BACHELOR THESIS & COLLOQUIUM – ME141502

MODIFICATION SYSTEM OF EXISTING BALLAST SYSTEM BY APPLYING ELECTROLYSIS METHOD AS A BALLAST WATER TREATMENT ON MV SINAR SABANG

Aditya Prabowo

NRP. 04211441000039

SUPERVISOR :

Ir. Hari Prastowo, M.Sc.

Dr. Eng. TrikaPitana, ST., M.Sc.

DOUBLE DEGREE PROGRAM

DEPARTMENT OF MARINE ENGINEERING

FACULTY OF MARINE TECHNOLOGY

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SKRIPSI – ME141502

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Aditya Prabowo

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APPROVAL FORM

MODIFICATION SYSTEM OF EXISTING BALLAST SYSTEM BY APPLYING ELECTROLYSIS METHOD AS A BALLAST WATER TREATMENT ON MV SINAR SABANG

BACHELOR THESIS

Submitted in fulfillment of the requirement for the degree of Bachelor in Engineering

at

Marine Operation and Maintenance (MOM) Laboratory

BachelorProgram Departmentof Marine Engineering

Faculty of Marine Technology

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DECLARATION OF HONOR

I hereby who signed below declare that :

This bachelor thesis has written and developed independently without any plagiarism act, and confirm consciously that all data, concepts, design, references, and material in this report own by Marine Operation and Maintenance (MOM) in Department of Marine Engineering ITS which are the product of research study and reserve the right to use for further research study and its development.

Name	: Aditya Prabowo
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Bachelor Thesis Title	: Modification System of Existing Ballast System by Applying Electrolysis Method as A Ballast Water Treatment On Mv Sinar Sabang
Department	: Marine Engineering

If there is plagiarism act in the future, I will fully responsible and receive the penalty given by ITS according to the regulation applied.

Surabaya, July 2018

Aditya Prabowo

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MODIFICATION SYSTEM OF EXISTING BALLAST SYSTEM BY APPLYING ELECTROLYSIS METHOD AS A BALLAST WATER TREATMENT ON MV SINAR SABANG

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ABSTRACT

Water Ballast is the sea water intentionally incorporated into the ship that has a function to keep the stability of the ship. Ballast water systems has a function to be able to stable the ship position in steady state or trim condition. Sea water that used as ballast contains a variety of organism such as bacteria, viruses, and various larvae of animals and marine plants. Although most organism can not survive when ballast water discharged from vessel, other organism may can survive and adapt in new habitat. Survivable organism can cause ecological, economic, and public health problems when these new species survive and become major species in the new environtment.In Marine Environment Protection Committee (MEPC) 71th discussed about the implementation of the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention), 2004, which will enter into force on 8 September 2017. As one of countries that ratified the BWM convention, all ship operator in Indonesia must prepare themself to comprises with of this convention. This thesis purposes is to create a design of a ballast water treatment plant using electrolysis method which will be implemented on the ship. To design a ballast water treatment plant, several consideration need to be calculated and determined to achieve the most cost-efficient and performance-efficient. After selecting the fitted ballast water treatment, it followed by redesign of ballast water system, then the system can be operated perfectly. Based on the results of this final project. The installation cost of techcross ballast water treatment around $ 203.597, within 20 weeks service schedule.

Keywords: Electrolysis, Ballast Water Treatment system, Installation

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MODIFIKASI SISTEM AIR BALLAST DENGAN MENGAPLIKASIKAN ELEKTROLISIS BALLAST WATER TREATMENT PADA KAPAL SINAR SABANG

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ABSTRAK

Air ballast adalah air laut yang sengaja dimasukkan ke dalam kapal untuk menjaga fungsi stabilitas kapal. Fungsi air ballast adalah menjaga agar posisi kapal tetap dalam kondisi trim.Air balllast yang digunakan mengandung berbagai macam organisme seperti bakteri, virus, berbagai macam larva binatang dan tumbuhan laut. Meskipun hampir semua organisme tidak dapat bertahan hidup ketika air ballast dipompa keluar dari kapal. Organisme yang masih bertahan hidup dapat menyebabkan masalah ekologikal, masalah ekonomikal, dan masalah kesehatan publik ketika spesies ini menjadi spesies mayor di lingkungan yang baru. Di dalam marine environtment protection committee (MEPC) yang ke-71 mendiskusikan tentang implementasi dari International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention), 2004, yang akan diimplementasikan pada tanggal 8 september 2017. Sebagai salah satu negara yang meratifikasi konvensi BWM, semua operator kapal di indonesia wajib mempersiapkan diri untuk menghadapi konvensi ini. Tugas akhir ini bertujuan untuk merancang perawatan air ballast pada kapal dengan menggunakan metode elektrolisis. Beberapa syarat perlu diperhitungkan serta ditentukan untuk mencapai efisiensi yang maksimal baik secara biaya maupun performa. Setelah memilih elektrolisis air ballast treatment, dilanjutkan dengan mendesain ulang air ballast sistem sehingga dapat berfungsi sempurna. Berdasarkan hasil dari tugas akhir ini, didapatkan harga instalasi perawatan air balllast merk techcross memerlukan biaya sekitar $ 203..597, dengan penjadwalan 20 minggu.

Kata kunci: Elektrolisis, Perawatan sistem air ballast, Instalasi

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PREFACE

All praise the authors say into the presence of God Almighty, who has provided his grace so that the author can complete this thesis. This thesis is supposed to fulfill the Bachelor Thesis course at authors study and also be hoped that authors gain more information regarding this thesis in the future.

The authors would like to say thanks for those who helped the author in the making of the thesis.

1. Author's beloved parents and sister, who always give prayer and support to the author.
2. Dr.Eng, M. Badrus Zaman, S.T., M.T., as Chairman of the Department of Marine Engineering Department, Faculty of Marine Technology ITS.
3. Ir. Hari Prastowo as the supervisor in the process of making this thesis.
4. Dr. Eng. TrikaPitana, ST., M.Sc. as the supervisor in the process of making this thesis.
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10. All of MOM Lab members who always there in bitter and sweet conditions.
11. Fellow friends of Double Degree in Marine Engineering batch 2014 who were struggling together for four years.

The author concerns in the imperfections of this thesis. Therefore, any criticisms and suggestions that are built from the reader will be expected. The author hopes this thesis provides benefits primarily for readers and additional for the author in the process of teaching and learning.

Surabaya, July 2018

Author

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CHAPTER I
INTRODUCTION

1.1. Background Overview

International Maritime Organization (IMO) adopted Ballast Water Management Convention since 2014. This convention is aims to prevent the spread of harmful aquatic organism from one region to another.

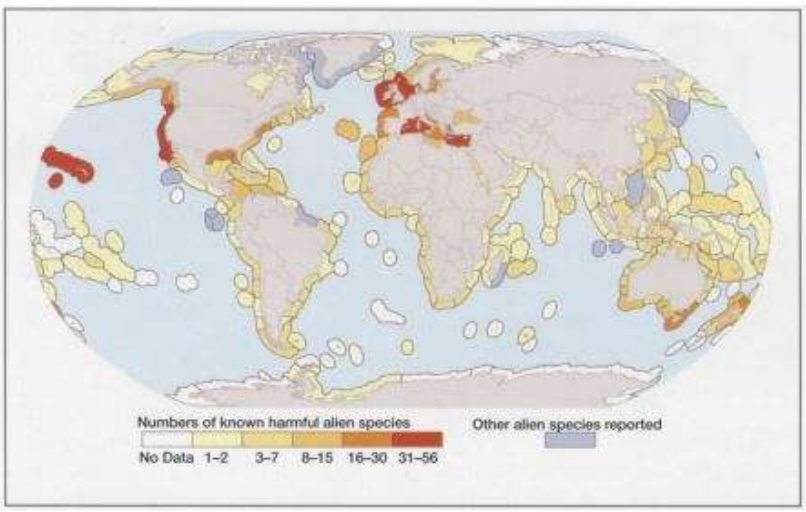

Figure 1. 1 Map of The Number of Harmful Alien Species by Coastal Ecoregion (Source: Assessing the Global Threat of Invasive Species to Marine Biodiversity 2013)

According to Ecological Society of America (ESA) 2013 database, invasive species are found in 84% of 232 marine ecoregions with 329 species for ecological impact and geographic extent. The most common pathway for marine species according to Ecological Society of America (ESA) was shipping, such as ballast and/or fouling. It about 228 species are caused by shipping activities and 57% of species are harmful.

Based on Ecological Society of America, there are several caused of introduced of marine alien Species and shipping activities are one of them. Almost 69% of marine alien species that introduced by shipping activities are harmful species.

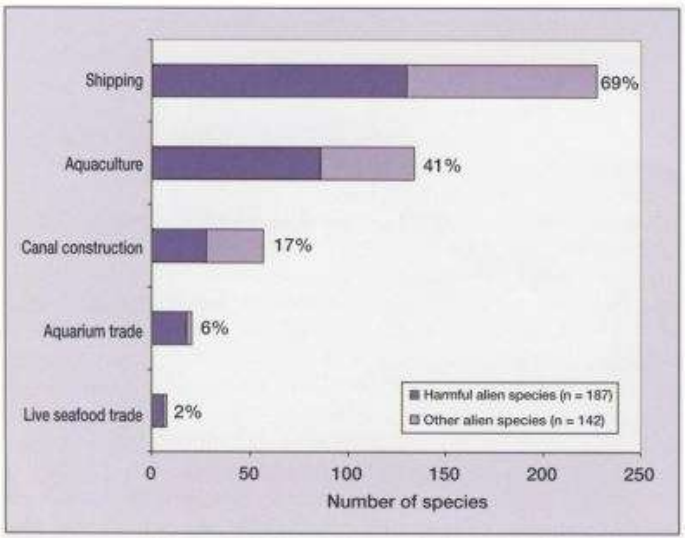

Figure 1. 2Number of marine alien species known or likely introduced by the most common human-assisted pathway (Source: Assessing the Global Threat of Invasive Species to Marine Biodiversity, 2013)

According to figure 1.1 and figure 1.2, this provide a powerful, objective argument in support of ongoing effort to improve ballast water management practices. International Maritime Organization (IMO) as specialized agency of the united nations responsible for regulating shipping already forced the Ballast Water Management Convention to entered in 8 September 2017.

In Marine Environment Protection Committee (MEPC) 71th discussed about the implementation of the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention), 2004, which will enter into force on 8 September 2017. According to Marine Environment Protection Comitee (MPEC) 71th, for the new keels of ships which are laid on or after 8 september 2017 shall install Ballast Water Management Treatment System on the ships. And for existing ship, the installation of Ballast Water Management Treatment System shall be conducted on renewal survey of IOPP.

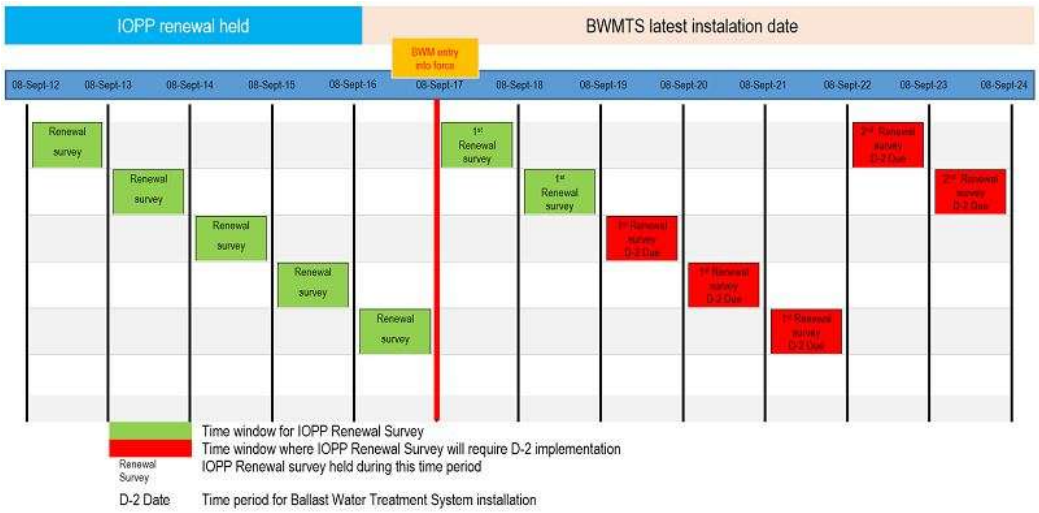

Figure 1. 3Timetable of Installation of Ballast Water Management Treatment System (Source: www.bki.co.id)

Currently, the BWM Convention has been ratified by 60 countries, and Indonesia is one of them. As one of countries that ratified the BMW convention,all ship operator in Indonesia must prepare to obey the rules of this convention. In order to respond the outcome of the convention, the vessel operator must have a strategy for each vessel to be verified as ship following the IMO convention rules in efficient ways.

There are so many types of ballast water treatment system and one of them is electrolysis type. Electrolysis water ballast treatment system works by generated sodium hypochlorate using electricity. Sodium hypochlorate can be generated by giving salt water electricity. Electrolysis type of ballast water treatment system met D-2 performance standard of ballast water convention 2004 by IMO. When initial of sodium hypochlorite concentration is at least 3.0 ppm, culturable bacteria reduce more than 99.99%, phytoplankton reduced more than 99% and mesozooplankton reduced more than 99%[1]. This result make electrolysis water ballast treatment is efficient to reduce aquatic organism in water ballast.

As one of vessel that operated internationally, MV SinarSabang must applied Ballast Water Management Treatment System on the ships by considering capital expenditure and operational expenditure of Ballast Water Management.

[1]Balpure Electrolysis Water Ballast System

1.2. Research Problems

Based on backgroud above the problems are:

1. How the system of electrolysis ballast water treatment works?
2. How to design the ballast water system after applied electrolysis ballast water treatment plant on MV Sinar Sabang?
3. How to design the engine room arrangement after applied electrolysis ballast water treatment plant on MV Sinar Sabang?

1.3. Research Limitations

This final project limitations are:

1. This thesis is focusin on the design of ballast water system on MV Sinar Sabang. Several equipment may be added.
2. Electrical design of ballast water system not included.
3. The selected water ballast system treatment are electrolysis method only.

1.4. Research Objectives

Based on problems mention above, the objectives of this final project are:

1. Investigate and calculate the parameters that are required in selecting electrolysis system.
2. Select the types of system of electrolysis ballast water treatment plant that available for MV Sinar Sabang.
3. To determine the most suited electrolysis ballast water treatment plant for MV Sinar Sabang.
4. To re-design the ballast water system of MV Sinar Sabang after applied electrolysis ballast water treatment.
5. To re-design the engine room arrangement of MV Sinar Sabang after applied electrolysis ballast water treatment.
6. To calculate the cost of installing the electrolysis ballast water treatment system.

1.5. Deliverable

This thesis output are:

1. P&iD of ballast water system
2. Engine room layout drawing
3. Detail calculation of capital expenditure and operational expenditure

1.6. Research Benefits

This final project is expected to give benefits for the various kind of parties. The benefits that can be obtained are:

1. Develop a design of ballast water system on the ship.
2. Develop a design of engine room arrangement on the ship.

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CHAPTER II
LITERATURE STUDY

2.1. Problem Overview

Every day, every single ship transported cargo as well as aquatic organism that had been taken onboard when ballast water was lloaded on board ship. There are about 10 Billion liters of ballast every hour that are released around the world. The amount of ballast a ship requires varies with the size and type of the ship, operational requirement on port, length of voyage, and weather experience or forecast[2]. Ballast water is sea water carried by ships to ensure its trim and stability. In ballast water there are so many harmful aquatic organism. When ballast water discharged, the organism may be survied and reproduced. This organism become invasive species. The spread of invasive species become threats to ecological. This problem provide a powerful, objective argument in support of ongoing effort to improve ballast water management practices.. In 2004, International Maritime Organization (IMO) adopted Ballast Water Management Convention. This convention provide ballast water management plan for ships to reduce the transfering of aquatic organism.

In Marine Environment Protection Committee (MEPC) 71th discussed about the implementation of the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention), 2004, which will enter into force on 8 September 2017[3]. According to Marine Environment Protection Comitee (MPEC) 71th, for the new keels of ships which are laid on or after 8 september 2017 shall install Ballast Water Management Treatment System on the ships. And for existing ship, the installation of Ballast Water Management Treatment System shall be conducted on renewal survey of IOPP. The importance of having ballast water treatment (BWT) on board vessels is a must. A major concern arising from discharge untreated ballast water is the invasive species can damaged the local environment. For example, the zebra mussels from polad and russia that are found in canada didn't have natural predators so this species can be easily reproduced.

Currently, the BWM Convention has been ratified by 60 countries, and Indonesia is one of them. As one of countries that ratified the BMW convention,all ship operator in Indonesia must prepare to obey the rules of this convention. In order

[2] Captain Nadeem Anwar.2011.Ballast water management 3rd Edition

[3]IMO. 2017. Report Of The Marine Environment Protection Committee On Its Seventy-First Session.London.

to respond the outcome of the convention, the vessel operator must have a strategy for each vessel to be verified as ship following the IMO convention rules in efficient ways.

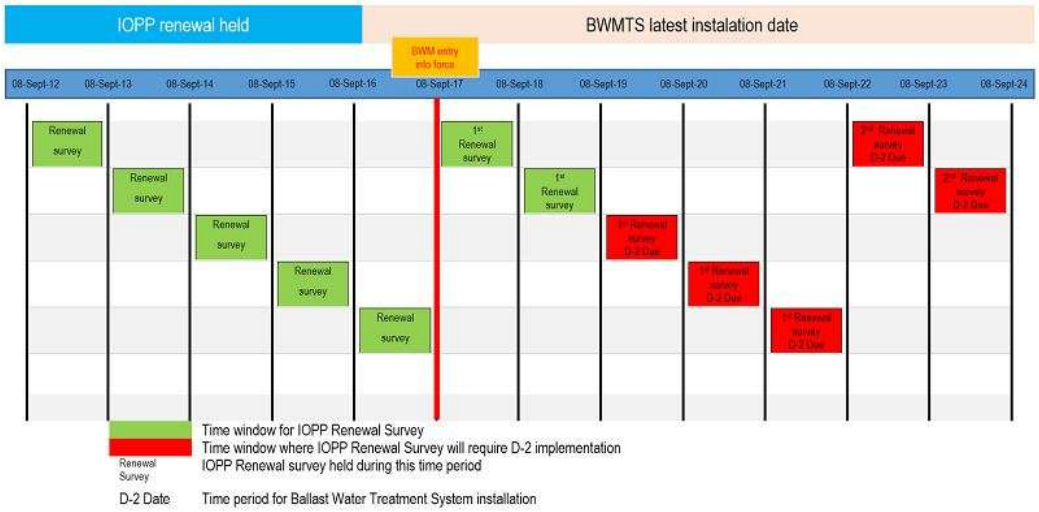

Figure 2. 1Timetable of Installation of Ballast Water Management Treatment System (Source: www.bki.co.id)

There are so many types of ballast water treatment system. And there are so many system on the market that claiming meet the requirement of ballast water convention.There is 69 Ballast Water Management Treatment System have received IMO type approval certificate and electrolysis system is one of them[4].Electrochemical system had been used for industrial since 1971[5]. This system is safety and economically effective to neutralize microorganism in a wide range.Electrolysis system works by generate sodium hypochlorate using electricity. Sodium hypochlorate prevent the organism to re-growth. Since the hypochlorate generated on demand, it doesn't need storage on board ship.Electrolysis type of ballast water treatment system met D-2 performance standard of ballast water convention 2004 by IMO. The required disinfectant of hypochlorite concentration to 100% efficiency to neutralize microorganism in ballast tank is even less than 15 ppm total residual oxidant (TRO) [6] . When initial of sodium hypochlorite concentration is at least 3.0 ppm, culturable bacteria reduce more than 99.99%,

[4]IMO.2016.List of Ballast Water Management System Which Received Type Approval Certification.
[5] Captain Nadeem Anwar.2011.Ballast water management 3rd Edition
[6] Captain Nadeem Anwar.2011.Ballast water management 3rd Edition

phytoplankton reduced more than 99% and mesozooplankton reduced more than 99%[7]. This result make electrolysis water ballast treatment is efficient to reduce aquatic organism in water ballast.

As one of vessel that enganged in international voyage, MV sinar sabang should provide water ballast treatment on board ship. The system that porposed to used is electrolysis ballast water treatment system by considering the capital expenditure and operational expenditure of electrolysis ballast water treatment system also considering the ballast water system that already existed and the engine room arrangement of MV sinar sabang so the electrolysis ballast water treatment can be placed.

2.2. Ballast Water

Ballast water is sea water carried by ships to ensure its trim and stability. Water ballast is pumped in to maintain the safe operation of the ships. In certain condition, ballast water are pumped into the ships. When there is no cargo in the ships, the ships become more lighter which is affect the stabilize of the ships, then ballast water pumped into ballast tank to stabilize the ship. When the process of loading and un-loading, ballast water also take-in into the ships or discharge from the ships to ensure the stability of process loading and un-loading.

[7]Balpure Electrolysis Water Ballast System

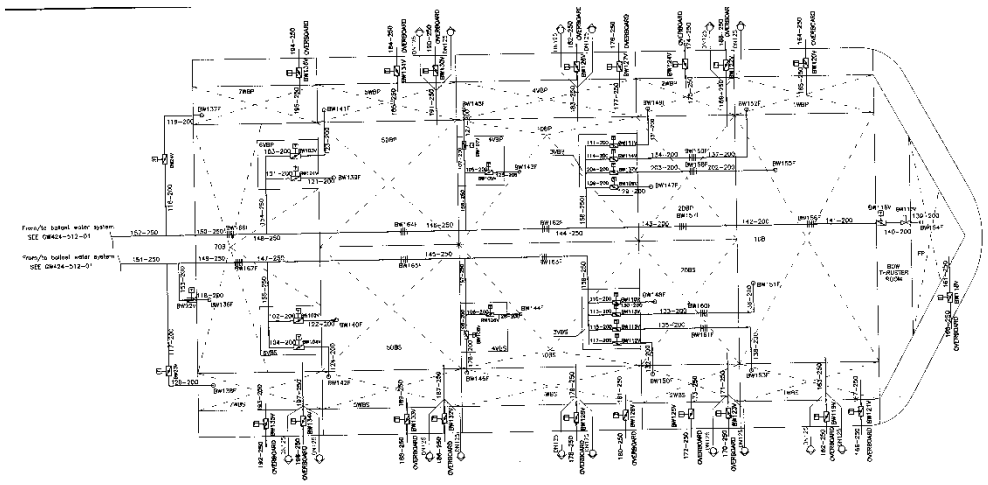

Figure 2. 2Water Ballast System Plan of MV SinarSabang (Source: Samudera Indonesia)

2.3. Ballast Water Convention

Sea water has been used as ballast to stabilize vessels at sea. When a vessels take ballast water on board, this water usually contains small pieces of organic or inorganic matter. These include bacteria, microbes, small invertebrates, eggs, cysts and larvae of various species. This species may survived in new environment and become invasive species. The spread of invasive species become threats to ecological and the economic of the planets.

Figure 2. 3Process of take in and discharge of ballast water that contain organic matter (Source: IMO)

Because of that, management of water ballast should be needed to minimalize the transfer of invasive species at sea. In 2004, International Maritime Organization (IMO) adopted Ballast Water Management Convention. The Convention requires all ships to implement a ballast water management plan. This help to reduce the transferring of harmfull organism from one location to another.

Ballast Water Management Convention enter into force on 8 September 2017. This made all ship operator in must prepare themself to obey the rules of this convention. All ships of 400 GT will be required to have an approved on board ballast water management plant and must have all documents that are needed such as ballast water record books and ballast water management procedure.

This convention is sets the standards that ballast water system should be meet. Ballast water treatment system must have a type approval certificate with the IMO guideline for the approval of ballast water management system.

Table 2. 1IMO standard for discharged ballast water

Organism Category	Regulation
Plankton, >50µm in minimum dimensions	<10 cels/m^3
Plankton, 10-50µm	<10 cels/ml
Toxigenic Vibrio Cholera	<1 colony forming unit(cfu)/100ml
Escherichia Coli	<250cfu/100ml
Intestinal Enterococci	<100cfu/100ml

2.4. Ballast Water Treatment

There is 69 Ballast Water Management Treatment System have received IMO type approval certificate[8]. From 69 type, most of it (50%) are ultraviolet system, and (23%) are electrolysis. There are 2 generic types of process technology used in water ballast treatment, solid-liquid separation and disinfection.

Solid-liquid separation is separation of solid material, including the larger suspended micro-organism from ballast water. Disinfection is removes inactivates micro-organism using chemical inactivation of micro-organism or physicochemical inactivation of micro-organism or deoxygenation of micro-organism.

[8]IMO.2016.List of Ballast Water Management System Which Received Type Approval Certification.

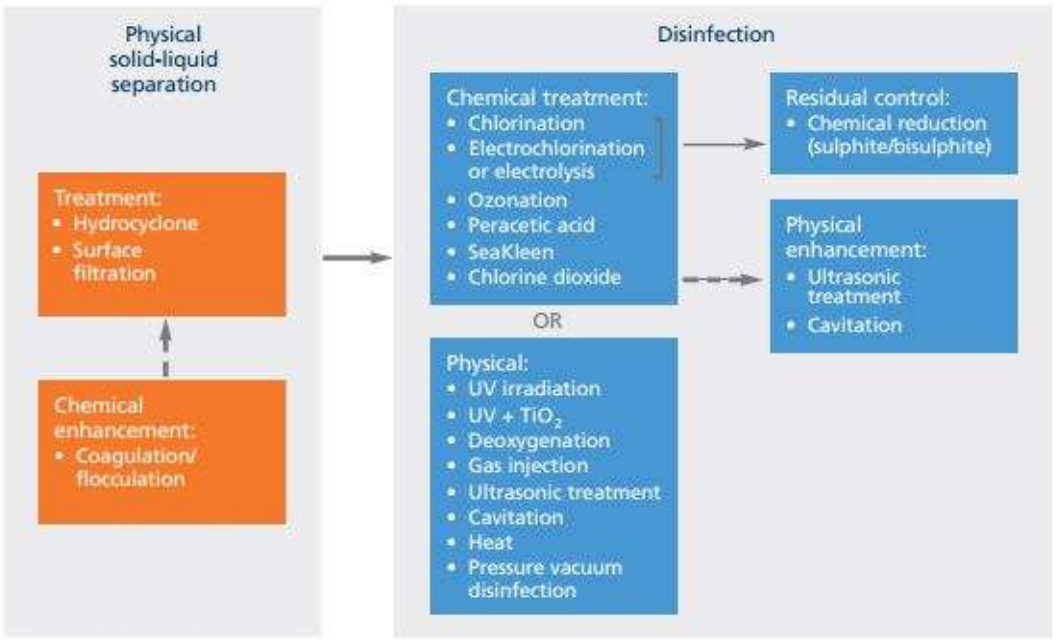

Figure 2. 4Generic Water Ballast Treatment Process (Source: www.lr.org)

2.5. Consideration of Selecting the Ballast Water Treatment System

Accoding to IMO International Convention for the control management of ships ballast water and sediment 2004, in section D-5 review of standarts by organization for ships, the ballast water management plan shall be specific and shall at least

1. safety considerations relating to the ship and the crew
2. environmental acceptability
3. Practicabillity
4. Cost Effectiveness
5. biological effectiveness in terms of removing harmful aquatic organism

According to Loyd Register about understanding ballast water management there are some consideration to selecting the water treatment system:

1. Ship type
2. Maximum and minimum ballasting and de-ballasting rates
3. Ballast tank capacity
4. The space required
5. The location of system component
6. Power availability

7. Health and safety
8. The effect of tank structure
9. The availability of consumables, spares and support
10. Capital and operating cost
11. Sistem availability and delivery time

For newbuilds ship, ship boulder should identity the options for installing the ballast water treatment system. This also involve the system drawings to show how a selection of different treatment option may be fitted. For existing ships the operators need to be aware about the modifications to fit the ballast water treatment system. The schematic arrangement and equipment drawing should obtained in order to develop a work plan[9]. The ship operator should provide the ballast water system drawings, functional requirements, and details of compartment spaces.

2.6. Electrolysis Ballast Water Treatment

Electrolysis system using seawater or other water containing NACl to generate an disinfecting solution contain chlorine. This system is using electricity to produce sodium hypochlorite. The general formula for generating sodium hypochlorite is

$$NaCl + H_2O + Electricity = NaOCl + H_2$$

$$or$$

$$Salt + Water + Electricity = Sodium\ Hypochlorite + Hydrogen\ Gas$$

Sodium Hypochlorite are prevent the organism in ballast water tank to regrowth. The allowance of maximum dosage of sodium hypochlorite in ballast water tank should not higher than 10 ppm[10]. The presence of sodium hypochlorite in ballast tank should be treated before de-ballasting. This chemicals are pollutant that should be neutralized by another chemicals before discharging ballast water.

[9]Lloyd Register. 2016. Understanding Ballast Water Management.
[10]Haraldsson, Michael. 2012. Chemical Ballast Water Treatment System.

Figure 2. 5Ballasting mode of electrolysis ballast water treatment (Source: Purimar)

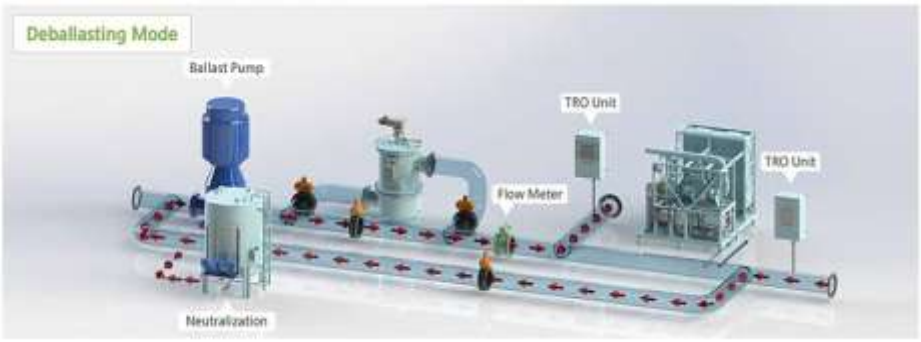

Figure 2. 6Deballasting mode of electrolysis ballast water treatment (Source: Purimar)

There are 2 types of electrolysis ballast water treatment:

1. Direct-Flow Electrolysis
   In this method, hypochlorite are used to disinfect ballast water. The process need the entire flow of ballast water go pass through the hypoclorite generator and then used to ballast. This type of ballast water treatment relies on the length of exposure to ensure its treatment[11]. The chemicals that are used in this type of water ballast treatment are pollutants chemicals that cannot discharged at sea unless they have sufficiently decomposed or neutralized by another chemical agents.

[11]Jee, Jaehoon., and Sangik Lee. January 2017. Comparative Feasibility Study on Retrofitting Ballast water Treatment System for a Bulk Carrier, Busan, Korea.

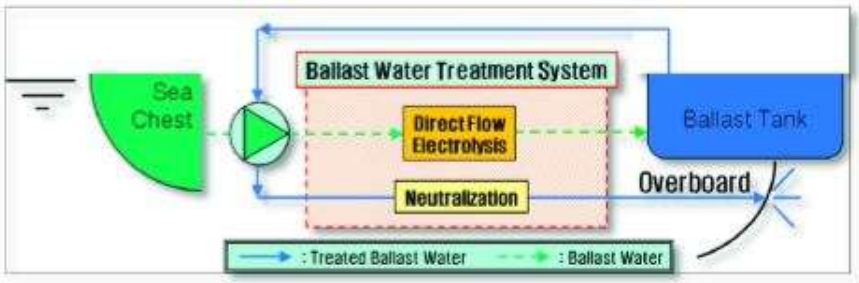

Figure 2. 7Direct-Flow Electrolysis Ballast Water Treatment (Source: comparative feasibility study on retrofitting ballast water treatment system for a bulk carrier, 2017)

2. Side Stream Electrolysis
   The difference between direct-flow electrolysis and side stream electrolysis are, side stream electrolysis only take small amount of ballast water from main ballast water and use for produce a concentrated disinfectant stream that is injected back to main ballast water

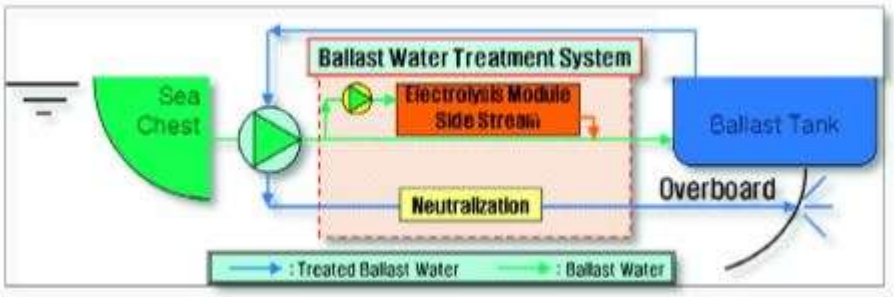

Figure 2. 8 Side Stream Electrolysis Ballast Water Treatment (Source: comparative feasibility study on retrofitting ballast water treatment system for a bulk carrier, 2017)

2.7. Future Value

Future Value is value of an asset at a specific date of time. It predicted the nominal future of money worth at a specified time in future by assuming a certain interest rate.

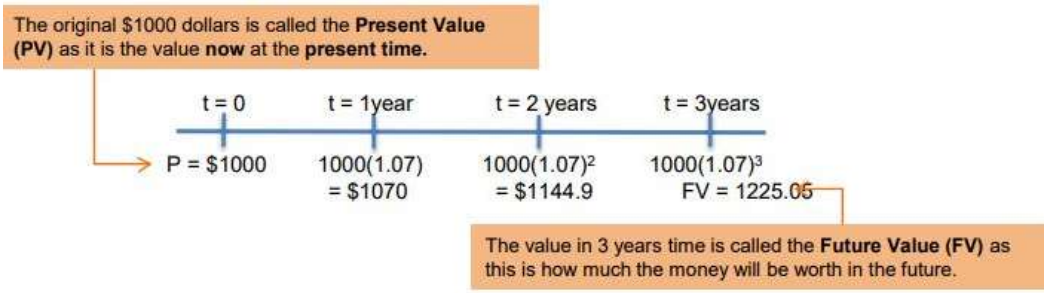

Figure 2. 9 Future Value (source: Flinders University)

The formula to find the future value is

$$Sn = P(1 + i)^n$$

Where

Sn = Future Value

P = Present Value

i = Annual interest rate

n = Number of years

CHAPTER III
METHODOLOGY

3.1. Methodology Flow Chart

The methodology flow chart shows all of steps for this final project research. The steps of this methodology are shows as in bellow

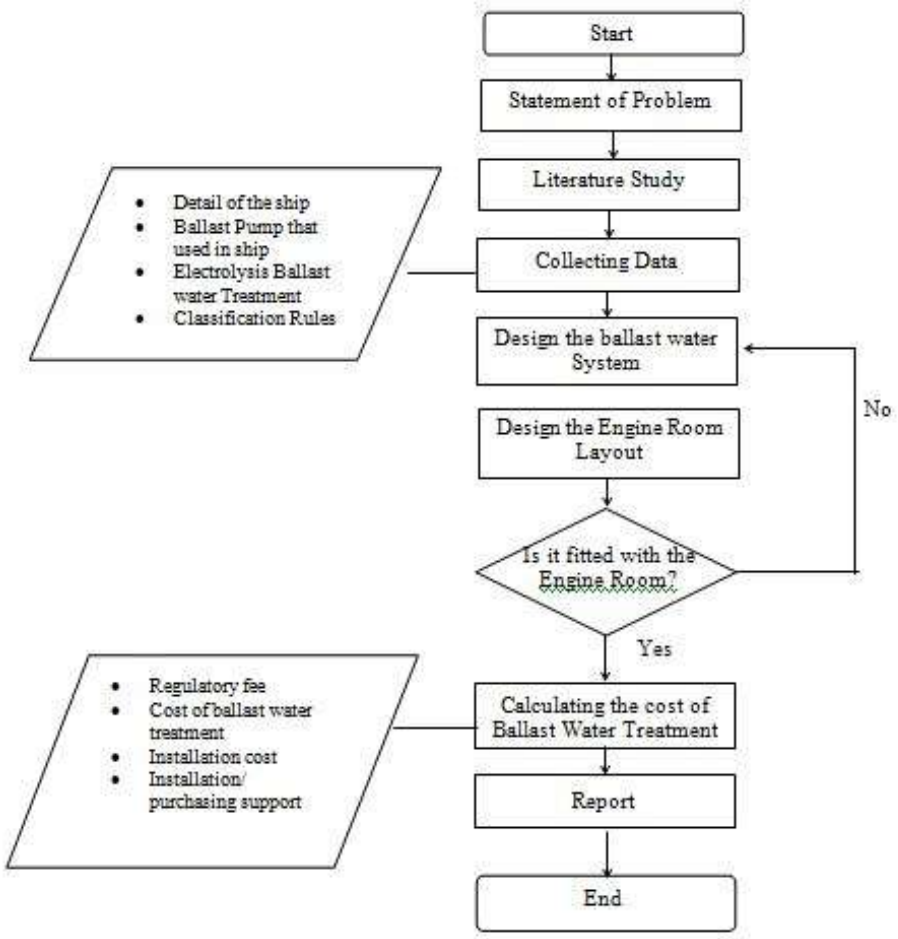

Figure 3. 1Flow Chart of Methodology

3.2. Statement of Problems

This stage is an early stage to construct the thesis. In this stage, questions and problems are being prepared specifically in order to determine the specific objectives of this thesis. The content of the thesis is to overcome the statement of the problems mentioned earlier and it will be done by collect some information about the electrolysis ballast water treatment.

3.3. Literature Study

Right after the problems is raised, a literature study is performed. The study of literature is done by reading papers, journals, thesis, media and literature books that relates and able to support this thesis.

3.4. Collecting Data

After literature study which support the thesis has been done, collecting data is being performed. Data collection is done by gather information to develop the conceptual design, most of data is available from the ballast water treatment manufacturer, classification socities, shipping company, countries regulation and several conventions which provide statutory rules. The data which may support this thesis is the ballast water treatment specification, ballast system, and engine room layout of ships.

3.5. Design the Ballast Water System

After every consideration is met the requirement and calculating the most suitable ballast water treatment system, then the ballast water system can be drawn. Ballast water system must use every consideration which has been calculated and determined before such as the ballast water capacity, pump capacity, and ballast water treatment capacity.

3.6. Design the Engine Room Arrangement

After design the ballast water system, the engine room layout of the ship can be drawn after ballast water treatment system added.

3.7. Calculating the Cost of Ballast Water Treatment

This calculation is required to estimate the cost a ballast system which able to operate. The cost is determined by design cost, regulatory fee, cost of ballast water treatment device, installation cost, installation or purchasing support and maintenance cost. By calculating the cost it can determine the most economical ballast water treatment.

CHAPTER IV
DATA ANALYSIS

4.1. Specification of MV SinarSabang

Detailed information about MV SinarSabang is needed to modification the ballast system of MV SinarSabang. The detailed information of SinarSabang is as shown in Table 4.1 bellow

Table 4. 1MV SinarSabang Information

Name of Ship	MV. SinarSabang
Ship Owner	Samudera Shipping Line, Ltd
Classification	Nippon KaijiKyokai
IMO Number	9435234
Class Number	089448
Flag	Singapore
Date of Build	21 October 2008
Type of Vessel	Container Ship
Length Overall	165.00 m
Breadth	27.40 m
Depth	14.30 m
Draft (Design)	10.916 m
Deadweight	23,350 DWT
Gross Tonnage	18,321 GT
Net Tonnage	10,395 GT
Capacity of TEUs	1,740 TEUs
Service Speed	19,80 knot
Ballast Water Capacity	7897 m^3
Total Crew	20 person

4.2. Ballast water system on MV SinarSabang

Detailed information about existing ballast system on MV SinarSabang such as ballast pump specification and pipe specification are needed in order to design the water ballast water treatment system.

Ballast pump specification

Capacity: 330m^3/H Dimension: 800x650x1590

Power: 37 Kw Head: 30 m

4.2.1. Existing ballast water system on MV SinarSabang

The process of ballasting starting from sea chest. Sea water distributed to ballast tank in ship by ballast pump. For de-ballasting process started by take up ballast water from ballast tank and then discharged to overboard. Deballasting process using ballast pump from ship as shown as in Figure 4. 1.

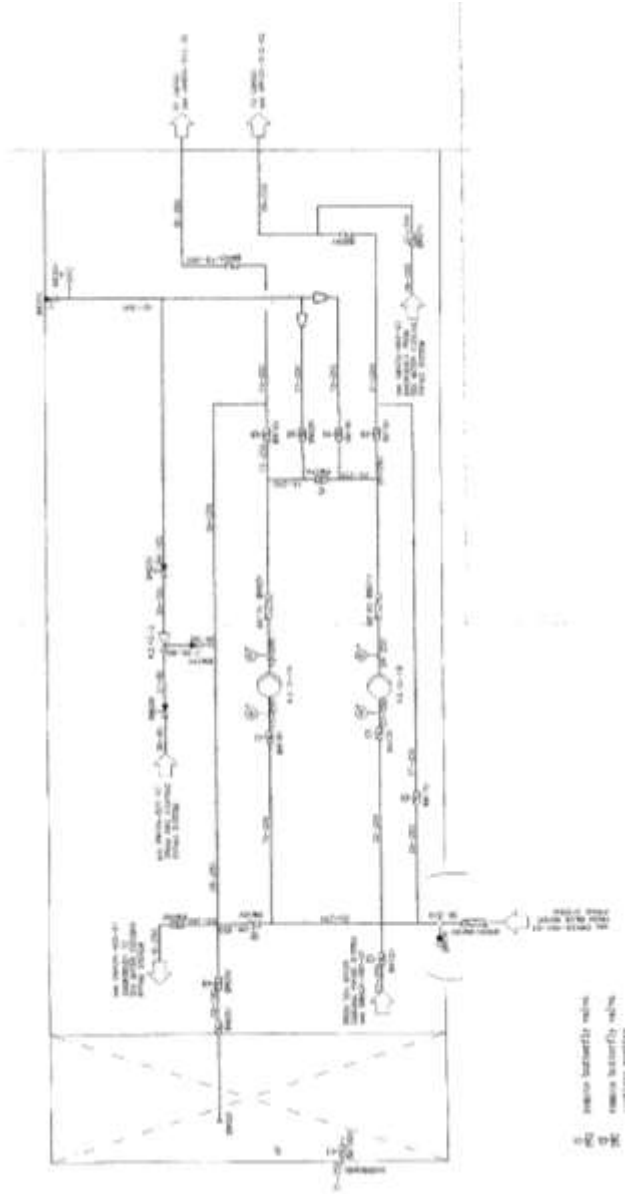

Figure 4. 1Ballast System of MV SinarSabang (Source: Samudera Indonesia)

4.2.2. Existing Engine Room on MV SinarSabang

Design of Engine Room Layout should be efficient in order to the position of components that placed in engine room can be easily monitoring and maintenance. Figure 4.2 is Existing Engine Room Layout of MV SinarSabang without electrolysis ballast water treatment.

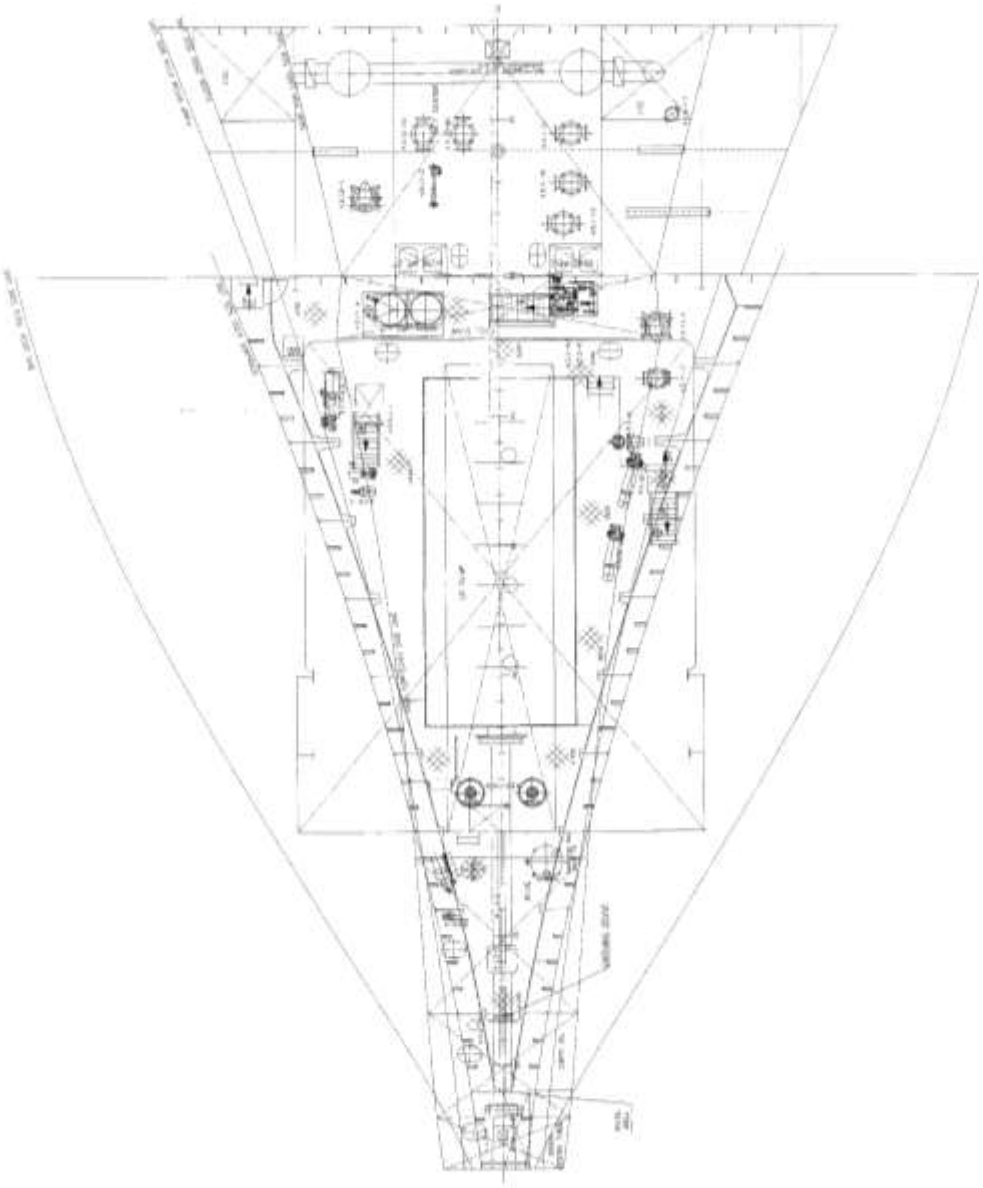

Figure 4. 2Engine Room of MV SinarSabang (Source: Samudera Indonesia)

4.3. Selection type of Electrolysis Ballast Water Treatment

To select the most suited Electrolysis Ballast Water Treatment, there are some considerations:

1. Ship type& Sizes
2. Maximum and minimum ballasting and de-ballasting rates
3. Ballast tank capacity
4. The space required
5. Power availability

For Container ship like MV Sinar Sabang, using electrolysis water ballast treatment is suitable because the salinity of sea water is high enough to treated by electrolysis method. Since Electrolysis system typically require a water temperature at least 15°C for electro-chlorination to be efficient, MV sinar sabang is suitable since the voyage is Surabaya-Singapore that has temperature higher than 15°C.

For ballasting and de-ballasting capacity, MV sinar Sabang use 2 Ballast pump. Each ballast pump has capacity 330m^3/H for 7897m^3 capacity ballast tank. Then to select the Electrolysis Ballast water treatment, the selecion capacity of water ballast treatment should at least 330m^3/H for each pumps.

4.3.1. Electrolysis Ballast Water Treatment

Ballast Water Treatment System that are selected to be installed on MV Sinar Sabang is Electrolysis Ballast Water Treatment System by using Techcross Electrolysis ballast water system. Techcross already certified by, ABS, USCG AMS, RS, BV, RINA, LR, Etc. Techcross Received IMO Final Approval on 2008.

The advantages of using Electrolysis Water ballast Treatment:

- Strong disinfection efficacy
- Low power consumption
- Low operational cost
- Automation system

Techcross have 5 types capacity of electrolysis ballast water treatment as listed in table 4.2 bellow.

Table 4. 2List of Techcross Ballast Water Treatment System

Type	Capacity	Dimension (mm)
ECU 150B	150 m^3/H	W790 x D540 x H862, 390kg
ECU 300B	300 m^3/H	W1243 x D763 x H862, 490kg
ECU 450B	450 m^3/H	W71490 x D763 x H862, 660kg
ECU 600B	600 m^3/H	W1840 x D763 x H862, 830kg
ECU 1000B	1000 m^3/H	W2000 x D1124 x H914.5, 1210 kg

According to 5 types capacity of techcross electrolysis ballast water treatment, the most suited electrolysis ballast water treatment is ECU 300B with 300m^3/H capacity since ECU 450 is too high for 330m^3/H capacity of ballast pump. Because capacity of electrolysis water ballast treatment is lower than the capacity of pumps. The ballasting time may be longer about 10%.

Electrolysis ballast water treatment specification:

Type: ECU 300B Voltage: 440 V

Capacity: 300m^3/H Size: W1243 X D763 X H862 (mm)

Power: 29 kW Weight: 490kg

4.3.2. Component of Electrolysis Ballast Water Treatment

To installed the system of electrolysis ballast water treatment, some component may be needed to running the system. Components that are needed in electolysis ballast water treatment is:

- ECU (Electro Chamber Unit)
  ECU is the main component of killing machine organism in electrolysist ballast water treatetment. ECU generated Chlorine by electrolized sea water.
  - Capacity: 300m^3/H
  - Power: 29 kW
  - Voltage: 440 V
  - Phase: 3ph
  - Frecuency: 60Hz
  - Size: W1243 X D763 X H862 (mm)
  - Weight: 490kg

- PDE (Power Distribution Equipment)
  PDE supplies AC 440V from ship to all component of electrolysis system and control communications of all other components
    - Voltage: 440 V
    - Phase: 3ph
    - Frecuency: 60Hz
    - Size: W600 x D630 x H1500
    - Weight: 175kg
- ANU (Auto Neutralization Unit)
  ANU is designed to automatically neutralize the treated ballast water so when its discharged, the residual biocides may not exceed 0.1 ppm according to TRO level measured by TSU
    - Neutralize: Sodium thiosulfate
    - Voltage: 220 V
    - Phase: 3ph
    - Frecuency: 60Hz
    - Size: W800 x D733 x H1655
    - Weight: 220kg
- TSU (TRO Sensor Unit)
  TSU measure the concentration of TRO (Total Residuant Oxidant) that generated by ECU when the process of ballasting. TSU checked the TRO level for proper neutralization during de-ballasting
    - Size: W800 x D733 x H1655
    - Voltage: 220 V
    - Frecuency: 60Hz
- CPC (Control PC)
  An upgraded touchsreen PC to operate Electrolysis system.CPC showed all the data relating to electrolysis operation
    - Size: W480 x D119 x H660
    - Voltage: 220 V
    - Frecuency: 60Hz
- T-Strainer
  T-strainer with 3mm mesh filter is used during ballasting operation to filter out any large marine organism in the incoming ballast water. It helps to protect electrodes inside electrolysis chamber unit to maintain the optimal performance
- CSU (Conductivity Sensor Unit)
  Measure electrical conductivity of sea water (salinity of sea water)

4.4. Calculation of Ballasting Time

Because the capacity of electrolysis ballast water treatment is lower than the capacity of ballast pump, we need to calculate the exceed time for ballasting.

Capacity of ballast tank: 7897m^3

Ballast Pump: 330m^3/H (2 pumps)

Electrolysis ballast water treatment: 300m^3/H

Time to ballasting (if 2 pumps operated): $t = \frac{V}{Q} = \frac{7897}{330 \times 2} = 11.97\ hours$

Time to ballasting with ballast water treatment: $t = \frac{V}{Q} = \frac{7897}{300 \times 2} = 13{,}17\ hours$

The different of time ballasting with and without electrolysis ballast water treatment is1.2 hours and can be tolerated for ballasting time.

4.5. Design of Ballast Water System with Electrolysis Ballast Water Treatment

To design the ballast water treatment system in ballast system MV sinarsabang, the existing ballast system should be checked and added the ballast water treatment system. The design water ballast treatment systemreferring to project guide of ballast water treatment. To design the ECU 300B ballast water treatment, it refers to techcross project guide. For ballasting the incoming ballast water passes through Conductivity sensor unit and flow meter unit to measure the salinity of ballast water and the flow rate. After that it passes through T-strainer before it is treated by ECU. Then goes through TSU to check the Total residual oxidant. After that it goes to ballast tank.

A main process during de-ballasting is neutralization of treated ballast water by Auto Neutralization Unit. Auto Neutralization Unit is designed to automatically neutralize the treated ballast water according to data about TRO concentration.

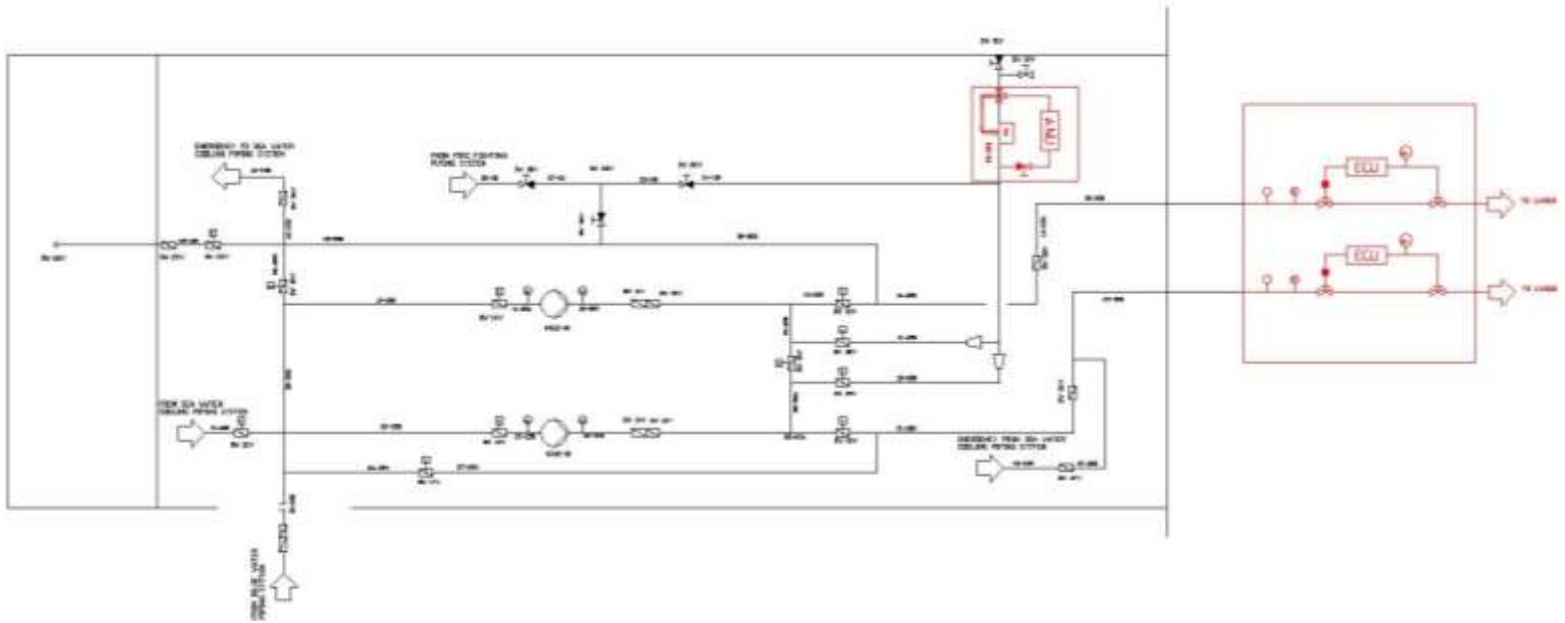

Figure 4. 3Ballast System of MV SinarSabang after added Electrolysis Ballast Water Treatment System

4.6. Design Engine Room of MV SinarSabang

To design the engine room after selecting the ballast water treatment, all the component should be listed and installed in engine room. Some equipment may place next to other equipment in one area to make it efficient to monitor the equipment. Designing the ballast water treatment equipment in engine room should refers to project guide of ballast water treatment. Because of MV SinarSabang Pump rooms still have plenty space to put the electrolysis ballast water treatment system equipment, the Electrolysis Chamber Unit, Auto Neutralizer Unit, Control PC, TRO Sensor Unit, and Power Distribution Unit are placed in Pump Room.

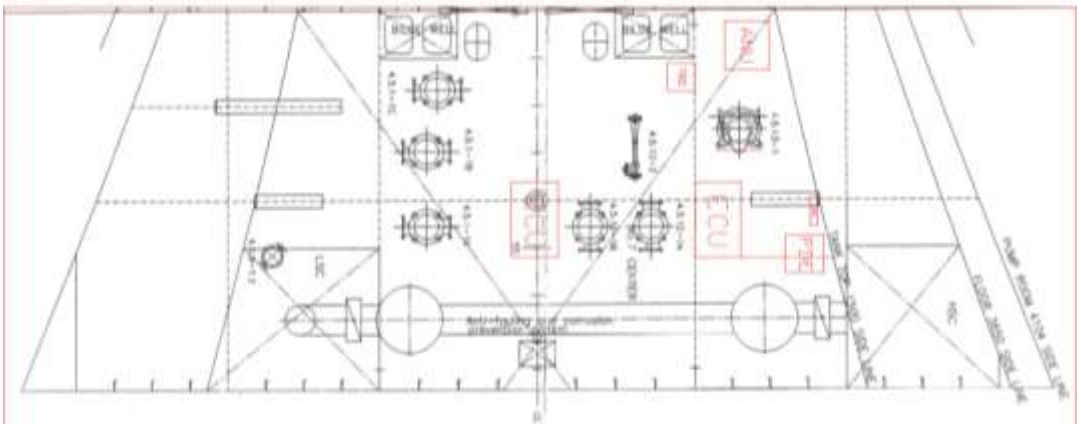

Figure 4. 4Pump Room of MV SinarSabang after added Electrolysis Ballast Water Treatment System

The design of engine room is place the electro Chamber Unit next in ballast water pump. The Auto Neutralizer Unit is placed next to Total Residual Oxidant sensor unit in order to maximize the system and minimize the usage of pipe. Auto Neutralizer Unit and Residual Oxidant sensor unitplaced close to overboard in order to maximize the process of de-ballasting sea water. Any electrical equipment is placed closed to each other like power distribution unit and control PC.

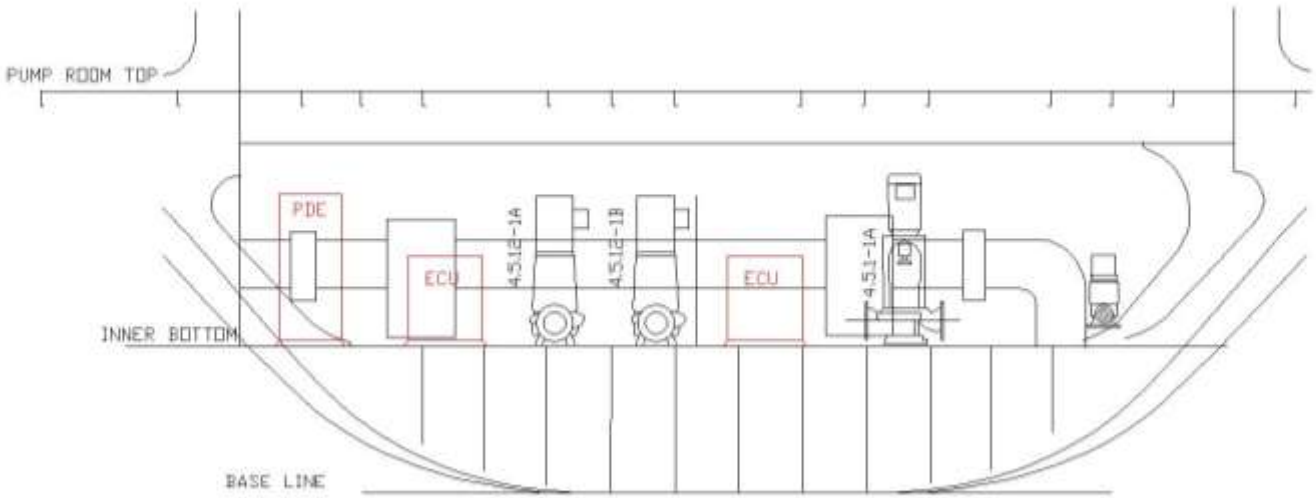

Figure 4. 5Pump Room of MV SinarSabang after added Electrolysis Ballast Water Treatment System

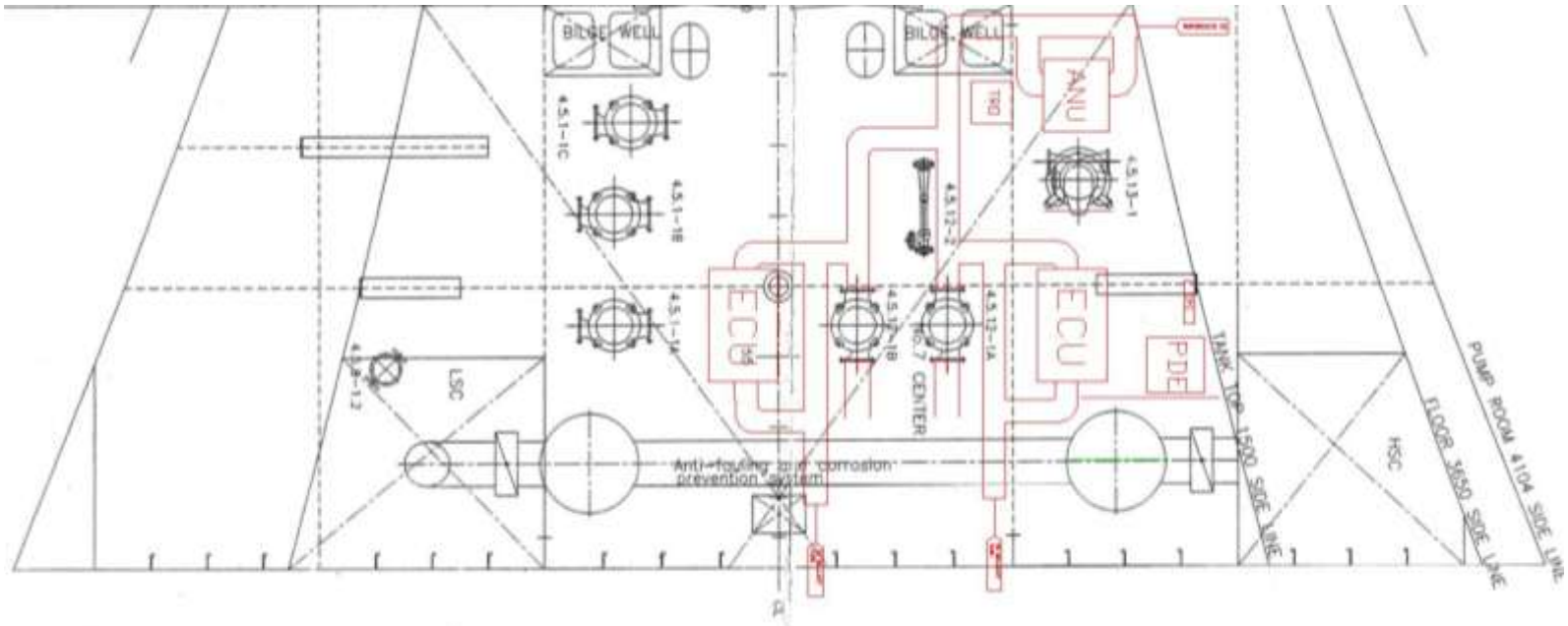

Figure 4. 6 Design of ballast water treatment pipes in engine room

4.7. Calculation of Electrical Capacity of MV SinarSabang

MV SinarSabang had 3 MAN B&W auxiliary engine with total power 1260 for each auxiliary engine. The total generated power of auxiliary engine is 3780kW power. When sailing, estimated load at peak load is around 85% of total power generated. According to the rules of the class, in BKI voume IV about rules for electrical installation, when the ship is in sailing condition, 2 generator set are operated with back up of 1 emergency generator set.

- Merk: Zhengjiang MAN B&W
- Type: 6L28 / 32H
- Total Power: 1260 kW
- SFOC: 189,5 g/kWh

Total Power required of Electrolysis ballast water treatment that will be installed on MV Sinar sabang is 58kW. It is around 1.53% of total capacity of power capacity. So the power capacity of MV sinar sabang is fullfill the required power of Techcross Electrolysis ballast water treatment system.

4.8. Cost Analysis of Ballast Water Treatment on MV SinarSabang

This analysis is calculating the cost of installment, maintenance, and operating of ballast water treatment system on MV SinarSabang.

4.8.1. Estimated Cost of Installment Ballast Water Treatment on MV SinarSabang

Installment Cost of Ballast Water Treatment is depending on the type of Ballast Water treatment. Different method of ballast water treatment had different cost of equipment.

This installment cost include the cost of equipment, labor cost, and all supporting system of electrolysis ballast water treatment. Pipe installation cost is referring to (general service rates 2014 from Rukindo Shipyard). The cost of side stream electrolysis ballast water treatment is referring to (JaehoonJee, 2017). And the other installation such as cables, shipment, are referring to data transports Canada discussion paper. Calculation of tax is referring to beacukai.go.id for calculate of import duty and value added tax. For detailed calculation of tax is as shown inTable 4. 4**.**

Table 4. 3 Estimated Cost of installation electrolysis ballast water treatment system on MV SinarSabang

no	Material	Specification	Volume		Price	Total Price
		Piping And Valve				
1	Steel Pipe	250mm diameter seamless steel, sch 80	28	meter	239,2	6697,6
2	Steel Pipe	300mm diameter seamless steel, sch 80	6	meter	279,6	1677,4
3	remotely butterfly valve	250mm diameter cast iron	4	unit	254,5	1017,9
4	butterfly valve	250mm diameter cast iron	3	unit	84,8	254,5
5	elbow pipe	250mm diameter seamless steel	18	unit	72,4	1302,4
		Equipment				
7	Electrolysis Chamber Unit	300 m^3/h, 440V, 60 Hz, 3ph W1243xD763xH862(mm), 490kg	2	unit		
8	Power Distribution unit	AC 440V, 3ph, 60Hz W700xD700xH1900(mm), 310kg	1	unit		
9	Auto Neutralizer Unit	AC 220V, 60Hz Sodium Thiosulfate W800xD733xH1655(mm), 308kg	1	unit	135000	135000
10	TRO Sensor Unit	AC 220V, 60Hz W470xD450xH1347(mm)	1	unit		
12	Control PC	AC 220V, 60Hz w480xD119xH660(mm), 35kg	1	unit		
		Electricity				
13	Cable and electrical equipment	5% of unit cost	1	Set	5400	5400
		Shipment				
14	Shipment		-	-	14.400	14400
15	mobilization				700	700
		Design and inspection				
16	Design and Inspection		-	-	6750	6750
17	Approval				4050	4050
		Tax				
18	Insurance cost	0.5% x (unit cost + freight)			747	747
19	import duty	7.5% x (unit cost + insurance cost)			10181,025	10181,025
20	Value added tax	10% x (unit cost+ import duty)			14518,1025	14518,1025
		labor cost				
21	Labour cost for Equipment and cable installation	1 foreman ($ 35/ days)	6	Days	35	210
		3 helper ($32/ days)	6	Days	32	192
22	Commisioning and test	$ 600/days (2 person)	2	Days	600	1200
				Grand Total ($)		203597,9
				Grand Total (Rp)		2.850.370.085

Table 4. 4 Tax Calculation

Tax Calculation			Price ($)	Price (Rp)
1	Electrolysis ballast treatment cost	1 unit	135.000	
2	Freight (Shipment)	-	14.400	
3	Equipment cost and freight	total of unit cost and freight	149.400	
4	Insurance cost	0.5% x (unit cost + freight)	72	1.008.000
5	Customs cost	(unit cost+freight+insurance) x Rupiah currency		2.092.608.000
6	import duty	7.5% x (customs cost)	1.085	15.195.600
7	Value added tax	10% x (customs cost)	1.549	21.679.560

4.8.2. Operational Cost Analysis of Ballast Water Treatment on MV SinarSabang

Operational cost of electrolysis ballast water treatment is depending on power requirement that used to operate Electrolysis ballast water treatment and cost of chemical treatment to neutralize the treated sea water before discharged into sea.

Table 4. 5Operational Cost Analysis of Electrolysis Ballast Water Treatment System

Item	Specification	Price per m^3	price per process
Fuel Cost			
Fuel Cost	Based on required kwH and power generation system Total kw needed: 58 kw SFOC = 189,5 g/kwH Time to operate (t=Q/v): 7897/600 = 13,1 hours Generated power (kwH = P x t): = 58 x 13,1 = 759.8 kwH Fuel Consumption (kwH x SFOC x 10-6) = 759,8 x 189,5x 10-6 = 0,143 ton Fuel cost per t diesel: $ 671,86 Fuel Cost total : 0,143 x 671, 86		96,08
Consumable			
Sodium Thiosulfate	neutralizer agent	$ 0.0125/m^3	98,71
		Grand total ($)	194,79
		Grand total (Rp)	2.727.038,72

Operational of electrolysis ballast water treatment from table 4.4is operational cost per m^3 ofpower requirementand chemical substance. Cost of chemical substance is referring to BalPure Electrolytic ballast water treatment. And for fuel cost per t diesel is referring to bunkerindex.com.

4.8.3. Maintenance Cost Analysis of Ballast Water Treatment on MV SinarSabang

Maintenance is really important to keep the equipment in best condition. Cost of maintenance is depending onBallast Water Treatment Project Guide, it also depending on time scale of repairing or replacing of necessary devices.

Table 4. 6Maintenance cost analysis of ballast water treatment system on MV SinarSabang

Maintenance		
Filter	Annual inspection and cleaning (include in labour cost)	-
Electrode	Annual inspection and electrode change (per 3 years)	1300
Labour	Annual Inspection (yearly)	420
other material	5% of work in way material (yearly) (not include change of filter, etc)	384

4.8.4. Future Value Analysis of Ballast Water Treatment

Future value is the value of an asset at a specific date. The concept of future value is based on the time value of money. To calculate the future value of electrolysis ballast water treatment by using formula

$$Sn = P(1 + i)^n$$

According to bank Indonesia, annual interest rate is 5,25% (29th June 2018). And estimated the efficiency lifetime of electrolysis ballast water treatment is around 15 years. The calculation of future value of electrolysis ballast water treatment is shown at table 4.6. According to calculation of future value, the price of electrolysis ballast water treatment is $ 290.847,5. And to achieve that sum of money, the company needs around $ 24.237 investment each year to buy new electrolysis ballast water treatment.

4.8.5. Service Schedule of installation Ballast Water Treatment on MV SinarSabang

Service Schedule of techcross electrolysis ballast water treatment scheduled around 20 weeks after contract. it is include the design and drawing, ECS manufacturing, material purchase order, shipment, installation and supervisor, and commissioning. Service schedule of installation of electrolysis ballast water treatment is referring to techross brochure. For service schedule are shown on table 4.7 and for detailed information about installation is shown on table 4.8. Detail information about installation is including pipes installation, seating installation, electricity installation and electrolysis equipment installation.

Table 4. 7Future Value of Electrolysis Ballast Water Treatment

Present value of electrolysis ballast water treatment ($): 135000

Annual interest rate: 5,25%

Future value of electrolysis ballast water treatment in years ($)														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
142087,5	149547,1	157398,3	165661,7	174359	183512,8	193147,2	203287,5	213960,1	225193	237015,6	249458,9	262555,5	276339,7	290847,5

Table 4. 8 Service Schedule of installation electrolysis ballast water treatment

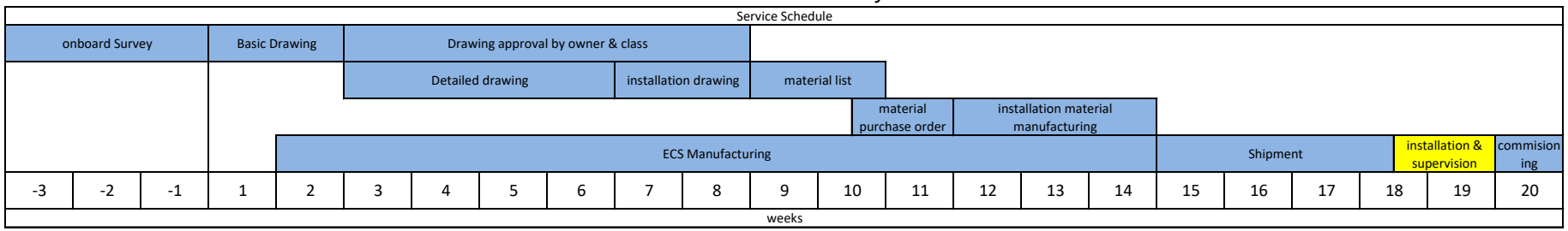

Table 4. 9 Detailed installation schedule

Installation							
installation of seating		electrity intallation				equipment installation	
	installation of pipe and valve						
1	2	3	4	5	6	7	8
Days							

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CHAPTER V
CONCLUSION AND SUGGESTION

5.1. Conclusion

In this final project for modifying water ballast system in MV SinarSabang by applying Electrolysis Ballast Water Treatment have the following result:

1. To determine the water ballast treatment system, there are some consideration such as ship type & sizes, maximum and minimum ballasting and de-ballasting rates, ballast tank capacity, the space required
2. The Electrolysis ballast Water treatment system that are selected to be installed on MV Sinar Sabang is Techcross Electrolysis ballast water system. Techcross already certified by, ABS, USCG AMS, RS, BV, RINA, LR, Etc. Techcross Received IMO Final Approval on 2008. The advantage of using electrolysis ballast water treatment is strong disinfection efficacy, low power consumption, low operational cost, and had automation system
3. The design of Electrolysis ballast water treatment system is referring to Techcross Project Guide. Several equipment are added such as electrolysis chamber unit, auto neutralizer unit, total residual oxidant, and power distribution equipment.
4. Total estimated cost to install Electrolysis ballast water treatment is around $ 203.597, or around 2.850.370.085 rupiah. That include installation of pipe and electrical, tax, and labour cost
5. Operational cost of electrolysis ballast water treatment is depending on power consumption of electrolysis ballast water treatment. Prices per process for fuel consumption is $98,76 and for chemical substance, sodium thiosulfate is $98,71 per process. The total is around 2.764.662 rupiah.
6. Service Schedule of Electrolysis ballast water treatment on MV Sinar Sabang is around 20 weeks. It include the Equipment Installation such as pipe installation, electrical installation, seating installation.

5.2. Suggestion

Based on this thesis, there are so many thing need to be improved to implement ballast water management convention. The things that need to be improved are:

1. Based on this thesis, import duty and value added tax are around $25.446. This tax is from importing Electrolysis ballast water treatment. If indonesia already ratified ballast water management convention, indonesia should start to produce ballast water treatment to reduce expenses on importing ballast water treatment.
2. Detail information of electrolysis ballast water treatment in this thesis cannot be obtained in project guide. Detailed information about electrolysis ballast water treatment can be obtain in shipping company that already installed electrolysis ballast water treatment.

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ATTACHMENT

Techcross Electrolysis Water Ballast Treatment

ELECTRO-CLEEN™ SYSTEM

Ballast water management system developed by Techcross

Techcross Electro-Cleen™ System (ECS) is one of the most effective ballast water management systems utilizing electrolysis.

ECS treats all incoming ballast water by in-situ production of hypochlorite with combined effects of electric shock and hydroxyl radical in the Electro Chamber Unit (ECU). This simple disinfection processing is so powerful that it destroys cell membrane of microorganisms and prevents re-growth, needing only one-time treatment. It means ECS contributes to reduction in time and operating cost.

Techcross has upgraded ECS through continuous research and development involving tests and approvals with classification societies for better performance. ECS obtained the world's first IMO Basic Approval in 2006 and many Type Approvals from the flag states and classification societies. In addition, ECS accepted as an AMS (Alternate Management System) from USCG (United States Coast Guard) in 2013 and the USCG Type Approval now under way is expected to be achieved within 2017.

Techcross has closely cooperated with classification societies to conduct various risk assessments including HAZOP (Hazard & Operability), hydrogen gas safety tests, FMEA (Failure Mode & Effects Analysis) and software verification. The FMEA was carried out in 2013 with the ABS in Houston, and was considered to be the industry's first one with class for BWMS. With all these risk assessments, Techcross has shown a strong commitment for improving safety of products.

IMO Final Approval 2008

Korean Government 2008

KR Type Approval 2008

Liberian Government 2011

ABS Type Approval 2011

Japanese Government 2012

USCG AMS 2013

RS Type Approval 2013

BV Type Approval 2013

RINA Type Approval 2013

Cyprus Government 2014

LR Type Approval 2015

Australia Government 2016

DNV&GL Type Approval 2016

CCS Type Approval 2017

*USCG Type Approval in process

1. ECU (Electro Chamber Unit)
2. TSU (TRO Sensor Unit)
3. PDE (Power Distributor Equipment)
4. ANU (Auto Neutralization Unit)
5. CPC (Control PC)
6. T-strainer
7. FMU (Flow Meter Unit)
8. CSU (Conductivity Sensor Unit)
9. FTS (Freshwater Temperature Sensor)

Ballasting

CSU → FMU → T-strainer → ECU → PDE → TSU → Ballast Tank

All the incoming ballast water passes through T-strainer before it is treated by ECU. ECU can disinfect marine organisms in the ballast water with one time treatment during ballasting.

Deballasting

FMU → ANU → TSU → Overboard

A main process during deballasting operation is neutralization of the treated water by ANU. ANU is designed to automatically neutralize the treated water according to data about flow rate and TRO concentration by FMU & TSU.

Advantages of ECS

- Strong disinfection efficacy
- Low power consumption
- Low operational costs
- Largest reference list
- Convenient installation and maintenance
- Automation of system
- Global network

SPECIFICATION OF ECS

Specific information of Electro-Cleen™ System

ECU (Electro Chamber Unit)		
Specification	ECU is the core component killing marine organisms in the ballast water ranging from ECU 150B to ECU 1000B. Each model can be combined in parallel to achieve higher TRCs (Treatment Rated Capacity).	
Size	ECU 150B	W790 X D540 X H862 (mm), 390kg
	ECU 300B	W1,243 X D763 X H862 (mm), 490kg
	ECU 450B	W1,490 X D763 X H862 (mm), 660kg
	ECU 600B	W1,840 X D763 X H862 (mm), 830kg
	ECU 1000B	W2,000 X D1,124 X H914.5 (mm), 1,210kg
Power Supply	AC 440V, 3ph, 60Hz (FROM PDE)	
Component	EM(Electro Module), PRU(Power Rectifier Unit), EPJ(ECU Power junction box), ESJ(ECU Signal junction box)	
Ex-Certificate	Ex II 2 G Ex de IIB T4 Gb : LCIE 12 ATEx 3095X / Ex de IIB T4 Gb : IECEx KGS 12.0008X	


< ECU 150B >


< ECU 300B >


< ECU 450B >


< ECU 600B >


< ECU 1000B >

PDE (Power Distributor Equipment)		
Specification	PDE supplies AC 440V from the ship to all other components of ECS and controls communications of all other components.	
Size	PDE 12A	W600 X D630 X H1,500 (mm), 175kg
	PDE 24A	W700 X D700 X H1,900 (mm), 310kg
	PDE A4	W700 X D530 X H1,500 (mm), 250kg
Power Supply	AC 440V, 3ph, 60Hz / AC220V, 60Hz	


< PDE 12A >


< PDE 24A >


< PDE A4 >


< ANU 5T >


< ANU 10T >

ANU (Auto Neutralization Unit)		
Specification	ANU is designed to automatically neutralize treated ballast water prior to its discharge so that the discharge of Residual Biocides may not exceed 0.1ppm (Instantaneous maximum limit) according to TRO level measured by TSU.	
Size	ANU 5T	W800 X D733 X H1,655 (mm), 220kg
	ANU 10T	W1,200 X D733 X H1,655 (mm), 308kg
Power Supply	AC 220V, 60Hz (FROM PDE)	
Neutralizer	Sodium Thiosulfate	
Mixture Ratio	2 (Fresh water) : 1 (Neutralizing agent)	
Tank Capacity	ANU 5T	100 Liter for each tank (Both : 200 Liter)
	ANU 10T	200 Liter for each tank (Both : 400 Liter)

TSU (TRO Sensor Unit)	
Specification	TSU measures concentrations of TRO (Total Residual Oxidant) generated by ECU during ballasting operation. TSU also checks the TRO level in the treated ballast water for proper neutralization of ballast water before its discharge.
Size	W470 X D450 X H1,347 (mm), 100kg
Power Supply	AC 220V, 60Hz (FROM PDE)
Ex-Certificate	II 2 G Ex px IIC T4 Gb / ITS11 ATEX 17384

CPC (Control PC & S/W)	
Specification	Control PC features an upgraded touchscreen interface which is easy & simple to operate ECS. In addition, the CPC shows all the data saved relating to ECS operation.
Size	W480 X D119 X H660 (mm), 35kg
Power Supply	AC 220V, 60Hz (FROM PDE)

T-strainer	
Specification	T-strainer with a 3mm mesh filter is used during ballasting operations to filter out large marine species and foreign materials in the incoming ballast water. It helps protect electrodes inside the ECU to maintain an optimal performance of ECU for a strong disinfection efficacy.
Size	W550 X D366 X H503 (mm), 87kg
Type	Straight, Angle
Pressure Range	-1 ~ 10 Bar

FMU (Flow Meter Unit)	
Specification	Measures flow rate of ballast water during ballasting and deballasting operation.
Power Supply	AC 220V

FTS (Freshwater Temperature Sensor)	
Specification	Measures temperature of cooling water supplied to a rectifier from vessel.
Power Supply	DC 24V

CSU (Conductivity Sensor Unit)	
Specification	Measures electrical conductivity of seawater passing through ECU during ballasting operation.
Power Supply	DC 24V

GDS (Gas Detection Sensor)	
Specification	Detects a possible leak of hydrogen gas from ECU.
Power Supply	DC 24V

RETROFIT SERVICE

Prompt and accurate service in retrofitting

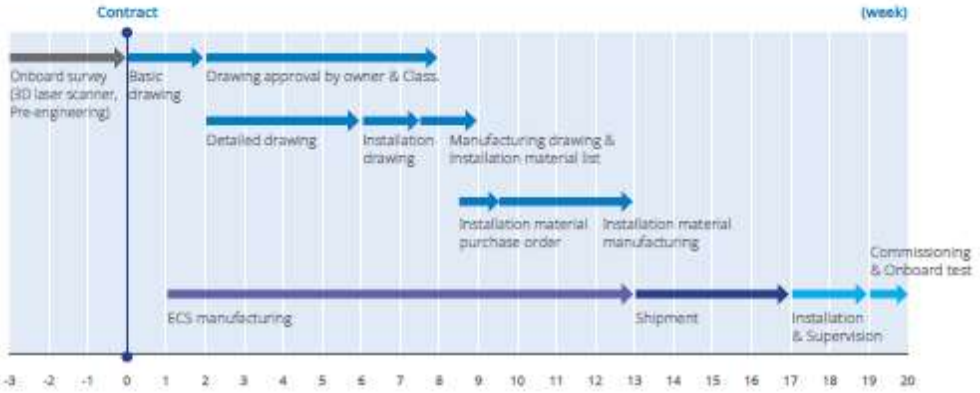
Techcross provides ship owners who are looking for retrofitting Ballast Water Management System with the total engineering solution.

Service Scope

Option 1	ECS supply + Commissioning
Option 2 (Engineering Solution)	Onboard survey + Design + ECS supply + Supervision + Commissioning
Option 3 (Turn key Solution)	Onboard survey + Design + ECS & Installation material supply + Installation & Supervision + Commissioning

Service Process

Service Schedule (Standard time table) : 20 weeks



GLOBAL NETWORK

Techcross' service agents all over the world

A/S Service Network

Country		Company	Address
Head Office		TECHCROSS	433 Nolosaneopbuk-ro, Gangseo-gu, Busan, Korea
Asia	Korea	Lastech	433 Nolosaneopbuk-ro, Gangseo-gu, Busan, Korea
		Olive Shipping Co., Ltd.	253-11, Gamcheonhang-Ro, Saha-Gu, Busan, Korea
	Singapore	Jason Electronics	194, Pandan Loop#06-05, Pantech Business hub, Singapore
	China	Winkong Marine Engineering Co., Ltd	Floor 17, Zhongxin Building, No.263, Liaoning Road, Qingdao, China
	Japan	Dowa Line Co., Ltd.	2-37-5, Nihhinbashi, Minatoku, Tokyo, 105-0003, Japan
		Uzushio Electric Co., Ltd.	105 Noma, Imabari City, Ehime Pref. 794-8582, Japan
	Taiwan	Reson Electronics Int'l Inc	12F, No.1-26, Kuoh-Jiann Road, Chien-Chen Dist., Kaohsiung, Taiwan
	India	Norinco	301, Orbit Plaza, New Prabhadevi Marg Prabhadevi, Mumbai - 400025, India
	UAE	DINTEC	No. 201, Tameem House Building, TECOM C, PO Box 54054, Dubai, UAE
Europe	Turkey	Amet Engineering	Guzelyali Mah. Bagdat Cad No : 54 Kat : 1 34903 Pendik, Istanbul, Turkey
	Netherlands	Wetering Trade & Services B.V.	Burnchotenweg 134 3089 KC Rotterdam The Netherlands
	Germany	Mareesystems GmbH	Kupferhammer 7, 22399 Hamburg, Germany
Americas	USA	Far-East Marine Service	8833 Knight Road, Houston, Texas 77054 USA

MEPC 71 Annex 4

ANNEX 4

RESOLUTION MEPC.287(71)
(adopted on 7 July 2017)

IMPLEMENTATION OF THE BWM CONVENTION

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

RECALLING Article 38(a) of the Convention on the International Maritime Organization concerning the functions of the Marine Environment Protection Committee conferred upon it by international conventions for the prevention and control of marine pollution from ships,

RECALLING ALSO that the International Conference on Ballast Water Management for Ships held in February 2004 adopted the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (the Convention) together with four conference resolutions,

NOTING that the entry-into-force conditions of the Convention were met on 8 September 2016 and that it will consequently enter into force on 8 September 2017,

BEING COGNIZANT of the fact that by the date of its entry into force more than 13 years will have elapsed since the adoption of the Convention,

NOTING that 60 States, the combined merchants fleets of which constitute approximately 68% of the gross tonnage of the world's merchant shipping, have acceded to the Convention as of 7 July 2017,

BEING CONSCIOUS of the need to provide certainty and confidence in the application of the Convention, thereby assisting shipping companies, shipowners, managers and operators, as well as the shipbuilding and equipment manufacturing industries, in the timely planning of their operations, and to encourage the early installation of ballast water management systems,

BEARING IN MIND that the International Conference on Ballast Water Management for Ships adopted regulation B-3 (Ballast water management for ships) of the Convention to ensure a smooth transition to the ballast water performance standard described in regulation D-2 between the years 2009 and 2019,

RECOGNIZING that time has elapsed since adoption of the Convention, which has resulted in uncertainty for ships regarding the application of regulation B-3 and that such uncertainty can be mitigated through the application of an appropriate timeline for implementing regulations D-1 (Ballast water exchange standard) and D-2 (Ballast water performance standard), upon entry into force of the Convention,

RECALLING that the Assembly, at its twenty-eighth session, adopted resolution A.1088(28) on *Application of the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004*, and requested it to keep the resolution under review and report back to the Assembly as appropriate,

HAVING APPROVED, at its seventy-first session, draft amendments to regulation B-3 of the Convention (MEPC 71/17, annex 2) with a view to adoption at its seventy-second session,

1 REQUESTS the Secretary-General to circulate the draft amendments to regulation B-3, in accordance with Article 19 of the Convention, to all Parties to the Convention and to all Members of the Organization immediately after the entry into force of the Convention;

2 RESOLVES that, in lieu of the implementation schedule recommended in resolution A.1088(28) and notwithstanding the schedule set forth in regulation B-3 of the Convention, the Parties should implement the amended regulation B-3 (MEPC 71/17, annex 2) immediately after entry into force of the Convention, with a view to avoiding the creation of a dual treaty regime during the time period between the entry into force of the Convention and the entry into force of the amended regulation B-3;

3 URGES States which have not yet acceded to the Convention to do so as soon as possible, in the understanding that the requirements of the amended regulation B-3 will be implemented upon the entry into force of the Convention;

4 REAFFIRMS the agreement reached at its sixty-eighth session, as contained in the Roadmap for the implementation of the Convention, regarding the provisions for non-penalization of early movers that have installed ballast water management systems approved in accordance with the *Guidelines for approval of ballast water management systems* (G8) (resolution MEPC.174(58), subsequently superseded by resolution MEPC.279(70)).

5 AGREES that this resolution supersedes resolution A.1088(28) on *Application of the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004*.

***

MV Sinar Sabang Information

SAMUDERA SHIPPING

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F. (+62 21) 6908318, 6913041
www.samudera.com
A member of the SAMUDERA INDONESIA GROUP

1. GENERAL INFORMATION

Name of Ship	MV. Sinar Sabang
Ship Owner	Samudera Shipping Line, Ltd.
Ship Manager	PT. Samudera Indonesia Ship Management
Classification	Nippon Kaiji Kyokai
IMO Number	9435234
Class Number	089448
Official Number	394694
Call Sign	9V7718
Flag	Singapore
Port of Registry	Singapore
Date of Build	21 October 2008
Ship Builder	Guangzhou Wenchong Shipyard, Co., Ltd.
Type of Vessel	Container Ship
Length Overall (LOA)	165.00 m
Breadth (B)	27.40 m
Depth (D)	14.30 m
Draft (Design) (T)	10.916 m
Deadweight	23,350 DWT
Gross Tonnage	18,321 GT
Net Tonnage	10,392 GT
Capacity of TEUs	1,740 TEUs
Service Speed	19.80 knot
Ballast Water Capacity	7,897 m^3
Total Crew	20 person
Main Engine	
• Maker	MAN B&W
• Type	7S 60 MC-C
• Total Power	16,660 kW / 22,667 HP
• Fuel Oil Consumption	5.54 tons / day
Auxiliary Engine	
• Maker	Zhengjiang MAN B&W
• Type	6L28 / 32H
• Total Power	1,260 kW / 1,714 HP
• Diesel Oil Consumption	0.55 tons / day
Navigation Equipment	
• Autopilot	Raytheon Anschutz GmbH / Anschutz
• Echo-Sounder	Japan Radio, Co., Ltd. / JRC-NWW 16
• Gyro Compass I	Raytheon Anschutz GmbH / Anschutz - STD 22
• Gyro Compass II	Raytheon Anschutz GmbH / Anschutz STD 22
• Inmarsat - C	Japan Radio, Co., Ltd. / JUE-85
• Magnetic Compass	Cassens & Plath Inc. / Reflecta/2
• Navtex	Japan Radio, Co., Ltd. / JRC-NRC 33
• Radar I	Japan Radio, Co., Ltd. / X-Band Arpa
• Radar II	Japan Radio, Co., Ltd. / S-Band Arpa
• Speed Log	Japan Radio, Co., Ltd. / JRC-JLN 205
Date of Docking Planning	08 - 15 January 2014
Duration	8 days

Installation Price

stx Canada Marine

APPENDIX G DETAILED COSTINGS

TANKER ELECTROLYSIS BWTS

Purchase and Installation of Equipment

	Installation Cost (mean)	1,635,215			
	Annual Operating Cost (mean)	69,433			
	Installation Man hours	6,353			
ID	Cost Item	Details	Low	Estimate	High
1000	Installation Costs				
1100	Ballast Water Treatment System	1 off 1000m³/hr.			
1101	BWTS System Hardware	Estimate $640,000. -10% + 20%	576,000	640,000	768,000
1102	BWTS installation labour	Estimate of 750 hours * Complexity factor for BWTS system. -10%, +40%	113,906	126,563	177,188
1103	BWTS spares purchase from OEM	Estimate 5% of procurement price.	28,800	32,000	44,800
1104	Other	Shipping, flat rate OEM costs, etc.	10,000	15,000	20,000
1200	Additional Equipment	Additional equipment required as part of installation (major items only)			
1201	Pumps	Installation of additional ballast/ stripping pumping capacity.	0	0	0
1202	Generator Sets	Installation of additional Generator capacity. Based on $815/kW and 687kW requirement. -15% + 15%	0	0	0
1203	Electrical Distribution	Installation of additional power distribution (major items, switchboards, etc.), 5%	0	0	0
1204	Spares (Additional equipment)	Covers spare parts for repairs in the event of system failure, one buy cost for lifetime of system	213	250	288
1205	Labour	Estimate of labour for above (30% of total)	21,516	25,313	29,109
1206	Circulation Heater	Installation of water heaters. Est $5000 each	4,500	5,000	7,000
1300	Supporting Electrical	Additional electrical work required			
1301	Cable	5% of system cost, -15%, +30%	27,200	32,000	36,800
1302	Labour	50% of system cost, -10%, +40%	37,969	42,188	59,063
1303	Other	Additional costs -Auxiliary Systems, 7.5% BWTS. -10%, +40%	43,200	48,000	67,200
1400	Supporting Piping	Additional pipe work			
1401	Pipework	10% of system cost, -15%, +30%	54,400	64,000	73,600
1402	Labour	100% of system cost, -10%, +40%	75,938	84,375	118,125
1403	Other	Additional costs -Auxiliary Systems, 7.5% BWTS. -10%, +40%	43,200	48,000	67,200
1500	Other Installation Costs	Misc.: deck plating to be replaced, welding consumables, steel for mounting structures, etc.			
1501	Work-in-way / Workshop Conversion labour	labour estimate for additional effort for getting equipment installed - Estimate 1000hrs machinery install* Vessel Complexity factor, -10%, +40%	101,250	112,500	157,500
1502	Work-in-way allowance	Material costs associated with work-in-way	54,400	64,000	73,600

stx Canada Marine

1503	HVAC Installation/upgrades	Material costs, estimate at 15% of BWTS installation			
1504	Engineering	Drawings, HAT/SAT/STW, owner support, etc. 100% of install labour, +/- 15%	71,719	84,375	97,031
1505	Project Management and administration	Based on 10 % of total labour cost. -10%, +40%	38,961	43,313	60,638
1506	Shipyard Support Labour	Based on 100% system installation labour. -10% +40%.	75,938	84,375	118,125
2000	**Operating Costs**				
2100	**Spares**	Items associated with BWTS			
2101	Spares (system)	Covers spare parts for repairs in the event of system failure, one buy cost for lifetime of system (covered by item 1204)			
2102	Spares (storage)	Overhead associated with storage of spare parts (shore)			
2200	**Fuel Costs**	Items associated with BWTS			
2201	Power consumed (yearly)	Power required by BWTS system: kWh when active * active time + idle requirement (Est 1kWhr). Est High + Backwash 10% of running time + Neutralising pump Est 5kWhr			
2202	Fuel Cost	Based on required kWh and power generation system: Total kW/h needed (from previous line) * t fuel to generate power (assume .22L per kWh, .83kg/L) * fuel cost per t diesel (assume $1100/MT). -15% +40%	4,016	4,725	6,615
2203	Additional Systems Power Consumed (yearly)	Includes constant auxiliary load 20kw constant, Circulation Heater 126kW (10% of ballasting time), Brine pump 2kW.			
2204	Additional Fuel Cost	As above. -10% + 40%	32,309	35,899	50,259
2300	**Consumables**				
2301	Filters	Limited to annual inspection and cleaning, covered in 2500.			
2302	Salt brine	For electrolysis systems: cost per t of brine (Est $100)*qty per treatment*annual number of treatments.	16,558	19,480	22,402
2500	**Maintenance**				
2501	Maintenance & repair labour	Labour for planned and unplanned work including replacing lamps, inspecting filters and system failures. -10% + 40%	3,797	4,219	5,906
2502	Maintenance materials	Related material costs to above (NOT the cost of new filters, bulbs, etc. - work-in-way materials only.) 5% of initial work-in-way cost annually. -10% + 40%	576	640	896

2. *Sea Valves / Overboard Discharge Valves*

Oven up for survey, clean, grind and box up in place.

Diameter	Globe Valve	Gate Valve
1"	Rp 418.000	712.500
2"	Rp 807.500	1.140.000
3"	Rp 952.850	1.425.000
4"	Rp 1.268.250	1.710.000
5"	Rp 1.689.100	2.280.000
6"	Rp 2.117.550	2.802.500
8"	Rp 2.535.550	3.325.000
10"	Rp 3.179.650	3.942.500
12"	Rp 3.802.850	4.560.000
14"	Rp 4.231.300	4.987.500
16"	Rp 4.766.150	5.462.500
18"	Rp 5.070.150	5.700.000
20"	Rp 5.070.150	6.080.000
22"	Rp 5.920.400	6.412.500
24"	Rp 6.348.850	6.887.500

NOTES :

a. In case of testing in shop, price to be 200 %.
b. Excluding repair / renewal of defective parts.
c. In case valves in tank, price to be 120 %.
d. In case of testing in place, price to be 150 %
e. For butterfly valve, will be charged of gate valve 120 %.
f. Freeing up of reach rod, will be charged extra.
g. For by pass valves will be charged extra.
h. For pneumatic valves, will be charged 300 %.
i. Excluding renew packing, nut and bolt.
j. Excluding staging and access work.

Piping Works

1. Renewal Straight Steel Pipes

Diameter	Per Meter					
	Sch. 40		Sch. 80		ST. GP	
1/2"	Rp	191.400	Rp	263.100	Rp	83.700
1"	Rp	242.200	Rp	282.600	Rp	155.500
2"	Rp	378.200	Rp	621.900	Rp	282.600
3"	Rp	849.200	Rp	941.850	Rp	444.000
4"	Rp	1.160.100	Rp	1.188.500	Rp	599.500
5"	Rp	1.402.300	Rp	1.471.100	Rp	754.975
6"	Rp	2.063.100	Rp	2.218.600	Rp	922.400
8"	Rp	2.547.500	Rp	2.783.700	Rp	1.233.375
10"	Rp	3.031.900	Rp	3.348.800	Rp	1.544.300
12"	Rp	3.516.200	Rp	3.913.900	Rp	1.855.300

NOTES :

a. *In case of length of each piece less than 1 m, price to be applied as 1 meter.*
b. *Removal and reinstallation for access to be charge 40 %.*
c. *For special material instead above to be charged separately (base on material spect).*
d. *For pipe in tank and pump room, cargo tank, duct keel, rate to be 135 %.*
e. *For pipe in engine room, rate to be 125 %.*
f. *For pipe in accommodation room, rate to be 105 %.*
g. *For pipe in DBT rates to be 150 %.*
h. *Additional woks : Clamps, testing, painting, necessary staging, bolt and nuts, gasket,, insulation and galvanizing shall be charged extra.*
i. *For pipe material to be suplied by dockyard.*
j. *For copper, cunife and other special* material pipes will be charged extra.

Ballast System Piping Diagram

BALLAST SYSTEM PIPING DIAGRAM						
no	Application of Pipes	NOM. DIA.	O.D. mm	THK. mm	MATERIAL	TYPE
1		300	325	8	Seamless Steel	20#
2		300	325	8	Seamless Steel	20#
3		250	273	7	Seamless Steel	20#
4		250	273	7	Seamless Steel	20#
5		250	273	7	Seamless Steel	20#
6		250	273	7	Seamless Steel	20#
7		250	273	7	Seamless Steel	20#
8		250	273	7	Seamless Steel	20#
9		250	273	7	Seamless Steel	20#
10		250	273	7	Seamless Steel	20#
11		250	273	7	Seamless Steel	20#
12		250	273	7	Seamless Steel	20#
13		250	273	7	Seamless Steel	20#
14		250	273	7	Seamless Steel	20#
15		250	273	7	Seamless Steel	20#
16		250	273	7	Seamless Steel	20#
17		250	273	7	Seamless Steel	20#
18		250	273	7	Seamless Steel	20#
19		250	273	7	Seamless Steel	20#
20		250	273	7	Seamless Steel	20#
21		250	273	7	Seamless Steel	20#
22		250	273	7	Seamless Steel	20#
23		250	273	7	Seamless Steel	20#
24		250	273	7	Seamless Steel	20#
25		250	273	7	Seamless Steel	20#
26		250	273	7	Seamless Steel	20#
27		250	273	7	Seamless Steel	20#
28		250	273	7	Seamless Steel	20#
29		250	273	7	Seamless Steel	20#
30		250	273	7	Seamless Steel	20#
31		250	273	9	Seamless Steel	20#
32		150	168	6	Seamless Steel	20#
33		100	114	4,5	Seamless Steel	20#
34		100	114	4,5	Seamless Steel	20#
35		80	89	4,5	Seamless Steel	20#
36		80	89	4,5	Seamless Steel	20#

BALLAST SYSTEM PIPING DIAGRAM						
no	Application of Pipes	NOM. DIA.	O.D. mm	THK. mm	MATERIAL	TYPE
37		80	89	4,5	Seamless Steel	20#
38		80	89	4,5	Seamless Steel	20#
39		200	219	6	Seamless Steel	20#

BALLAST SYSTEM PIPING DIAGRAM									
valve	Type	Standart	Name	Dn	PN MPa	MATERIAL	Name Plate Stand	Words on name plate	Remarks
BW01V	DN250	1D10250TNS	BUTTERFLY VALVE	250	1	CAST IRON	C2	NO 2 BALLAST PP OUT	
BW02V	DN251	1D10250TNS	BUTTERFLY VALVE	250	1	CAST IRON	C2	NO 1 BALLAST PP OUT	
BW03V	DN252	1D10250TNS	BUTTERFLY VALVE	250	1	CAST IRON	C2	B.W FROM/TO SB	
BW04V	DN253	1D10250TNS	BUTTERFLY VALVE	250	1	CAST IRON	C2	B.W FROM/TO PS	
BW05V	DN254	1D10250TNS	BUTTERFLY VALVE	250	1	CAST IRON	C2	EMER. TO SEAWATER COLING SYSTEM	
BW06V	DN255	2A10250TNS	BUTTERFLY VALVE	250	1	CAST IRON	C2	EMER. FROM SEAWATER COLING SYSTEM	
BW07V	DN256	2A10250TNS	BUTTERFLY VALVE	250	1	CAST IRON	C2	FROM BILGE WATER PIPING SYSTEM	
BW08V	DN257	1D10200TNS	BUTTERFLY VALVE	250	1	CAST IRON	C2	FROM BILGE WATER PIPING SYSTEM	
BW09V	DN258		CHECK BUTTERFLY V.	250	1,6	DUCTILE IRON	C2	NO 2 BALLAST PP OUT	
BW10V	DN259		CHECK BUTTERFLY V.	250	1,6	DUCTILE IRON	C2	NO 1 BALLAST PP OUT	
BW11V	DN260		CHECK BUTTERFLY V.	250	1,6	DUCTILE IRON	C2		
BW12V	DN261		REMOT BUTT. V.	300	1	CAST IRON	C2	FROM SEAWATER COOLING PIPING SYSTEM	IMPORT

BALLAST SYSTEM PIPING DIAGRAM									
valve	Type	Standart	Name	Dn	PN MPa	MATERIAL	Name Plate Stand	Words on name plate	Remarks
BW13V	DN250		REMOT BUTT. V.	250	1	CAST IRON	C2	NO 2 BALLAST PP IN	IMPORT
BW14V	DN250		REMOT BUTT. V.	250	1	CAST IRON	C2	NO 1 BALLAST PP IN	IMPORT
BW15V	DN250		REMOT BUTT. V.	250	1	CAST IRON	C2	BALLAST PP OUT	IMPORT CONTINUE WORKING
BW16V	DN250		REMOT BUTT. V.	250	1	CAST IRON	C2	BALLAST PP OUT	IMPORT CONTINUE WORKING
BW17V	DN250		REMOT BUTT. V.	250	1	CAST IRON	C2	NO 2 BALLAST PP PASS-BY	IMPORT
BW18V	DN250		REMOT BUTT. V.	250	1	CAST IRON	C2	NO 1 BALLAST PP PASS-BY	IMPORT
BW19V	DN250		REMOT BUTT. V.	250	1	CAST IRON	C2	BALLAST PUMP TO OVERBOARD	
BW20V	DN250		REMOT BUTT. V.	250	1	CAST IRON	C2	BALLAST PUMP TO OVERBOARD	
BW21V	DN250		REMOT BUTT. V.	250	1	CAST IRON	C2	BETWEEN BALLAST PP OUT	
BW25V	DN150		REMOT BUTT. V.	150	1	CAST IRON	C2	FROM/TO AP	
BW26V	AS10100		STOP & CHECK	100	1	CAST IRON	C2	FROM EJECOR PP OUT TO OVERBOARD	
BW27	AS10080		STOP & CHECK	80	1	CAST IRON	C1	FROM B.W. PIPE TO EJECTION IN	

BALLAST SYSTEM PIPING DIAGRAM									
valve	Type	Standart	Name	Dn	PN MPa	MATERIAL	Name Plate Stand	Words on name plate	Remarks
BW28V	AS10080		STOP & CHECK	80	1	CAST IRON	C2	FROM FIRE FIGHTING PIPING SYSTEM EJEC. PP	
BW29V	DN150		BUTTERFLY VALVE	150	1	CAST STEEL	C2	FROM/TO AP	
BW30V	DN15	M521DF40-00	STOP	15	1	CAST IRON	C1	SAMPLING VALVE	
BW31V	DN300	A10300QDF20	STOP & CHECK	300	1	BRONZE	C2	B.W TO OUTBOARD (P)	
BW100V	DN250		REMOT BUTT. V.	250	1	CAST STEEL	C2	DISCHARGED FROM AP TK	IMPORT

AUTHOR BIOGRAPHY

The Author's name is Aditya Prabowo, born on 29 March 1996 in Cimahi, West Java. As the oldest child from two siblings. Derived from a simple family with a Father named Franciscus Hadi Prabowo and Mother named Christiana S. M. However, fortunate to have a formal education at SD Santo Yosef Surabaya, he continued his study at SMP Santa Maria Surabaya, and SMA Santa Maria Surabaya.In 2014, author proceed to pursue bachelor degree at Department of Marine Engineering (Double Degree Program with Hochschule Wismar), Faculty of Marine Engineering, Institut Teknologi Sepuluh Nopember Surabaya specializes in Marine Operation and Maintenance.During the study period, Author did activities in campus organizations such as: UKAFO ITS (2014-2015), Keluarga Mahasiswa Katolik (2014-2017) and MOM Laboratory (2017-2018).