baik secara kualitas maupun kuantitas. HFO saat ini selain memiliki kosentrasi aspal yang lebih tinggi, juga telah mengalami perubahan *properties*, seperti viskositas dan densitas. Penurunan kualitas bahan bakar ini dapat menyebabkan timbulnya komplikasi masalah baik pada mesin induk maupun pada komponen-komponen sistem pengolahan bahan bakar. Untuk mengurangi efek tersebut, bahan bakar dapat dihomogenkan melalui proses yang dinamakan homogenisasi.

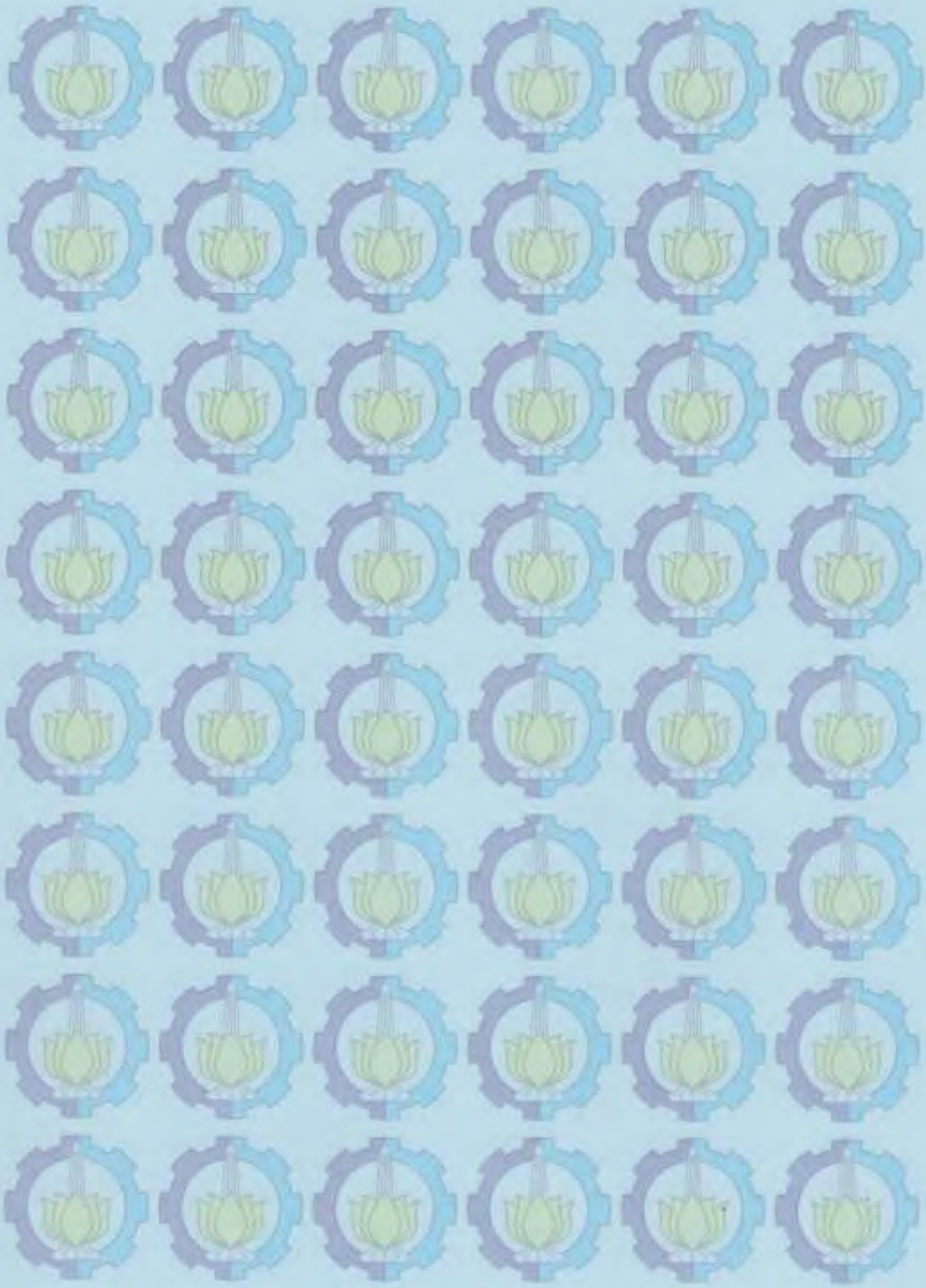
Proses homogenisasi menjadi hal yang krusial khususnya untuk bahan bakar HFO. Melalui proses homogenisasi, *sludge* bahan bakar dapat berkurang, kualitas pembakaran menjadi lebih baik, dan berpengaruh positif terhadap berkurangnya emisi gas buang dan berkurangnya

NOx. Proses homogenisasi dilakukan oleh alat yang dinamakan homogenizer.

Pada tugas akhir ini, penulis akan meneliti pengaruh pemasangan homogenizer pada sistem bahan bakar kapal tanker PT. Pertamina. Penelitian dilakukan dengan membandingkan perbedaan biaya konsumsi bahan bakar antara kapal tanker milik PT. Pertamina yang telah dilengkapi dengan homogenizer, MT. Pangkalan Brandan, dengan tanker PT. Pertamina yang belum terpasang homogenizer. Penelitian dilakukan dengan membandingkan FOC dua kapal dengan dimensi yang hampir sama dan menghitung keuntungan dari penurunan biaya bahan bakar.

Dikarenakan fluktuasi harga bahan bakar, maka harga bahan bakar akan disimulasikan memalui lima skenario harga yang berbeda yaitu, menurun 2,93% pertahun, menurun 1,47% pertahun, harga konstan, meningkat 6,7% pertahun, dan meningkat 13,41% pertahun. Melalui kalkulasi ekonomis, hasil dari pemasangan homogenizer selama sepuluh tahun memberikan efek pada pengurangan biaya konsumsi bahan bakar sebesar ; $47.462,1 dengan skenario harga bahan bakar menurun 2,93% pertahun, $52.615,9 dengan skenario harga bahan bakar menurun 1,47% pertahun, $58.185,0 dengan skenario harga bahan bakar konstan, $89.928,0 dengan skenario harga bahan bakar meningkat 6,7% pertahun, dan $134.975,1 dengan skenario harga bahan bakar meningkat 13,41% pertahun. Payback period secara keseluruhan pada kelima skenario harga akan tercapai pada periode empat tahun setelah masa operasional.

Kata kunci : Konversi bahan bakar, pengurangan biaya bahan bakar, homogenizer, sistem bahan bakar kapal.



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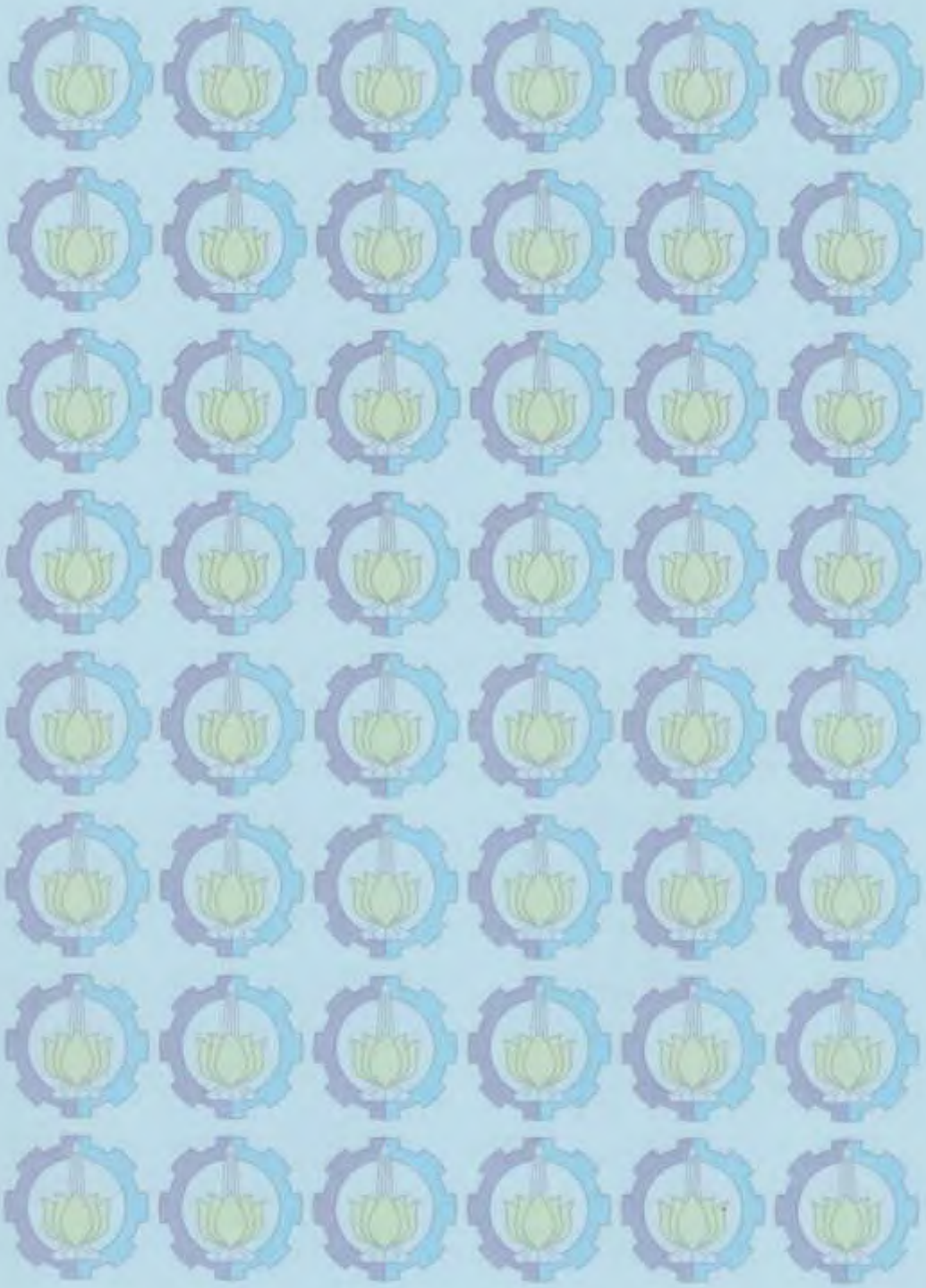

PREFACE

Praise to Allah SWT, for his blessing, mercy and compasion to author, so this bacelor thesis can be finished on time. Bachelor thesis with title "Technical and Economical Overview of Homogenizer Instalation on PT. Pertamina Tanker Ship's Fuel System" are propossed to fulfill requirement of graduation from Marine Engineering Department, Faculty of Marine Technology, Institut Teknologi Sepuluh Nopember Surabaya.

Author hope that, this thesis can be usefull to add insight and knowledge about fuel cost saving, especially using homogenizer. Author realized that this bachelor thesis are still far from perfection. Because of that, author hope that the reader will give suggestion, critics, and opinion to the author in the future.

During the process of this bachelor thesis, author get a lot of support and assistance from various parties, so that on this occasion the author would like to thank :

1. My father and mother (Mr. Suprihono and Mrs. Ernawati) for attention, moral and material support that relentlessly always given. Also sisters (Prabawati Nur Safitri and Khoirul Annisa) which always give support.
2. Semin, S.T., M.T., Ph.D. and Dr. I Made Ariana, S.T., M.T. as the supervisors who was willing to give time to share knowledge and willing to guide author to finish this bachelor thesis. Thank you for the motivation that always given to the author.

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8. Mr. Rahadian Lingga and all NaSDEC patners for all assitance, knowledge, and insight that have been given to author to finish this bachelor thesis.
9. CV. Alpha Omega for discussion, information ,and data, especially about homogenizer, that very help author to finish this bachelor thesis.

10. Mr. Ryota Sugimoto, Technical Management Division, Daihatsu Diesel Mfg. Co., Ltd. Japan, for information and data that have been given to author to finish this bachelor thesis.
11. All parties that can not be mentioned one by one, thanks for the assitance that have been given to author over the time.

Hopefully this bachelor thesis can be useful and easy to understand for anyone who read it. Authors also want to apologize if there are some errors and mistake, and authors are looking foward for criticism and constructive suggestions for improvement in the future.

Surabaya, Juli 2016

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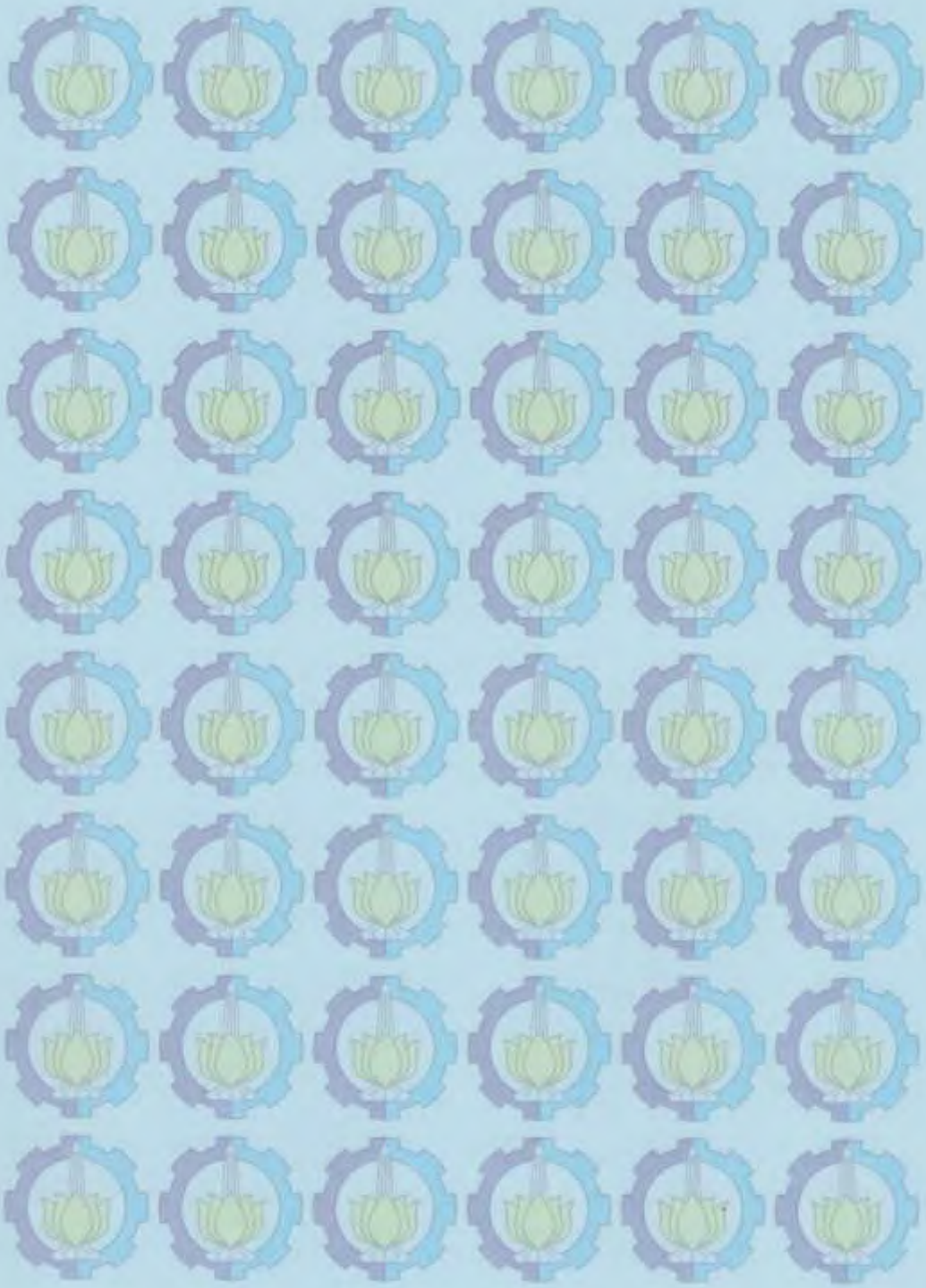

CHAPTER I
INTRODUCTION

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INTRODUCTION

1.1 Background

As we now in recent time, HFO become one of choice of fuel for the engine on board, because it has a relatively cheaper price compared to HSD (diesel) and MDO. However, unlike the HSD which is can be used directly, HFO must have a system of preparation before it flowed into the ship's engine. HFO system generally includes storage tanks, transfer pumps, settling tanks, separators, service tank, booster pump. The system has been provided by the onboard system .

Because the more advanced refining process, HFO has changes in terms of quality and quantity. HFO currently has a higher concentration of asphalt content and also experiencing a change in the fuel properties, such as viscosity and density.

Homogenization process becomes important for fuel especially HFO. By performing the homogenization of fuel, fuel waste can be reduced, the quality of combustion can be better, and also able to provide a positive influence for the reduction of emissions and a reduction in NOx levels.

Homogenization process is done with a tool called a homogenizer. The expected result is not only to reduce waste and emissions of ships, but also to save fuel consumption on ships.

1.2 Statement Of Problems

Based on the above description some statement of problems are formulated, which is :

a) What are the technical matters required for the installation of fuel homogenizer system on a tanker ship PT**.** Pertamina **?**

b) How long for the ship company to gain payback time for using a homogenizer in PT. Pertamina tanker ship fuel System?

1.3 Research Limitation

Research limitation on this bachelor thesis are :

a) Research using technical analysis to gahter information and data from PT. Pertamina as ship owner, PT. PAL Indonesia as ship builder, NaSDEC as consultant and CV. Alpha Omega as homogenizer distributor

b) Homogenizer cost comparison does not include the cost of maintenance during the operational.

1.4 Research Objectives

The research objective of this bachelor thesis are below :

a) To know the important equpiments that are technically required for the installation of fuel homogenizer system in PT. Pertamina's tanker,

b) To know the economic value which will be obtained by PT. Pertamina if the fuel system on the tanker is equipped with a homogenizer.

1.5 Research Benefits

From the research that will be conducted, it is expected to provide benefits to various parties. The benefits include:

a) To provide knowledge about the addition homogenizer components that could potentially save fuel on ships in Indonesia,

b) Provide knowledge of technical matters required in the installation of fuel homogenizer system PT. Pertamina's tanker,
c) Can provide recommendations for the PT. Pertamina and other shipping companies about the advantages of using a homogenizer from the economic review,
d) Can determine the cost reduction in fuel consumption after using a homogenizer vessels in the short, medium and long term.

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CHAPTER II
STUDY LITERATURE

CHAPTER II
STUDY LITERATURE

2.1. Theory

The process of homogenization can be explained by the picture below. Rotor and stator of homogenizer will smooth the HFO which flowed through. Content of the asphalt on the HFO is micronized to approximately 5 μm and homogeneously mixed. Asphalt content when is not homogenized may result on amount of waste formation (slude) and and may lead to incomplete combustion.

Proses homogenisasi dengan *homogenizer* rotor dan stator

Figure 0.1 Homogenization process

2.1.1 The decreasing of fuel quality in the oil market

Fifty years ago, the use of fuel residues such as HFO different from now. First HFO still have a better quality (still high hydrogen content) and the concentrations of tar and other impurity content is low. This is because the first distillation process is simple, so fuel residue generated approximately 50 percent of the crude oil that entered the distillery. But with the development of refining technologies that become more advanced, now fuel residues generated only about 16 percent of the crude oil that is included in the distillery. The residual fuel has a low

hydrogen content and high asphalt content. Thus, the use of fuel residues on the current becomes more complicated and must pass a process of preparation before can be used.

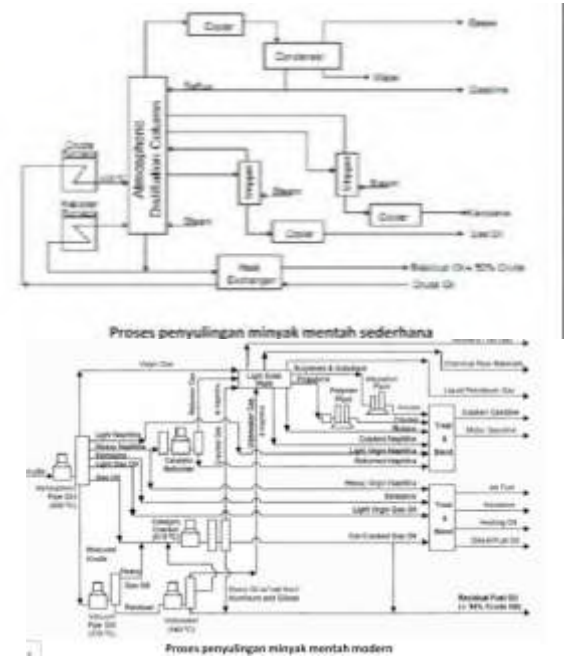


Figure 0.2 Oil destilation process

This Modern Distillation Process influence fuel quality The effect include:

a) The content of hydrogen on fuel is lower
b) Increasing concentrations of sulfur, vanadium, sodium and other metals contained naturally in crude oil
c) Increased density which is make more complicate for the process of separation of water content and impurities

d) Increased content of asphalt
e) Increased fuel waste due to the higher content of asphalt

2.1.2 The effect of fuel droplet size in the combustion process

The quality of fuel combustion and the formation of deposits, is closely related to the size of the fuel droplets which are sprayed into the combustion chamber. Ideally, the small droplet size will produce more complete combustion, because more surface area of fuel droplets. With a more complete combustion of the deposit produced less and less.

Homogenizer functioned so that fuel can be blended up to 5 µm. Usually in HFO, the droplet size of aspalt can reach 120 µm, this big size can cause some inefficiency.

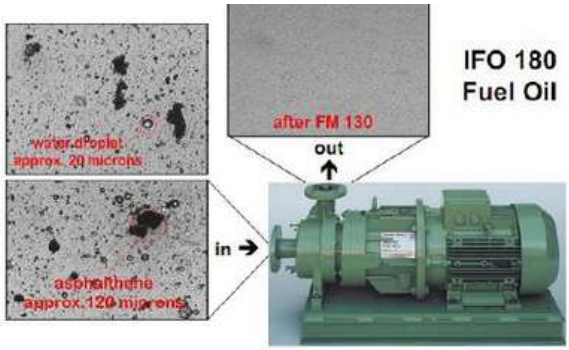


Foto mikroskopik hasil dari *homogenizer*

Figure 0.3 Microscopic photo of homogenization result

2.2. Homogenizer

2.2.1 Parts and Working Principle of Homogenizer

Homogenizer work based on the working principles of mechanical shear force and style of ultrasonic waves (ultrasonic force). Inside there is a kind of serration conical homogenizer conical generate hydrodynamic force, consisting of shear, friction, and acceleration of style with high frequency. High content of asphalt molecules, the existence of cat-fines (catalyst, usually aluminum and silicon compounds, used in the fuel production processes), water content, etc. in-the homogenized into fuel (in this case HFO) up to a maximum particle size of 5 μm

In brief, homogenizer is composed of two main components:

1. Stator

Stator part have serration inward arranged in a circle. Part stator is the stationary part

2. Motor

The motor part is the part that has serrations arranged in a circular directional exit deal with serrations stator. This section is attached to the motor rotor that is always moving (rotating)

The motor and the stator is designed in such a way so as to accelerate the flow of fuel fluid so passing through a homogenizer.

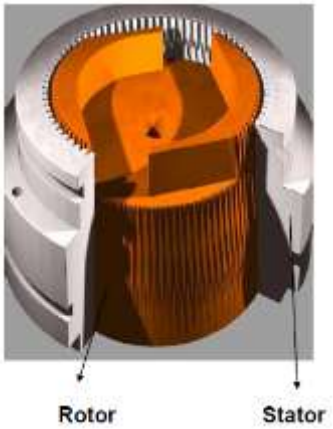


Figure 0.4 Part of homogenizer

While the stator is not moving, constantly rotating part of the motor with 1750 rpm, making mechanical contact between the particles with a homogenizer asphalt, asphalt or with other particles. Homogenizer in asphalt particles get hydrodynamic power, the force of friction and shear, particle acceleration due to the power transmitted on particles, and high-frequency ultrasonic waves.

When the asphalt particles have passed through the homogenizer, the resulting particles become finer (3-5 microns). This causes the particle size of the particles of asphalt can be mixed perfectly with the fluid fuel. Mixing these particles have an effect on the reduction of oil sludge formed.

2.2.2 Homogenizer Instalation Benefit

The use of homogenizer bring the operational usefulness of the ship. Some positive gains obtained are as follows:

1. More effective fuel use

Without the use of homogenizer lot of wasted asphalt particles. These particles are wasted due to the relatively large size (120 microns or more) so it can not pass through the filter and purifier. Asphalt particles (C57H26) basically could potentially be a fuel if the size is smaller. Here homogenizer role. With the use of homogenizer particles wasted asphalt can be minimized so that the use of fuel becomes more effective

2. Reduces the formation of fuel oil sludge (up 80%)

Sludge formed by the particles are relatively large. With the homogenizer, the particles will be reduced in size (5 microns or smaller) that can be mixed with fuel without fear can form sludge. With the reduction in sludge that is formed, it also reduced the cost allocated to the treatment, storage, and disposal of sludge itself.

3. Improving the quality of combustion

The existence of a relatively large asphalt particles which can escape at any time of the filter and purifier, can cause combustion in the combustion chamber becomes less than perfect. Relatively large particle size does not allow for atomized by the injector. Carburetion failure can cause the asphalt particles do not burn completely. This can cause problems such as power generated is less, the formation of depressions in the piston crown and others.

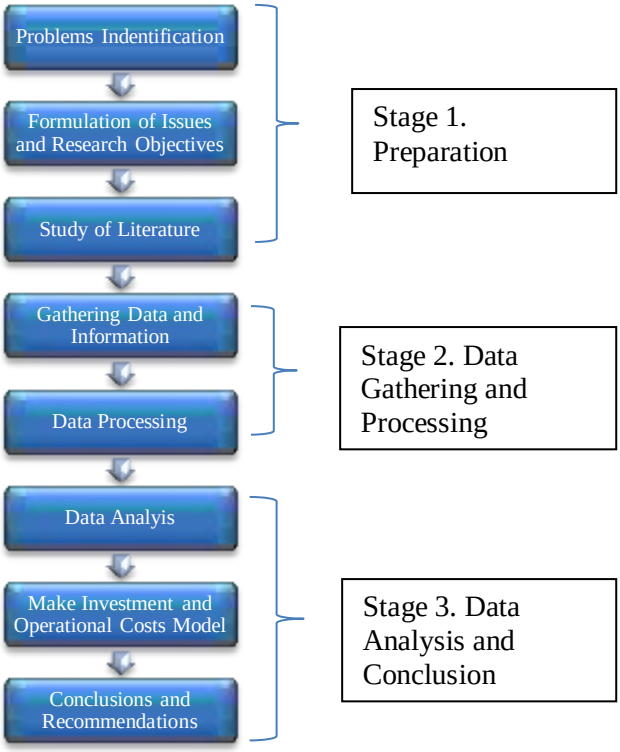
4. Reduce air emissions (NOx) and reduce engine maintenance costs

With the formation of the fuel particles is more homogeneous, the combustion occurs in the combustion chamber can be more perfect. Incomplete combustion can damage the piston and also produce air emissions. In addition to the increasingly size of the fuel particles, the systems which the fuel pass through would be more durable. This certainly can reduce maintenance costs to be incurred.

CHAPTER III
METHODOLOGY

CHAPTER III
METHODOLOGY

This bachelor thesis will be conducted by make technical and economical overview of homogenizer instalation on PT. Pertamina tanker ship's fuel system. The method of the study will provide easier way to analys the problem which will be solved. Schematicly, research methodology are shown below :



Research methodology which will be conducted are devided become three major group, which is preparation stage, data gathering and processing, and data analysis and conclusion.

3.1. Preparation Stage

3.1.1 Problem identification

Problem identification is preliminary step in this research. The problem which will be analized have to be clearly identified. The problem which will be the topic of the research is technical and economical overview of homogenizer instalation on PT. Pertamina tanker ship's fuel system.

3.1.2 Formulation of issues and research objectives

After problem identification, the next step are formulation of Issue and research objective. Formulation of issues is the main problem which will be solved. Reseach objective is to know the important things that are technically required for the installation of fuel homogenizer system in PT. Pertamina's tanker and to know the economic value which will be obtained by PT. Pertamina if the fuel system on the tanker is equipped with a homogenizer.

3.1.3 Study of literature

Study of literature will be conducted to gain theories which is related to the problem solving process. Study of literature study working principle of homogenizer, homogenizer performance, homogenizer parts, homogenezation result process, and benefit of homogenization process.

3.2. Data Gathering and Processing Stage

3.2.1 Gathering data and information

Required data which will be used in research will be obmitted from literature study from PT. Pertamina, PT. PAL Indonesia, and Homogenizer maker. Additional resources will be collected from books, literature, brochure, or paper which will be gathered from internet.

3.2.2 Data processing

Data and information which have already be gathered then will be processed with overview method, which is technical and economical overview.

3.3. Data Analysis and Conclusion

3.3.1 Data analysis

From the previous data processing, then data will be analized more deeper.

3.3.2 Make investment and operational costs model

After data analysis, all data then will be presented in model. This model consist of Investment model and Operational Cost model. Data modelling will make review and conclusion activity become more easier and simple to understand.

3.3.3 Conclusion and recomendations

After data modelling, the conclution can be made, which is also final summary from research result which can answer problems from the research.

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CHAPTER IV
OBSERVATION RESULT AND DATA ANALYSYS

CHAPTER IV
OBSERVATION RESULT
AND DATA ANALISYS

4.1. Observation Data Result

4.1.1. Ship object

Figure 0.1 MT. Pangkalan Brandan

Name	:	MT. Pangkalan Brandan
IMO Number	:	9601675
Builder	:	PT PAL Indonesia (Persero)
Owner	:	PT. Pertamina
Technical management	:	Fleet III
Delivery	:	12 Nov 2014
Cargo	:	Product Oil/White Oil

4.1.2. Ship main data

Length Overall	:	157,20 m
Breadth Mould	:	27,70 m
Depth Mould	:	12,00 m
Deadweight	:	17.500,00 ton
Cargo Hold Capacity	:	24.725,00 m^3
Class	:	NK Class

4.1.3. Main engine

Type 6S35MC-7	:	MAN B & W
Manufacturer	:	STX
Fuel (viscosity 700 cst)	:	Heavy Fuel Oil
Out-put RPM (MCR)	:	4.504 kW at 173

4.1.4. Ship generator

Type	:	6DK20e
Manufacturer	:	Daihatsu
Quantity	:	3 unit
Engine Output	:	1040 kW
Generator Output	:	990 kW
Fuel Oil	:	MDO

4.1.5. Ship Speed

Service speed	:	13, 6 knots
Maximum Speed	:	127.0 RPM
Over Speed	:	131.1 RPM
Fuel Consumption (Design Prediction)	:	30.0 ton/day

4.1.6. Homogenizer Data

Figure 4.2 Homogenizer

Brand	:	S.I.T
Type	:	CD92TM
Mycronizer MD 85-M-MD/SR-IL		
Apllication	:	Sludge Reduction
– In Line		
Serial No	:	12-1605
Year	:	2012
Customer	:	PT. PAL
Indonesia (Persero)		
Plant	:	HN 272
Operating Media	:	HFO & MDO
Operation Temperaturre	:	100oC
Min. Temperature	:	70oC fot HFO,
40oC for MDO		
Max. Temperatue	:	150oC
Capacity Max.	:	1,5 m3/h (IFO
700/50oC)		
Operation Pressure	:	6 kg/cm2

Power Consumption	:	4,0/4,5 kW
Power Source	:	400/440 V – 50/60 Hz
Plant Dimension		:
Lenght	:	900 mm
Height	:	540 mm
Width	:	620 mm

4.1.7. Instalation Diagram

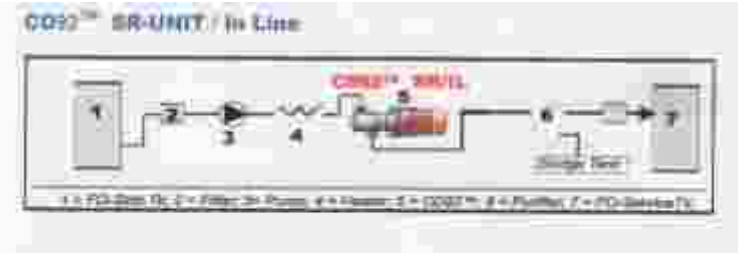


Figure 4.3 Instalation diagram – SIT Opration Manual

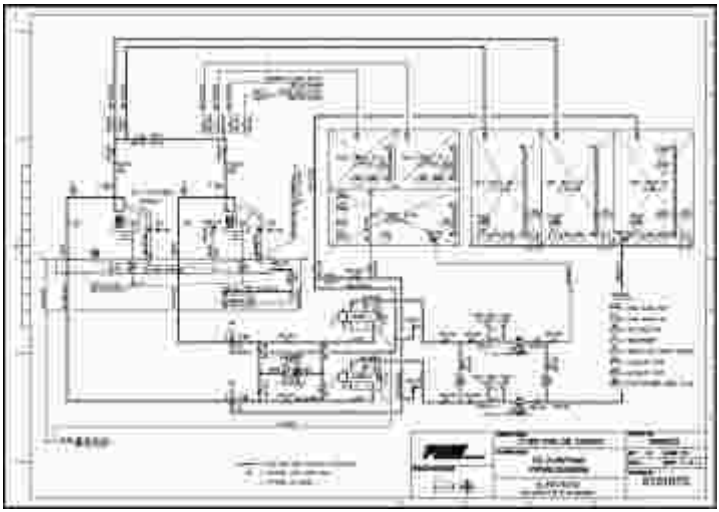


Figure 4.4 Homogenizer in MT. Pangkalan Brandan fuel system drawing

4.1.8. Sister Ship Data

Figure 4.5 MT. Palusipat

Name	:	MT. Palu Sipat
IMO Number	:	9106651
Length Overall	:	160,00 m

LBP	:	154,00 m
Breadth	:	26,80 m
Depth	:	11,50 m
Draught	:	6.9m
Speed Service	:	13,00 knots
Main Engine	:	S35MC7 / 4959 kW
Complement	:	37 person
Gross Tonnage	:	13964
Deadweight	:	17.500 ton
Year Delivery	:	2000
Home port	:	Jakarta
Class society	:	BKI - LR

4.2. Technical Overview

Based on data observation, below are the equipment which are necessary to install within homogenizer in MT. Pangkalan Brandan fuel systems :

a. Electric Motor

Brand	:	Hansa
Power	:	4,0/4,5 kW
Voltage	:	400/440
Frequency	:	50/60 Hz
RPM	:	2950/3490

b. Pressure Transmitter

Quantity	:	2
Type	:	Electronic type/
Fuel In – Out		
Range Pressure	:	0 – 25,0 kg/cm^2

c. Thermometre(s)

Quantity	:	2
Type	:	Electronic type/
Fuel In – Out		

	Range Temp.	:	0 – 150^{o}C
d.	Inlet Flange		
	DN/PN	:	32/ 16
e.	Outlet Flange		
	DN/PN	:	32/ 16
f.	Switchboard		
	Operating Voltage PE/ 50/60 Hz	:	3 x 400/ 440 V/
	Current Consuption:		Max. 21.5 A
	Max. Fuse	:	40 A
	Control Voltage	:	230 V/ 50 Hz
	Regulation IP 55	:	VDE and VBG4/
	Dimension mm	:	600 x 380 x 210
	Final Paintig	:	RAL 7035
g.	Coating		
	Type	:	Primer
h.	Final Painting		
	Marine Paint RAL 6019	:	Marine Paint,
i.	Drip Pan		
	Type	:	SR-Steel St 37, Square pipings 50 x 50 x 2,6 mm

4.3. Engine Room Log Book

Engine room log book is a track record of all ship machinery parameters, performance, maintenance, and malfunctions. The recorded values and information are used as a reference, to compare and record data that can be used for a lot of purpose.

In PT. Pertamina, engine room log book have to be delivered every month by ship crews to head office management. In this research, engine room log book is

used to examine the effect of homogenizer instalation to fuel oil consumption cost in real operational conditon. Two engine room log book from two ship with similiar dimension and same type of engine will be compared. Complete engine room log book are attached in appendix.

4.3.1. Engine log MT. Palusipat

Built by PT. PAL Indonesia in late 1997, MT. Palusipat is equipped with MAN B&W 7S35MC 4959kW main engine. MT. Palusipat duty is to deliver product oil from refinery to distribution terminals from Port Tanjung Wangi to Port Cilacap, Port Padang, Port Tanjung Priok, back to Port Cilacap again and finally headed to Port Makasar. This trip take time about 1 month in average.

It's have been known that MT. Palusipat is not equipped with homogenizer in fuel system instalation. For that reason, fuel oil consumption cost of MT. Palusipat will become a sample for ship fuel oil consumption cost whithout homogenizer.

Below are presented engine log MT. Palusipat in sailing periode at month of February 2016 :

Table 4.1 Engine log MT. Palusipat

PALUSIPAT					
Date	**Under Way**	**Propelling**	**RPM**	**Speed**	**FO - IFO 380**
1		2,2			
2		0,8			0,05
3	23,8	0,2	139	8,5	12,375
4	16,1	1,1	140	10,5	9,056
5-7					
6					
7					
8		2,2			
9	2	1,9	109	9,5	0,687
10	24		141	8,5	13,5
11	24		138	9,25	12,525
12	24		134	10,75	13,225
13	7,8	3,2	135		4,3
14	14,9	2,2	142	11,5	6,7
15	24		141	12	13,475
16	11,8	2,6	138	11	6,187
17					
18					
19		1			1,125
20		2,3			
21					
22	11	1,3	114	10,2	6,709
23	16,6	1,8	138	11,5	9,64
24	4	3,6	141		2,145
25	17,4				0,648
26	2,8	2,1	114	10	12,021
27	24		137	11,2	11,579
28	23		137	11	6,322
29	14,7	2,1			
	267,5	30,6			144,543

From table above it's can be obtained that in a month trip, MT. Palusipat consume 144,543 MT of HFO 380. From 29 days sailing, 23 days are main engine working hours, which means in 6 days main engine are not active, that's why there is no IFO consumption in day 5, 6, 7, 17, 18, and 21. At this inactive days, ship is berthing in current port to loading or unloading product oil.

Engine working hours are consist of underway and propelling. Propelling is a stage of ship when the ship are going to the port, or going to leave the port, at this stage main engine still running at normal condition, that's why the rpm in engine log still indicate the same rpm with Underway condition. Meanwhile, underway it's stage when the ship are sailing in the high sea. In table above, total main engine working hours of MT. Palusipat are 298,1 hours.

At some days like date 1, 8, 20, and 29, the ship is still in propelling stage, but there is no IFO 380 fuel oil consumption record. This happens because main engine only consumme MDO for initial starting fuel before use IFO 380.

4.3.2. Engine log MT. Pangkalan Brandan

Built by PT. PAL Indonesia in 2011, MT. Pangkalan Brandan is equipped with MAN B&W 6S35MC 4504 kW main engine. MT. Pangkalan Brandan duty is to deliver product oil from refinery to distribution terminals from Port Merak to Port in Surabaya, Port in Banyuwangi, Tanjung Manggis, Port Kotabaru, and back to Port Merak. This trip take time about 1 month in average.

It's have been known that MT. Pangkalan Brandan is equipped with homogenizer in fuel system instalation. For that reason, fuel oil consumption cost of MT.

Pangkalan Brandanwill become a sample for ship fuel oil consumption cost whithout homogenizer. Below are presented engine log MT. Pangkalan Brandan in sailing periode at month of January 2016 :

Table 4.2 Engine log MT. Pangkalan Brandan

PANGKALAN BRANDAN					
Date	**Under Way**	**Propelling**	**RPM**	**Speed**	**FO - IFO 600**
1	5	0,9	158	13,1	3,765
2-4					
5		1,5			
6					
7	4,5	5,7	160	12,4	3,264
8	24		160	13,4	18,945
9	3,8	1,3	160	13,6	2,851
10					
11		3,2			
12		3			
13		3,4			
14		3,2			
15	11,8	1,1	160	13,3	9,284
16					
17		2			
18	3,7	2	159	13,5	2,217
19	3,8	3,5	160	13,5	3,393
20	24		159	12,8	18,617
21	1,5	1,8			1,107
22		1,6			
23	14	1,8	155	12,8	9,788
24	25		156	12,5	19,065
25	17,4	1	156	12,3	12,949
26-30					
31		6,3			
	138,5	43,3			105,245

From table above it's can be obtained that in a month trip, MT. Pangkalan Brandan consume 105,245 MT of HFO 600. From 31 days sailing, 20 days are main engine working hours, which means in 11 days main engine are not active, that's why there is no IFO consumption in day 1, 2, 3, 4, 6 10, 16, 26, 27, 28, 29, and 30. At this inactive days, ship is berthing in current port to loading or unloading product oil. In table above, it's also been known that total main engine working hours of MT. Pangkalan Brandan are 181,8 hours.

At some days like date 5, 11, 12, 13, 14, 17 and 22, the ship is still in propelling stage, but there is no IFO 380 fuel oil consumption record. This happens because main engine only consumme MDO for initial starting fuel before use IFO 600.

4.4. Fuel Oil Consumption Comparison

To compare fuel oil consumption from MT. Pangkalan Brandan and MT. Palusipat, it's required to find fuel oil consumption record when both ship are sailing at the same similiar speed. For this purpose, sample date are taken from date 25 in MT. Pangkalan Brandan engine log and date 15 in MT. Palusipat engine log.

Operational SFOC than can be calculated by devided total FOC in date 15 with engine power multiply by total main engine working hour in date 15. Annual, monthly, daily, and hourly FOC of main engine than can be calculated according information from main engine log.

Table 4.3 Fuel oil consumption MT. Pangkalan Brandan

Sample Date -	Formula	SFOC Pangkalan Brandan (IFO 600)	
25	FOC/h = Total FOC/Engine BHP/Total Hour	0,0001 5625	Ton/K wH
FOC MT. Pangkalan Brandan (MT)			
Hour FOC	SFOC Pangkalan Brandan x 4504 kW	0,7037 5	MT
Daily FOC	SFOC Pangkalan Brandan x 4504 kW x 11,5 Hour	8,0931 25	MT
Monthly FOC	SFOC Pangkalan Brandan x 4504 kW x 11,5 Hour x 12 Day	97,117 5	MT
Annualy FOC	SFOC Pangkalan Brandan x 4504 kW x 11,5 Hour x 12 Day x 12 Month	1165,4 1	MT

From table above, it shows that FOC fot MT. Pangkalan Brandan is 1165,41 MT. Same calculation also apllied to MT. Palusipat. But, since MT.Palusipat have one cylinder less than MT. Pangkalan Brandan main engine, instead multiply SFOC MT. Palusipat with engine power MT. Palusipat itself, it's have to multiplied to engine power of MT. Pangkalan Brandan.

Table 4.4 Engine power

Main Engine Power Pangkalan Brandan	4504 Kw
Main Engine Power Palu Sipat	4959 kW

By doing this conversion calculation, converted FOC of MT. Palusipat than can be used to assumption FOC for MT. Pangkalan Brandan whithout homogenizer instalation.

Table 4.5 Fuel oil consumption MT. Palusipat converted to MT. Pangkalan Brandan

Sample Date -	Formula	SFOC Palusipat (IFO 380)	
15	FOC/h = Total FOC/Engine BHP/Total Hour	0,000113 22	Ton/k wH
FOC MT. Palusipat Converted to FOC MT. Pangkalan Brandan (MT)			
Hour FOC	SFOC Palusipat x 4504 kW	0,509943 20	MT
Daily FOC	SFOC Palusipat x 4504 kW x 11,5 Hour	5,864346 81	MT
Monthly FOC	SFOC Palusipat x 4504 kW x 11,5 Hour x 12 Day	70,37216 173	MT
Annualy FOC	SFOC Palusipat x 4504 kW x 11,5 Hour x 12 Day x 12 Month	844,4659 4071	MT

4.5. Fuel Oil Price Prediction

Since fuel oil price have expierienced fluxtuation in past decade, it's necessary to make prediction scenario for oil price, whether the future price will be icrease or decrease. Fuel oil price prediction are predicted for the next 10 years oil price. Below are five scenario of fuel oil price prediction for the next 10 years :

a. Scenario 1
   Pessimistic 1 : -2,93% annualy (decrease)
b. Scenario 2
   Pessimistic 2 : -1,47% annualy (decrease)
c. Scenario 3
   Constant : 0% annualy (constant)
d. Scenario 4
   Optimistic 1 : 6,7% annualy (increase)
e. Scenario 5
   Optimistic 2 : 13,41% annualy (increase)

Table 4.6 Fuel oil price prediction

FUEL OIL PRICE PREDICTION (USD/MT)															
Year	Pessimistic 1			Pessimistic 2			Constant Price			Optimistic 1			Optimistic 2		
	MDO	IFO 380	IFO 600	MDO	IFO 380	IFO 600	MDO	IFO 380	IFO 600	MDO	IFO 380	IFO 600	MDO	IFO 380	IFO 600
0	345,00	232,00	160,00	345,00	232,00	160,00	345,00	232,00	160,00	345,00	232,00	160,00	345,00	232,00	160,00
1	334,89	225,20	155,31	339,94	228,60	157,66	345,00	232,00	160,00	368,12	247,55	170,72	391,25	263,10	181,45
2	325,07	218,60	150,76	334,96	225,25	155,34	345,00	232,00	160,00	392,80	264,14	182,17	443,70	298,37	205,77
3	315,54	212,19	146,34	330,05	221,95	153,07	345,00	232,00	160,00	419,13	281,85	194,38	503,17	338,37	233,36
4	306,30	205,97	142,05	325,22	218,70	150,82	345,00	232,00	160,00	447,22	300,74	207,41	570,62	383,72	264,64
5	297,32	199,94	137,89	320,45	215,49	148,61	345,00	232,00	160,00	477,19	320,89	221,31	647,12	435,16	300,11
6	288,60	194,08	133,85	315,75	212,33	146,44	345,00	232,00	160,00	509,18	342,40	236,14	733,87	493,50	340,34
7	280,14	188,39	129,92	311,13	209,22	144,29	345,00	232,00	160,00	543,31	365,35	251,97	832,24	559,65	385,97
8	271,93	182,87	126,11	306,57	206,15	142,18	345,00	232,00	160,00	579,72	389,84	268,86	943,80	634,67	437,71
9	263,96	177,51	122,42	302,07	203,13	140,09	345,00	232,00	160,00	618,58	415,97	286,88	1070,32	719,75	496,38
10	256,23	172,30	118,83	297,65	200,16	138,04	345,00	232,00	160,00	660,04	443,85	306,10	1213,80	816,24	562,92
Annual Price Decrease	8,9	6,0	4,1	4,7	3,2	2,2	0,0	0,0	0,0	-31,5	-21,2	-14,6	-86,9	-58,4	-40,3
%	2,93	2,93	2,93	1,47	1,47	1,47	0,00	0,00	0,00	-6,70	-6,70	-6,70	-13,41	-13,41	-13,41

4.6. Economical Analisys

4.6.1. Initial Ivestment

Total initial investment are gained from purchase order PT. PAL Indonesia to S.I.T. Homogenizer GmbH. Complete purchase order document can be found in attachment. This table below shows the summary of the purchase order.

Table 4.7 Initial investment

No	Item	Total Price
1	Homogenizer Part	28,000 USD
2	Electric Motor	
3	Pressure Transmitter	
4	Thermometre(s)	
5	Inlet Flange	
6	Outlet Flange	
7	Switchboard	
8	Coating	
9	Final Painting	
10	Drip Pan	

4.6.2. Operational Cost

Operational cost consist of electricity cost. As stated in homogenizer operational guide, the instalation of homogenizer will add 4.5 kW to ship electricity load. It's also known from 6DK20e Daihatsu Generator's shop trial records, that generator fuel consumption at full load is 214.4 g/kWh.

Below are the prediction of homogenizer fuel oil consumtion a year :

Table 4.8 Electricity fuel oil consumtion

No	Electricity Fuel Oil Consumption		
1	Homogenizer Load	4,5	kW
2	Generator FO consumption	214,4	g/kWh
3	MDO consumption per hour	964,80	g
4	MDO consumption per day	11,10	kg
5	MDO consumption per month	133,14	kg
6	MDO consumption per year	1,60	Ton

Below are the prediction of homogenizer electricity fuel oil cost up to 10 years with five different MDO price scenario :

Table 4.9 Electricity fuel oil cost

Electricity Fuel Oil Cost (USD/Year)					
Year	Pessimist 1	Pessimist 2	Constant Price	Optimist 1	Optimist 2
	MDO	MDO	MDO	MDO	MDO
0	$552,0	$552,0	$552,0	$552,0	$552,0
1	$535,8	$543,9	$552,0	$589,0	$626,0
2	$520,1	$535,9	$552,0	$628,5	$709,9
3	$504,9	$528,1	$552,0	$670,6	$805,1
4	$490,1	$520,3	$552,0	$715,5	$913,0
5	$475,7	$512,7	$552,0	$763,5	$1.035,4
6	$461,8	$505,2	$552,0	$814,7	$1.174,2
7	$448,2	$497,8	$552,0	$869,3	$1.331,6
8	$435,1	$490,5	$552,0	$927,6	$1.510,1
9	$422,3	$483,3	$552,0	$989,7	$1.712,5
10	$410,0	$476,2	$552,0	$1.056,1	$1.942,1

4.6.3. Fuel Oil Saving Cost Calculation

In order to calculate fuel oil saving cost, it's necessary to calulate fuel oil consumption cost MT. Pangkalan Brandan and MT. Palusipat. Fuel oil consumption cost MT. Pangkalan Brandan can be calculated by multiply IFO 600 price at respective year to MT. Pangkalan Brandan annual fuel oil consumption, meanwhile assumed fuel oil consumption cost for MT. Pangkalan Brandan whithout homogenizer can be calculated by multiply IFO 380 price at respective year to MT. Palusipat annual fuel oil consumption which already have been converted.

This table below shows the calcluation result for MT. Pangkalan Brandan fuel oil consumption cost and assummed MT. Pangkalan Brandan fuel oil consumption cost whithout homogenizer for 10 years with 5 different fuel oil price scenario.

Table 4.10 Fuel oil consumption cost MT. Pangkalan Brandan

FUEL OIL CONSUMPTION COST MT. PANGKALAN BRANDAN (USD/YEAR)					
Year	Pessimistic 1	Pessimistic 2	Constant Price	Optimistic 1	Optimistic 2
	IFO 380	IFO 380	IFO 380	IFO 380	IFO 380
0	186465,60	186465,60	186465,60	186465,60	186465,60
1	181000,24	183732,91	186465,60	198963,62	211461,63
2	175695,07	181040,27	186465,60	212299,34	239808,42
3	170545,39	178387,09	186465,60	226528,90	271955,15
4	165546,65	175772,79	186465,60	241712,20	308411,20
5	160694,43	173196,80	186465,60	257913,18	349754,24
6	155984,43	170658,57	186465,60	275200,04	396639,39
7	151412,48	168157,53	186465,60	293645,57	449809,58
8	146974,53	165693,15	186465,60	313327,43	510107,32
9	142666,67	163264,88	186465,60	334328,48	578488,07
10	138485,06	160872,20	186465,60	356737,15	656035,38

Table 4.11 Fuel oil consumption cost MT. Palusipat converted to MT. Pangkalan Brandan

FO CONSUMPTION COST MT.PALUSIPAT CONVERTED TO MT. PANGKALAN BRANDAN (USD/MT)					
Year	Pessimistic 1	Pessimistic 2	Constant Price	Optimistic 1	Optimistic 2
	IFO 380	IFO 380	IFO 380	IFO 380	IFO 380
0	195916,10	195916,10	195916,10	195916,10	195916,10
1	190173,74	193044,91	195916,10	209047,55	222178,98
2	184599,69	190215,80	195916,10	223059,15	251962,45
3	179189,02	187428,15	195916,10	238009,89	285738,45
4	173936,93	184681,35	195916,10	253962,72	324042,18
5	168838,79	181974,81	195916,10	270984,80	367480,58
6	163890,07	179307,93	195916,10	289147,80	416741,98
7	159086,41	176680,14	195916,10	308528,19	472606,95
8	154423,54	174090,85	195916,10	329207,57	535960,71
9	149897,34	171539,52	195916,10	351273,00	607807,16
10	145503,80	169025,57	195916,10	374817,39	689284,74

Fuel oil saving cost then can be calculate by subtract fuel oil consumption cost of IFO 380 fuel to fuel oil consumption cost of IFO 600. Fuel oil saving cost then used to calculate payback period.

4.7. Pay Back Period

Payback period is the length of time required to recover the cost of an investment. The payback period of a given investment or project is an important determinant of whether to undertake the position or project, as longer payback periods are typically not desirable for investment positions.

Before calculate pay back periode, first it's necessary to calculate cost saving benefit from homogenizer usage. Cost saving benefit is gained from fuel consumption cost of system that haven't install homogenizer, minus fuel consumption cost of system that already install homogenizer.

Net revenue than can be calculated by folowing formula :

$$\textit{Net Revenue} = \textit{Cost Saving Benefit} - (\textit{Initial Investment} + \textit{Operational Cost} + \textit{Depresiation}) \quad (4\text{-}1)$$

Payback period than can be traced by obseving in which year the accumulative net revenue has reach equilibrium with initial investment, operational cost, and depresiation. Below are calculation result table and graph of payback period for homogenizer instalation in MT. Pangkalan Brandan fuel systems in five different scenario :

Table 4.12 Payback period scenario pessimistic 1

Year	Payback Period Pessimistic 1							
	Initial Investment	Cost Saving Benefit	Cost Saving Benefit Accumulative	Operational Cost	Operational Cost Accumulative	Depresiation	Summary	%
0	$28.000,0	$0,0	$0,0	$0,0	$0,0	$0,0	-$28.000,0	-100,00%
1	$0,0	$9.450,5	$9.450,5	$535,8	$535,8	$2.800,0	-$21.885,3	-78,16%
2	$0,0	$9.173,5	$18.624,0	$520,1	$1.055,9	$2.800,0	-$13.231,9	-47,26%
3	$0,0	$8.904,6	$27.528,6	$504,9	$1.560,8	$2.800,0	-$4.832,2	-17,26%
4	$0,0	$8.643,6	$36.172,2	$490,1	$2.050,9	$2.800,0	$3.321,4	11,86%
5	$0,0	$8.390,3	$44.562,5	$475,7	$2.526,6	$2.800,0	$11.235,9	40,13%
6	$0,0	$8.144,4	$52.706,9	$461,8	$2.988,4	$2.800,0	$18.918,5	67,57%
7	$0,0	$7.905,6	$60.612,5	$448,2	$3.436,6	$2.800,0	$26.375,9	94,20%
8	$0,0	$7.673,9	$68.286,5	$435,1	$3.871,7	$2.800,0	$33.614,8	120,05%
9	$0,0	$7.449,0	$75.735,5	$422,3	$4.294,0	$2.800,0	$40.641,4	145,15%
10	$0,0	$7.230,7	$82.966,1	$410,0	$4.704,0	$2.800,0	$47.462,1	169,51%

Table 4.13 Payback period scenario pessimistic 2

Year	Payback Period Pessimistic 2							
	Initial Investment	Cost Saving Benefit	Cost Saving Benefit Accumulative	Operational Cost	Operational Cost Accumulative	Depresiation	Summary	%
0	$28.000,0	$0,0	$0,0	$0,0	$0,0	$0,0	-$28.000,0	-100,00%
1	$0,0	$9.450,5	$9.450,5	$543,9	$543,9	$2.800,0	-$21.893,4	-78,19%
2	$0,0	$9.312,0	$18.762,5	$535,9	$1.079,8	$2.800,0	-$13.117,4	-46,85%
3	$0,0	$9.175,5	$27.938,0	$528,1	$1.607,9	$2.800,0	-$4.469,9	-15,96%
4	$0,0	$9.041,1	$36.979,1	$520,3	$2.128,3	$2.800,0	$4.050,8	14,47%
5	$0,0	$8.908,6	$45.887,7	$512,7	$2.641,0	$2.800,0	$12.446,7	44,45%
6	$0,0	$8.778,0	$54.665,7	$505,2	$3.146,2	$2.800,0	$20.719,5	74,00%
7	$0,0	$8.649,4	$63.315,0	$497,8	$3.644,0	$2.800,0	$28.871,0	103,11%
8	$0,0	$8.522,6	$71.837,6	$490,5	$4.134,5	$2.800,0	$36.903,1	131,80%
9	$0,0	$8.397,7	$80.235,3	$483,3	$4.617,8	$2.800,0	$44.817,5	160,06%
10	$0,0	$8.274,6	$88.510,0	$476,2	$5.094,1	$2.800,0	$52.615,9	187,91%

Table 4.14 Payback period scenario constant price

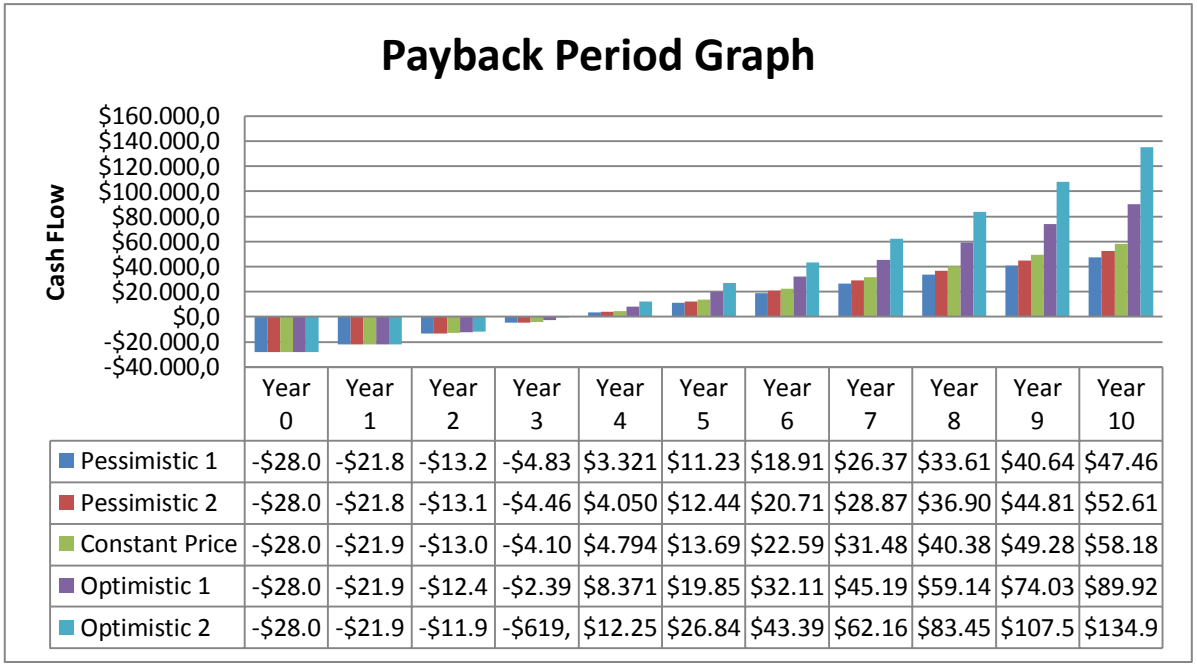
Year	Payback Period Constant Price							
	Initial Investment	Cost Saving Benefit	Cost Saving Benefit Accumulative	Operational Cost	Operational Cost Accumulative	Depresiation	Summary	%
0	$28.000,0	$0,0	$0,0	$0,0	$0,0	$0,0	-$28.000,0	-100,00%
1	$0,0	$9.450,5	$9.450,5	$552,0	$552,0	$2.800,0	-$21.901,5	-78,22%
2	$0,0	$9.450,5	$18.901,0	$552,0	$1.104,0	$2.800,0	-$13.003,0	-46,44%
3	$0,0	$9.450,5	$28.351,5	$552,0	$1.656,0	$2.800,0	-$4.104,5	-14,66%
4	$0,0	$9.450,5	$37.802,0	$552,0	$2.208,0	$2.800,0	$4.794,0	17,12%
5	$0,0	$9.450,5	$47.252,5	$552,0	$2.760,0	$2.800,0	$13.692,5	48,90%
6	$0,0	$9.450,5	$56.703,0	$552,0	$3.312,0	$2.800,0	$22.591,0	80,68%
7	$0,0	$9.450,5	$66.153,5	$552,0	$3.864,0	$2.800,0	$31.489,5	112,46%
8	$0,0	$9.450,5	$75.604,0	$552,0	$4.416,0	$2.800,0	$40.388,0	144,24%
9	$0,0	$9.450,5	$85.054,5	$552,0	$4.968,0	$2.800,0	$49.286,5	176,02%
10	$0,0	$9.450,5	$94.505,0	$552,0	$5.520,0	$2.800,0	$58.185,0	207,80%

Table 4.15 Payback period scenario optimistic 1

Year	Payback Period Optimistic 1							
	Initial Investment	Cost Saving Benefit	Cost Saving Benefit Accumulative	Operational Cost	Operational Cost Accumulative	Depresiation	Summary	%
0	$28.000,0	$0,0	$0,0	$0,0	$0,0	$0,0	-$28.000,0	-100,00%
1	$0,0	$9.450,5	$9.450,5	$589,0	$589,0	$2.800,0	-$21.938,5	-78,35%
2	$0,0	$10.083,9	$19.534,4	$628,5	$1.217,5	$2.800,0	-$12.483,1	-44,58%
3	$0,0	$10.759,8	$30.294,2	$670,6	$1.888,1	$2.800,0	-$2.393,8	-8,55%
4	$0,0	$11.481,0	$41.775,2	$715,5	$2.603,6	$2.800,0	$8.371,6	29,90%
5	$0,0	$12.250,5	$54.025,8	$763,5	$3.367,1	$2.800,0	$19.858,6	70,92%
6	$0,0	$13.071,6	$67.097,4	$814,7	$4.181,8	$2.800,0	$32.115,6	114,70%
7	$0,0	$13.947,8	$81.045,1	$869,3	$5.051,1	$2.800,0	$45.194,0	161,41%
8	$0,0	$14.882,6	$95.927,8	$927,6	$5.978,7	$2.800,0	$59.149,1	211,25%
9	$0,0	$15.880,1	$111.807,9	$989,7	$6.968,4	$2.800,0	$74.039,5	264,43%
10	$0,0	$16.944,5	$128.752,4	$1.056,1	$8.024,4	$2.800,0	$89.928,0	321,17%

Table 4.16 Payback period scenario optimistic 2

Year	Payback Period Optimistic 2							
	Initial Investment	Cost Saving Benefit	Cost Saving Benefit Accumulative	Operational Cost	Operational Cost Accumulative	Depresiation	Summary	%
0	$28.000,0	$0,0	$0,0	$0,0	$0,0	$0,0	-$28.000,0	-100,00%
1	$0,0	$9.450,5	$9.450,5	$626,0	$626,0	$2.800,0	-$21.975,5	-78,48%
2	$0,0	$10.717,4	$20.167,9	$709,9	$1.335,9	$2.800,0	-$11.968,1	-42,74%
3	$0,0	$12.154,0	$32.321,9	$805,1	$2.141,0	$2.800,0	-$619,1	-2,21%
4	$0,0	$13.783,3	$46.105,2	$913,0	$3.054,0	$2.800,0	$12.251,2	43,75%
5	$0,0	$15.631,0	$61.736,2	$1.035,4	$4.089,4	$2.800,0	$26.846,8	95,88%
6	$0,0	$17.726,3	$79.462,5	$1.174,2	$5.263,6	$2.800,0	$43.398,9	155,00%
7	$0,0	$20.102,6	$99.565,1	$1.331,6	$6.595,1	$2.800,0	$62.169,9	222,04%
8	$0,0	$22.797,4	$122.362,4	$1.510,1	$8.105,2	$2.800,0	$83.457,2	298,06%
9	$0,0	$25.853,4	$148.215,8	$1.712,5	$9.817,7	$2.800,0	$107.598,1	384,28%
10	$0,0	$29.319,1	$177.534,9	$1.942,1	$11.759,8	$2.800,0	$134.975,1	482,05%



	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Pessimistic 1	-$28.0	-$21.8	-$13.2	-$4.83	$3.321	$11.23	$18.91	$26.37	$33.61	$40.64	$47.46
Pessimistic 2	-$28.0	-$21.8	-$13.1	-$4.46	$4.050	$12.44	$20.71	$28.87	$36.90	$44.81	$52.61
Constant Price	-$28.0	-$21.9	-$13.0	-$4.10	$4.794	$13.69	$22.59	$31.48	$40.38	$49.28	$58.18
Optimistic 1	-$28.0	-$21.9	-$12.4	-$2.39	$8.371	$19.85	$32.11	$45.19	$59.14	$74.03	$89.92
Optimistic 2	-$28.0	-$21.9	-$11.9	-$619,	$12.25	$26.84	$43.39	$62.16	$83.45	$107.5	$134.9

Figure 4.6 Payback period graph

From tables and graph above, it can be known that payback period occur in year 4 in all scenario. Furthermore, for 10 years life time of homogenizer operation, PT. Pertamina will gain fuel saving benefit value from installing homogenizer. Various fuel saving value which gained by MT. Pangkalan Brandan based five different scenarion are as follows :

a) Scenario Pessimistic 1 in 10 years operation : $47.462,1
b) Scenario Pessimistic 2 in 10 years operation : $52.615,9
c) Scenario Constant Price in 10 years operation : $58.185,0
d) Scenario Optimistic 1 in 10 years operation : $89.928,0
e) Scenario Optimistic 2 in 10 years operation : $134.975,1

4.8. IRR

Internal rate of return (IRR) is the interest rate at which the net present value of all the cash flows (both positive and negative) from a project or investment equal zero.

Internal rate of return is used to evaluate the attractiveness of a project or investment. If the IRR of a new project exceeds a company's required rate of return, that project is desirable. If IRR falls below the required rate of return, the project should be rejected.

The formula for IRR is:

$$0 = P0 + P1/(1+IRR) + P2/(1+IRR)2 + P3/(1+IRR)3 + \ldots + Pn/(1+IRR)n \quad (4\text{-}2)$$

Where P0, P1, . . . Pn equals the cash flows in periods 1, 2, . . . n, respectively; and IRR equals the project's internal rate of return.

Calculation of IRR can be done by interpolation. Assumption are taken in IRR calculation by determine the life operation of homogenizer are 10 years. By determine NPV is 0 in year 10, IRR value than can be obtained. The folowing formula can be use to find IRR value :

IRR = Lower Discount Rate + [NPV at Lower rate * (Higher Rate - Lower Rate) / (NPV at Lower Rate - NPV at Higher Rate)]

(4-3)

Below are calculation result table and graph of IRR for homogenizer instalation in MT. Pangkalan Brandan fuel systems for 10 years life time operation in five different scenario :

Table 4.17 Payback period scenario pessimistic 1

Pessimistic 1											
Year	Net Cashflow	Present Value Factor					Present Value				
		5%	10%	15%	20%	30%	5%	10%	15%	20%	30%
0	-$28.000	1,000	1,000	1,000	1,000	1,000	-$28.000	-$28.000	-$28.000	-$28.000	-$28.000
1	-$21.885	0,952	0,909	0,870	0,833	0,769	-$20.843	-$19.896	-$19.031	-$18.238	-$16.835
2	-$13.232	0,907	0,826	0,756	0,694	0,592	-$12.002	-$10.935	-$10.005	-$9.189	-$7.830
3	-$4.832	0,864	0,751	0,658	0,579	0,455	-$4.174	-$3.630	-$3.177	-$2.796	-$2.199
4	$3.321	0,823	0,683	0,572	0,482	0,350	$2.732	$2.269	$1.899	$1.602	$1.163
5	$11.236	0,784	0,621	0,497	0,402	0,269	$8.804	$6.977	$5.586	$4.515	$3.026
6	$18.919	0,746	0,564	0,432	0,335	0,207	$14.117	$10.679	$8.179	$6.336	$3.919
7	$26.376	0,711	0,513	0,376	0,279	0,159	$18.745	$13.535	$9.916	$7.361	$4.203
8	$33.615	0,677	0,467	0,327	0,233	0,123	$22.752	$15.682	$10.989	$7.818	$4.121
9	$40.641	0,645	0,424	0,284	0,194	0,094	$26.198	$17.236	$11.553	$7.877	$3.832
10	$47.462	0,614	0,386	0,247	0,162	0,073	$29.138	$18.299	$11.732	$7.665	$3.443
IRR	15%						$57.466	$22.214	-$360	-$15.049	-$31.156

Table 4.18 Payback period scenario pessimistic 2

Pessimistic 2											
Year	Net Cashflow	Present Value Factor					Present Value				
		5%	10%	15%	20%	30%	5%	10%	15%	20%	30%
0	-$28.000	1,000	1,000	1,000	1,000	1,000	-$28.000	-$28.000	-$28.000	-$28.000	-$28.000
1	-$21.893	0,952	0,909	0,870	0,833	0,769	-$20.851	-$19.903	-$19.038	-$18.245	-$16.841
2	-$13.117	0,907	0,826	0,756	0,694	0,592	-$11.898	-$10.841	-$9.919	-$9.109	-$7.762
3	-$4.470	0,864	0,751	0,658	0,579	0,455	-$3.861	-$3.358	-$2.939	-$2.587	-$2.035
4	$4.051	0,823	0,683	0,572	0,482	0,350	$3.333	$2.767	$2.316	$1.954	$1.418
5	$12.447	0,784	0,621	0,497	0,402	0,269	$9.752	$7.728	$6.188	$5.002	$3.352
6	$20.719	0,746	0,564	0,432	0,335	0,207	$15.461	$11.696	$8.958	$6.939	$4.293
7	$28.871	0,711	0,513	0,376	0,279	0,159	$20.518	$14.815	$10.854	$8.057	$4.601
8	$36.903	0,677	0,467	0,327	0,233	0,123	$24.977	$17.216	$12.064	$8.582	$4.524
9	$44.817	0,645	0,424	0,284	0,194	0,094	$28.890	$19.007	$12.740	$8.686	$4.226
10	$52.616	0,614	0,386	0,247	0,162	0,073	$32.302	$20.286	$13.006	$8.498	$3.817
IRR	17%						$70.623	$31.412	$6.230	-$10.223	-$28.406

Table 4.19 Payback period scenario constant price

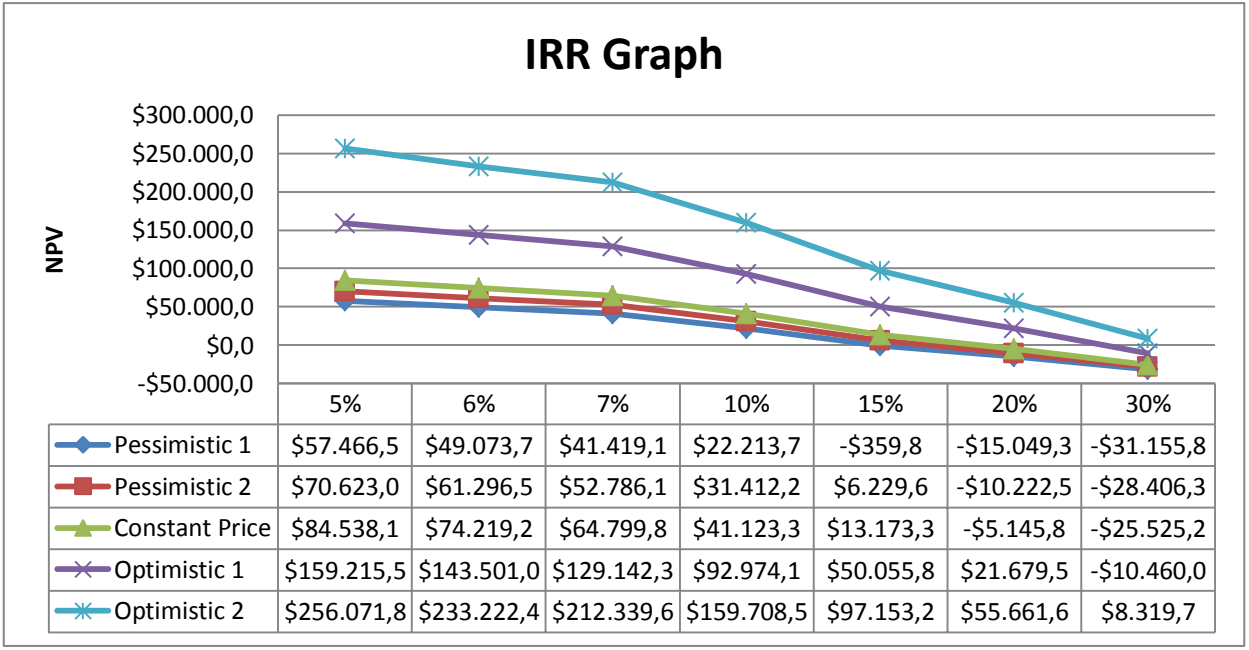
Constant Price											
Year	Net Cashflow	Present Value Factor					Present Value				
		5%	10%	15%	20%	30%	5%	10%	15%	20%	30%
0	-$28.000	1,000	1,000	1,000	1,000	1,000	-$28.000	-$28.000	-$28.000	-$28.000	-$28.000
1	-$21.902	0,952	0,909	0,870	0,833	0,769	-$20.859	-$19.910	-$19.045	-$18.251	-$16.847
2	-$13.003	0,907	0,826	0,756	0,694	0,592	-$11.794	-$10.746	-$9.832	-$9.030	-$7.694
3	-$4.105	0,864	0,751	0,658	0,579	0,455	-$3.546	-$3.084	-$2.699	-$2.375	-$1.868
4	$4.794	0,823	0,683	0,572	0,482	0,350	$3.944	$3.274	$2.741	$2.312	$1.679
5	$13.692	0,784	0,621	0,497	0,402	0,269	$10.728	$8.502	$6.808	$5.503	$3.688
6	$22.591	0,746	0,564	0,432	0,335	0,207	$16.858	$12.752	$9.767	$7.566	$4.680
7	$31.489	0,711	0,513	0,376	0,279	0,159	$22.379	$16.159	$11.838	$8.788	$5.018
8	$40.388	0,677	0,467	0,327	0,233	0,123	$27.336	$18.841	$13.203	$9.393	$4.951
9	$49.286	0,645	0,424	0,284	0,194	0,094	$31.771	$20.902	$14.010	$9.552	$4.648
10	$58.185	0,614	0,386	0,247	0,162	0,073	$35.721	$22.433	$14.382	$9.397	$4.221
IRR	18%						$84.538	$41.123	$13.173	-$5.146	-$25.525

Table 4.20 Payback period scenario optimistic 1

Optimistic 1											
Year	Net Cashflow	Present Value Factor					Present Value				
		5%	10%	15%	20%	30%	5%	10%	15%	20%	30%
0	-$28.000	1,000	1,000	1,000	1,000	1,000	-$28.000	-$28.000	-$28.000	-$28.000	-$28.000
1	-$21.939	0,952	0,909	0,870	0,833	0,769	-$20.894	-$19.944	-$19.077	-$18.282	-$16.876
2	-$12.483	0,907	0,826	0,756	0,694	0,592	-$11.322	-$10.317	-$9.439	-$8.669	-$7.386
3	-$2.394	0,864	0,751	0,658	0,579	0,455	-$2.068	-$1.799	-$1.574	-$1.385	-$1.090
4	$8.372	0,823	0,683	0,572	0,482	0,350	$6.887	$5.718	$4.786	$4.037	$2.931
5	$19.859	0,784	0,621	0,497	0,402	0,269	$15.560	$12.331	$9.873	$7.981	$5.349
6	$32.116	0,746	0,564	0,432	0,335	0,207	$23.965	$18.128	$13.884	$10.755	$6.654
7	$45.194	0,711	0,513	0,376	0,279	0,159	$32.119	$23.192	$16.990	$12.613	$7.202
8	$59.149	0,677	0,467	0,327	0,233	0,123	$40.034	$27.593	$19.336	$13.756	$7.251
9	$74.040	0,645	0,424	0,284	0,194	0,094	$47.727	$31.400	$21.047	$14.349	$6.982
10	$89.928	0,614	0,386	0,247	0,162	0,073	$55.208	$34.671	$22.229	$14.524	$6.523
IRR	26%						$159.216	$92.974	$50.056	$21.679	-$10.460

Table 4.21 Payback period scenario optimistic 2

Optimistic 2											
Year	Net Cashflow	Present Value Factor					Present Value				
		5%	10%	15%	20%	30%	5%	10%	15%	20%	30%
0	-$28.000	1,000	1,000	1,000	1,000	1,000	-$28.000	-$28.000	-$28.000	-$28.000	-$28.000
1	-$21.975	0,952	0,909	0,870	0,833	0,769	-$20.929	-$19.978	-$19.109	-$18.313	-$16.904
2	-$11.968	0,907	0,826	0,756	0,694	0,592	-$10.855	-$9.891	-$9.050	-$8.311	-$7.082
3	-$619	0,864	0,751	0,658	0,579	0,455	-$535	-$465	-$407	-$358	-$282
4	$12.251	0,823	0,683	0,572	0,482	0,350	$10.079	$8.368	$7.005	$5.908	$4.289
5	$26.847	0,784	0,621	0,497	0,402	0,269	$21.035	$16.670	$13.348	$10.789	$7.231
6	$43.399	0,746	0,564	0,432	0,335	0,207	$32.385	$24.498	$18.763	$14.534	$8.991
7	$62.170	0,711	0,513	0,376	0,279	0,159	$44.183	$31.903	$23.372	$17.350	$9.908
8	$83.457	0,677	0,467	0,327	0,233	0,123	$56.487	$38.933	$27.282	$19.409	$10.231
9	$107.598	0,645	0,424	0,284	0,194	0,094	$69.359	$45.632	$30.586	$20.853	$10.146
10	$134.975	0,614	0,386	0,247	0,162	0,073	$82.863	$52.039	$33.364	$21.799	$9.791
IRR	33%						$256.072	$159.708	$97.153	$55.662	$8.320



	5%	6%	7%	10%	15%	20%	30%
Pessimistic 1	$57.466,5	$49.073,7	$41.419,1	$22.213,7	-$359,8	-$15.049,3	-$31.155,8
Pessimistic 2	$70.623,0	$61.296,5	$52.786,1	$31.412,2	$6.229,6	-$10.222,5	-$28.406,3
Constant Price	$84.538,1	$74.219,2	$64.799,8	$41.123,3	$13.173,3	-$5.145,8	-$25.525,2
Optimistic 1	$159.215,5	$143.501,0	$129.142,3	$92.974,1	$50.055,8	$21.679,5	-$10.460,0
Optimistic 2	$256.071,8	$233.222,4	$212.339,6	$159.708,5	$97.153,2	$55.661,6	$8.319,7

Figure 4.7 IRR graph

Based on table and graph above, we can see that IRR result are :

a. Scenario Pessimistic 1 : IRR 15%
b. Scenario Pessimistic 2 : IRR 17%
c. Scenario Constant Price : IRR 18%
d. Scenario Optimistic 1 : IRR 26%
e. Scenario Optimistic 2 : IRR 33%

It can be seen that more high the oil price rise, more high the IRR value will result.

ATTACHMENT - 1
MT. PANGKALAN BRANDAN

BIRO KLASIFIKASI INDONESIA

SERTIFIKAT KLASIFIKASI MESIN

CERTIFICATE OF CLASSIFICATION FOR MACHINERY

No. 019609

No. Register : 20382
No. IMO : 9601675
Dual Class : KI - NK

PANGKALAN BRANDAN

Dengan ini diterangkan bahwa instalasi mesin KAPAL TANGKI MINYAK, BAJA
This is to certify that the undermentioned machineries of above named

tersebut di atas telah disurvey dalam rangka SURVEY PENERIMAAN KELAS
ship has been surveyed for

pada tanggal *on* 18.03.2015 di *at* SURABAYA oleh Surveyor *by Surveyors*

Biro Klasifikasi Indonesia, sesuai dengan ketentuan-ketentuan Peraturan Biro Klasifikasi Indonesia
to the Biro Klasifikasi Indonesia, in compliance with the requirements of the Rules of Biro Klasifikasi Indonesia

1. MESIN UTAMA (Jumlah, merek dan tipe)
   Main Engine (Number, license and type)
   1 (satu) buah Mesin Diesel STX ENGINE MAN, 6S35-MC7, 4 Tak Kerja Tunggal

   Tenaga efektif *Effective power* 6040 HP pada putaran *at* 173 Rpm *rpm*
   Dibangun di *Built at* KOREA oleh *by* STX ENGINE CO,.LTD Pada *in* 2012

   Nomor mesin *No.* SB6S3-11685

2. MESIN BANTU (Jumlah, merek, tipe dan daya)
   Auxiliary Engine (Number, license, type and power)
   3 (tiga) buah DAIHATSU, 6 DK - 20E, 3 x 965 HP

   Dibangun di *Built at* JAPAN oleh *by* DAIHATSU DIESEL MFG. CO., LTD. Pada *in* 2012

Instalasi mesin tersebut akan didaftar dalam Register dengan karakter kelas
The machineries will be entered in the Register with the character

✠ SM

dan dinyatakan berlaku sampai Survey Pembaruan Kelas pada tanggal
and will remain valid until Class Renewal Survey on

17 MARET 2020

dengan syarat bahwa survey yang ditentukan dalam Peraturan BKI untuk dapat mempertahankan kelas dipenuhi
provided that survey as required by the BKI Rules for maintenance of the class are fulfilled,

Poros baling-baling : Periode survey *Propeller shaft : Periodicity of survey* 5 (lima) Tahun
Survey terakhir *Last survey* 18 MARET 2015

Dikeluarkan di Jakarta, tanggal *Issued at Jakarta, on* 14 AGUSTUS 2015

BIRO KLASIFIKASI INDONESIA
Direktur Klasifikasi
Classification Director

IMAN SATRIA UTAMA

23252-466-37-84-485-12
F31.1.05-2013/Rev.0

054134

PERTAMINA

PT. PERTAMINA (PERSERO)
SHIPPING - MARKETING & TRADING DIRECTORATE
MT.PANGKALAN BRANDAN (Y H P H)

ENGINE LOG PERIODE : JANUARI 2016

DATE	AT PORT	ANCHORAGE	UNDER WAY	PROPELLING	RPM	SPEED	DISTANCE	PRESSURE (Mpa)					TEMPERATURE (°C)										TURBO CHARGER	FO & DO CONSUMPTION				L O CONSUMPTION								RUN. HOURS		
								FUEL RACK	FUEL OIL	HTCW JACKET COOLING	LUBRICATING OIL	SCAV ENG. AIR	SEA WATER	FRESH WATER LTCW	ENGINE ROOM	EXHAUST GAS		JACKET COOL	COOLER		FUEL OIL			M / E		A / E	T.O.H	MEDRIPAL	MEDRIPAL	SALTY.	TURBO LUB	TURALIK	GC LUB	TURALIK	MASRI RO	MEDITRAN	CARGO OIL PUMP		
																HIGH	LOW	IN / OUT	F.W IN/OUT	L.O. IN / OUT																		
																								FO	DO	DO	DO	307	570	415	68	82	100	43	220	SX	1	2	3
1		18,1	5,0	0,0	158	13,1	65,5	ANCHORAGE AT TANJUNG SEKONG																3,765	0,478	2,056	0,480												
2		24,0						ANCHORAGE AT TANJUNG SEKONG																		1,920	0,480												
3		24,0						ANCHORAGE AT TANJUNG SEKONG																		1,920	0,480												
4		24,0						ANCHORAGE AT TANJUNG SEKONG																		1,920	0,480												
5	7,3	15,2		1,5				LOADING CARGO AT JETTY PERTAMINA TJ SEKONG																	0,053	2,160	0,480												
6	24,0							LOADING CARGO AT JETTY PERTAMINA TJ SEKONG																		1,920	0,480												
7	13,8		4,5	5,7	160	12,4	56,9	8,6	7,4	3,6	2,2	2,3	30	46	40	390	380	64/75	44/38	48/42	117	20844		3,264	0,491	2,104	0,480	200	30	20									
8			24,0		160	13,4	321,6	8,6	7,4	3,6	2,2	2,3	30	46	40	390	380	64/75	44/38	48/42	117	20783		18,945		1,920	0,480		90										
9		18,9	3,6	1,5	160	13,6	69,3	ANCHORAGE AT KARANG JAMUANG AREA																	2,851	0,731	2,104	0,480		30										
10		24,0						ANCHORAGE AT KARANG JAMUANG AREA																		1,920	0,480												
11	1,9	18,9		3,2				DISCHARGE CARGO AT PORT JETTY PERTAMINA GOSPIRE SURABAYA																	2,246	2,432	0,480										8,4		
12	14,1	6,9		3,0				ANCHORAGE AT KARANG JAMUANG AREA																	3,272	2,088	0,480		30										
13	10,6	10,0		3,4				DISCHARGE CARGO AT PORT JETTY PERTAMINA GOSPIRE SURABAYA																	1,270	3,120	0,480										19,3		
14	20,8			3,2				DISCHARGE CARGO AT PORT JETTY PERTAMINA GOSPIRE SURABAYA																	1,849	3,640	0,480		30										
15		11,1	11,8	1,1	160	13,3	171,5	8,6	7,4	3,6	2,2	2,3	30	46	40	390	380	64/75	44/38	48/42	117	21509		9,264	0,689	2,101	0,480		90										
16	24,0							ANCHORAGE AT TANJUNG WANGI																		1,920	0,480												
17	2,9	19,1		2,0				ANCHORAGE AT TANJUNG WANGI																	0,356	2,400	0,480										6,3		
18	18,8		3,7	2,0	159	13,7	78,0	DISCHARGE CARGO OIL AT JETTY PERTAMINA TJ WANGI																2,217	0,371	2,368	0,470												2,2
19	15,7		3,8	0,5	160	13,5	112,0	DISCHARGE CARGO OIL AT JETTY PERTAMINA TJ MANGGIS																2,393	1,010	3,232	0,480												3,8
20			24,0		159	12,8	307,2	8,6	7,4	3,6	2,2	2,3	30	46	40	390	380	64/75	44/38	48/42	117	20859		18,017		1,920	0,480		120										
21		20,7	1,5	1,8				ANCHORAGE AT KOTA BARU AREA																	1,107	1,136	2,144	0,480		30										
22	10,8	11,6		1,6				DISCHARGE CARGO OIL AT JETTY PERTAMINA KOTA BARU																	0,263	3,000	0,480										10,0		
23	8,2		14,0	1,8	155	12,8	179,2	8,3	7,4	3,6	2,2	2,3	30	46	40	390	380	64/75	44/38	48/42	117	20138		9,786	0,765	2,400	0,480	200	90										
24			25,0		158	12,5	300,0	8,4	7,4	3,6	2,2	2,3	30	46	40	390	380	64/75	44/38	48/42	117	20153		19,085		1,920	0,480		190										
25		5,6	17,4	1,0	156	12,3	213,2	8,4	7,4	3,6	2,2	2,3	30	46	40	390	380	64/75	44/38	48/42	117	20185		12,949	0,636	2,080	0,480		140										
26		24,0						ANCHORAGE AT TANJUNG SEKONG																		1,920	0,480												
27		24,0						ANCHORAGE AT TANJUNG SEKONG																		1,920	0,480												
28		24,0						ANCHORAGE AT TANJUNG SEKONG																		1,920	0,480												
29		24,0						ANCHORAGE AT TANJUNG SEKONG																		1,920	0,480												
30		24,0						ANCHORAGE AT TANJUNG SEKONG																		1,920	0,480												
31	10,6	7,1		6,3				ALONG SIDE AT JETTY PERTAMINA TANJUNG GEREM																	1,033	2,728	0,480												
																								105,245	16,582	69,235	14,870										37,7	6,3	6

Master

CAPT. LA KAING
NP.10015494

PT PERTAMINA
DIRECTORATE M&T
PANGKALAN BRANDAN
(PERSERO)

Chief Engineer

URTUNG SIDODADI
NP.10016073

PERTAMINA

PT. PERTAMINA (PERSERO)
SHIPPING - MARKETING & TRADING DIRECTORATE

MT.PANGKALAN BRANDAN

ABSTRACT LOG PERIODE : JANUARI 2016

VOY	DEPARTURE (FULL AWAY) PORT	MONTH	DATE	HOUR & MINUTE	ARRIVAL (STBY) PORT	MONTH	DATE	HOUR& MINUTE	IN PORT	ANCHORAGE	UNDERWAY	PROPELLING	RPM	TRUE DISTANCE	SPEED	T.O.H DO	M/E FO	M/E DO	A/E DO
	MERAK	1	7	07.30							9,5	8,1	159,9	126,4	13,3	3,360	7,029	1,050	14,000
					SURABAYA	1	9	15.48	47,4	8,7		11,2				0,960	21,796	0,731	4,024
	SURABAYA	1	14	12.00							11,8	3,2	160	156,9	13,3	2,400		8,637	13,398
					BANYUWANGI	1	15	23.48	21,7	54,2		5,1				0,480	9,264	0,689	2,101
	BANYUWANGI	1	18	08.18							7,0	2,0	159	95,2	13,6	1,430	2,217	0,729	6,688
					TJ MANGGIS	1	19	16.18	15,7			2,1				0,480	3,393	1,010	3,232
	TJ MANGGIS	1	19	11.30							26,0	1,4	159	335,4	12,9	0,480	18,617		1,920
					KOTA BARU	1	21	13.30	19,0	32,3		3,3				0,480	1,107	1,139	2,144
	KOTA BARU	1	23	22.00							57,4	1,8	156	717,5	12,5	0,960	9,788	1,026	5,400
					MERAK	1	25	05.24	10,6	129,6		7,3				3,840	32,034	1,571	16,328
T O T A L																14,870	105,245	16,582	69,235

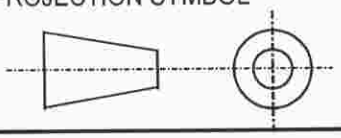
Master

PT. PERTAMINA (PERSERO) DIREKTORAT PAT PANGKALAN BRANDAN

CAPT. LA BAING
Np. 10015464

Chief Engineer

UNTUNG SIDODADI
NP.10016073

YEAR : 2014			PROJECT NAME **PRODUCT OIL TANKER 17,500 LTDW** **PANGKALAN BRANDAN**	PROJECT NO. **M000272**
	DATE	APPROVAL	DRAWING / DOCUMENT NAME : **FO. PURIFYING PIPING DIAGRAM**	OWNER : PERTAMINA
DRAWN BY	-	-		CLASS : NK
DESIGNED BY	24/12			DESIGNER : PT. PAL
CHECKED BY	30/12			GROUP : M & O
APPROVED BY	31/12			SCALE : -
ALL RIGHTS RESERVED ARE PROPERTIES OF PT PAL INDONESIA PROJECTION SYMBOL 			PAL INDONESIA	SIZE : A4, A3 SHEET 1 OF 5 DRW/ DOCUMENT NO. **5131013**

SYMBOL MARK

SYMBOL	N A M E	SYMBOL	N A M E
	STOP VALVE		ORIFICE SUCTION BELLMOUTH
	STOP VALVE (SCREW END)		CAP TYPE SOUNDING HEAD
	HOSE VALVE		SELF CLOSING COCK TYPE SOUNDING HEAD WITH TEST VALVE
	SCREW DOWN STOP AND CHECK VALVE		AIR VENT PIPE HEATING COIL
	TREE WAY VALVE		AIR VENT PIPE HEAD (WITHOUT WIRE NET)
	SAFETY VALVE ESCAPE VALVE		AIR VENT PIPE HEAD (WITH WIRE NET)
	PRESS. REDUCING VALVE		GLASS LEVEL GAUGE FLAT TYPE C/W SELF CLOSING V/V
	GATE (SLUICE) VALVE		MAGNETIC LEVEL GAUGE TYPE
	BUTTERFLY VALVE		CYL. GLASS LEVEL GAUGE W/ SELF CLOSING V/V W/ STOP V/V
	EMRG. SHUT-OFF VALVE (AIR OPERATED)		FLOAT LEVEL GAUGE (ROD TYPE)
	DIAGPHRAGMA TYPE CONTROL VALVE WITH JACK HANDLE		FLOAT LEVEL GAUGE (INNER FLOAT TYPE)
S	SOLENOID VALVE		FLOAT LEVEL GAUGE (OUTTER FLOAT TYPE)
W	WAX TYPE TEMP. CONTROL VALVE	LI	LEVEL INDICATOR
H	HYDROULIC OPER. VALVE P PNEUMATIC OPER. VALVE	P	PRESS. GAUGE C COMPOUND GAUGE
	FLOAT CHECK VALVE FLAP CHECK VALVE	T	THERMOMETER
	FOOT VALVE SELF CLOSING DRAIN VALVE	F	FLOW METER
	SWING CHECK VALVE	PS	PRESS. SWITCH TS TEMPERATURE SWITCH LS LEVEL SWITCH
	SCREW ENDED COCK		TRANSMITTER
	FLANGE ENDED COCK		CAPILLARY TUBE
	FLANGE TYPE 3 WAY COCK T TYPE L TYPE		FLEXIBLE TUBE
	LOCKED COCK BALL VALVE		ELECTRIC CABLE
	LOCKED VALVE NORMAL OPEN NORMAL CLOSE		CONTROL AIR PIPE
	Y TYPE STRAINER	FS	FLOW SWITCH MS MICRO LIMIT SWITCH
	OIL TRAY WITH DRAIN PLUG (ABT. 160)	PI	PRESS. INDICATOR
	SIMPLEX STRAINER	M	MOTOR ELECT.
	DUPLEX STRAINER		AIR HORN
	MUD BOX		ELECT. HEATER WITH TANK
	ROSE BOX	P'P	PUMP (ATTACHED MACHINE)
	STEAM OR AIR TRAP	XA	GENERAL ABNORMAL ALARM
	HAND PUMP	PC	PRESS. CONTROL PN AIR PURGE UNIT
	CYL. SIGHT GLASS FLAT SIGHT GLASS	TC	TEMPERATURE CONTROL
	TEE PIECE (FLANGE END)	LC	LEVEL CONTROL
	TEE PIECE (SCREW END)	ESD	EMERG. SHUT DOWN
	SPECTACLE FLANGE NORMAL OPEN NORMAL CLOSE	AST	AUTOMATIC START
	HOPPER BLIND FLANGE BLIND PLATE	ASP	AUTOMATIC STOP
	PENETRATION PIECE REDUCER	LAL	LEVEL ALARM LOW LAH LEVEL ALARM HIGH
	EXPANSION JOINT	TAL	TEMP. ALARM LOW TAH TEMP. ALARM HIGH

TABLE OF MATERIAL
(PIPE, JOINT AND VALVE)
FO. PURIFYING PIPING DIAGRAM

System	Pipe Size (mm)	Pipe		Flange, sleeve or coupling	Valve		Press. Standard	Design Press.	Press. Test		Design Temp.	Pipe Treatment	
		Material	Thick.		Body	Disk & Seat			Before Install	After Install		Inside	Outside
All Valves Attaced to FO. Tanks Except DB. Tk.	Above 40A	-	-	-	Cast Steel	SUS or Bronze	5K	-	-	-	45ºC	-	-
	40A&Below				Bronze	Bronze							
HFO. Purifying Suct. (5H)	Above 40A	STPG 370–S	SCH 40	Slip on Flange or Sleeve welded	Cast Iron	SUS or Bronze	5K	3Bar	1,5x 3Bar	1,5x 3Bar	70ºC	WH	-
	40A&Below				Bronze	Bronze							
MDO. Purifying Suct. (5H)	Above 40A	STPG 370–S	SCH 40	Slip on Flange or Sleeve welded	Cast Iron	SUS or Bronze	5K	3Bar	1,5x 3Bar	1,5x 3 Bar	40ºC	WH	-
	40A&Below				Bronze	Bronze							
HFO. Purifying Disc. (5H) With Class Certificate (*)	Above 40A	STPG 370–S	SCH 40	Slip on Flange or Sleeve welded	Cast Steel	SUS or Bronze	5K	3Bar	1,5x 3Bar	1,5x 3 Bar	90ºC	WH	-
	40A&Below				Bronze	Bronze							
MDO. Purifying Disc. (5H) With Class Certificate (*)	Above 40A	STPG 370–S	SCH 40	Slip on Flange or Sleeve welded	Cast Iron	SUS or Bronze	5K	3Bar	1,5x 3Bar	1,5x 3 Bar	45ºC	WH	-
	40A&Below				Bronze	Bronze							
Air vent (9W)	ALL	STPG 370–E	SCH 40	Sleeve welded or Slip On Flange	-	-	5K	-	-	-	45ºC	GZ	GZ
Sludge line (9W)	Above 40A	SGP-E 125A & Above, SGP-B 100A & Below	-	Sleeve welded or Slip On Flange	Cast Iron	SUS or Bronze	5K	-	-	Leak Test	60ºC	WH	-
	40A&Below				Bronze	Bronze							
ALL - Class Approved type	Below 15A	C 1220 - T	-	Brass union with bite joint	Bronze Screwed	-	30K	-	-	Leak Test	45ºC	-	-

NOTE : 1. WH= Pickling GZ= Galvanizing

STEEL PIPE SCHEDULE

NOMINAL DIAMETER		OUTSIDE DIA. (MM)		THICKNESS (MM)					
(MM)	(IN)	STEEL PIPE	GRE 2000M	S G P	STPG. 370 SCH. 40	STPG. 370 SCH. 80	ROLLING STEEL PLATE	STPL 39S	GRE 2000M
6	1/8	10.5							
8	¼	13.8		2.3	2.2	3.0			
10	3/8	17.3		2.3	2.3	3.2			
15	½	21.7		2.8	2.8	3.7		2.8	
20	¾	27.2		2.8	2.9	3.9			
25	1	34.0	27	3.2	3.4	4.5			3.8
32	1 ¼	42.7		3.5	3.6	4.9			
40	1 ½	48.6	42	3.5	3.7	5.1			3.8
50	2	60.5	53	3.8	3.9	5.5			4.1
65	2 ½	76.3		4.2	5.2	7.0			
80	3	89.1	82	4.2	5.5	7.6			4.1
100	4	114.3	105	4.5	6.0	8.6			5.2
125	5	139.8		4.5	6.6	9.5			
150	6	165.2	159	5.0	7.1	11.0			5.4
200	8	216.3	209	5.8	8.2	12.7			7.0
250	10	267.4	263	6.6	9.3	15.1			8.6
300	12	318.5	314	6.9	10.3	17.4	4.5		10.2
350	14	355.6	359	7.9	11.1	19.0	4.5		11.6
400	16	406.4	407	7.9	12.7	21.4	4.5		
450	18	457.2					4.5		
500	20	508.8	505	7.9	15.1		6.0		16.0
550	22	558.8					6.0		
600	26	609.6					6.0		
650	28	660.4					6.0		
700	28	711.2					6.0		
750	30	762.0					6.0		

SEAMLESS COPPER PIPE SCHEDULE

NOMINAL DIAMETER		OUTSIDE DIAMETER	THICKNESS (MM)		Note : DIAMETER OF CUT PIPE SHOWS OUTSIDE DIAMETER
(MM)	(IN)	(MM)	10K	30K	
4	-	6	1.0	1.2	
6	1/8	8	1.0	1.4	
		10	1.2	1.6	
8	¼	12	1.2	1.6	
10	3/8	15	1.2	1.6	
15	½	20	1.6	2.0	
20	3/4	25	1.8	2.3	
25	1	30	1.8	2.5	
32	1 ¼	35	2.3	2.5	
40	1 ½	45	2.3	3.0	

TO EMERG. D/G MDO. DAY TK.
SEE D/N 4116801
TO INCI. MDO. DAY TK.
SEE D/N 5131033

5H-14 (25)(*)

5H-16(25)(*) 5H-08(25)(*) 5H-13(25)(*) 5H-06(40)(*) 5H-15(40)(*)

5HV-028 5HV-021 5HV-023 5HV-024 5HV-022 5HV-016

5H-11 5HV-017 (40)(*)

5HV-030 5HV-029

R40/25 R40/25

B B

FO. PURIFIER
1200Liter/h

TC PC TC PC

2 1

A D A D

5HV-031 5HV-032

F F

9WV-022 9WV-023

9W-43(100) 9W-44(100) 9W-08 (40)

9W-46(65) AIR PIPE TO MANIFOLD
SEE D/N 5131030

5H-07(25)(*)

LAH 030

9W-40 (40) FO. PURIF. SLUDGE TK.

9WV-024

9W-42 (40)

9W-48(25)

TO BILGE TANK (9W-30)
SEE D/N 5131021

FROM LO. PURIF. SLUDGE TK.
SEE D/N 5131012
TO SLUDGE PUMP
SEE D/N 5131021

9W-49(25)

5H-03(40)(*) 5H-03(40)(*)

MDO. SERV. TK.2 (5.87m3) ML PN LAL

MDO. SERV. TK.1 (5.87m3) ML PN LAL

LAH ASP AST LAL

MDO. SETT. TANK (5.90m3) ML PN

5H-09(25)(*)

5HV-001

HFO SERV. TK. 2 (11.73m3)

HFO SERV. TK. 1 (9.90m3)

HFO SETT. TK. (9.58m3)

LAH ASP AST ML

(100°C) TAH T PN LAL

5HV-002

(50)5H-02

5HV-020 5HV-019

5H-12 (25)(*) 5HV-018

5H-07(25)(*)

(40)5H-01

5H-05(40)

HEATER 1 H-28

AIR TE CV1

5HV-006 (25)(*)

5HV-026 5HV-015

HOMOGENIZER
1200Liter/h
P C R40/32 R40/32
T T T

5H-05(40)

HEATER 2 H-29

AIR TE CV1

5HV-025 5HV-012

5HV-007 5H-03(40)(*) (25)(*)

5H-09(25)(*)

5HV-035 5HV-036

PURIF. FEED. PUMP 1
1.2 M3/h x 3 BAR
P C P'P

5HV-033 5HV-010 R40/25 5HV-003 32 MESH 5HV-011 5HV-005

5HV-013 5HV-009

5H-05 (40) 5H-04 (40)

PURIF. FEED. PUMP 2
1.2 M3/h x 3 BAR
P C P'P

5HV-034 5HV-008 R40/25 5HV-004 32 MESH 5HV-014 R50/40

9W-93(15)

TO OILY SEP. TK. (7L-73)
SEE D/N 5131008

REMARKS :

- (LAH) = LEVEL ALARM HIGH
- (LAL) = LEVEL ALARM LOW
- (PN) = AIR PURGE UNIT
- (T) = THERMOMETER
- (TI) = THERMO. FOR DISTANT READING
- (AST) = AUTOMATIC START
- (ASP) = AUTOMATIC STOP
- (ML) = FLOAT MAGNETIC LEVEL GAUGE

======== = PIPE WITH HEAT TRACING & INSULATION

(*) = MATERIAL WITH CLASS CERT.

* = SUPPLIED BY MAKER

PAL INDONESIA

PROJECTION SYMBOL

PROJECT NAME :
17.500 TDW. OIL TANKER

PROJECT NO:
M000272

DRAWING NAME :
FO. PURIFYING
PIPING DIAGRAM

SIZE : A3 CLASS : NK

SCALE : SHEET : 5 OF : 5

DRAWING NO :
5131013

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3 2 1

D C B A

ATTACHMENT - 2
MT. PALUSIPAT

SHIP PARTICULAR

NAME OF SHIP	: MT.PALU SIPAT / P-1025
NATIONALITY	: INDONESIA
PORT OF REGISTRY	: JAKARTA
OWNER	: PERTAMINA
CALL SIGN	: Y H K S
KIND OF SHIP	: OIL TANKER
LOA (Length Over All)	: 160 M
LPP (Length Between Perpendiculars)	: 154 M
BREADTH MOULDED	: 26.80 M
DEPTH MOULDED	: 11.50 M
DESIGN DRAFT	: 07.00 M
SCANTLING DRAFT	: 07.50 M
SERVIVE SPEED	: 13.00 KNOTS
DWT	: 17.500 TON
GROSS TONNAGE (GRT)	: 13.964 TON
NETTONAGE (NT)	: 4.658 TON

MAIN ENGINE

TYPE	: DE 7 S 35 MC
BHP	: 6650
RPM	: 170
MAKER	: MITSHUBISHI INDUSTRY LTD JAPAN
BUILDERS	: PT.PAL INDONESIA (SURABAYA)
KEEL LAID	: SEPTEMBER 12 TH , 1997
LAUNCHING	: JULY 15 TH , 1999
DELIVERY	: MARCH 24 TH , 2000
REGISTER CLASS	: LLOYD REGISTER & BKI
IMO NO	: 9106651
TANDA SELAR	: 13.964 NO.2033 / Ba

FREE BOARD & DEADWEIGHT TABLE

LOAD LINE	GRID(Letter)	FREE B(mm)	DRAFT	DISPL	DWT (mt)
SUMMER	(S)	4.515	7.016	24.052	17.945
TROPICAL	(T)	4.369	7.162	-	-
TROPICAL FRESH WATER	(TD)	4.208	7.323	-	-
FRESH W	(D)	4.354	7.177	-	-
WINTER	(I)	4.661	6.870	-	-

M.T. PALU SIPAT

REZL 02/08/08

MASTER

INTERTANKO'S STANDARD TANKER CHARTERING QUESTIONNAIRE 88 (Q88) **Version 3**

1.	**VESSEL DESCRIPTION**			
1.1	Date updated:		28 Jul 2015	
1.2	Vessel's name:		**PALUSIPAT**	
1.3	IMO number:		9106651	
1.4	Vessel's previous name(s) and date(s) of change:		N/A	
1.5	Date delivered:		Mar 24, 2000	
1.6	Builder (where built):		PT PAL INDONESIA	
1.7	Flag:		INDONESIA	
1.8	Port of Registry:		JAKARTA	
1.9	Call sign:		YHKS	
1.10	Vessel's satcom phone number:		+ 870773908485	
	Vessel's fax number:		N/A	
	Vessel's telex number:		N/A	
	Vessel's email address:		yhks@amosconnect.com	
1.11	Type of vessel:		Oil Tanker	
1.12	Type of hull:		Double hull	
Classification				
1.13	Classification society:		BKI	
1.14	Class notation:		+ 100 (!) "OIL TANKER ESP" SM	
1.15	If Classification society changed, name of previous society:		N/A	
1.16	If Classification society changed, date of change:		N/A	
1.17	IMO type, if applicable:		N/A	
1.18	Does the vessel have ice class? If yes, state what level:		NO	
1.19	Date / place of last dry-dock:		Belawan	13 May 2015
1.20	Date next dry dock due		Nov 2017	
1.21	Date of last special survey / next survey due:		13 May 2015	May 2020
1.22	Date of last annual survey:		May 13 2015	
1.23	If ship has Condition Assessment Program (CAP), what is the latest overall rating:		N/A	
1.24	Does the vessel have a statement of compliance issued under the provisions of the Condition Assessment Scheme (CAS): If yes, what is the expiry date?		N/A	
Dimensions				
1.25	Length Over All (LOA):		160.00 Meters	
1.26	Length Between Perpendiculars (LBP):		154.59 Meters	
1.27	Extreme breadth (Beam):		26.80 Meters	
1.28	Molded depth:		11.50 Meters	
1.29	Keel to Masthead (KTM) / KTM in collapsed condition (if applicable):		43.1 Meters	N/A
1.30	Bow to Center Manifold (BCM) / Stern to Center Manifold (SCM):		76.5 Meters	51 Meters
1.31	Distance bridge front to center of manifold:		51 Meters	
1.32	Parallel body distances:	Lightship	Normal Ballast	Summer Dwt
	Forward to mid-point manifold:	48 Meters	50 Meters	Meters
	Aft to mid-point manifold:	46.25 Meters	48.25 Meters	Meters
	Parallel body length:	92.5 Meters	97.5 Meters	Meters
1.33	FWA at summer draft / TPC immersion at summer draft:		Millimeters	MetricTons
1.34	What is the max height of mast above waterline (air draft)		Full Mast	Collapsed Mast
	Lightship:		41.23 Meters	N/A
	Normal ballast:		36.23 Meters	N/A
	At loaded summer deadweight:		36.11 Meters	N/A
Tonnages				
1.35	Net Tonnage:		14517 T	
1.36	Gross Tonnage / Reduced Gross Tonnage (if applicable):		13964 T	
1.37	Suez Canal Tonnage - Gross (SCGT) / Net (SCNT):		N / A	N / A

1.38	Panama Canal Net Tonnage (PCNT):			N/A	
Loadline Information					
1.39	Loadline	Freeboard	Draft	Deadweight	Displacement
	Summer:	4.515 Meters	6.985 Meters	17945 MT	MT
	Winter:	4.661 Meters	6.839 Meters	17482 MT	MT
	Tropical:	4.369 Meters	7.131 Meters	18518 MT	MT
	Lightship:	9.63 Meters	1.87 Meters		MT
	Normal Ballast Condition:	6.5 Meters	5 Meters	10212 MT	MT
1.40	Does vessel have multiple SDWT?			N/A	
1.41	If yes, what is the maximum assigned deadweight?			N/A	
Ownership and Operation					
1.42	Registered owner - Full style:		PT. PERTAMINA (PERSERO) Jl. Medan Merdeka Timur No. I A Jakarta Pusat.		
1.43	Technical operator - Full style:		Shipping – Marketing Directorate PT.PERTAMINA (PERSERO) Jl.Yos Sudarso No.32-34, Tanjung Priok Jakarta 14320 – Indonesia Phone : +62 21 4301086		
1.44	Commercial operator - Full style:		Shipping – Marketing Directorate PT.PERTAMINA (PERSERO) Jl.Yos Sudarso No.32-34, Tanjung Priok Jakarta 14320 – Indonesia Phone : +62 21 4301086		
1.45	Disponent owner - Full style:		Shipping – Marketing Directorate PT.PERTAMINA (PERSERO) Jl.Yos Sudarso No.32-34, Tanjung Priok Jakarta 14320 – Indonesia Phone : +62 21 4301086		

2.	**CERTIFICATION**	**Issued**	**Last Annual or Intermediate**	**Expires**
2.1	Safety Equipment Certificate:	May 20, 2015		May 12, 2016
2.2	Safety Radio Certificate:	May 20, 2015		May 12, 2016
2.3	Safety Construction Certificate:	May 20, 2015		May 12, 2016
2.4	Load line Certificate:	May 19, 2015		Oct 18, 2015
2.5	International Oil Pollution Prevention Certificate (IOPPC):	Apr 8, 2013	20 May 2015	Mar 21, 2016
2.6	Safety Management Certificate (SMC):	Jun 6, 2014		Feb 17, 2019
2.7	Document of Compliance (DOC):	Mar 4, 2013	23 Dec 2014	Dec 02, 2017
2.8	USCG (specify: COC, LOC or COI):	N/A		
2.9	Civil Liability for oil polution Damage Certificate (CLC):	Feb 20, 2015		Feb 20, 2016
2.10	Civil Liability for Bunker Oil Pollution Damage Convention Certificate (CLBC):	Feb 20, 2015		Feb 20, 2016
2.11	U.S. Certificate of Financial Responsibility (COFR):	N/A		
2.12	Certificate of Fitness (Chemicals):	N/A		
2.13	Certificate of Fitness (Gas):	N/A		
2.14	Certificate of Class:	May 19, 2015		Oct 18, 2015
2.15	International Ship Security Certificate (ISSC):	Sep 26, 2013		Sep 25, 2018
2.16	International Sewage Pollution Prevention Certificate (ISPPC)	Jun 11, 2015		Jun 10, 2018
2.17	International Air Pollution Prevention Certificate (IAPP):	Jun 29, 2015		Jun 10, 2018
Documentation				
2.18	Does vessel have all updated publications as listed in the Vessel Inspection Questionnaire, Chapter 2- Question 2.24, as applicable:		Yes	
2.19	Owner warrant that vessel is member of ITOPF and will remain so for the entire duration of this voyage/contract:		Yes	

BIRO KLASIFIKASI INDONESIA

SERTIFIKAT KLASIFIKASI MESIN

CERTIFICATE OF CLASSIFICATION FOR MACHINERY

No. 019596

No. Register : 07123
No. IMO : 9106651

PALU SIPAT/PERTAMINA-1025

Dengan ini diterangkan bahwa instalasi mesin KAPAL TANGKI MINYAK, BAJA
This is to certify that the undermentioned machineries of above named

tersebut di atas telah disurvey dalam rangka SURVEY PEMBARUAN KELAS
ship has been surveyed for

pada tanggal *on* 08.03.2015 s/d 19.05.2015 di *at* BELAWAN oleh Surveyor *by Surveyors*

Biro Klasifikasi Indonesia, sesuai dengan ketentuan-ketentuan Peraturan Biro Klasifikasi Indonesia
to the Biro Klasifikasi Indonesia, in compliance with the requirements of the Rules of Biro Klasifikasi Indonesia

1. MESIN UTAMA (Jumlah, merek dan tipe)
   Main Engine (Number, license and type)
   1 (satu) buah Mesin Diesel MITSUI-MAN B & W, 7S35 MC, 4 Tak Kerja Tunggal

   Tenaga efektif *Effective power* 6650 HP pada putaran *at* 170 Rpm *rpm*
   Dibangun di *Built at* JAPAN oleh *by* MITSUI ENGINEERING & SHIPBUILDING CO.LTD Pada *in* 1997

   Nomor mesin *No.* 3662

2. MESIN BANTU (Jumlah, merek, tipe dan daya)
   Auxiliary Engine (Number, license, type and power)
   3 (tiga) buah DAIHATSU, 6 DK-20, 3 x 960 HP

   Dibangun di *Built at* JAPAN oleh *by* DAIHATSU DIESEL ENGINE CO., LTD. Pada *in* 1997

Instalasi mesin tersebut akan didaftar dalam Register dengan karakter kelas
The machineries will be entered in the Register with the character

✠ SM

dan dinyatakan berlaku sampai Survey Pembaruan Kelas pada tanggal
and will remain valid until Class Renewal Survey on

08 MARET 2020

dengan syarat bahwa survey yang ditentukan dalam Peraturan BKI untuk dapat mempertahankan kelas dipenuhi
provided that survey as required by the BKI Rules for maintenance of the class are fulfilled,

Poros baling-baling : Periode survey *Propeller shaft : Periodicity of survey* 5 (lima) Tahun
Survey terakhir *Last survey* 11 MEI 2015

Dikeluarkan di Jakarta, tanggal *Issued at Jakarta, on* 14 AGUSTUS 2015

BIRO KLASIFIKASI INDONESIA
Direktur Klasifikasi
Classification Director

IMAN SATRIA UTAMA

15/03 2016
have checked by O/S

PT. PERTAMINA (PERSERO)
DIT . PEMASARAN & NIAGA PERKAPALAN
MT. PALUSIPAT

PERTAMINA

KEPADA YTH :
Bpk. BUDI UTOMO
Owner Superintendent
Di Jakarta

Dengan hormat,
Bersama ini kami lampirkan dokumen laporan bulanan MT. PALU SIPAT yang terdiri dari :

1. Running Hours Main Engine
2. Daily Work Record
3. Running Hours Auxiliary Engine
4. Daily Work Aux Engine
5. Chemical Consumption
6. Condition All Pump & Purifier
7. LO Consumption Report
8. Engine Log
9. Abstrack Log

Engine Log

Month : FEBRUARI 2016

MT. PALU SIPAT / P.1025

Date	Hour: In Port	Temporary Anchor	Under Way	Propeling	Pressure Kg/cm2: R.P.M	Av. Speed	o/o Slip	Handle Position	FO In / Out	Jacket Cooling	Piston Cooling	Bearing Oil	Scavenging Air	P.V.C. pp.in / Out	Sea Water	Temperature: Engine Room	Sea Water	Scavenging Air	FO Heater	Exhaust: Highest	Exhaust: Lowest	Jkt cool: Highest	Jkt cool: Lowest	Pist cool: Highest	Pist cool: Lowest	Cooler: LO IN	Cooler: LO OUT	Cooler: FW IN	Cooler: FW Out	Main Thrust	T/C: R P M 1	Aux. THERMAL OIL	Working Hours of Aux. Engine: Cargo Oil Pump 1	Cargo Oil Pump 2	Cargo Oil Pump 3	Diesel Engine 1	Diesel Engine 2	Diesel Engine 3	LO & FO Consumption / day: M. 367	M. 570	M. 412	TURBO LUBE 68	TUR 42	TUR. 43	Fuel Oil For M/E	Diesel Oil For M/E	Diesel oil For A/E	Diesel Oil For thermal	Fuel Oil For thermal
1	0.60	21.00		2.20																																4.00	24.00													
2	23.20			0.80																															15.10	24.00	24.00		10										
3			23.80	0.20	139	8.5		6.2	8.2	1.70	2.2	1.8	1.3			46	32		110	390	360	81	77	66	54	55	50	73	48	39	15300						24.00	0.50		280											
4		8.80	16.10	1.10	140	10.5		6.30	7.9	1.70	2.2	1.8	1.1			41	31		113	400	360	80	76	56	56	54	50	70	48	39	15300						17.00	24.00		200											
5		24.00																																			24.00												
6		24.00																																			24.00												
7		24.00																																		3.00	24.00		35											
8	21.20	0.80		2.20																																24.00	3.00												
9	20.10		2.00	1.90	109	9.5		5.40	8.4	1.70	2.2	1.8	0.6			37	31		109	380	350	72	68	56	50	50	46	60	40	37	11300						22.00	8.50		52											
10			24.00		141	8.50		6.40	8.3	1.70	2.2	1.8	1.3			40	32		113	390	360	82	75	58	55	56	50	70	48	39	15400							24.00		280											
11			24.00		138	9.25		6.40	7.8	1.70	2.2	1.8	1.3			41	32		109	395	370	65	62	58	55	57	52	74	50	39	15500						24.00	1.00		280											
12			24.00		134	10.75		6.60	8.2	1.70	2.2	1.8	1.3			42	32		110	390	350	77	72	57	54	54	50	66	48	39	15400						24.00			280											
13	13.00		7.80	3.20	135			6.40	8.2	1.70	2.3	1.8	1.1			43	32		112	390	345	76	71	56	54	54	48	64	46	36	15000					5.20	24.00	16.00		126											
14	9.90		11.90	2.20	142	11.50		6.40	7.7	1.70	2.3	1.8	1.2			41	32		115	390	350	76	72	56	54	55	50	70	48	39	15300					3.30	3.50	24.00		175											
15			24.00		141	12.00		6.40	7.5	1.70	2.2	1.8	1.1			41	32		120	390	350	77	72	56	54	55	48	70	48	39	14800							24.00		280											
16		9.80	11.60	2.60	138	11.00		6.30	7.5	1.70	2.3	1.8	1.2			42	32		119	390	350	68	64	56	53	53	48	62	46	36	15100						12.50	16.20		95											
17	24.00																																	14.40	24.00	24.00												
18	24.00																																	7.60	24.00	24.00												
19	23.00			1.00																																20.00	24.00		25											
20		21.70		2.30																																24.00												230			
21		24.00																																		24.00														
22		11.70	11.00	1.30	114	10.25		5.00	9.4	1.70	2.2	1.8	0.5			40	32		112	390	360	67	64	52	50	50	47	67	44	38	10000						24.00			140											
23		3.40	19.60	1.80	136	11.50		6.30	7.8	1.70	2.2	1.8	1.2			42	32		116	395	350	71	68	56	54	54	48	66	45	39	15200						3.50	21.00		230											
24	2.40	14.00	4.00	3.60	141			6.30	7.6	1.70	2.2	1.8	1.2			42	32		118	400	360	74	68	56	54	55	50	68	56	39	15600						20.00	8.00		20											
25	24.00																																			24.00														
26	19.10		2.80	2.10	114	10.00		5.40	9.7	1.80	2.2	1.8	0.5			39	32		110	390	350	68	65	54	52	50	46	64	42	38	11200						4.00	24.00		35											
27			24.00		137	11.25		6.00	8.3	1.70	2.2	1.8	1.0			40	32		116	400	360	74	70	56	54	54	48	67	46	39	14100							24.00		280											
28			23.00		137	11.00		6.00	8.2	1.70	2.2	1.8	1.0			41	33		116	410	390	75	71	56	53	54	48	64	45	39	14100						24.00	5.00		280											
29	7.20		14.70	2.10																															2.70	24.00	14.20		195	180									
Total	211.90	185.00	267.50	39.60																												0.00		52.30	0.00	422.00	453.40	0	3255	180	0	0	750	114.948	8.622	37.778	0.00	0.00

Ship movement : Arrival & Departure

Date	Shifting	Up / Alongside	Discharge / Loading Cargo	Ocean or Port	Shifting Pier	Remark
01.02.2016		Alongside	Discharge	Tg. Wangi		
07.02.2016		Alongside	Loading	Cilacap		
12.02.2016		Alongside	Discharge	Pasuruan		
18.02.2016		Alongside	Discharge	Tg. Priok		
24.02.2016		Alongside	Loading	Cilacap		
29.02.2016		Alongside	Discharge	Makassar		

Date	Demage, Repairing Maintenance & Change Control	Date	Demage, Repairing Maintenance & Change Control
1/2/2016	Clean F.W cooler Main Engine	19/2/2016	Renewing O-ring Cover handle Of Windlass port side
3/2/2016	Cleaning Bosch pump Main Engine	20/2/2016	Maintenance Aux #
4/2/2016	Assembly Compressor Air Control	22/2/2016	Cleaning Filter LO Thermal Oil pump
5/2/2016	Transfer LO Cyl. To Storage tank	23/2/2016	Wrapping Flexible join of Circulation pump A/E 1 &2
7/2/2016	Continue Assembly Air Control compressor	24/2/2016	Maintenance Hydraulic pump Winchlass Renewed oil seal & Check Coupling Rubber
9/2/2016	Prepare Mechanical Seal Thermal Oil Circulation pump No.2	25/2/2016	Bunker MFO (300.000 KL) & MDO(70.000KL)
10/2/2016	Assembly Thermal Oil pump No. 2	26/2/2016	Added LO Thermal Oil To Expansi Tank
11/2/2016	Clean Condensor Air Conditioning	27/2/2016	Transfer LO Turalik 43 for Windlass Storage th
12/2/2016	Clean Fuel Oil Filter Of Main Engine & Transfer LO MED 412 To storage tank		
13/2/2016	Clean Auto Filter supply pump Main Engine & Maintenance Emergency Generator		
15/2/2016	Service Valve Air Control		
16/2/2016	Cleaning Sea Cheast P/S		
17/2/2016	Filling Expansi Of thermal oil & Check auto Blowerof Main engine		
18/2/2016	Cleaning Cooler M.A.C. unit And Renewed Pipe Line out let		

Master

Capt. ASEP SUPYANI

No. 747178

Chief Engineer

PRIYONO

No. 10014691

PERTAMINA DIREKTORAT PEMASARAN DAN NIAGA PERKAPALAN - MT.PALU SIPAT / P.1025 - CHIEF ENGINEER'S ABSTRACT LOG

Period : FEBRUARY 2016

PERTAMINA

Departure				Arrival				Draft		Hour				Fuel Consumption (KL)																					
																	In Port							At Sea											
Port	Day	Month	Hour & Min	Port	Day	Month	Hour & Min	Fore	AFT	In Port	Temporary Anchor	Underway (Eng Work)	Propelling	Sailing or voyage remaining HFO	Sailing or voyage remaining MDO	Received HFO / MDO	Main Engine HFO	Main Engine MDO	Aux Engine HFO	Aux Engine MDO	Thermal oil heater HFO	Thermal oil heater MDO	Inert gas generator MDO	Main Engine HFO	Main Engine MDO	Aux Engine HFO	Aux Engine MDO	Thermal oil heater HFO	Thermal oil heater MDO	Total Use HFO	Total Use MDO	Arrival Remaining HFO	Arrival Remaining MDO
TG.WANGI	00	02	11.13	-	-	-	-							262.642	62.778			0.366		3.089										0.000	3.445		
-	-	-	-	CILACAP	04	02	04.05							240.036	58.782									22.606			4.018			22.606	4.018		
CILACAP	08	02	08.08	-	-	-	-							240.036	48.628			0.668		9.468										0.000	10.136		
-	-	-	-	PADANG	12	02	19.45							195.729	41.214									44.307			7.412			44.307	7.412		
PADANG	13	02	21.54	-	-	-	-							186.729	38.181			0.868		2.167										0.000	3.033		
-	-	-	-	TG. PRIUK	15	02	22.36							167.318	33.810									28.411			4.371			28.411	4.371		
TG. PRIUK	21	02	23.42	-	-	-	-							167.318	19.275			1.891		12.844										0.000	14.535		
-	-	-	-	CILACAP	25	02	15.06							148.764	15.791									18.554			3.484			18.554	3.484		
CILACAP	26	02	07.08	-	-	-	-							448.764	81.303			0.439		9.049										0.000	9.488		
-	-	-	-	MAKASSAR	29	02	02.42							417.994	75.172									30.770			5.131			30.770	5.131		
MAKASSAR																		0.245		2.091										0.000	2.336		
																	3.000	4.445	0.000	22.994		0.000	0.000	104.648	0.000	0.000	25.474		0.000	134.648	57.287	0.000	0.000

Running Hours					
MAIN ENGINE	Port	batteryoil	GENERATOR	No.1	
	Up	batteryoil		No.2	
	Dpt	batteryoil		No.3	
	Port	batteryoil	AIC	No.1	
	Up	batteryoil		No.2	
	Dpt	batteryoil	REFRIGERATOR	No.1	
COP	No.1	-		No.2	
	No.2	batteryoil	MAIN AIR COMPRESSOR	No.1	
				No.2	
BALLAST PUMP	No.1		IGG FAN	No.1	
	No.2			No.2	
STRIPPER PUMP			THERMAL OIL	No.1	
TANK CL PUMP			CIRC PUMP	No.2	

Fuel oil (KL)										
	Port	Date	Name	Quantity		Name	Quantity			
				KL	MT		KL	MT		
Remaining	AT SEA	28/01/16	HFO	262.642	252.899	MDO	67.806	59.447		
Received	CILACAP	29/01/16	HFO	100.000		MDO	70.000	61.320		
Received			HFO			MDO				
Received			HFO			MDO				
Received			HFO			MDO				
Received			HFO			MDO				
Total (month)				362.642	352.899		137.806	120.767		
Cons. (month)				144.848	139.567		63.387	55.527		
ROB	AT SEA	01/02/16	HFO	417.994	402.481	MDO	74.419	65.240		

Lubricating Oil (liter)													
		M/E	C/L Oil	AE	H TEMP						M.A.C	TERMAL
		MRD 307	MRD 570	MED 413	TS. LUB 68	KOMPEH 68	TUR. 32	TUR 46	MAS R-220	GC 100	TER XT 22	
Remaining	New	7813	5967	5380	192	570	5745	2140	2826	1032	975	
	System											
	Old											
Received												
Total		7813	5967	5380	192	570	5745	2140	2826	1032	975	
Consumed 1 month		0	3233	780	0	0	50	730	0	95	0	
ROB	New	7813	2734	5380	192	570	5695	1410	2826	937	975	
	System											
	Old											

MASTER : Capt. ASEP SUPYANI

CHIEF ENGINEER : PRIYONO

PERTAMINA DIRECTORATE MARKETING MT. PALU SIPAT (PERSERO)

ATTACHMENT - 3

MITSUBISHI DIESEL GENERATOR

E

SPECIFICATIONS
FOR
MAIN DIESEL GENERATOR ENGINE

(650 kW ACG x 900 min-1 3 sets/ship)

OWNER :Pertamina
17,500DWT WHITE PRODUCT TANKER
SHIPYARD :PT.PAL-INDONESIA

B

DAIHATSU DIESEL MFG.CO.,LTD.
TECHNICAL DEPARTMENT
OSAKA JAPAN

HULL NO.	M000271/272	DRAWN BY	M. Ochi
ENG. MODEL	6DK–20e	CHECKED BY	K. Shikano
LIST NO.	AQA10012765F		
DATE	Aug. 27, 2010	APPROVED BY	Y. Tomochi
REVISION	B. P.1,2, 4,5,6,8,10,12 Sep.14,2010 M.Ochi C. P.3, 6,7,8 Feb.7,2011 M.Ochi D. P.3, 5 Mar.4,2011 M.Ochi E. P.1,8,14 Mar.20,2011 E.Matsuda F. P.5,6,9 Sep.15,2011 M.Ochi		

1. GENERAL

1.1 Rules and Regulations

The diesel generator engine will be complied with the requirements of the following rules and regulations of the latest issue.

1) Classification ..... NK
2)Compliance for Engine Air Pollution Prevention with Marpol, AnnexⅥ,Regulation 13
Statement of Compliance issued by classification society should be submitted.
3) Japanese industrial standard ..... JIS
4) Miscellaneous
The other not specifically mentioned in this specifications will be manufactured on the basis of manufacturer's quality control standard.
5) Flag ..... Unknown

1.2 Conditions

Machinery	ambient temp. +5 to 45℃ cooling sea water temp. 32℃ relative humidity 60 % barometric press. 100kPa
General power source	AC 440 V, 60 Hz,3-phase
Control power source	AC 220 V, 60 Hz,1-phase and DC24 V
Starting air source	3.0 MPa
Control air source	0.6 - 0.9 MPa
Heating steam source.....	0.7 MPa saturated, working

1.3 Installations

Diesel engine will be rigidly coupled to the generator as maker's standard and placed together on the common bed.
Diesel generator set should be rigid-installed onto the hull structure.

1.4 Pipe connection flanges

Pipe connection flanges which are connected to the shipyard's piping will be provided in accordance with JIS.
JIS counter-flanges will be supplied by Daihatsu.

1.5 Name and caution plates

Name plates are written in English.
Caution plates are written in English.
Unit is the SI system.
ie., pressure unit is Bar and temperature unit is ℃ B

1.6 Painting

Generator engine and accessories.....	Munsell 7.5BG7/2
Exhaust manifold cover	Aluminum heat resisting paint
Control panel	Munsell 7.5BG7/2

1.7 Plans

Approval plan.....	8 copies
Working plan.....	8 copies
Final plan.....	8 copies of final drawings, CD 1 copy instruction manuals and test report Statement of Compliance, for each ship

1.8 Fuel oil

Marine Diesel Oil, equivalent to ISO 8217 F-DMA or DMB (HFRR should be below 460 μ m)

1.9 Notes for Fuel oil pre-treatment

1) Upon deep deliberation with separator maker, the best centrifugal separation system should be applied.
2) Recommended fuel properties before engine
   Aluminum content : < 10 mg/kg
   Water content : < 0.2 % by volume
   Sodium content : < 50 mg/kg

1.10 Fuel oil when engine starting, stopping and normal condition

Engine starting and stopping ..... MDO
Normal operation ..... MDO

1.11 Notices for operation

The engine, together with proper external system arrangements, can be operated on the above-mentioned fuel, still:

- fuel oil viscosity at the inlet port of engine should be kept to $14 \pm 1.5 mm^2/s(cSt)$ in any case.
- viscosity of MDO at the inlet port of engine $\geqq$ 2.0 mm^2/s (cSt)
- recommendable continuous low load $\geqq$20% (130kW Gen. output)
- No load operation before stopping is proper to as short as possible, less than 5 min.

1.12 Recommended lubricating oil

System oil .....API service grade CD SAE30 TBN10 to 15
Governor oil .....same as system oil SAE30

Supplier	Oil brand
BP	BP ENERGOL DL-MP30
	CASTROL MLC30
CHEVRON	DELO 1000 Marine Oil SAE30
TEXACO	TARO XD SAE30
EXXON MOBIL	EXXMAR 12TP30 or MOBIL GARD312
GULF	GULF VERITAS DPO30
PETROBRAS	MARBRAX CCD310
SHELL	GADINIA 30
TOTAL,FINA	RUBIA S SAE30 OR DISOLA M3015

PERTAMINA OIL. : SALLYX415,SAE-40,TBN15-20 **C,D**

1.13 Fluid holdings in engine

Lubricating oil .... LO cooler 22 lit. + LO tank 1350 lit. = initial filling quantity about 1377lit.
(engine in running condition 86 lit.)
Governor oil..... 1.3 lit.
Jacket CW ..... engine 85 lit.
Cooler CW..... air cooler 23 lit. + LO cooler 11 lit.

2. PRINCIPAL PARTICULARS

2.1 Type of Engine..... vertical in-line 4-stroke single-acting non-reversible direct injection trunk piston type with exhaust turbocharger and air cooler

2.2 Type of Generator..... synchronous self-exciting brushless, bracket type self-lubricating two(2) sleeve bearings
Supplier: DAIHATSU
Maker: TAIYO ELECTRIC CO.,LTD. B

2.3 Direction of rotation..... clockwise as viewed from generator end

2.4 Control ..... manual start/stop :remote and engine-side
automatic start :managed by MSB
automatic stop :caused by engine emergency shutdown
synchronization :manual/auto on MSB and engine-side

2.5 Engine starting method..... compressed air start
2.6 Engine cooling system..... Jacket / Fresh water Cooler / Fresh water 36℃ B

2.7 Location of Turbocharger..... opposite side to generator

2.8 Camshaft.....built-up type

2.9 Diesel generator data

Engine model	6DK–20e
Quantity of cylinders	6
Cylinder bore x Piston stroke	200 mm x 300 mm
Engine rated output	710 kW
Engine speed	900 min^{-1}
Mean effective pressure	1.67 MPa
Mean piston speed	9.0 m/s
Maximum pressure	≦17.7 MPa
Overload capacity	110% for an hour every 12 hours
Lube oil consumption	0.8g/kWh (estimate at full load)
Fuel oil consumption *1) *2)	201g/kWh +5% with pumps

Generator capacity	812.5 kVA
Generator rated output	650 kW
Power factor	0.8 lagging
No. of poles	8
Voltage Phase Frequency	AC 450 V 3-phase 60 Hz
Insulation	Class F

Quantity of DG set	three(3) sets/ship
Parallel running	Fellow D/Gs

*1)Fuel oil consumption is based on the engine output (kW) at crankshaft-end using fuel lower calorie of 42700kJ/kg, under 100% generator load, on condition that the engine drives each one (1) of LO pump and CW pump.
*2)Fuel oil consumption is based on **IMO Tier 2 limitation** of MARPOL 73/78 ANNEX Ⅵ

ADK20-7074-6

TEST RECORDS OF THE DIESEL ENGINE AT SHOP TRIAL
ディーゼル機関試運転成績書

SHIPYARD :	MESSRS. PT.PAL INDONESIA(PERSERO)	
造 船 所 :		SNO. M000272
ENGINE TYPE :		
機 関 型 式 :	6DK-20e	
ENGINE NO. :		
機 関 番 号 :	DK620E0073 , DK620E0074 , DK620E0075	
DATE OF MFG.:		
製 造 年 月 :	Jan. - 2012	

RECORDS OF SHOP TRIAL
記 事

24 - Jan. - 2012	RUNNING TEST 運 転 検 査
24 - Jan. - 2012	OVERHAUL INSPECTION 分 解 検 査

DAIHATSU DIESEL MFG. CO., LTD.
MORIYAMA FACTORY, SHIGA
QUALITY CONTROL DEPT.

JUDGMENT 判 定	good

APPROVED BY: S. Nakao

APPROVED BY: M. Shono

CHECKED BY: Y. Ochiai

SPECIFICATIONS　主要目

DIESEL ENGINE		ディーゼル機関						
Engine model & type	機関仕様、型式	4-cycle diesel engine 立形単動4サイクルディーゼル機関	:	6DK-20e				
Engine No.	機関番号	DK620E0073 , DK620E0074 , DK620E0075						
Rated output & speed	定格出力及び回転速度	710	kW	(966)	PS,	900	min^{-1}	
No of cylinder,Bore & Stroke	シリンダー数、直径、行程	6	、	200	mm 、	300	mm	

A. C. GENERATORS		交流発電機						Purchase 購入品
Manufacture	製作所	Taiyo Electric Co.,Ltd						made
Output, Cycle	出力、周波数	812.5	KVA	(650)	kW 、	60	Hz	
Voltage、Current & P.F.	電圧、電流、力率	450	V 、	1042	A 、	80	%	

ACCESSORY	付属機器						
	Mfg. 製作所	Type 形式	Spec. 仕様	No.1	No.2	No.3	
Turbo-charger 過給機	IHI	TPS48-F33	CV33CT65CA17 TV01TT16TA70	Xi302976	Xi302977	Xi302978	
Air cooler 空気冷却器	DDK	DH-48HZ-1	———	Z48751	Z48752	Z48753	
Governor 調速機	BOSCH	RHD6-MC	Design No.	105856-5580			
			Serial No.	11115003	11115004	11116002	

SURVEYOR'S MARK	規格			
	No.1 Eng.	No.2 Eng.	No.3 Eng.	
Diesel engine ディーゼル機関	MK 78B112D E NO.DK620E0073 24-1-12	MK 78B112D E NO.DK620E0074 24-1-12	MK 78B112D E NO.DK620E0075 24-1-12	
A.C. Generator 交流発電機	MK 822 NG M.NO.285265 22-12-11	MK 822 NG M.NO.285266 22-12-11	MK 822 NG M.NO.285267 22-12-11	

VALVE ADJUSTMENTS				調整要目表			
Intake valve 吸気弁	Open (before T.D.C) 開 (上死点前)	Degree 度	60	Top clearance ピストン頂隙		7.5	mm
	Close (after B.D.C) 閉 (下死点後)	Degree 度	35	Injection pressure 燃料噴射圧力		29.4	MPa
	Clearance 間隔	mm	0.31			300	kg/cm^2
Exhaust valve 排気弁	Open (before B.D.C) 開 (下死点前)	Degree 度	55	Fuel pump 燃料ポンプ	Type 形式	104257-3060	
	Close (after T.D.C) 閉 (上死点後)	Degree 度	50	Nozzle 噴射弁	Type 形式	DLL137TE2810N5	
	Clearance 間隔	mm	0.31	Firing order 着火順序		1-5-3-6-2-4	
Fuel injection timing (before T.D.C) 燃料ポンプ突き始め(上死点前)		Degree 度	9				
Starting valve 起動弁	Open (before T.D.C) 開 (上死点前)	Degree 度	4	Direction of crank rotation (Viewed from the flywheel) 回転方向(フライホイル側から見て)		Clock wise 時計方向	
	Close (after T.D.C) 閉 (上死点後)	Degree 度	130				

TYPE : 6DK-20e

LOAD RUNNING TEST

Date of test : *24-1-2012

No.1 ENG.

ENG.NO. : DK620E0073

Kind of load				%	Standard at 100%	* 25	* 50	* 75	* 100	* 100	* 110				
Time of recording				O'clock-min	—	9-00～9-20	9-40	10-00	10-30	11-00	11-20				
Runnning test time				min		20	20	20	30	30	20				
Generator output				kW		163	325	488	650	650	715				
Fuel consumption **				kg/h		52.5	77.3	107.2	138.8	138.8	152.9				
(be based on Gen.output) **				g/kWh		323.0	237.9	219.8	213.5	213.5	213.8				
(be based on Eng.output) **				g/kWh	≦ 201 +5%	293.9	224.8	209.9	204.5	204.5	204.8				
Gen.efficiency at P.F.=1.0						91.0	94.5	95.5	95.8	95.8	95.8				
Fuel pump rack reading						11.0	15.0	18.0	21.0	21.0	23.0				
Cooling water pressure				MPa	For reference	0.23	0.23	0.23	0.23	0.23	0.23				
Lub. oil pressure	Bearing			MPa	0.4 ～ 0.55	0.54	0.52	0.50	0.50	0.50	0.50				
	Turbo-charger			MPa	0.2 ～ 0.5	0.48	0.45	0.43	0.42	0.42	0.41				
Boost air pressure				MPa		0.032	0.089	0.149	0.219	0.219	0.248				
Fuel oilpressure				MPa	For reference	0.46	0.45	0.44	0.44	0.44	0.43				
Lub. oil temperature	Oil cooler	Inlet		℃		35	56	60	62	63	63				
		Outlet		℃		14	24	35	36	37	38				
	Engine inlet			℃		37	54	55	55	55	55				
Cooling water temperature	Engine	Inlet		℃		50	66	67	68	68	69				
		Outlet		℃		54	68	70	71	71	71				
Exhaust gas temperature	Cylinderhead outlet		1	℃	Difference ≦10%	265	270	280	300	300	310				
			2	℃		265	270	280	300	300	310				
			3	℃		265	275	290	320	325	335				
			4	℃		265	275	290	310	310	325				
			5	℃		260	275	295	320	320	330				
			6	℃		255	275	300	320	320	330				
	Turbo-charger inlet			℃		325	370	400	420	420	435				
	Turbo-charger outlet			℃		280	300	300	290	290	300				
Fuel oil temperature				℃	For reference	16	17	18	19	19	20				
Boost air temperature				℃	45 ～ 55	20	27	35	46	46	51				
Maximum combustion pressure			1	MPa	Difference ≦±0.3	6.1	8.1	10.2	12.1	12.1	12.9				
			2	MPa		6.0	8.0	10.0	12.1	12.1	12.9				
			3	MPa		6.0	8.0	10.0	12.0	12.0	12.9				
			4	MPa		6.0	8.0	10.1	12.1	12.1	13.0				
			5	MPa		5.9	8.0	10.0	12.1	12.1	12.9				
			6	MPa		5.9	7.9	10.0	12.0	12.0	12.9				
Generator bearing temperature		Coupling side		℃		22	29	33	34	36	38				
		Other side		℃		25	30	33	33	34	35				
Other Data															
Air temp. at Turbo-charger inlet				℃		13	13	14	15	16	16				
Room temperature				℃		9	10	11	12	12	12				
F.O. temp. of F.O.flowmeter inlet				℃		11	12	12	13	13	13				
C.W. temp. of Air cooler inlet				℃		12	13	14	17	17	18				
Humidity				%		68	66	64	59	59	57				
Atmospheric pressure				hPa		998	998	997	997	997	996				

* Inspected by DAIHATSU

**Corrected value with Low heating value 42.7 MJ/kg , Accordance with ISO

Fuel consumption (be based on Eng.output) = Fuel consumption (be based on Gen.output) × Gen.efficiency

TYPE : 6DK-20e

No.1 ENG.　　ENG.NO. : DK620E0073

*Crank-shaft Deflection

Date of test ; *19-1-2012

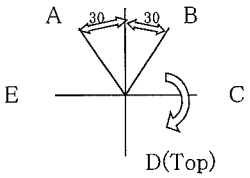
Cold condition (Standard +3.0～−3.0)　　(Gen.side←→Eng.side)　　UNIT: 1/100mm

	1	2	3	4	5	6		
A	0.0	0.0	0.0	0.0	0.0	0.0		
B	±0	±0	±0	±0	±0	±0		
C	+1.0	+0.2	0.0	+0.5	+0.5	+0.2		
D	+2.5	0.0	−0.5	0.0	+0.8	+0.5		
E	+1.5	−0.2	0.0	+0.5	+0.5	+0.2		

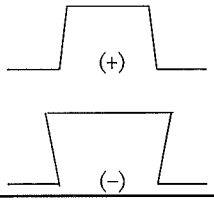
Hot condition (crank-arm temperature 66 ℃)

	1	2	3	4	5	6		
A	0.0							
B	±0	±0	±0	±0	±0	±0		
C	−2.0							
D	−5.0							
E	−2.0							

View from the fly-wheel



Dial gauge reading



*Temperature after continuous operation (℃)

Date of test ; *20-1-2012

Diesel Engine

No.	1	2	3	4	5	6	7		
Main bearing	63	65	67	67	67	66	63		
Crank pin bearing	64	65	65	65	64	64	−		
Lub. oil	64								

*Engine starting test

Date of test ; *23-1-2012

Air receiver capacity	Time	Pressure	Time	Pressure	Time	Pressure
100 L	1	2.45	8	1.25	15	
Initial pressure	2	2.15	9	1.15	16	
2.45 MPa	3	2.00	10	1.00	17	
Room temperature	4	1.80	11	0.95	18	
9 ℃	5	1.65	12	0.85	19	
	6	1.50	13	×0.70	Standard ≧6	≦1.18
	7	1.35	14			

*Protecting Device test

Date of test ; *23-1-2012

Over speed (stop)	(1008～1035) 1020 min^{-1}	L.O. filter difference pressure rise (alarm)	GOOD		
L.O. pressure down (stop)	(0.20±0.01) 0.20 MPa				
C.W. temp. rise (stop)	($90\pm^{3}_{2}$) 90 ℃				

Fuel oil ;	Exxon mobil oil "A"
Density ;	0.8439 g/cm^3 at 15℃
Low heating value ;	42.80 MJ/kg
Lub. oil ;	MARINE T103
Power factor;	100%
Drawing ;	T.NAKAGAWA
Checked ;	T.FUJIMOTO

TYPE : 6DK-20e

LOAD RUNNING TEST

Date of test : *24-1-2012

No.2 ENG.

ENG.NO. : DK620E0074

Kind of load				%	Standard at 100%	* 25	* 50	* 75	* 100	* 100	* 110				
Time of recording				O'clock-min	—	9-00～9-20	9-40	10-00	10-30	11-00	11-20				
Runnning test time				min		20	20	20	30	30	20				
Generator output				kW		163	325	488	650	650	715				
Fuel consumption **				kg/h		52.6	77.6	107.1	139.1	139.1	153.2				
(be based on Gen.output) **				g/kWh		323.6	238.7	219.7	214.0	214.0	214.3				
(be based on Eng.output) **				g/kWh	≦ 201 +5%	294.5	225.6	209.8	205.0	205.0	205.3				
Gen.efficiency at P.F.=1.0						91.0	94.5	95.5	95.8	95.8	95.8				
Fuel pump rack reading						11.5	15.0	18.5	21.5	21.5	22.5				
Cooling water pressure				MPa	For reference	0.25	0.25	0.25	0.25	0.25	0.25				
Lub. oil pressure	Bearing			MPa	0.4 ～ 0.55	0.54	0.52	0.51	0.50	0.50	0.50				
	Turbo-charger			MPa	0.2 ～ 0.5	0.48	0.44	0.42	0.40	0.40	0.40				
Boost air pressure				MPa		0.030	0.089	0.151	0.220	0.220	0.248				
Fuel oilpressure				MPa	For reference	0.46	0.45	0.45	0.43	0.43	0.42				
Lub. oil temperature	Oil cooler	Inlet		℃		33	56	60	62	62	62				
		Outlet		℃		13	25	36	37	38	38				
	Engine inlet			℃		34	54	54	54	54	54				
Cooling water temperature	Engine	Inlet		℃		48	68	68	68	68	69				
		Outlet		℃		51	70	70	70	70	71				
Exhaust gas temperature	Cylinderhead outlet		1	℃	Difference ≦10%	270	275	280	295	300	310				
			2	℃		275	275	290	315	315	325				
			3	℃		255	275	290	315	315	330				
			4	℃		275	285	295	315	315	330				
			5	℃		260	280	300	320	320	335				
			6	℃		260	285	300	315	315	330				
	Turbo-charger inlet			℃		320	365	390	420	420	440				
	Turbo-charger outlet			℃		270	300	295	290	290	295				
Fuel oil temperature				℃	For reference	17	19	20	21	22	22				
Boost air temperature				℃	45 ～ 55	17	25	34	45	45	49				
Maximum combustion pressure			1	MPa	Difference ≦±0.3	6.0	8.0	10.1	12.0	12.0	12.8				
			2	MPa		6.0	8.0	10.0	12.1	12.1	12.9				
			3	MPa		6.0	8.0	10.0	12.0	12.0	13.0				
			4	MPa		5.9	7.9	10.0	12.0	12.0	13.0				
			5	MPa		5.9	7.8	10.0	12.0	12.0	12.9				
			6	MPa		5.9	7.9	10.1	12.0	12.0	12.9				
Generator bearing temperature	Coupling side			℃		20	28	32	34	36	38				
	Other side			℃		24	31	33	34	35	36				
Other Data															
Air temp. at Turbo-charger inlet				℃		13	15	17	18	18	19				
Room temperature				℃		9	10	11	12	12	12				
F.O. temp. of F.O.flowmeter inlet				℃		10	11	11	12	12	12				
C.W. temp. of Air cooler inlet				℃		12	13	14	17	17	18				
Humidity				%		68	66	64	59	59	57				
Atmospheric pressure				hPa		998	998	997	997	997	996				

* Inspected by DAIHATSU

**Corrected value with Low heating value 42.7 MJ/kg , Accordance with ISO

Fuel consumption (be based on Eng.output) = Fuel consumption (be based on Gen.output) ×Gen.efficiency

TYPE : 6DK-20e

No.2 ENG.　　ENG.NO. : DK620E0074

*Crank-shaft Deflection

Date of test ; *19-1-2012

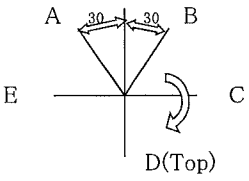
Cold condition (Standard +3.0～−3.0)　　(Gen.side←→Eng.side)　　UNIT: 1/100mm

	1	2	3	4	5	6		
A	0.0	0.0	0.0	0.0	0.0	0.0		
B	±0	±0	±0	±0	±0	±0		
C	+1.0	0.0	0.0	0.0	+0.8	+0.2		
D	+2.5	0.0	−0.2	0.0	+1.0	+0.2		
E	+1.0	0.0	0.0	0.0	+0.8	+0.2		

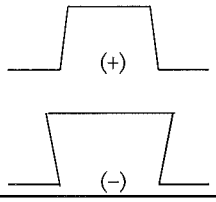
Hot condition (crank-arm temperature 66 ℃)

	1	2	3	4	5	6		
A	−0.5							
B	±0	±0	±0	±0	±0	±0		
C	−2.5							
D	−5.5							
E	−2.5							

View from the fly-wheel



Dial gauge reading



*Temperature after continuous operation (℃)

Date of test ; *20-1-2012

Diesel Engine

No.	1	2	3	4	5	6	7		
Main bearing	63	66	67	67	67	66	63		
Crank pin bearing	65	65	66	66	65	64	−		
Lub. oil	64								

*Engine starting test

Date of test ; *23-1-2012

Air receiver capacity	Time	Pressure	Time	Pressure	Time	Pressure
100 L	1	2.45	8	1.20	15	
Initial pressure	2	2.10	9	1.10	16	
2.45 MPa	3	1.90	10	1.00	17	
Room temperature	4	1.70	11	0.90	18	
9 ℃	5	1.55	12	0.80	19	
	6	1.40	13	×0.65	Standard	
	7	1.30	14		≧6	≦1.18

*Protecting Device test

Date of test ; *23-1-2012

Over speed (stop)	(1008～1035) 1020 min^{-1}	L.O. filter difference pressure rise (alarm)	GOOD		
L.O. pressure down (stop)	(0.20±0.01) 0.20 MPa				
C.W. temp. rise (stop)	(90$\pm^{3}_{2}$) 90 ℃				

Fuel oil ;	Exxon mobil oil "A"
Density ;	0.8439 g/cm^{3}at 15℃
Low heating value ;	42.80 MJ/kg
Lub. oil ;	MARINE T103
Power factor;	100%
Drawing ;	Y.IWATUKI
Checked ;	T.FUJIMOTO

TYPE : 6DK-20e

LOAD RUNNING TEST

Date of test : *24-1-2012

No.3 ENG.

ENG.NO. : DK620E0075

Kind of load				%	Standard at 100%	* 25	* 50	* 75	* 100	* 100	* 110				
Time of recording				O'clock-min	—	9-00～9-20	9-40	10-00	10-30	11-00	11-20				
Runnning test time				min		20	20	20	30	30	20				
Generator output				kW		163	325	488	650	650	715				
Fuel consumption **				kg/h		52.5	77.5	107.0	138.9	138.9	153.6				
(be based on Gen.output) **				g/kWh		323.3	238.6	219.6	213.7	213.7	214.8				
(be based on Eng.output) **				g/kWh	≦ 201 +5%	294.2	225.5	209.7	204.7	204.7	205.8				
Gen.efficiency at P.F.=1.0						91.0	94.5	95.5	95.8	95.8	95.8				
Fuel pump rack reading						11.0	14.5	18.0	21.0	21.0	22.5				
Cooling water pressure				MPa	For reference	0.24	0.24	0.24	0.24	0.24	0.24				
Lub. oil pressure	Bearing			MPa	0.4 ～ 0.55	0.55	0.52	0.51	0.50	0.50	0.50				
	Turbo-charger			MPa	0.2 ～ 0.5	0.49	0.46	0.43	0.42	0.42	0.41				
Boost air pressure				MPa		0.030	0.086	0.150	0.222	0.222	0.250				
Fuel oilpressure				MPa	For reference	0.44	0.43	0.43	0.42	0.42	0.42				
Lub. oil temperature	Oil cooler	Inlet		℃		34	54	58	61	61	62				
		Outlet		℃		12	24	34	36	37	38				
	Engine inlet			℃		34	52	54	54	54	54				
Cooling water temperature	Engine	Inlet		℃		49	68	69	70	70	70				
		Outlet		℃		51	70	71	72	72	73				
Exhaust gas temperature	Cylinderhead outlet		1	℃	Difference ≦10%	270	275	280	295	300	310				
			2	℃		265	270	285	310	310	320				
			3	℃		255	270	285	315	320	335				
			4	℃		255	270	290	310	310	330				
			5	℃		255	275	290	315	320	335				
			6	℃		255	270	295	315	320	335				
	Turbo-charger inlet			℃		320	370	390	420	420	435				
	Turbo-charger outlet			℃		270	305	305	300	300	305				
Fuel oil temperature				℃	For reference	16	17	18	20	20	21				
Boost air temperature				℃	45 ～ 55	15	24	34	46	46	50				
Maximum combustion pressure			1	MPa	Difference ≦±0.3	6.0	8.1	10.0	11.9	11.9	12.8				
			2	MPa		5.9	7.9	10.0	12.0	12.0	12.9				
			3	MPa		5.9	8.0	10.1	12.1	12.1	13.0				
			4	MPa		5.8	7.9	10.0	12.0	12.0	12.9				
			5	MPa		5.8	7.9	10.1	12.1	12.1	13.0				
			6	MPa		5.9	7.9	10.1	12.1	12.1	13.0				
Generator bearing temperature	Coupling side			℃		23	29	33	35	36	38				
	Other side			℃		24	30	34	35	36	37				
Other Data															
Air temp. at Turbo-charger inlet				℃		12	14	16	19	20	20				
Room temperature				℃		9	10	11	12	12	12				
F.O. temp. of F.O.flowmeter inlet				℃		10	10	10	10	10	11				
C.W. temp. of Air cooler inlet				℃		12	13	14	17	17	18				
Humidity				%		68	66	64	59	59	57				
Atmospheric pressure				hPa		998	998	997	997	997	996				

* Inspected by DAIHATSU

**Corrected value with Low heating value 42.7 MJ/kg , Accordance with ISO

Fuel consumption (be based on Eng.output) = Fuel consumption (be based on Gen.output) ×Gen.efficiency

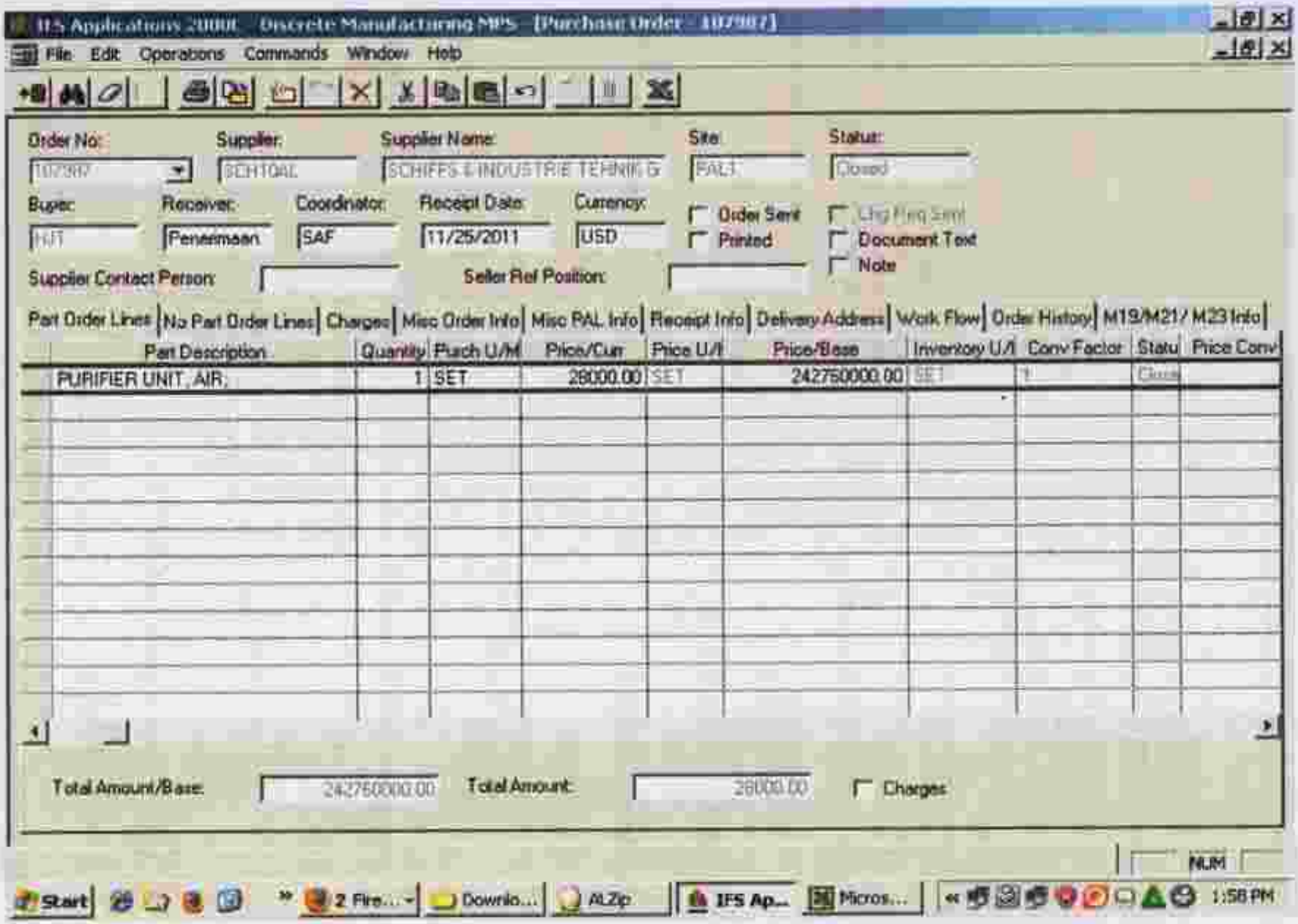
ATTACHMENT - 4
HOMOGENIZER PURCHASE ORDER

PAL INDONESIA

PURCHASE ORDER

Number : PC 11 HJT 107989
Project Name : Tanker 17.500 LTDW
Project Code : M000272
Final Negotiation : Dated March 07, 2011

1. Place and date of order	: Surabaya, July 29, 2011
2. Company's name, address, contact details	: PT PAL INDONESIA (PERSERO)
- Name	: **HARSUSANTO**
- Address	: Ujung Surabaya, 60155 Indonesia
- Contact person	: Achmad Djuhairi
- Phone	: +62 031 3292275 ext.4000
- Fax	: +62 031 3292426
- E-mail	: adjuhairi@pal.co.id
3. Vendor's name, address, contact details	: Schiffs & Industrie Technik GmbH (SIT GmbH)
- Name	: **EGON STACHE**
- Address	: Wittenmoor 36, 22525 Hamburg
- Contact person	: Egon Stache
- Phone	: +49 040 837061
- Fax	: +49 040 837276
- E-mail	: service@sit-hamburg.com
4. Description of the Goods	: Homogenizer, the detail specification, scope of supply and accessories as mentioned in ANNEX TO ORDER I.
5. Scope of supply shall include :	
- Quantity	: 1 (one) sets / ship as mentioned in ANNEX TO ORDER I.
- Classification	: NK
- Certificate	: NK Class Certificate and related Certificate
6. Price of the Goods (Order Price)	: Total material supplied USD 28.000 (Say USD Twenty eight thousand) per shipset CIF Surabaya Port Incoterms 2000. In this contract PT PAL prohibit vendor to use shipping line as mentioned in ANNEX II
7. Delivery - Delivery Time	: On April 07, 2012 CIF Surabaya port
- Port/ Place of Loading	: Germany Port
- Port of Destination	: CIF Surabaya Port
- Consignee	: PT PAL Indonesia
- Packaging Condition	: As will be adequate for sea-borne export shipment / Seaworthy Packaging.
- Partial shipment/Trans-shipment	: Not Allowed / Not Allowed
- Notice	: Seller shall inform the Buyer of the expected shipment date prior to twenty (20) days of shipment by written.
8. Penalties	: 0,1% per day of Order price for every day of delay on Equipment as Clause 7 and or relevant documents and or relevant service as per clause 10 (document) maximum penalty 10% of Order price.
9. Term of Payment	: 20% Advanced Payment within 14 days after signed the contract against Bank Guarantee 20% and 80% by LC at Sight open 2 months before shipment.


IFS Applications 2000t - Discrete Manufacturing MPS - [Purchase Order - 107307]
File Edit Operations Commands Window Help
Order No:
Supplier:
Supplier Name:
Site:
Status:
107307
SCHTOAL
SCHIFFS & INDUSTRIE TECHNIK G
PAL1
Closed
Buyer:
Receiver:
Coordinator:
Receipt Date:
Currency:
Order Sent
Printed
Chg Req Sent
Document Text
Note
HJT
Peneemann
SAF
11/25/2011
USD
Supplier Contact Person:
Seller Ref Position:
Part Order Lines
No Part Order Lines
Charges
Misc Order Info
Misc PAL Info
Receipt Info
Delivery Address
Work Flow
Order History
M19/M21/M23 Info
Part Description
Quantity
Purch U/M
Price/Curr
Price U/I
Price/Base
Inventory U/I
Conv Factor
Statu
Price Conv
PURIFIER UNIT, AIR,
1
SET
28000.00
SET
242750000.00
SET
1
Close
Total Amount/Base:
242750000.00
Total Amount:
28000.00
Charges
NUM
Start
2 Fire...
Downlo...
ALZip
IFS Ap...
Micros...
1:56 PM

ATTACHMENT - 5
S.I.T. HOMOGENIZER

OPERATION MANUAL
FINAL DRAWING

CD92™ Mycronizer
MD - MagneticDrive

CD92™ Type:	85-M-MD/SR-IL
Application:	Sludge Reduction - In Line
Ser.-No:	12-1605
Year:	2012
Customer:	PT. PAL Indonesia (Persero)
Plant/Vessel:	HN 272

S.I.T

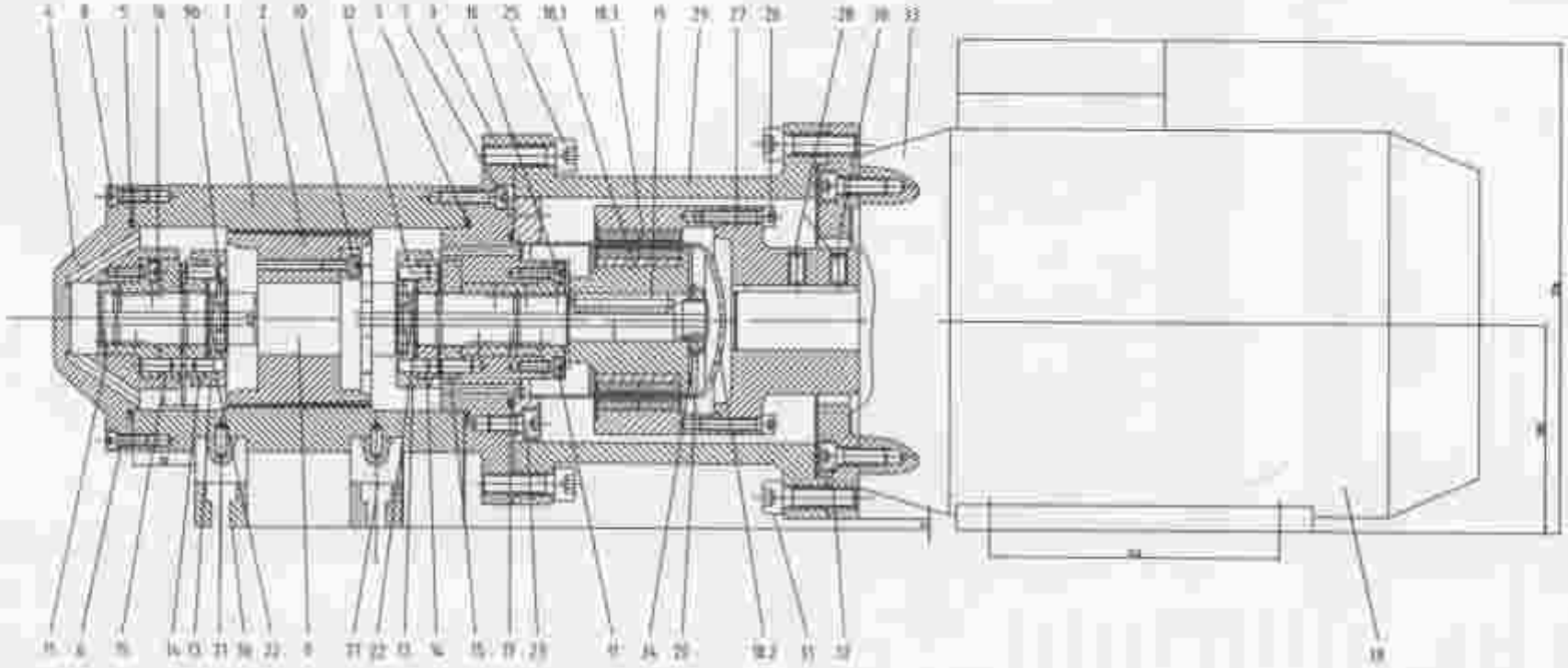
NEW ADDRESS
Friedensallee 128
22763 Hamburg

S.I.T - SchiffS-&IndustrieTechnik GmbH
Wittenmoor 38 - D-22525 Hamburg / Germany
Phone: +49(0)40 - 837061 - Fax: +49(0)40 - 837278 - e-Mail: service@sit-hamburg.com - www.sit-hamburg.com

Table of Contents

CD92-MD (Magnetic Drive) MYCRONIZER

S.I.T



1	Stator
2	Rotor
3	Bearing support R
4	Bearing support F
5	O-Ring (2x 88x3 Vi)
6	Hexagon socket screw (2x M8x20 A2)
7	Hexagon socket screw (6x M8x25)
8	Hexagon socket screw (2x M6x20)
9	Shaft
9a	Slotted pin (4x 4x10)
10	Hexagon socket screw (6x M6x16)
11	Bearing bush (2x)
12	Pin (4x 6x16)
13	Support ring (2x)
14	Thrust disk - Static (2x)
15	Thrust disk - Dynamic (2x)
16	Hexagon socket screw (6x M6x12 VZ)
17	O-Ring (75x3 Vi)
18	Magnetic coupling
18.1	Magnet - Static
18.2	Can
18.3	Magnet -Dynamic
19	Key (8x35)
20	Shaft nut (KM4 M20x1,5)
21	Hexagon socket screw (4x M8x55)
22	Retaining ring (2x DIN 471 - 25 mm)
23	Hexagon socket screw (8x M8x16 VZ)
24	
25	
26	Hexagon socket screw (8x M6x25 VZ)
27	Coupling half
28	Threaded pin (2x DIN 913 M8x16)
29	Lantern
30	Intermediate flange
31	Hexagon socket screw (4x M10x35 VZ)
32	Hexagon socket screw (4x M8x20 A2)
33	Bracket
34	Tab washer (M04)
35	Connection flange (2x)
36	Support (2x)
37	Connection flange
38	Hexagon socket screw (4x M6x55)
39	E-Motor
40	Serrated lock washer (8x M8)
41	Spring lock washer (4x Gr. 6)
42	Spring lock washer (4x Gr. 10)

Stifte und Schrauben in Schnittebene gedreht
pins and screws are turned into section

CD92-85-M					
				Mycronizer 85 - M-MD	
			S-I-T	Mycronizer	
				CD92-85-00-M-MD	

S.I.T Schiffs- & Industrie Technik GmbH
Telefon: +49 (0)40 83 70 61
Telefax: +49 (0) 40 83 72 19
Finkenstieker 12a
22763 Hamburg

Einzelbauteile / Single Parts
Mycronizer
CD92-85-M-MD

S·I·T

Pos. Item	Artikelbezeichnung Designation	Beschreibung Description	Stück Quantity	Teil ID-No. Part ID-No	DIN DIN
1	Stator	St 1.0570	1	ST-02-07	DIN 17 350
2	Rotor	St 1.0570	1	RT-02-07	DIN 17 350
3	Lagerträger K / bearing support K	St 1.0570	1	LTK-01-06	DIN 17 100
4	Lagerträger F / bearing support F	St 1.0570	1	LTF-01-06	DIN 17 100
5	O-Ring	IDP88x3Vi	2	OR-06-05	
6	Inbusschraube / hexagon socket screw	IBH M6x20A2	4	IS-06-05-620	
7	Inbusschraube / hexagon socket screw	IBH M6x25	4	IS-06-05-625	
8	Inbusschraube / hexagon socket screw	IBH M6x20	4	IS-06-05-620	
9	Welle / shaft	42CrMo4V	1	WS-02-07	
9b	Kerbstift / slotted pin	IUE 4x10 A2	4	KS-06-05-410	
10	Inbusschraube / hexagon socket screw	IBH M5x12VZ	6	IS-06-05-1035	
11	Lagerbuchse / bearing bush	CuAl10Ni5Fe4	2	LBa-06-05	DIN 17 865
12	Stift / pin	IGF 6x16	4	S-01-06-616	
13	Stützring / support ring	St 1.0570	2	STR-01-06	
14	Anlaufscheibe / thrust disk - Static	Carsic 310	2	AS-06-05-S	
15	Anlaufscheibe / thrust disk –Dynamic	Carsic 310	2	AS-0605-D	
16	Inbusschraube / hexagon socket screw	IBH M8x16VZ	6	IS-06-05-425	
	Anschlußflansch / connection flange	St 1.0570	2	AF-01-06	DIN 17 100
	Inbusschraube / hexagon socket screw	IBH M6x50	4	IS-01-06	
17	O-ring	IDP 75x3Vi	1	OR-06-05-753	
18	Magnetkupplung / magnet coupling	Minex SB 75/19	Set	MK-06-05-75	
18.1	Magnet Statisch / magnet static	Included			
18.2	Spalttopf / can	Included			
18.3	Magnet Dynamisch / magnet dynamic	Included			
19	Paßfeder / key	DIN 6885–A6 6x32	1	PF-12-05-632	
20	Wellenmutter / shaft nut	KM4 M20x1.5	1	NM-06-05-2015	
21					
22	Sicherungsring / retaining ring	DIN 471 – 25mm	2	SR-06-05-25	
23	Inbusschraube / hexagon socket screw	IBH M8x16 VZ	12	IS-06-05-816	
24	Inbusschraube / hexagon socket screw	IBH M8x45VZ	8	IS-06-05-845	
25	Inbusschraube / hexagon socket screw	IBH M10x45A2	4	IS-06-05-1045	
26	Inbusschraube / hexagon socket screw	IBH M5x30VZ	4	IS-06-05-630	
27	Kupplungsnabe / coupling hub	AlMgSi1	1	KN 02-07	
28	Gewindestift / threaded pin	DIN 913 M8x16	2	GS-06-05-816	
29	Laterne / lantern	AlMgSi1	1	LL-02-07	
30	Zwischenflansch / intermediate flange	AlMgSi1	1	ZF-02-07	
31	Inbusschraube / hexagon socket screw	IBH M10x45VZ	4	SKS-03-05-1235	
32	Inbusschraube / hexagon socket screw	IBH M8x25A2	6	IS-06-05-825	
33	E-Motorflansch / bracket	Electric Motors	1		
34	Sicherungsblech / tab washer	DIN 5406 MB 4	1	SB-06-05-20	
35	Motorkonsole / motor foundation	L 75 x 50	1	MK 12-06	DIN 1725 T2
36	Gerätefuß / support	AlMgSi1	1	GF 12-06	DIN 1725 T2
37	Anschlußflansch / connection flange	St. 1.0570	2	AF-01-06	DIN 17 100
38	Inbusschraube / heagon socket screw	IBH M8x60	8	IS 03-05-860	
39	Drehstrommotor / E-Motor	A3AA 100 L	1		

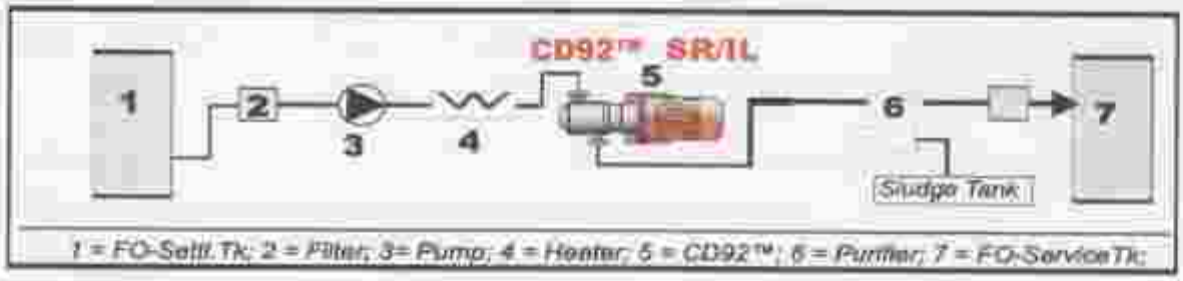
Ersatzteile / Spare parts – Makers Stand.

	Artikelbezeichnung Designation	Stück Quantity
5	O-Ring	2
11	Lagerbuchse / bearing bush	2
13	Stützring / support ring	1
14	Anlaufscheibe / Thrust disk – Static	1

Pos. Item	Artikelbezeichnung Designation	Stück Quantity
15	Anlaufscheibe / Thrust disk – Dynamic	1
16	Inbusschraube / hexagon socket screw	6
17	O-Ring	1
22	Sicherungsring / retaining ring	1

START-UP PROCEDURE

CD92™ SR-UNIT / In Line



For safe operation please follow this guide:

		OK
1.	Check running lights and current availability in switchboard	☐
2.	Open in-/outlet valves	☐
3.	Deliver pre-warmed fuel to mycronizer	☐
4.	Temperature should not be less than **70°C for HFO, 40° for MDO**	☐
5.	When unit in operation rise up pressure	☐
6.	If operating temperature HFO, MDO or magnet is above 150°, plant stops automatically for safety reason	☐
7.	Start the unit by pressing the green start button	☐
8.	Load indication:	
	if 22 KW = abt. 17-19 Amp.	☐
	if 11 KW = abt. 9-12 Amp.	☐
	if 7,5 KW = abt. 8-10 Amp.	☐

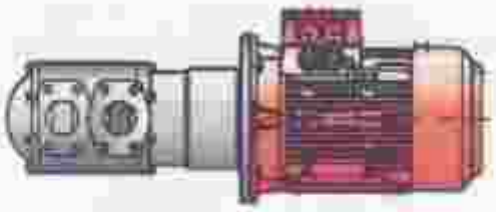
If everything is in operation

adjust the flushing interval of purifier stepwise to maximum. Sludge amount is a function of the flushing adjustment. Extended intervals (less flushes/day) reduce the sludge formation.

Remarks:

The CD92™ M-MD is fitted with thrust disk out of silicium – system for long term trouble-free operation.

If in port supply pumps should be stopped, make sure that mycronizer also taken out of operation. Danger of overheating by rotating of unit in own fuel.



Schiffs- & IndustrieTechnik GmbH

Phone: +49 (40) 83 70 61

E-Mail: service@sithamburg.com

Updated: 23.02.2016

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Schiffs- & Industrie Technik GmbH

MAINTENANCE - CD92™-UNITS

No. 1 – CD92-SR (Sludge Reduction)
No. 2 – CD92-CI (Combustion Improvement)
No. 3 – CD92-WIDE (Water-In-Diesel/Fuel-Emulsification)
No. 4 – CD92-WOR (Waste-Oil-Regeneration)

How to maintain CD92-fuel conditioning units:

1. **START UNIT:**
   - Check running lights at switchboard, current available
   - Check load on amp. meter
   - Start internal supply pump
   - Check fuel pressure by opening both inlet and outlet valves slowly
   - When finished switch selection, switch to position ***AUTO***.
   - Start-up temperature of **min. 65-70° C** is reached

2. **FLUSHING INTERVALS**
   - **Purifier:** Adjust flushing intervals depending on oil quality up to 3 hours or max. 4 hours
   - **CD92-WOR-Plant only:** adjust timer in switchboard up to 3 hours circulating period.

3. **REPAIR / CLEANING**
   Open unit after approx. 8.000 hours for service resp. cleaning purpose.
   - check condition of bushes
   - clean rotor micronizer
   - clean inner magnet and can
   - clean inner and outer magnet.
   - Flanges are sealed by o-rings. After opening of unit at least o-rings have to be renewed incl. o-rings in flanges.
   - Thrust disks to be handled with care
   - For allover cleaning of unit use preferrably diesel oil respectively petroleum.

4. **In case of repairs to main engine, please stop micronizer,**
   this in order to avoid overheating or dry-run.

5. **If during first start up NOISE observed, stop unit.** Reason can be insufficient oil flow in unit caused by too low temperature and disturbed heat transfer.

6. **Avoid stress to pipe connections.**

Quotation from Shell Brochure "Bunker Quality":
"The mechanism of blending process itself is equally important. The components must be ***completely homogenised*** *and this is* ***extremely difficult*** *to achieve without suitable efficient blending equipment" – in our case:* ***only with CD92-M-unit.***

Issued: March 2006

WIRING DIAGRAM

CD-SR - Sludge Reduction System
Selfling In Line Service

CD92™ Type:	100-M-MD
Power:	11.0 kW (50 Hz) 13.0 kW (60 Hz)

Operating Voltage:	3 x 400/440V / PE / 50/60 Hz
Current Consumption:	max. 21.5 A
Control Voltage:	230 V / 50 Hz
Regulations:	VDE and VBG4 / IP55

Remarks	Temperature Control must be installed and connected. Otherwise the CD92™ cannot be started

Color Coding:	phase R or U = black phase S or V = black phase T or W = black Control used = red

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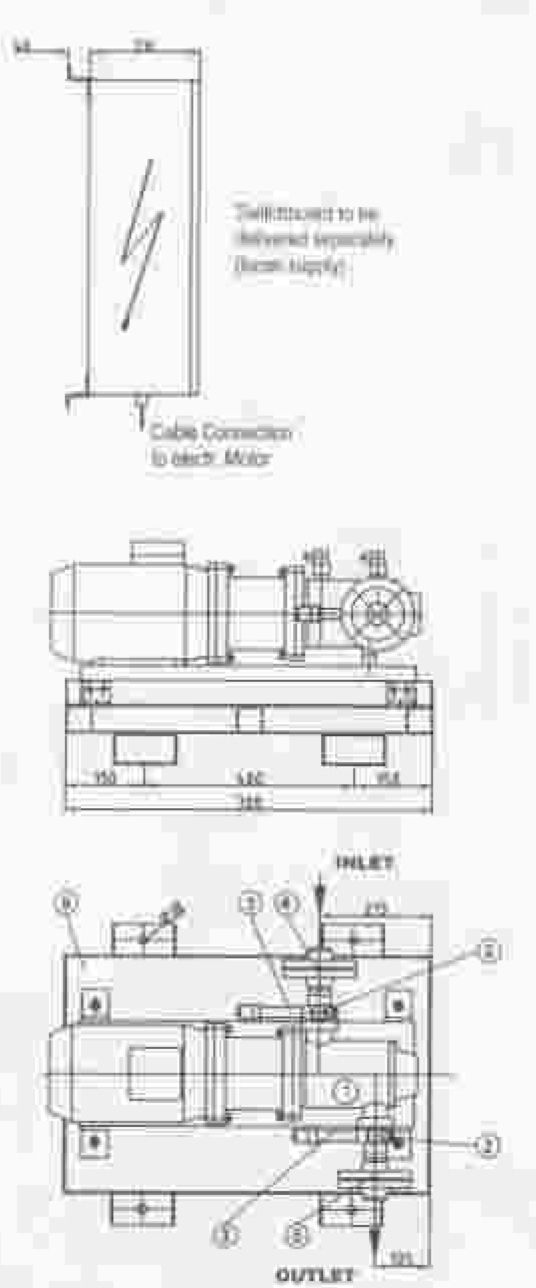
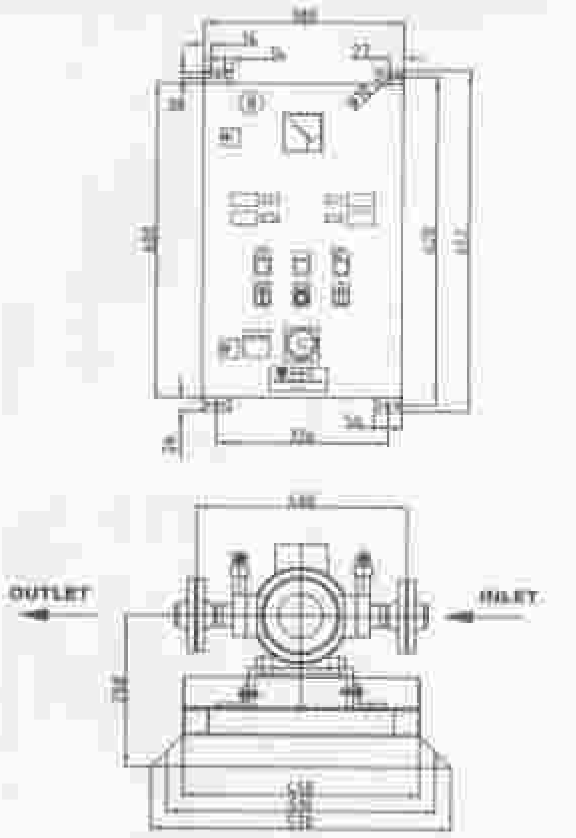
Schiffs- & IndustrieTechnik GmbH

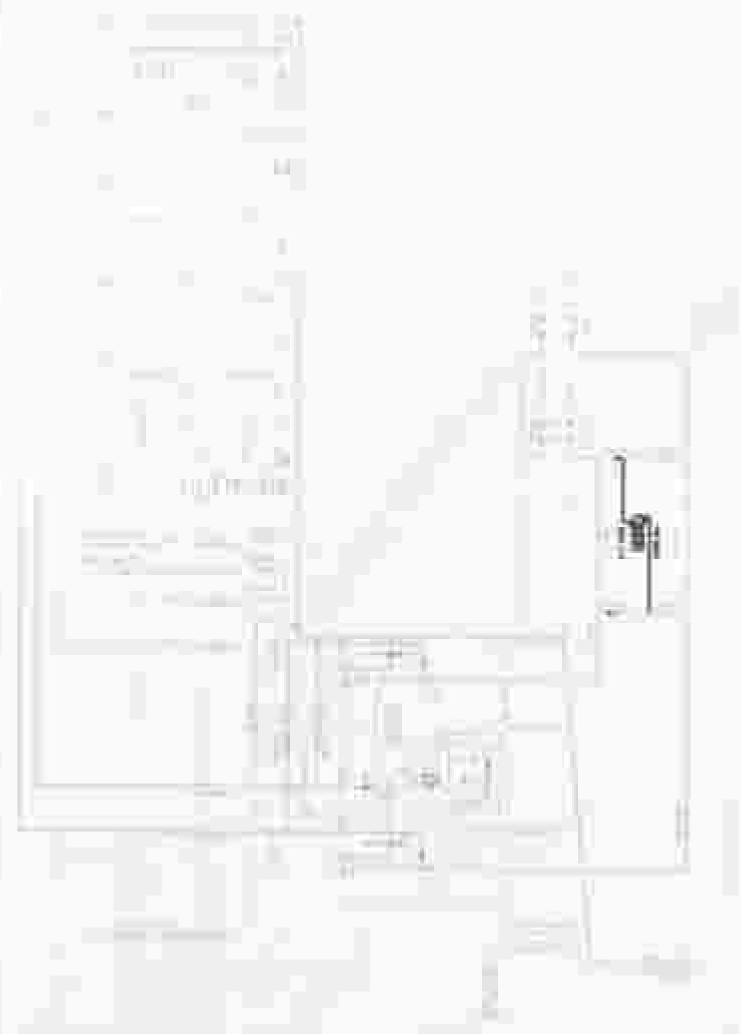
EQUIPMENT LIST

Pos. / Components *(as per System Overview)*		Description / Designation
1 CD92™	Type:	1 x CD92-85-M-MD/SR-IL
	Capacity max.:	< 1.5 m³/h (IFO 700/50°C)
	Operation Pressure:	< 6.0 kg/cm²
2 Electric Motor	Operation Temperature:	< 100 °C
	Power Consumption:	4.0 / 4.5 kW
	Power Source:	400 / 440 V – 50 / 60 Hz
3 Pressure Transmitter	Type:	2 x Electronic type / Fuel IN – OUT 0 – 25.0 kg/cm²
4 Thermometer(s)	Type:	2 x Electronic type / Fuel IN – OUT 0 – 150°C
5 Thermometer	Type:	
6 Inlet Flange	DN / PN: DIN:	32 / 16
7 Outlet Flange	DN / PN: DIN:	32 / 16
8 Switchboard	Operating Voltage:	3 x 400 / 440 V / PE / 50/60 Hz
	Current Consumption:	max. 21.5 A
	Max. Fuse:	40 A
	Control Voltage:	230 V / 50 Hz
	Regulations:	VDE and VBG4 / IP 55
	Dimensions:	600 x 380 x 210 mm
	Final Painting:	RAL 7035
9 Coating	Type:	Primer
10 Final Painting	Type:	Marine Paint, RAL 6019
11 Drip Pan	Type:	SR-Steel St 37 Square pipings 50 x 50 x 2.6 mm
Plant Dimensions	Length:	900 mm
	Height:	540 mm
	Width:	620 mm

FOR GUIDANCE ONLY !







- ☒ Final Drawing
- ☒ Approval Drawing
- ☒ Working Drawing
- ☒ Class NK

Only applicable for S.I.T-CD92™ Mycronizer

Projekt: **PT. PAL - HN 272**

Application: **CD92™ - SR Sludge Reduction - InLine**

PRELIMENARY! ERRORS EXCEPTED / ALL RIGHTS RESERVED!

S.I.T

CD92™ Mycronizer 85-M-MD

CD92™ - SR-System -IL

SIGMARINE BTD

7238

a three pack issue

December 1999
revision of 6-1995

DESCRIPTION

a general purpose gloss paint based on a modified alkyd resin

PRINCIPAL CHARACTERISTICS

- particularly suitable as a finish for topsides, topside deck and deck equipment
- a quick drying, hard, tough, water and weather resistant coating with moderate gloss retention
- can be applied over intact existing conventional systems on Sigmarine undercoat and on suitable primers, such as Sigmarine zinc primer Sigmarine primer 2P or Sigmarine primer RL depending on the system
- good adhesion properties in wet and dry exposure conditions
- this coating is particularly suitable for areas intermittently exposed to water-immersion and atmospheric conditions
- also available with non-skid material (supplied separately) for use on deck surfaces
- certificate for low flame spread; see sheet 1885

COLOURS AND GLOSS

see marine shadecard - gloss

BASIC DATA AT 20°C

Mass density	approx. 1,1 g/cm³
Solids content	approx. 45-49% (colours) - 45% (white) by volume
VOC (supplied)	max. 3,5 lb/gal - 420 g/l
Recommended dry film thickness	35 µm per coat
Theoretical spreading rate	12,8-14,0 m²/l (colours) - 12,7 m²/l (white) for 35 µm
Touch dry after	1 hour at 20°C, 3 hours at 5°C
Overcoating interval	min. 16 hours at 20°C, 24 hours at 5° - 10°C max. no limitations
Shelf life (cool and dry place)	at least 12 months
Flash point	36°C

RECOMMENDED SUBSTRATE CONDITIONS AND TEMPERATURES

- previous coat dry and free from any contamination
- the temperature of the substrate should be at least 3°C above dew point

SYSTEM SPECIFICATION

systems for topsides and topside
systems for superstructure and deck fittings

hybrid sheet 3102
system sheet 3104

WORKSHOP TEST

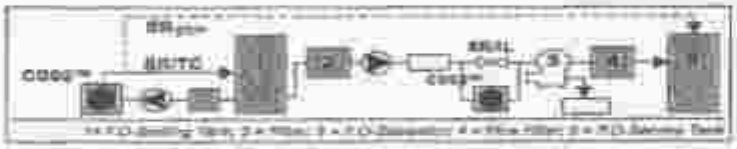
❶ CD92™-SR

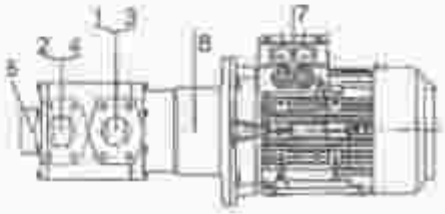
(Sludge Reduction)

S.I.T

Customer:	PT Pel – Indonesia	**Vessel:**	HN 272
Comm. No.:	3.01.1460	**Class Approval:**	yes / no
Month / year:	March 2012	**Delivery Date:**	16.03.2012

Technical Data / Unit	**85-M-MD / SR – IL**			**Serial No:**	**12-1606**
Capacity m³/h:	1,5 m³/h			MDO / HFO :	< 700 cSt - IFO/60° C
E-Motor:	maker: Hanas	kW 4.0 / 4.5	V: 400/440	Hz 50 / 60	RPM: 2.950 / 3.490
HFO Feed Pump:	maker:	type:	cap.:	m³/h KW:	RPM:
Instrumentation:	thermometer / manometer via / elec.			Flow Direct:	out 2-4 / in 1-3
Outfit:	Pipe Ø = 32	SAE Ø = 32		Test Fuel / HFO:	380 IFO / 50°C
				Op. Press. bar:	< 3,0
Test Pressure / bar:	< 18,0			Op. Temp. °C:	< 100





Measurement Points:

1. Fuel Temperature Inlet
2. Fuel Temperature Outlet
3. Fuel Pressure Inlet
4. Fuel Pressure Outlet
5. Sleeve Temperature
6. Magnet Temperature
7. Electrical Load

Date	Time	F.O. Temperature °C		F.O. Pressure bar		Electr. Load Amp.			S.R.U. Purifiers			F.O. Sludge Heating	
		1 in	2 out	3 in	4 out	7			Run. Hour	Flush. Setting ltr.	Flow Setting m³/h	Sludge & Water prod. Ltr./day	Sludge Removal
	1st	88.5	90	4.8	3.2	10.5							
	2nd	108	108	5.0	3.8	10.0							
	3rd	111	111	5.2	4.3	9.8							
	4th												
	5th												

Remarks: Test runs = standard data in workshop, type 100-140-M

Note Start-up temperatures 70°C, avoid dry run!

For your guidance please find attached Performance Record (blank form submitted on CD-ROM).

Stamp: S.I.T / Production

S.I.T
Schiffs-Industrie Technik GmbH
Friedensallee 128
D-22763 Hamburg

Date: 15.03.2012

Surveyor / Class:

Date: 15.03.2012

Remarks: produced acc. Qualification-Nr. ISO 9002 CE IMO 2000 – NOx MARPOL Leg. 73/78

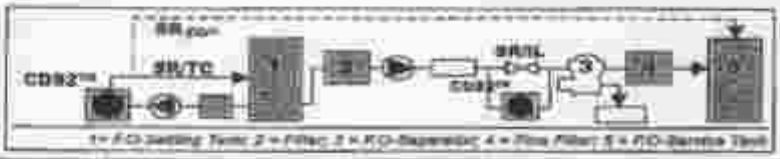
❶CD92™ SLUDGE PERFORMANCE RECORD
CD92™ - SR (Sludge Reduction)

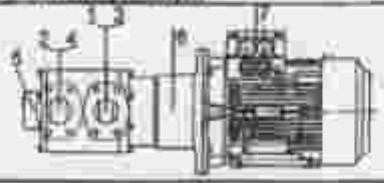
S.I.T

Customer:	PT Pal – Indonesia	Vessel:	HN 272
CD92™ Type:	85-M-MD/SR-IL	Class:	NK
Main Engine:		Output:	kW / BHP

RECOMMANDATION: According to Regulation 20 (4) Marpol 73/78 this table should be kept together with the oil record book.

Technical Data:	CD92™- 85-M-MD / SR-IL			Serial No.:	12-1605
Unit Capacity:	1.5 m³/h			Oil Flow-Direct.:	out 2-4 / in 1-3
E-Motor Maker/Capacity:	Hansa - 4.0/4.5 kW	400 / 440 V		50 / 60 Hz	2.950 / 3.490 RPM
Instrumentation:	Therm./Manom. vis./elec.	Outfit		Pipe Ø 32	SAE Ø 32
Fuel - Type:	HFO / MDO			Hour Counter (total):	





Date	Time	F.O. - Fuel Cons. Q= (m³/+dT	F.O. - Temperature °C		F.O. - Pressure bar				Electr. Load/ amp	F.O. Purifiers		F.O.Sludge-Handling	
		HFO – MDO	1 in	2 out	3 in	4 out	5	6	7	Motor Run Hours per day	Flushes per day	Sludge & Water prod. Ltr / day	Sludge burned/day
01.		/ 380											
02.		/											
03.		/											
04.		/											
05.		/											
06.		/											
07.		/											
08.		/											
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28.		/											
29.		/											
30.		/											
31.		/											
Total													

CONCLUSION
: Total Sludge Produced x100 = % Sludge
Total Fuel Consumption

Remarks :

Date : Signature :

Note : A result below 1% will already be accepted under consideration of German **1%-Clause**

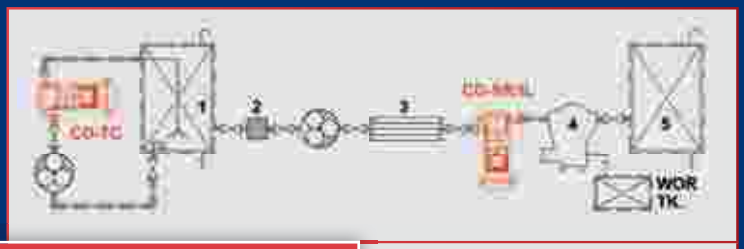
The CD92-SR: "Sludge Reduction System"

No experiments.
Choose the Original.

Meet the permanent rising of Fuel costs!

Protect your budget!
Ask for S.I.T CD92-Homogenizer!

Following see the potential of our CD92-System to reduce fuel costs.



1: F. O. Settl. Tk. 3: F. O. Heater 5: Serv. Tk.
2: F. O. Filter 4: Separator

CD-SR

Fuel Conditioning

The production of F.O. sludge is a direct function of the conventional fuel purification/separation process with regard to the function principle of the used technology, rotor-stator principle.

Conditioning (homogenizing) of the fuel prior to purification is the easiest way to solve this problem. Because of the well balanced fuel structure, the flushing sequences of the purifiers/separators can be extended to the maximum available time, which as a consequence will lead to a reduced sludge production down to less than 20% of the conventional amount.

Fuel conditioning (homogenization) prevents the agglomeration of asphaltenes. The result is that more fuel is passing the separator, which now is remarkable unloaded from the separation process. Considering these facts, fuel conditioning improves the fuel handling from the economic and the ecologic point of view.

Effects & Benefits…

- ☑ Reduced sludge build-up from F. O. Separators and F. O. Filters.
- ☑ Recovery of former sludge disposals as valuable operation fuel for us in both main engine and generator.
- ☑ Reduced bottom layers in F. O. Tanks.
- ☑ Extendable flushing intervals of F. O. Separators and F. O. Filters (reduced maintenance work, reduced spare parts requirements, less displacement of water, stable water seal, easier bowl cleaning, etc.).
- ☑ Installation possible without interference of operation.

Only achievable with CD92-Mycronizer.

The Core of each CD92-system: Different Application, same CD92-Homogenizer.

20 YEARS

With our treatment process we don't add and don't withdraw anything from the fuels. The catfines remain untreated and further on maintained by purifiers and filters.

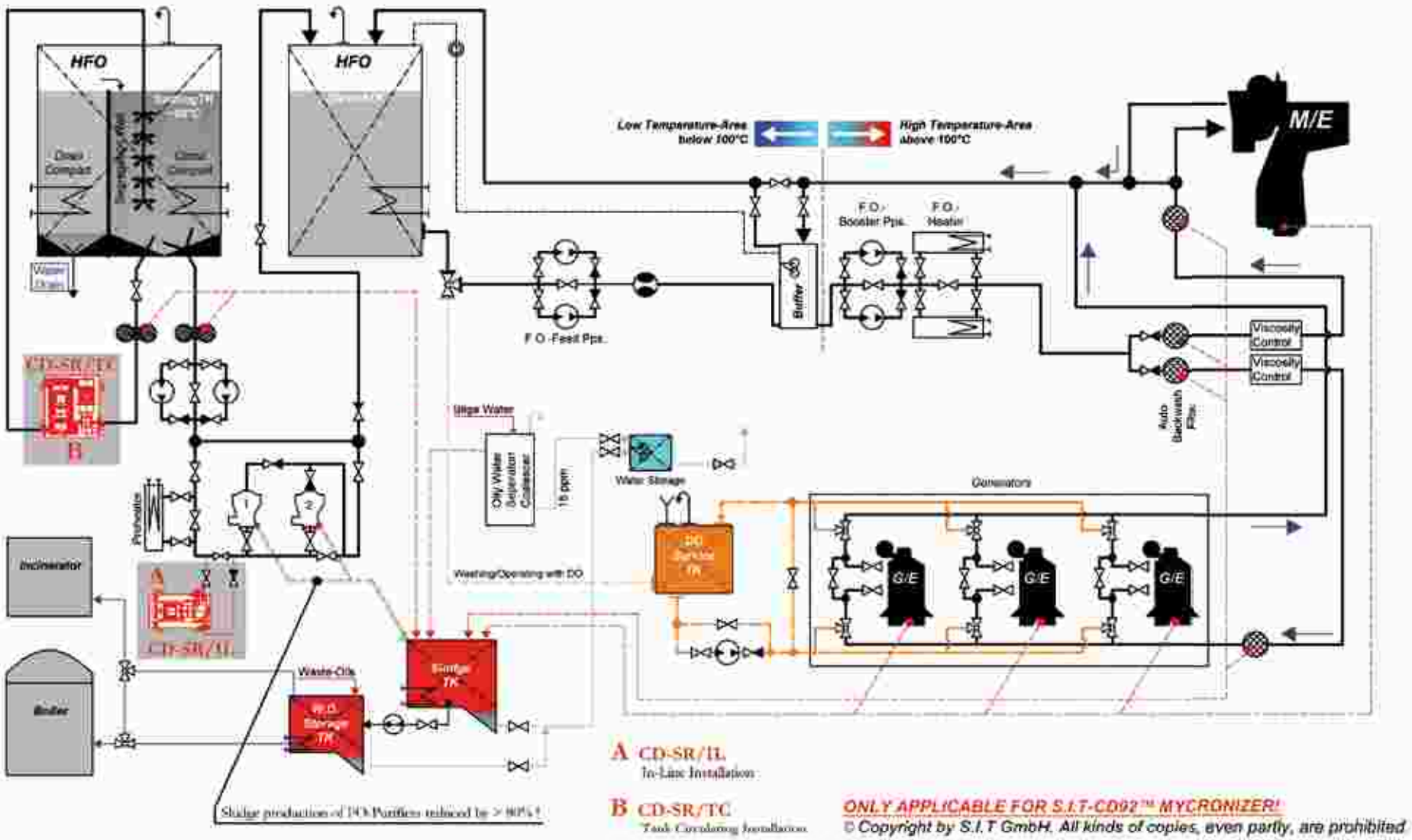
S.I.T establishes a new, improved technical standard in order to be able to continue to guarantee an economic and ecological use of heavy fuel oils in future.

S.I.T systems are approved by class societies ABS & LR and complying with Marpol 73/78, IMO 2000 requirements.

ABS TYPE APPROVAL PROGRAM · Lloyd's Register · MARPOL

S·I·T

The CD92-SR: "System-Description"



S.I.T systems are approved by class societies ABS & LR and complying with Marpol 73/78, IMO 2000 requirements.

ABS TYPE APPROVAL PROGRAM · Lloyd's Register · MARPOL

S·I·T

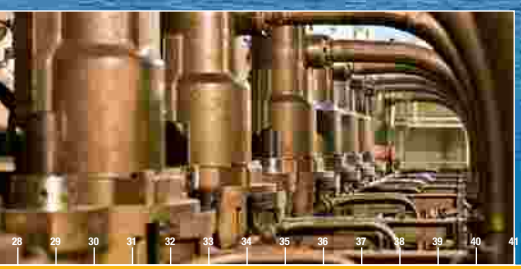
ATTACHMENT - 6
OTHERS HOMOGENIZER BRAND

aqua metro

everything that counts

Homogenizer

Better combustion, less maintenance



Features

- Continuous homogenizing by shearing of asphaltene clusters
- Pure mechanical and no chemical treatment
- Continuous generation of water in fuel emulsion
- Sludge treatment on board

Benefits

- Reduction of sludge
- Increases amount of burnable fuel
- Less wear and tear on engine components
- Individual optimization of combustion process

www.aquametro.com

VD 7-962 e 05.2015

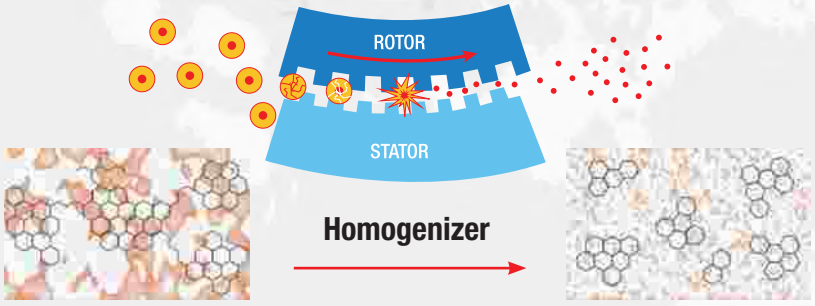
System description

The homogenizer is a dynamic milling machine and it mainly consists of a specially constructed stator / rotor-milling gear to improve the fuel quality as well as to allow sludge treatment on board of sea-going vessels.

- Pure mechanical homogenizing
- Free adjustable clearance between rotor and stator
- Creates long term stable fuel-water emulsion
- Low maintenance

Principle

The Homogenizer operates on the principles of mechanical shearing and ultrasonic forces. It utilizes a special conical shaped milling gear, to generate high hydrodynamic power consisting of shearing, friction and acceleration forces with pressure waves of high frequency. The high molecular asphaltenes are reduced in their size to below 5 µm and homogenized into the heavy fuel oil.



Asphaltenes formed into cotton like strands in residual oil

Asphaltenes are sheared back to approx. 5 µm into a homogeneous blend

Specification and ordering information

Power supply		400/440 V; 50/60 Hz	
Working pressure		max. 15 bar	
Working temperature		max. 150 °C	
Size / Type	**Capacity IFO380** at 130°C (~13cSt) [m³/h]	**Flange (in- /out-let)** DIN/ISO 2633 [mm; bar]	**Art. No.**
Homogenizer HG100	3.0	DN 32; PN 16	94709
Homogenizer HG130	8.0	DN 50; PN 16	94710
Homogenizer HG150	12.0	DN 65; PN 16	94711
Homogenizer HG220	25.0	DN 80; PN 16	94735

Optional control panel / Type	**Art. No.**
Control panel CP100	95191
Control panel CP130	94725
Control panel CP150	94726
Control panel CP220	94734

SALES PARTNER:

HEAD OFFICE:

AQUAMETRO AG
Ringstrasse 75

CH-4106 Therwil
Phone +41 61 725 11 22
Fax +41 61 725 15 95
info@aquametro.com

Aquametro Marine GmbH
Friedrich-Barnewitz-Str. 7

D-18119 Rostock-Warnemünde
Phone +49 381 519 64 88 1
Fax +49 381 519 64 88 2
rostock@aquametro.com

AQUAMETRO ME JLT
Jumeirah Lake Towers
Jumeirah Bay X3, Office 1807
P.O. Box 334132
Dubai / UAE
Phone +971 56 7587 801
info.amme@aquametro.com

www.aquametro.com

AQUAMETRO REPRESENT. OFFICE
Regus Business Centre
Level 3, Neo Vikram
Link Road, Andheri (West)
Mumbai - 400 053 / India
Phone +91 961 901 3282

sales.india@aquametro.com

AQUAMETRO Japan
1-18-4, Nakane
Meguro-ku

Tokyo 152-0031 / Japan
Phone +81 3 3723 8611
Fax +81 3 5729 4607
yasuhiko.takahashi@aquametro.com

AQUAMETRO KOREA LTD
3F, 169, Sameo-ro,
Haeundae-gu

Busan 612-050 / Korea
Phone +82 51 905 55 66
Fax +82 51 905 55 69
aquametro@korea.com

AQUAMETRO (S.E.A.) PTE LTD
190 Woodlands Industrial Park E5,
#08-17 Woodlands BizHub

Singapore 757516 / Singapore
Phone +65 6899 1980
Fax +65 6899 2972
customersupport@aquametro.com.sg

AQUAMETRO (CHINA) PTE LTD
Sales Office
190 Woodlands Industrial Park E5
#08-17 Woodlands BizHub
Singapore 757516 / Singapore
Phone +65 6899 1980
Fax +65 6899 2972
sales.china@aquametro.com.sg

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A0.2 - 05.2015 - Art. Nr. 12088

JOWA TECHNOLOGY AB

TO WHOM IT MAY CONCERN

Service letter, June 2011

Product presentation:

JOWA - HOMOGENIZER

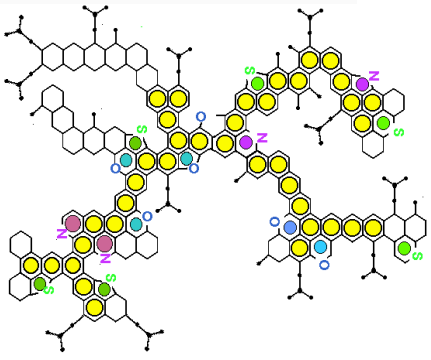
Today's challenge:

"It's all about asphaltenes in fuel. …"

Core problem:

Residual fuel has a high concentration of asphaltenes, which contributes to a wide range of combustion problems and undesirable combustion by-products.

Asphaltenes are special problematic parts in fuel, because of large and heavy combustible hydrocarbon components, which are often insoluble.



Typical structure of asphaltenes

Long asphaltenes chains in fuel have the tendency to cluster into big particles even over 100µm in size.

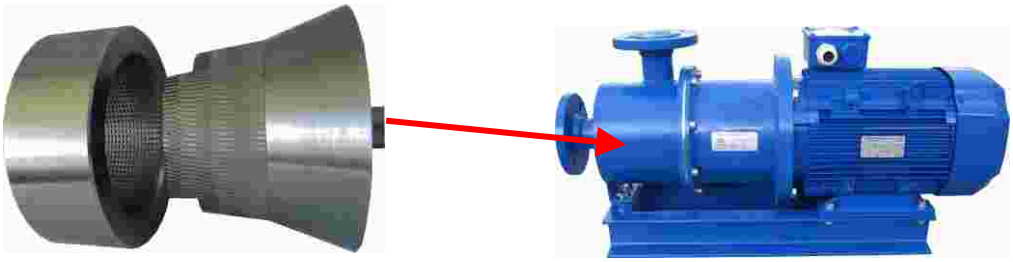
These big particles consist of complex high calorie combustible hydrocarbons yet are unusable in this phase due to their size.

Filters will remove these asphaltenes cluster and will unnecessary clog finally.

Non- homogeneous fuel with a high amount of asphaltenes cause incorrect injection with non-uniform spray pattern resulting in incomplete and bad combustion.

JOWA TECHNOLOGY AB

ONLY technical solution* JOWA - HOMOGENIZER*:



JOWA - HOMOGENIZER is a dynamic fuel milling machine.

Between conical shaped grinding surfaces of rotor and stator fuel is exposed to hydrodynamic shearing and friction forces.

In result the high molecular asphaltenes in fuel will be milled to a well balanced homogeneous fuel, with particles of about 5µm in size.

Operational advantages:

Pre-treatment of fuel results in a smooth combustion, which will lead to much cleaner engine parts.

Life time of filters and fuel parts will increase drastically.

Combustion will be more complete which results in less deposits and smoke free exhaust.

These operational advantages will affect a very fast return of investment together with decreased maintenance costs.

JOWA – HOMOGENIZER can therefore be considered as a welcome addition in a fuel system both from technical and commercial viewpoint.

Summary:

- reduces sludge output
- improves combustion
- reduces wear and tear on engine parts
- reduces deposits on exhaust pipes and funnels

"It's all about asphaltenes particle size in fuel. …

Fuel treatment with **JOWA - HOMOGENIZER** *is the most efficient way to reduce these."*

FUEL TREATMENT SYSTEMS

HOMOGENIZER SYSTEM

OPTIMIZE YOUR COMBUSTION

With fuel oil often accounting for more than 40% of a vessels operation costs, efficient combustion is of crucial importance. Furthermore, fuel oil quality can have serious long term implications for engine wear and it's associated costs.

The Homogenizer has been specifically designed to solve the uniformity problems ship owners and operators face when running on heavy fuel oil. There is no better chemical-free approach for best treatment of heavy fuel oil, water-in-fuel-emulsion and sludge.

The equipment incorporates a hermetically sealed magnetic coupling drive and special hard material combination, suitable for very high pressure and temperature applications.

THE JOWA GROUP

For many decades now, Jowa has been a trusted and reliable supplier of technical environmental protection equipment to the shipping industry. We can offer every conceivable service for installation supervision, operation, monitoring and control of Jowa's equipment. You can choose between our own personnel or one of our trained representatives all over the world.

Sweden
JOWA AB
Tulebovägen 104
S-428 34 Kållered
Sweden
Telephone: +46-31 726 54 00
Telefax: +46-31 795 45 40
website: www.jowa.com
e-mail: info@jowa.se

Norway
JOWA NORGE A/S
Solbergveien 22
3057 Solbergelva
Norway
Telephone: +47-3223 6700
Fax: +47-3223 6701
website: www.jowa.no
e-mail: post@jowa.no

Germany
JOWA GERMANY GMBH
Hansestrasse 21 / Haus 2
18182 Rostock-Bentwisch
Germany
Telephone: +49-381 6302 660
Fax : +49-381 6302 641
website: www.jowa.de
e-mail: info@jowa.de

Netherlands
JOWA HOLLAND
Ebweg 61
2991 LS Barendrecht
Netherlands
Telephone: +31(0)180 55 71 33
Fax : +31(0) 180 61 11 27
website: www.jowa-holland.nl
e-mail: post@jowa-holland.nl

USA
JOWA USA, INC.
59 Porter Road
Littleton, MA 01460
USA
Telephone: +1-978 486 98 00
Fax: +1-978 486 01 70
website: www.jowa-usa.com
e-mail: info@jowa-usa.com

Singapore
JOWA (S) PTE., LTD.
93 Lorong N Telok Kurau #05-04
Singapore 425244
Singapore
Telephone: +65-6872 8802
Fax: +65-6872 8896
website: www.jowa.sg
e-mail: jowaspdk@singnet.com.sg

China
JOWA (Shanghai) Marine Equipment Co.,Ltd.
5111 Luo Shan Road,
Pudong New Area
Shanghai 201204
China
Telephone: +86-21-3390 6889/90/91/92
Fax: +86-21-3390 7550
e-mail: jowasha@jowa.com.cn

China
JOWA (Shaoxing) Enviroment Protection Equipment Co.,Ltd.
3# He Hu Road
Paojiang Industrial Estate
Shaoxing 312071
China
Telephone: +86 575 88179900
Fax: +86 575 88158630

Korea (South)
Jowa Korea Co. Ltd.
1650-6, Song Jung Dong
Gang Seo - Gu
618-819 Busan
South Korea
Telephone: +82-51-831-4911~3
Fax: +82-51-831-4914
website: www.jowakorea.kr
e-mail: info@jowakorea.kr

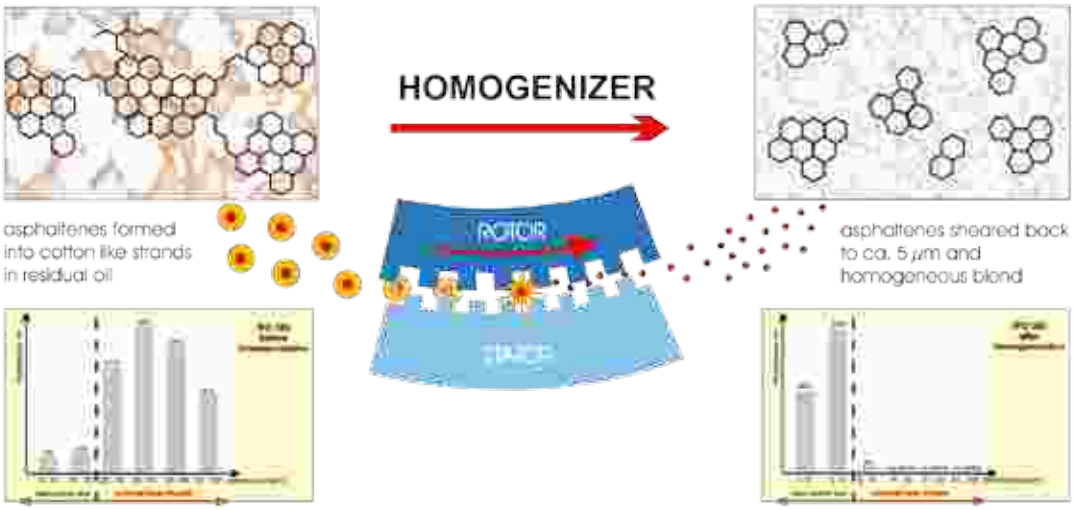
JOWA

Operational Principle

The Homogenizer operates on the principles of mechanical shearing and ultrasonic forces. It utilises a special conical shaped milling gear, to generate high hydrodynamic power consisting of shearing, friction and acceleration forces with pressure waves of high frequency. The high molecular asphaltenes, the existing cat-fines, remaining water etc. are homogenized into heavy fuel oil with maximum particle size of 5 µm.

Main Features

» Reduction of fuel oil sludge
» Increased burnable fuel amount with improved fuel efficiency
» Improved combustion quality and reduced exhaust emissions
» Reduced wear on engine components and reduced operational costs
» For more info see Jowa Germany website www.jowa.de
» Std - cap 5-8 m^3/h



BENELUX, CHINA, SOUTH AMERICA
Ruysch Technical-Agencies Holland BV
Oosterenstraat 3
7203 CM Zutphen
The Netherlands

Mr Hans Ruysch / Mr Jeroen Verwart
Tel +31 575 515 744
Fax +31 575 515 744
agencies@ruysch.biz

CANADA & U.S.A.
Premier Engines
54, Clark Street
Welland
Ontario L3B 5W6

Mr Peter Stevens
Tel +1 905 788 3305
Fax +1 905 788 3833
Peter.stevens@premierengines.com

CYPRUS, SYRIA, LEBANON, UKRAINE
Island Oil
145-149 Dhr. Hadjipavlou Street, 2nd Floor
Christel Building 3036, Limassol
Cyprus

Mr Ian Lurke
Tel +357 2588 0000
Fax +357 2574 5466
ian.l@island-oil.com

FRANCE, ITALY, SWITZERLAND, GREECE, MONACO, MOROCCO
G. D. Supply
Impasse des Lilas II Les Fregates
13340 Rognac
France

Mr Gerard Dawn
Tel +33 44 278 2191
Fax +33 44278 2195
gdsupply@wanadoo.fr

GERMANY
TSG Technischer Service GmbH
Rantzkamp 53
25337 Elmshorn
Germany

Mr Bernd Meyneorg
Tel +49 4121 450 1834
Fax +49 4121 450 1835
tech.serv@t-online.de

SPAIN
TSC Technical Supply Center
Sarobe Kalea 8
20800 Zarautz
Spain

Mr Inaki Urbieta
Tel +34 94 389 6002
Fax +34 94 383 5325
tscurbieta@terra.es

INDONESIA
CV ALPHA OMEGA
Jl. Gubeng Masjid 55
Surabaya 60131
Indonesia

Mr Khun S Wiryasaputra
Tel +62 343 631683
Fax +62 343 631690
khun@cv-ao.com

TURKEY
Kulmar Shipping & Trading
Rihtim Caddesi
Fatih Isham No: 131/1
80090 Karakoy / Istanbul
Turkey

Mr Aykut Sorman
Tel +90 2122529387
Fax +90 2122522378
kulmar@ttnet.net.tr

FTS

FTS – WASTE OIL RE-GENERATION (FTS-R)

Application principle

Waste oil is an inevitable by-product of any ship's installation. This oil is generally a mixture of fuel oil sludge, lube oil sludge, miscellaneous waste oils and water.

One can discharge this mixture onshore. Some choose to mix it with gasoil and use it on board. With the application of a FTS-R unit, the original mixture can be made homogeneous allowing for an excellent combustion in either an incinerator or boiler.

An sludge treatment installation (not supplied by FTS)

Key Benefits

- Further environment unloading
- Large money savings
- Improved fuel efficiency
- Sludge treatment separator maintenance reduction

Turn waste into profit

Waste oil is difficult to burn and to be able to do this it must be mixed 1:1 with expensive gasoil.

This means that burning 1 T of waste oil costs you around € 500.

Using FTS-R will save you instant money!

Fluids with different characteristics are difficult to mix; most oils will float on water for example. The chemical explanation for this is that each fluid has it's own stress or surface tension.

By applying FTS homogenising technique, this stress will be overcome. The result will be a new stable fluid consisting of particles of 2 – 3 micron in average. This fluid can now be well atomised and burned.

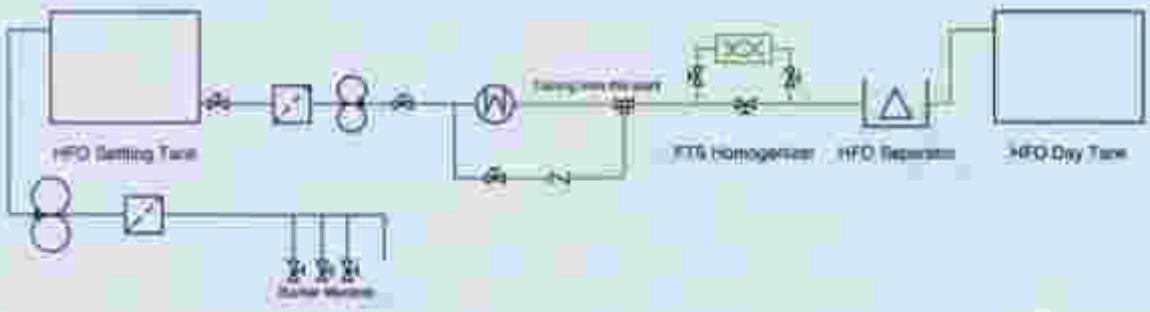
Patented technology

FTS – SLUDGE REDUCTION (FTS-SR)

Installation

FTS offers a system that does not require any substantial modification to the existing fuel system. Everything that is required is supplied into one factory tested skid.
A FTS-S unit is installed right before the fuel oil separator after the feed pump.

An FTS homogeniser can be easily installed. With a standard small footprint each unit can also be tailor made according customer requirements.



Connections

An FTS-SR unit is installed in the circulation loop prior to the engine.

FTS-SR units are available in 5 different capacities ranging from 1 to 25 m³/hr.

Depending on the size a homogenizer requires 3 – 27 kW at 380 / 50 Hz or 440 V / 60 Hz.

A FTS homogeniser complies with all Classification Societies' strict regulations.

FTS

FTS – SLUDGE REDUCTION (FTS-SR)

Application principle

Asphaltene build-up is a process that originates from the refinery yet continuous on board. Asphaltenes, often bound to harmfull solids, are rejected by the separator.

Homogenisation will diminish the size of the asphaltenes while leaving solids unharmed. This ability allows the separator to better distinguish solids from the valuable fuel and therefore improves it's efficiency. Given this improvement, cleaning intervals can be drastically extended.

The use of a FTS-S homogeniser can result in a reduction of sludge by over 80%.
An FTS-S unit will self amortise within 6 to 12 months.

Fuel analysis

Independent analysis of fuel oil samples taken from various points in the fuel treatment system of various ships prove that the use of FTS equipment is not harmful to the system.
In the contrary, it contributes to a better efficiency and reliability.

Key Benefits

- Drastic separator unloading
- Improved separator efficiency
- Large money savings
- Improved fuel efficiency
- Separator maintenance reduction
- Widely accepted

MODERN TECHNOLOGIES

FTS - WATER-IN-FUEL EMULSION (FTS-W)

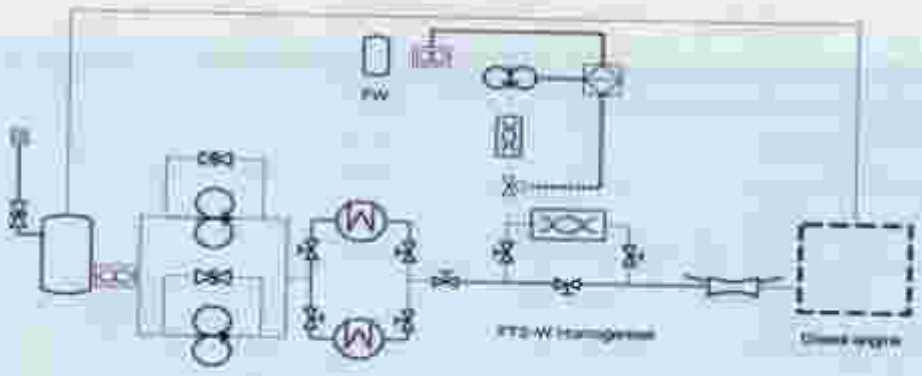
Installation

FTS offers a system that does not require any substantial modification to the existing fuel system. Everything that is required is supplied into one factory tested skid.

An FTS unit can be connected to your existing fresh water system.

To obtain the maximum efficiency while remaining your engine output we advise to perform this installation together with your engine supplier.

Water dosage is very precise due to sophisticated measurement technique.



Water in Fuel ?

The FTS efficiency allows for a prolonged stable emulsion.
No free water will re-appear in the engine.

Connections

An FTS-W unit is installed in the circulation loop prior to the engine.

FTS-W units are available in 5 different capacities ranging from 1 to 25 m³/hr.

Depending on the size, a homogeniser requires 3 – 27 kW of 380 / 50 Hz or 440 V / 60 Hz.

A FTS homogeniser complies with all Classification Societies' strict regulations.

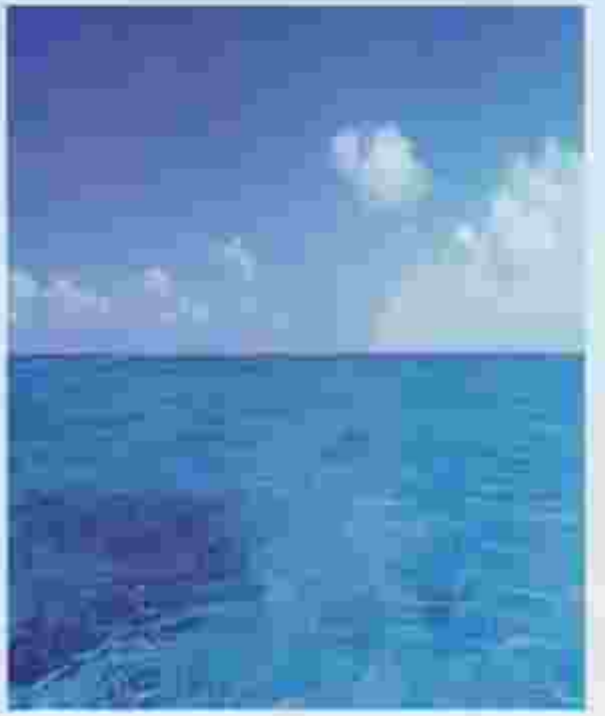
FTS – WATER-IN-FUEL EMULSION (FTS-W)

Application principle

It is a well known fact that by leading water into the cylinder during the combustion the combustion temperature will reduce which will consequently reduce the emission of NOx emissions.

Engine manufacturers have determined that a stable water in fuel emulsion is the most efficient way to establish this.
FTS offers a technique that could result in a reduction of NOx emission by over 20%.

This could be of great help in your attempt to comply with Marpol's Annex VI limitations.



Did you know?

Fuel and water, when mixed, will normally separate due to differences in their specific weight and chemical characteristics.

Homogenisation by FTS results in an emulsion whereby each microscopic droplet of water is encapsulated by a coat of fuel. Surface stress factors have been eliminated, the emulsion will remain stable.

When being injected into the combustion chamber, the water will further enhance the atomisation and improves fuel efficiency.

Key Benefits
- NOx reduction
- Improved engine reliability
- Improved fuel efficiency
- Continuous prolonged engine output
- Reduction of visible smoke
- Extended maintenance intervals
- Widely accepted

NOISE-INTERNATIONAL

FTS

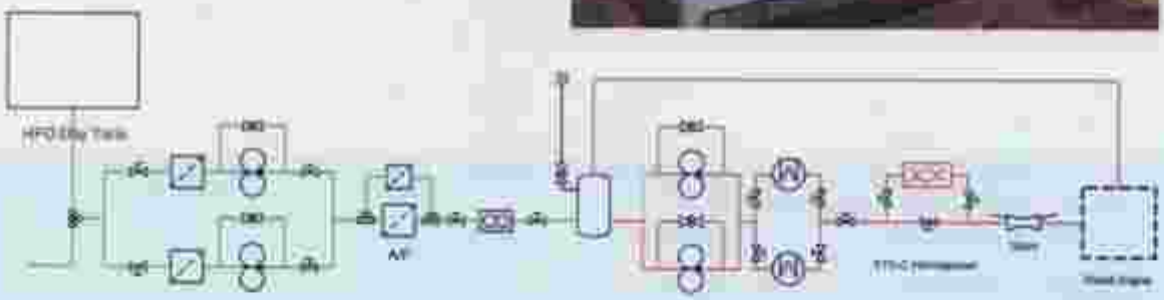
FTS - COMBUSTION OPTIMISATION (FTS-C)

Installation

The FTS Combustion Optimisation unit is small and relatively easy to install, either at new-built or retrofit.

The unit is to be installed in the booster unit, preferably as close to the engine as possible, before the viscosity regulator.

Customers can choose to have the unit incorporated into the booster module. FTS can also supply the unit in a standalone skid.



Connections

An FTS-C unit is installed as close to the engine as possible.

FTS-C units are available in 5 different capacities ranging from 1 to 25 m^3/h.

Depending on the size a homogeniser requires 3 – 27 kW of 380 / 50 Hz or 440 V / 60 Hz.

The unit is connected through flanges. The total build-in space is minimum and will require minor alterations to your piping only.

All FTS homogenisers complies with all major Classification Societies' strict requirements.

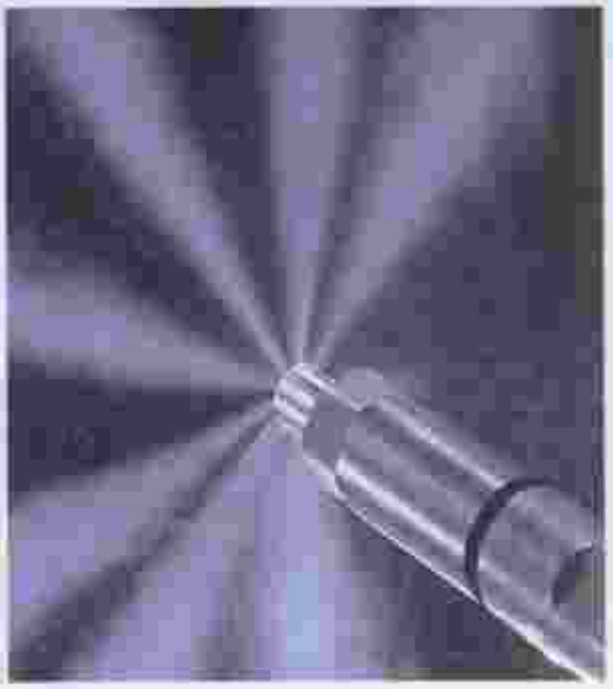
combustion optimisation

FTS - COMBUSTION OPTIMISATION (FTS-C)

Application principle

Variations in pressure and temperature strongly influence the build-up of asphaltenes into large clusters. Although having a high calorific value, these clusters simply can not burn completely.

Homogenisation counteracts this build up allowing for a near perfect atomisation that will result in a smooth and clean combustion.



Compare it to a log of wood on a fire. It will take a while before it is burned. Mill this same log into sawdust and you will get a twice powerful flame.

Recognise any of the following

- Stalling HP pumps?
- Filters clogged on the inside?
- Rapid tube oil fouling?
- General engine fouling?
- Poor turbocharger performance?

Then you are experiencing the consequences of asphaltene build-up.

- This can be effectively solved by applying a simple-to-install low cost FTS – Combustion Optimisation unit.

Key Benefits

- Insensitivity for poor fuel quality
- Improved engine reliability
- Improved fuel efficiency
- Continuous prolonged engine output
- Reduction of visible smoke
- Extended maintenance intervals
- Fast return on investment
- Widely accepted

ENGINEERED MULTIFUEL SOLUTIONS

High precision machining

An FTS homogeniser is based on a rotor / stator principal, both with a special conical shape and machined surface. With 3000 rpm and a clearance of around 50 microns, passing fuel oil will be subjected to high shear force and ultrasonic waves.

It is due to the very high precision machining skills that this process is efficient and durable. FTS offers a 5 year guarantee on rotor and stator.

Treatment efficiency

Homogenisation by FTS equipment is very efficient and by far exceeds any other technique. Simply because it is mechanical, efficiency can be ensured.
No other technique has proven to be equally efficient for treatment of gasoil as well as >700 cSt HFO.

Sealing

Sealing is established by use of a Garlock® patent seal, suitable for temperatures up to 180°C, of which similar types are also being used for bitumen pumps.
The sealing package is triple redundant and insensitive for vibration. Minor preventive maintenance is required no more than once per year.

Reliability

The use of FTS equipment not only improves the installation's system, it's own design is rigid and reliable resulting in a minimum requirement for maintenance.

Range of application

- 2 Stroke & 4 Stroke engines
- HFO and IFO Systems
- Marine & Stationary installations

Return on investment

Only a machine that is efficient is worth investing in. Depending on the application, FTS equipment amortizes within 6 months to 2 years.

Quality control of precision parts at Lohar Kan Fänvecrank

FTS

Homogenisation

The principle of homogenisation is to convert organic particles of various sizes into equal size, therefore homogeneous.

Large (but good) particles are a burden, smaller one's can be fully utilised.
Homogenisation will make you practically invulnerable to the varying non-homogeneous fuel oil quality.

The FTS Homogeniser

An FTS homogeniser reduces the size of all organic soft particles to 2-3 micron.

Harmful solids pass through the FTS homogeniser unharmed.
An FTS homogeniser does not add nor does it extract anything from the fuel.

"Homogenising fuel enhances fuel efficiency"

Acceptance

The advantages of the use of homogenisers are widely recognized by engine manufacturers, classification societies, the International Maritime Organization and many satisfied customers.

FTS Homogenisers are type approved by Germanischer Lloyd.

CAPACITIES

FTS 10	1.000 l / h
FTS 40	4.000 l / h
FTS 75	7.500 l / h
FTS 120	12.000 l / h
FTS 250	25. 000 l / h

FTS

Fuel oil and sludge problems

Emissions

The emission quality depends on the condition of the engine but also on the quality of the fuel. The condition of the engine however is strongly influenced by the quality of the fuel.

The increased horse power to weight ratio of today's engines causes an increase in NOx emission.

Market requirements are in conflict with our attempts to reduce global NOx levels.

Waste oil

Each ship produces fuel sludge of around at least 1% of the daily fuel consumption. Fuel sludge consists of fuel, water, organic sediments and harmful solids like catalytic fines.

Shore disposal

Disposal of sludge at a shore facility can be a costly business. There is no global standard for discharge costs and maximum allowable sludge tank filling. Port authorities' requirements can vary greatly.

Extreme prices are known to have been charged for waste oil disposal at several ports.

"Sludge is more expensive than fuel."

FTS

Today's distillate fuel

The quality of today's intermediate and heavy distillate fuel is an increasing worry for many users. Not only does it vary worldwide, it's price keeps rising as well.

While regulations as stipulated in Annex VI of Marpol 73/78 describe stricter emission limitations, this quality becomes an even bigger worry.

Fuel quality not only worries those with an environmental sense but also those in charge of economics.

"Guarantee Continuous Fuel Quality"

Fuel stability

Distillate fuel is a complex mixture of various fractions. Marine fuel often is a blend of different products. As such it may not always be as stable. Stability stands for the tendency of the various fractions to remain in suspension.

Even when stable, the formation of large clusters of e.g. asphaltenes is a common phenomena. In an unstable fuel, this event grows to be excessive.

Particles can reach sizes over 100 micron in diameter.

On board test of e.g. stability are indicative yet not always conclusive. Shore analysis results are normally not received before departure of the vessel.

Supply chain

Fuel oil quite often contains unwanted waste products that were accidentally added somewhere in the supply chain. One simply can not completely control fuel quality.

FTS

FUEL TECHNOLOGY SYSTEMS

FTS Fuel Technology Systems GmbH

FTS was founded in 2004 as a daughter company of Lothar Kalil Feinmechanik and TSG Technischer Service GmbH, Hamburg. Kalil exists for over 50 years and has over 10 years of experience in the technique of manufacturing homogenizers. TSG has over 10 years of experience in engineering, installation and commissioning of homogenization installations.
TSG has fully developed today's successful water-in-fuel emulsification installation.

FTS designed a new homogenizer: simple, durable and efficient.

With in-house engineering and manufacturing, the highest quality can be guaranteed.

FTS Fuel Technology Systems GmbH
Grandhuthsweg 14
22549 Hamburg
- Germany -
Phone +49 4121 4501831

Technical Workshop Elmshorn
Ramskamp 53
25337 Elmshorn
- Germany -
Phone +49 4121 4501831
Fax +49 4121 4501832

mail@fts-hamburg.com
www.fts-hamburg.com


FUEL TECHNOLOGY SYSTEMS
FTS

CHAPTER V
CONCLUSION AND SUGGESTION

CHAPTER V
CONCLUSION AND SUGGESTION

2.1. Conclusion

Based on study of this research, it can be conclude the research result as follows :

1. To install homogenizer in to MT. Pangkalan Brandan ship fuel system, the folowing item is required : electric motor, pressure transmitter, thermometres, switchboard, coating, final painting, drip pan, and mycronizer part.

2. Over the 10 years life time of homogenizer operation, PT. Pertamina will gain fuel saving value from installing homogenizer. Fuel oil saving value are ; $47.462,1 with fuel oil price decrease 2,93% annually, $52.615,9 with fuel oil price decrease 1,47% annually, $58.185,0 with constant fuel oil price, $89.928,0 with fuel oil price increase 6,7% annually, and $134.975,1 with fuel oil price increase 13,41% annually. Payback period will be obtained within 4 years after operation.

2.2. Suggestion

1. This research can be continued by study the environment benefit from intalling homogenizer in the ship. It has been claimed that homogenizer not only can reduce fuel cost, but also can reduce NOx content, sludge, and other unuseful waste material.

2. This research result will be more accurate if there are provided by homogenizer maintenance history record for 10 years operation. The new instalation of this equipment in MT. Pangkalan Brandan and very few ship in Indonesia

which already install this equipment have lead to lack of information about maintenance record. For the next decade, trend of using homogenizer will be increased, so the maintenance record source can be found more easy and accurate result research can be gained.

3. It's sugested that in the next reseach, in analisys comparing operational fuel oil consumption, precentage of engine load is to be considered. The addition precentage of main engine load will provide more accuracy in operational SFOC calculation and comparison.

CHAPTER VI
REFFERENCES

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REFERENCES

[1]Adnan, Faizul Amri.2014. "Effectiveness of Homogenization Equipment on Very Large Crude Carrier Vessel. MARTEC Conference Paper. **Universiti Teknologi Malaysia.**

[2]Aqua Metro Germany. **Homogenizer Product Brochure**. 2015.

[3]Burak, Stephen, 2004. "Improving HFO Usage by Homogenization, Ashland Speciality Chemical Company". **United State – Ashland Inc.**

[4]CD92-SR S.I.T. **Homogenizer. S.I.T. Homogenizer Product Brochure**. Hamburg Germany.

[5]FO. Purifiying Piping Diagram. Product Oil Tanker 17,500 LTDW Pangkalan Brandan. **PT. PAL Indonesia**. 2012.

[6]Fuel Technology Systems . FTS Homogenizer Brochure. **FTS Fuel Technology Systems GmbH.** Elmshorm Germany.

[7]I Made Ariana, Nishida O, Fujita H, Harano W And Fujio M. 2006. Removal of Marine Diesel Particulate Matter by Electrostatic Precipitator. **Maritime Science – Kobe University.** 10th ICESP-X. Cairns-Australia.

[8]JOWA Group Sweden. **Homogenizer System Reference Manual.** 2009.

[9]Monthly Report. MT. Palusipat Engine Log. **Shipping-Marketing & Trading Directorate PT. Pertamina (Persero).** 2016.

[10]Monthly Report. MT. Pangkalan Brandan Engine Log. **Shipping-Marketing & Trading Directorate PT. Pertamina (Persero).** 2016.

[11]Operational Manual Final Drawing. 2012. CD92TM Mycronizer MD – Magnetic Drive. **S.I.T. – Schiffs- & IndustrieTechnik GmbH.** Hamburg Germany.

[12]Purchase Order S.I.T. Homogenizer PC 11 HJT 107989, PT PAL Indonesia (Persero) - Schiffs Industrie Technik (SIT GmbH). **Logistic Division PT. PAL Indonesia (Persero)**. 2011.

[13]Rischmann, Jürgen. 2006. "The Role of the Homogenizer in Modern Shipping". **Lloyd's Register Technical Association**. Lloyd's Register.

[14]Semin and Rosli Abu Bakar. 2007. A Technical Review of the Future Internal Combustion Engines. **Faculty of Mechanical Engineering, University Malaysia Pahang.** MARINE Vol.4 ISSN: 0216-9886.

[15]Sertifikasi Klasifikasi Mesin. Pangkalan Brandan. **Biro Klasifikasi Indonesia**. 2015.

AUTHOR BIOGRAPHY

BIOGRAPHY OF AUTHOR

Author was born in Purworejo, Central Java in 10th October 1994 with father Mr. Suprihono and mother Mrs. Ernawati. Author is second son of three sibblings. In 2000, author study elementary school in SD N 1 Pangenrejo and graduated in 2006. Then author continue the study in junior high school SMP N 2 Purworejo, and graduated in 2009. Author then continue study in senior high school SMA N 1 Purworejo and graduated in 2012. After graduated from senior high school, author move to surabaya and continue to pursue higher education in Double Degree Programme in Marine Engineering Department, Faculty of Marine Technology, Institut Teknologi Sepuluh Nopember, Surabaya. Author specialized his field study in Marine Power Plant. During study in college, author has actively contribute college organization and voluntered in social activities outside college. In the second year author serve as vice president of UKM Catur ITS, become president in third year, and serve as Coordinator of Board Advisor Council in fourth year. In HIMASISKAL, author serve as staff of Public Relation Department in second year, and head division of PSDM Department in third year. In LMB ITS, author serve as staff of PSDM Department in second year and serve as Coordinator of Sport

Organizations Council in fourth year. Author also volunteered as voluntary teacher fo Lentera Harapan (NGO) in Dolly, Surabaya, from second year to fouth year. In field experience, author has been conducting On Job Training in PT. Daya Radar Utama – Jakarta in 2014, in PT. Pertamina (Perkapalan) – Jakarta in 2015, In PT. General Electric (Alstom) Indonesia – Surabaya in 2016, and intership in National Ship Design and Engineering Centre from 2014 to 2015. In 2014 author awarded as 2nd Finalist of Climater-Smart Leaders Programme, Indonesian Foundation for Sustainable Development. Author completed his bachelor engineering study of marine engineering in 8 semesters.

Muhammad Lutfi Pragola Putra
Student of Marine Engineering Department, FTK – ITS
lutfi.pragola.putra@gmail.com.