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TURBOCHARGER CHARACTERISTIC ANALYSIS OF 93KW MARINE DIESEL ENGINE

PROPOSED BY:
ARVIAN PRADANA
42 12 101 024

DOUBLE DEGREE PROGRAM OF MARINE ENGINEERING DEPARTMENT
FACULTY OF MARINE TECHNOLOGY
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
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OUTLINE

- Background
- Problem Formulation and Scope
- Methodology
- Discussion and Results
- Conclusions



BACKGROUND

- Fishing vessels with a size of 30 GT is under development
- Development carried out for fishing vessels are design, economical, and performance
- Improvement of engine performance can be done by installation of turbocharger
- The aim of its installation is to increase power output and efficiency engine
- Study of the results must be done for the further result



PROBLEM FORMULATION & SCOPE

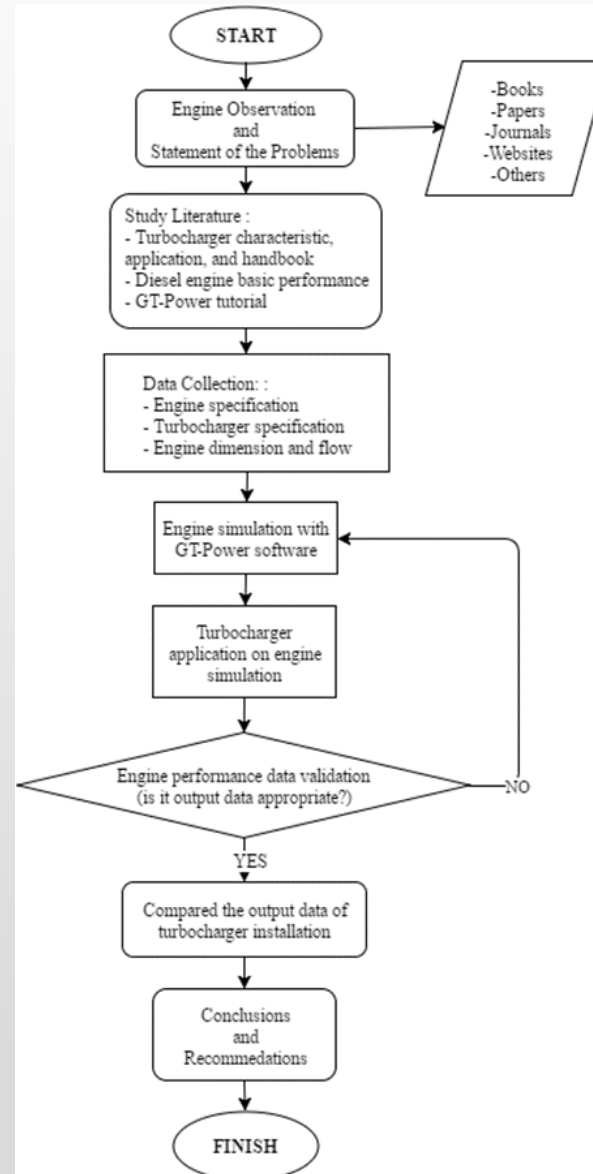
■ Problem Formulation

1. How to select a turbocharger for marine diesel engine with 93 kW of power output?
2. How to match the engine with a turbocharger?

■ Scope of Problem

1. The simulation using simulation modeling software
2. Simulation only used to find the performance of the engine which had been installed by turbocharger
3. The experiment will be done to compare the efficiency and performance of the engine which had been installed by turbocharger with a different specification

METHODOLOGY FLOW CHART





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DISCUSSION AND RESULTS



SIMULATION PROCESS USING SOFTWARE

There are a few step of simulation process, as follows:

- Collecting data of engine flow and arrangement
- Enviroment input object
- Compressor object
- Intake valve object
- Cylinder object
- Exhaust valve object
- Injection system object
- Turbine object
- Cranktrain object

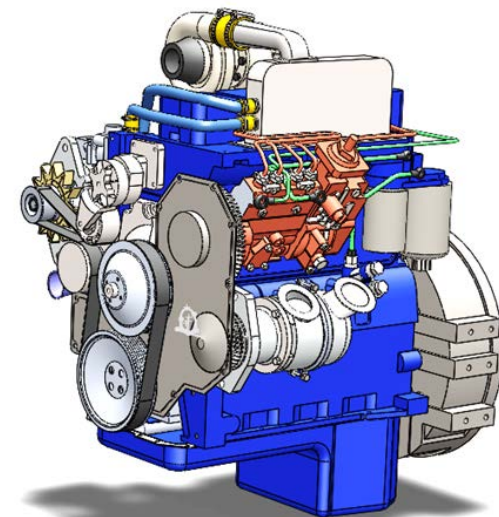


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ENGINE DATA

- Engine Specification Data (designed by Juniono Raharjo, 2015)
 - No. of Cylinder : 4
 - Displacement : 3.9 L
 - Bore : 102 mm
 - Stroke : 120 mm
 - Inlet Valve : 45 mm (clearance = 0.25 mm)
 - Outlet Valve : 43 mm (clearance = 0.51 mm)
 - Compression Ratio : 16.5 : 1
 - Firing Order : 1-3-4-2



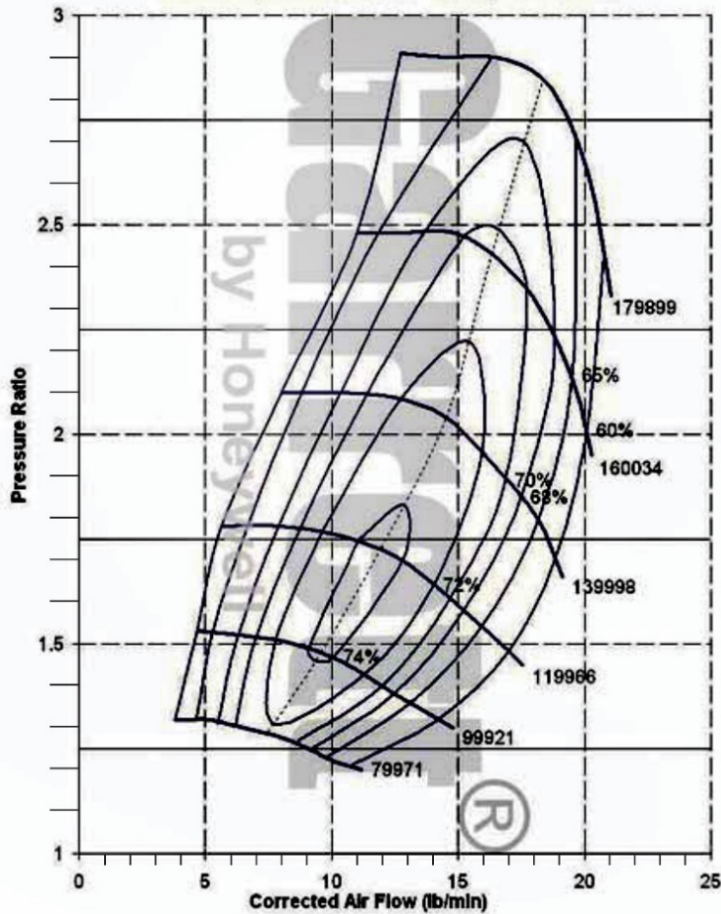


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TURBOCHARGER I DATA

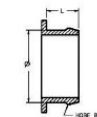
GT2052, 52.2mm, 48 Trim, 0.51 A/R



Garrett
by Honeywell

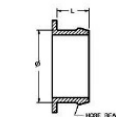
GT2052
727264-3 & 727264-7

Compressor Inlet
HOSE CONNECTIONS
TABULATED AS (Ø x L)



Ø 54 x 25

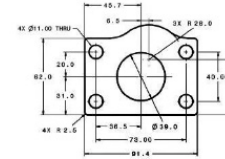
Compressor Outlet
HOSE CONNECTIONS
TABULATED AS (Ø x L)



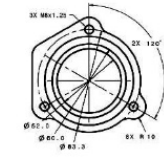
Ø 50 x 25

Oil Inlet
Available with
M10 x 1.0 (F)
OR
M10 x 1.0 (M)

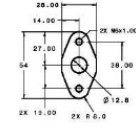
Turbine Inlet



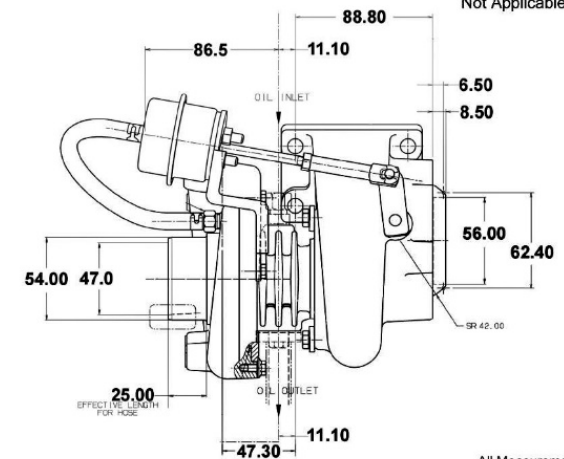
Turbine Outlet



Oil Outlet



Water
Not Applicable



All Measurements in MM



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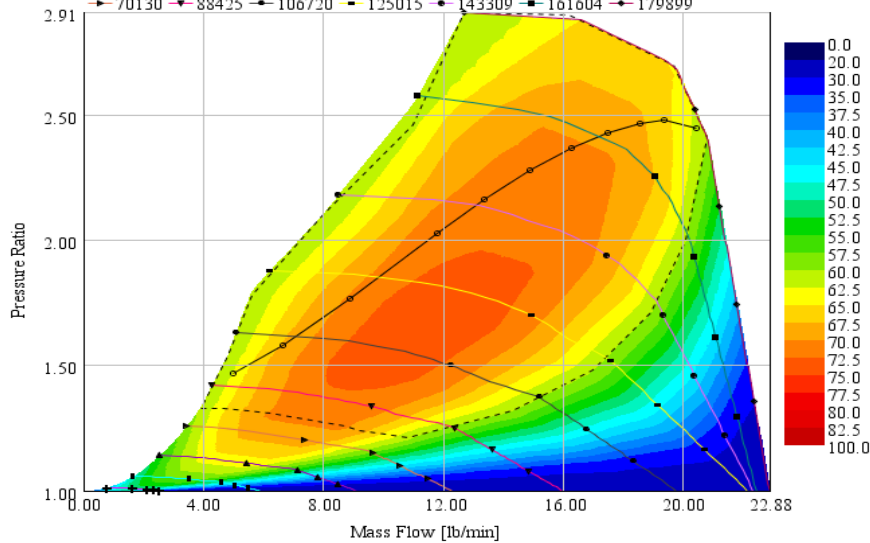


TURBOCHARGER I OUTPUT

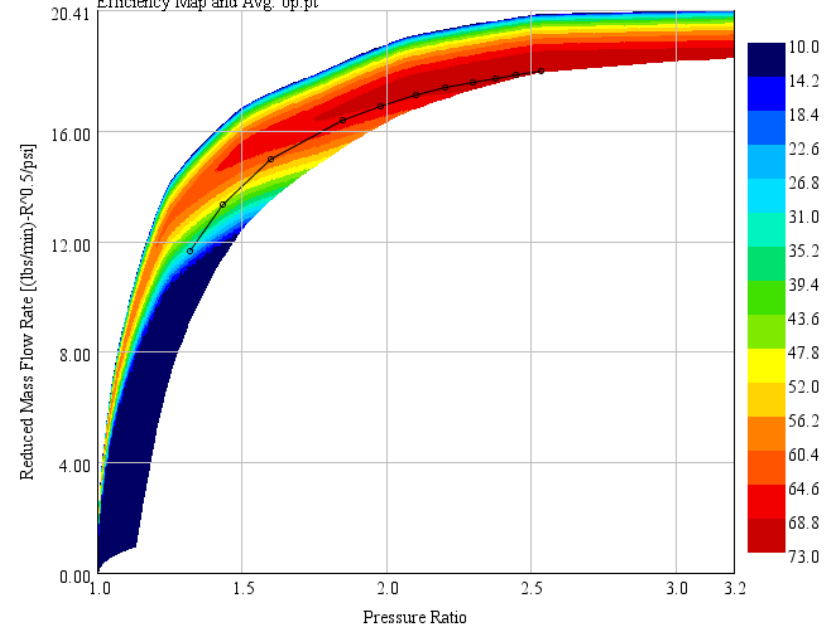
Compressor: Efficiency Map - Corrected

Efficiency Map and Avg. op.pt

--- Input Data Window + 15246 - 33540 - 51835
--- Cycle Average Values (EOR) ---
+ 70130 + 88425 + 106720 + 125015 + 143309 + 161604 + 179899



Turbine: Efficiency Map
Efficiency Map and Avg. op.pt





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TURBOCHARGER I OUTPUT

Type of Device	Compressor	Turbine
Speed [RPM]	178662	178662
Pressure Ratio (static)	2.48	2.48
Pressure Ratio	2.45	2.54
Mass Flow Rate [kg/s]	0.15	0.15
Power [kW]	21.1	23.6
Efficiency [%]	61.4	72.1
Inlet Pressure [bar]	0.94	3.01
Outlet Pressure [bar]	2.34	1.21
Inlet Temperature [K]	297	898
Outlet Temperature [K]	437	766
Map PR Exceeded/Stalled ?	NO	NO
PR less than 1.0 ?	NO	NO

RPM	Brake Power (kW)	SFOC (g/kWh)	TORQUE (Nm)
2200	96.823	228.023	420.269

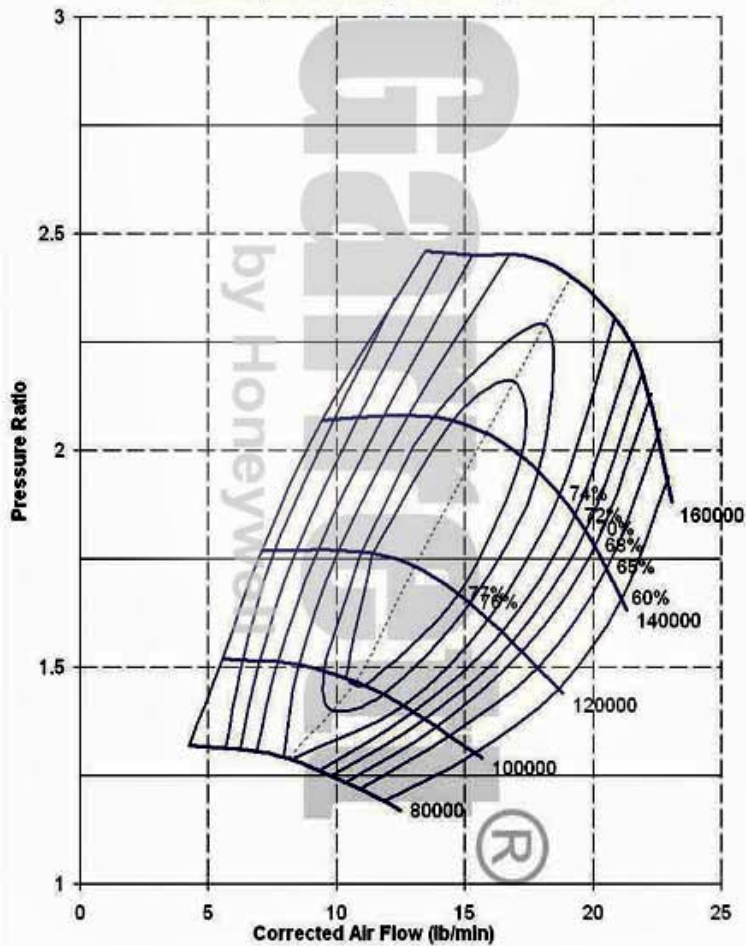


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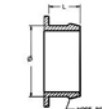
TURBOCHARGER II DATA

GT2052, 52.2mm, 52 Trim, 0.51 A/R



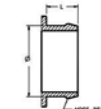
Garrett GT2052
by Honeywell 727264-1 & 727264-2

Compressor Inlet
HOSE CONNECTIONS
TABULATED AS (D x L)



Ø 54 x 25

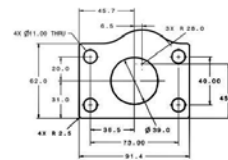
Compressor Outlet
HOSE CONNECTIONS
TABULATED AS (D x L)



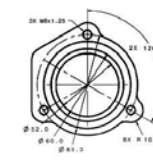
Ø 50 x 25

Oil Inlet
Available with
M10 x 1.0 (F)
or
M10 x 1.0 (M)

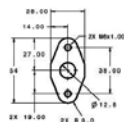
Turbine Inlet



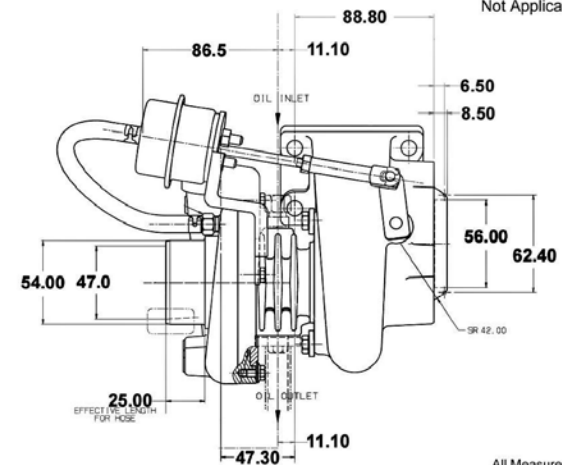
Turbine Outlet



Oil Outlet



Water
Not Applicable



All Measurements in MM



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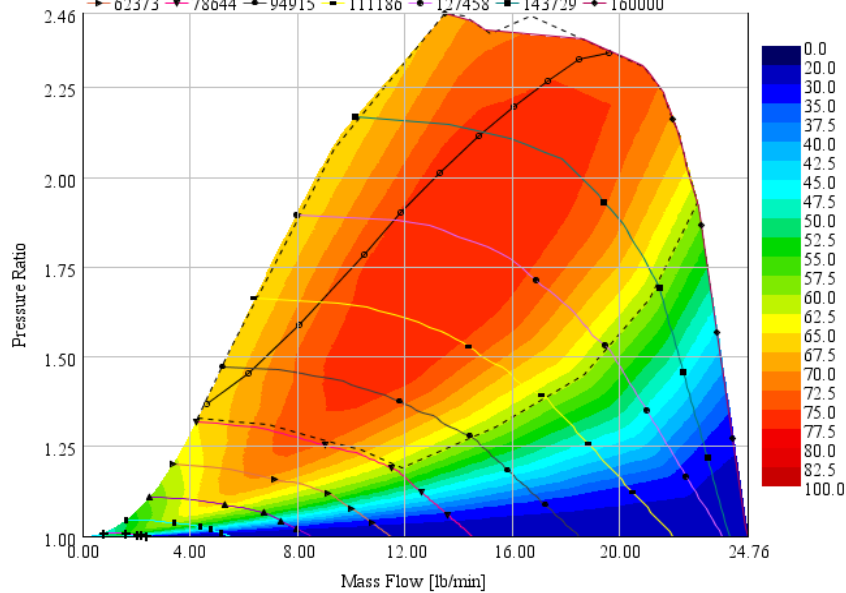
TURBOCHARGER I OUTPUT

Compressor: Efficiency Map - Corrected

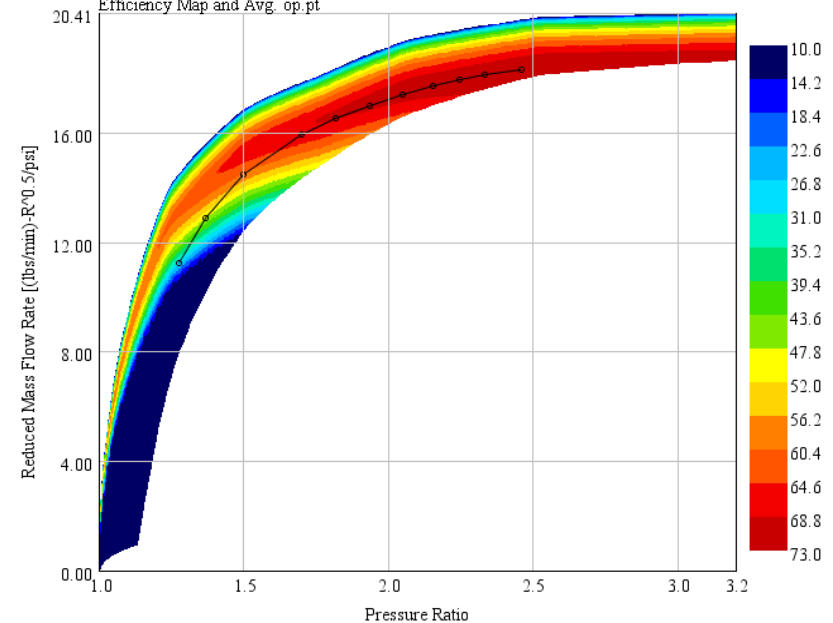
Efficiency Map and Avg. op.pt

— Cycle Average Values (EOR) --- Input Data Window + 13559 + 29831 + 46102

+ 62373 + 78644 + 94915 + 111186 + 127458 + 143729 + 160000



Turbine: Efficiency Map
Efficiency Map and Avg. op.pt





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TURBOCHARGER II OUTPUT

Type of Device	Compressor	Turbine
Speed [RPM]	165365	165365
Pressure Ratio (static)	2.38	2.41
Pressure Ratio	2.35	2.46
Mass Flow Rate [kg/s]	0.14	0.15
Power [kW]	16	22.1
Efficiency [%]	73.9	72
Inlet Pressure [bar]	0.95	2.89
Outlet Pressure [bar]	2.25	1.2
Inlet Temperature [K]	297	896
Outlet Temperature [K]	408	768
Map PR Exceeded/Stalled ?	NO	NO
PR less than 1.0 ?	NO	NO

RPM	Brake Power (kW)	SFOC (g/kWh)	TORQUE (Nm)
2200	93.622	228.489	406.374

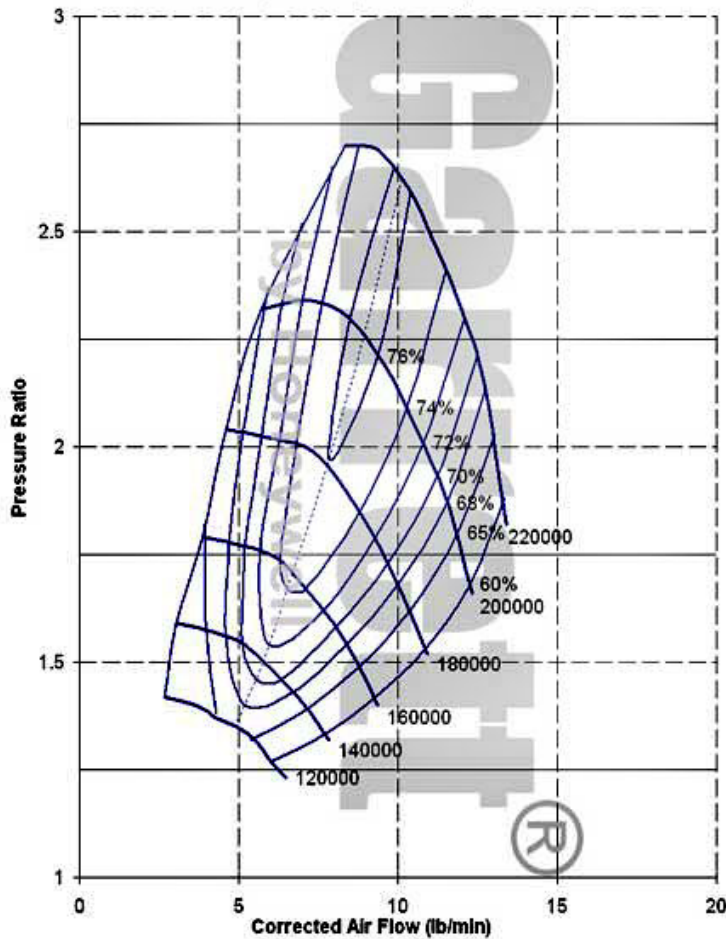


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TURBOCHARGER III DATA

GT1241, 41mm, 50 Trim, 0.33 A/R



Garrett GT1241
by Honeywell 756068-1

Compressor Inlet

HOSE CONNECTIONS
TABULATED AS (Ø x L)



Ø 45.9 x 23.25

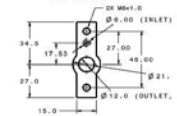
Compressor Outlet

HOSE CONNECTIONS
TABULATED AS (Ø x L)

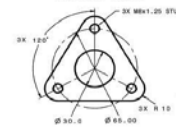


Ø 36 x 20

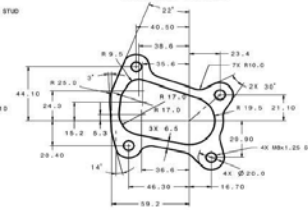
Oil Inlet



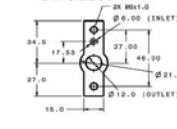
Turbine Inlet



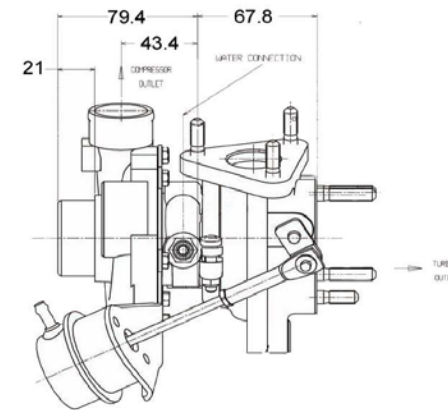
Turbine Outlet



Oil Outlet



Water
M12 x 1.50



All Measurements in MM



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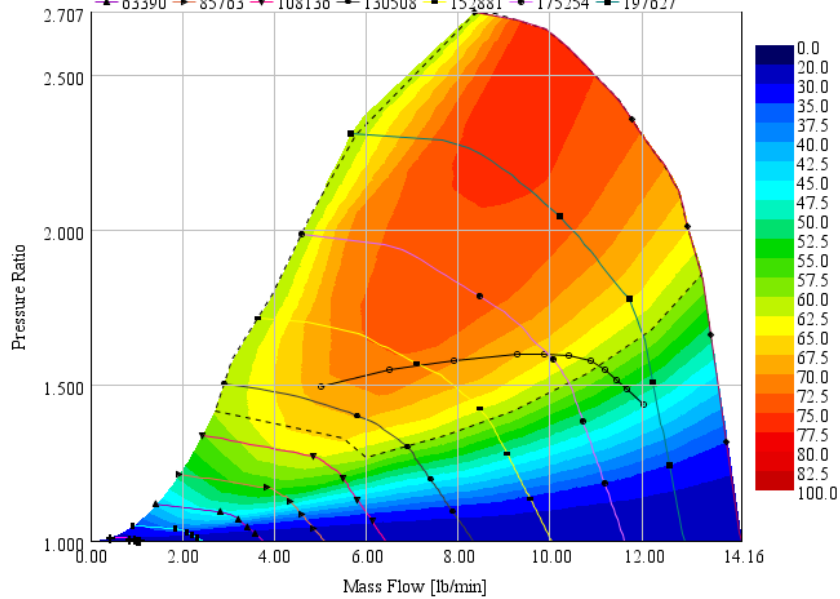
TURBOCHARGER I OUTPUT

Compressor: Efficiency Map - Corrected

Efficiency Map and Avg. op.pt

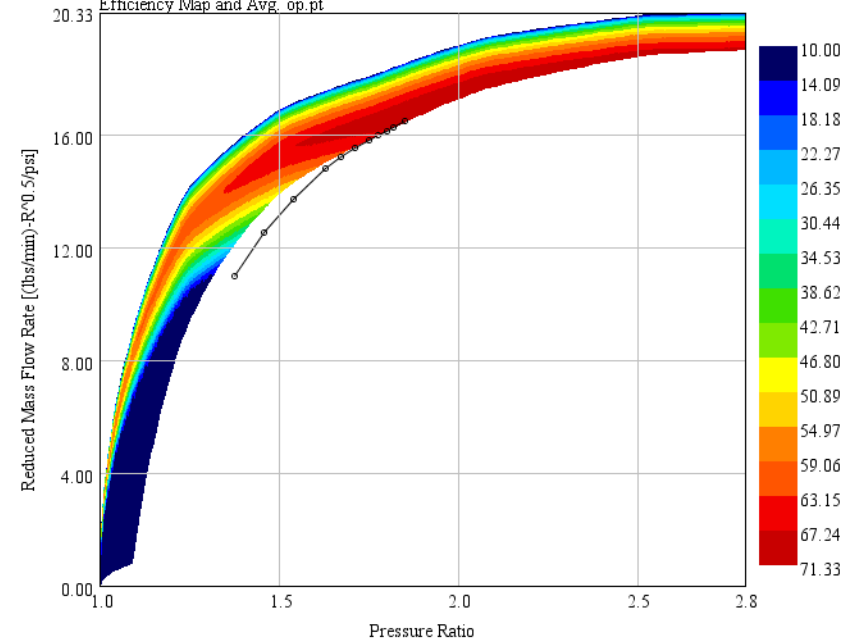
— Cycle Average Values (EOR) --- Input Data Window + 18644 + 41017

▲ 63390 → 85763 → 108136 → 130508 → 152881 • 175254 ■ 197627



Turbine: Efficiency Map

Efficiency Map and Avg. op.pt





TURBOCHARGER III OUTPUT

Type of Device	Compressor	Turbine
Speed [RPM]	194046	194046
Pressure Ratio (static)	1.43	1.82
Pressure Ratio	1.44	1.85
Mass Flow Rate [kg/s]	0.09	0.09
Power [kW]	6.2	8.9
Efficiency [%]	47.4	67.7
Inlet Pressure [bar]	0.97	1.97
Outlet Pressure [bar]	1.38	1.08
Inlet Temperature [K]	298	879
Outlet Temperature [K]	365	793
Map PR Exceeded/Stalled ?	NO	NO
PR less than 1.0 ?	NO	NO

RPM	Brake Power (kW)	SFOC (g/kWh)	TORQUE (Nm)
2200	51.929	254.828	225.401



CONCLUSIONS

1. Turbocharger match results known from operating line turbocharger to the engine performance. From the first turbocharger (GT2052-3), maximum power output value is 96.823 kW at 2200 RPM. Obtained torque value by 420.269 Nm, with a specific fuel oil consumption by 228.02 g/kWh. The second turbocharger (GT2052-1), maximum power output value is 93.622 kW at 2200 RPM. Obtained torque value by 406.374 Nm, with a specific fuel oil consumption by 228.389 g/kWh. The third turbocharger (GT1241), maximum power output value is 51.929 kW at 2200 RPM. Obtained torque value by 225.401 Nm, with a specific fuel oil consumption by 254.828 g/kWh. Turbocharger can be considered match if the efficiency level turbocharger $>80\%$. So turbocharger selected is GT2502-1 with highest efficiency at full load.
2. Maximum load of the engine at 2200 RPM installed with GT2502-1 turbocharger, power generated value is 93.662 kW. Efficiency of the selected turbocharger compressor map is 73.933%, and turbine efficiency map 72.022%. Compressor and turbine revolution is at 165365 RPM. Boost pressure generated at highest point of this turbocharger used is 2.247 bar, with a temperature of 408.01 K.



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- Tancrez M. 2010. Turbine Adapted Maps for Turbocharger Engine Matching. M.Sc Thesis. Universidad Politécnica de Valencia, Spain.



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THANK YOU
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