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ANALYSIS OF CONVERTER GAS WITH PERFORMANCE TEST VALIDATION *LIQUEFIED PETROLEUM GAS* (LPG) DRIVE MOTOR BOATS / FISHING VESSEL

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Abstract

During most of Small Fishermen use fishing boats with a gasoline engine. Fuel shortages and the high price of oil makes its own problems for small fishing. The use of alternative energy that is cheap, convenient, safe to drive a small fishing boat engines are indispensable.This study is to design a converter gas with methods VDI 2221 (Verein Deutscher Ingeieure = Association of German Engineers), and experimentation. To get the engine performance, torque and power effective, it is necessary in order to be considered for the fishermen to use LPG as an alternative fuel. The first results of this study using LPG fuel directly, two systems created using pneumatic flow control valves, and the use is purely 3kg LPG gas. The third material gas converter using aluminum in order to make corrosion resistant, because this gas converter application to the tangent of motor fishing boat with sea water. From lab scale test results show that the converter gas is made to function properly. Thus obtained, 7.71 Nm torque, and motor power 1.46 Kw at 1800 rpm motor rotation with the LPG consumption of 7.26 grams / minute.

Keywords: design, converter gas, test validation, power, petrol engine.

INTRODUCTION

According to the Law No. 45 of 2009 on the amendment of Law No. 31, 2004, stated that the Small Fishermen are people whose livelihood is fishing for subsistence - days using fishing boats with the greatest 5 gross tone. [1] Most of Small Fishermen use boats with engine four stroke gasoline. Fish catching require boperational iaya about 70% for fuel oil. If fuel prices rise, the operating costs of fishing will be high so that the income of fishermen declined.Fuel shortages and the high price makes its own problems for small fishing. The use of alternative energy that is cheap, convenient, safe and compatible for small fishing boats drive enginery is needed.[2] In general, fishing boat under 5 gross tone many that use gasoline combustion engines. Therefore, the need for further research on the modification converter gas to air ratio and gas right on the motor fishing boat fishermen. Produce a draft design and make new gas converters for motor fishing boat optimal, in accordance with the standards and prioritize ergonomic, and safety factor. Analyze and test validation engine achievement are: torque, effective power, specific fuel consumption, fuel consumption, the ratio of fuel to air, the air mass flow rate. In optimizing fuel resources are one of the concrete steps that the energy conversion engine technology development, through the study of the modification of an engine. [2]

The next study was conducted modification gas converter design and validation test. Modification designed gas converter aims to optimize the use of gas converters on gasoline motor to find the mixing ratio of air and fuel gas is right. So with the manufacture of gas converters is expected accomplishments engine, the torque and the same effective power with the use of fuel oil with cheaper operating costs and easier operation in comparison with the previous kit converter.

Literature review

According Bagus Baruno in his research (Performance Liquefied Petroleum Gas (LPG) At the Motor Fuel 6.5 Hp For Alternative Fuels Fishing Boat Small Motor) The use of LPG as fuel is technically able to reduce the surface temperature of the engine, exhaust gas temperature and fuel consumption compared to motors which operates using gasoline. [3]

According Ma'muri1, Ari Kuncoro, Susilo Wisnugroho in his research (Design of converter kit dual fuel (LPG - diesel) for diesel engines traditional fishing boat) From the laboratory scale test results show that the converter kit that has been created to function well and is able to drain LPG into the engine through the intake manifold. [4]

According to Ana Ramadhayanti in his research (Identify Factors Affecting Performance Improvement Fishermen Cilincing Using Converter Kit) Government programs in the distribution of "converter kit" for fishermen other than a form of government concern to fishermen, to lower the cost of fuel is also part of the conversion of the fuel to gas , Utilization of gas as a fuel for fishing vessels [5]

Problem Statments

Based on the subject matter that is contained in the background, then this study were drawn formulation of the problem as follows:

1. How to design and create a converter gas that can replace carburetors on a motorcycle fishing boats for fishermen?
2. How comparison of fuel with air work on gas converters in compositions in accordance with the operational needs of the motor.
3. How to Influence the design of this new gas konventer on engine performance.
4. Is there any influence of performance gas converters work on the motor fishing boats for fishermen to get thrust.

Research purposes

Based on the background as well as the problem, the purpose of this research is:

1. Produce a draft design and make new gas converters for motor fishing boat optimal, in accordance with the standards and prioritize ergonomic, also safety factor.
2. Analyze and test validation engine achievement is: torque, effective power, fuel consumption.

Benefits Research

The benefits of this research include:

1. Provide information about the use of LPG as a fuel substitute gasoline for fishing boat.
2. This research is expected to contribute to the fishermen in the use of gas LPG as an alternative fuel in a motor boat.
3. The results obtained can be a reference for further research in the future.

THEORETICAL BASIS

Motor Fuel

Motor fuel is one kind of heat engine, that engine that converts thermal energy to mechanical work or changing the chemical energy of fuel into mechanical energy. Before becoming mechanical energy, chemical energy of fuel is converted first into thermal energy or heat through combustion of fuel with excess air. The combustion was done in the heat engine itself and some are done outside the otto cycle heat engine and the petrol engine is also called the constant volume cycle, where combustion occurs during constant volume. [6][7]

External combustion engine

External combustion engine is where the combustion process occurs outside of the engine itself is the heat of the fuel it is not converted into kinetic energy but exceed its medium first and then changed form the mechanical energy. In general, steam engine and turbine has a character that can only be used as prime movers large size, for example, locomotives, ships, and power plant and does well when used as a driver generator versatile, motorcycles and vehicles (car) and can be seen as in the picture 1.

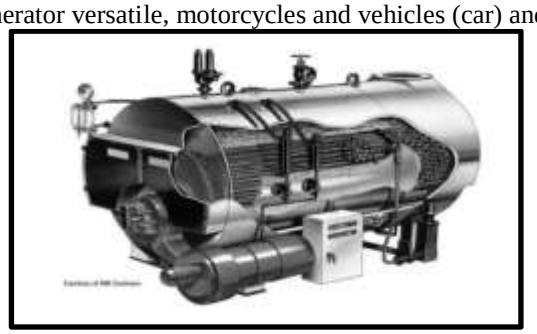


Figure 1. Motor Combustion Affairs

Internal Combustion engine

Combustion engine is the combustion of fuel occurs in the engine itself so that the heat from the combustion can instantly be converted into mechanical power construction and planning engines become smaller and simpler, like a diesel engine that can operate in a state of high temperature with cycles repeated and motor fuel use is widespread because have a strong and reliable force in addition to the fuel becomes more economical and efficient. As shown in Figure 2.

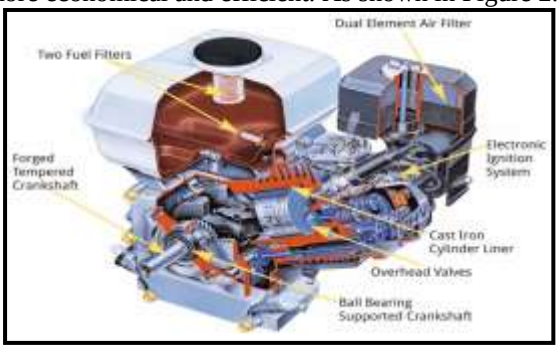


Figure 2. Motor Combustion

Work principle Otto cycle (Four Stroke)

Motor gasoline four stroke have one process at each step: Step suction begins with the movement of the piston from the top dead point (TDC) to bottom dead center (BDC), the suction valve is open and the exhaust valve is closed. Through the suction valve, a mixture of fuel, air into the combustion chamber. The compression stroke crankshaft rotates moving the piston to TDC after reaching the BDC. Intake valve and exhaust valve is closed.

Fuel-air mixture is compressed, the pressure and temperature in the cylinder increases, so that the mixture is flammable. This compression process also called press step, when the piston moves from BDC towards TDC and the second valve is closed. Step workplace where both valves closed. At the time the piston reaches TDC, stepping electric spark from the spark plug and burns the air-fuel mixture pressure and high temperature. Step wasting After BDC crankshaft moves the piston to TDC, cylinder volume decreases. At the time of the exhaust step intake valve is closed and the exhaust valve open. The plunger presses flue gas out of the cylinder. so that the cycle happens repeatedly as in figure 3.[8]

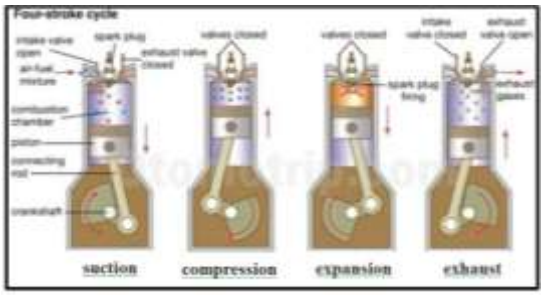


Figure 3. Step motor work four stroke

Gas Converter Design Methods

Planning an efficient planning prosecuted engine, simple and systematic. With the method VDI 2221 (Verein Deutscher Ingeieure = Association of German Engineers), planning in designing construction enginery becomes easier and systematic. Basically, the design concept is an attempt to be able to meet the necessary requirements in the manufacture of a device making it possible to obtain results products are best as you wish. VDI 2221 method developed by Gerhard Pahl and Wolfgang Beitz[11] in Engineering Design book is divided into several stages, namely:

a) Explanation of the task (clarifying the task)
b) The design concept (conceptual design)
c) The design of the shape / form (embodiment design)
d) Design of details / complete (detailed design)

Table 1. Matrix solution principles.

No	variable	variant		
		A	B	C
1	Type LPG			
2	Pressure valve			
3	kinds of hose			
4	Type safety valve			
5	System flow control			

Fishing Boats

Fishing vessels can be distinguished on the fishing vessel is not motorized and motorized fishing boats. A motorized fishing boats ships using fuel as a source of propulsion motors and propellers as a means of propulsion. Based on the driving motor, fishing boats can be distinguished on the outside motorized fishing boat (outboard engine) and a motorized fishing boat in the (inboard engine). [9][3]

Converter Kit

The working principle is to deliver LPG converter kit into the engine. LPG is stored in the LPG cylinders at high pressure. Before entering konveretr kit, LPG pressure is too high. The pressure is then lowered by lowering the pressure (regulator). Furthermore, LPG is mixed with air by the air mixer (mixer). Next LPG and air mixture into the combustion chamber.[10] as shown in Figure 4.

Figure 4. The model of the converter kit

Drive System Selection

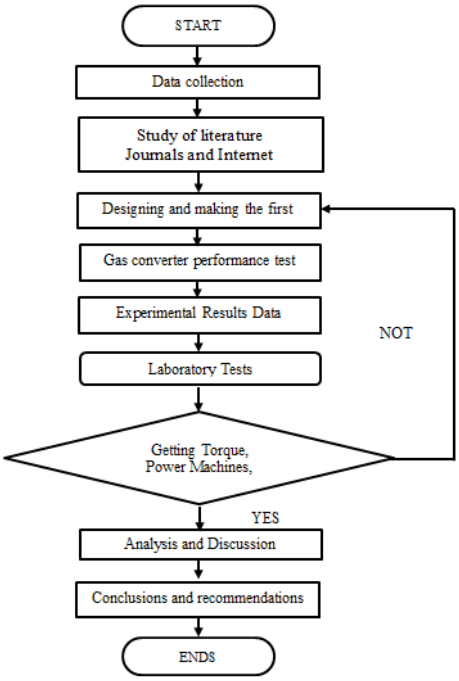
The drive system has been used is the motor of gasoline four stroke, because less fuel consumption, engine specifications that will be used in the analysis of the drive system is of general gasoline motors GX270 T2 as shown figure 5.

Figure 5. Motor gasoline

Details Technical Data General GX270 T2

- Horse Power: 8.0HP
- Engine Type: Single Cylinder, OHV 25, 4-Stroke, Air-Cooled
- Bore x Stroke: 77x58 mm (3.0x2.3 in)
- Displacement: 270 cm3 (16.5 cu in)
- Compression Ratio: 8.2: 1
- Net Horse Power Output: 6.6Kw (9 HP) / 3600 rpm
- Maximum Torque: 1.95kgf-meters (Nm 19:12) / 2500rpm
- Net Torque: 17.7 Nm (13.1 ft lbs) at 2,500 rpm
- PTO Shaft Rotation: Counter clockwise (from PTO shaft side)
- Ignition System: Magneto transistorized ignition
- Starting System: Recoil
- Fuel Tank Capacity: 6 Liters
- Air Cleaner: Semi - Dry
- Carburetor: Horizontal type butterfly valve
- Oil Capacity: 1.1 Liters
- Lubrication System: Forced Splash
- Governor System: Centrifugal Mechanical
- Dimension (L x W x H): 380 x 430 x 410 mm,
- Weight: 25 Kg

RESEARCH METHODS



Picture. 7. Flowchart design (Flowcarth)

The converter design is made

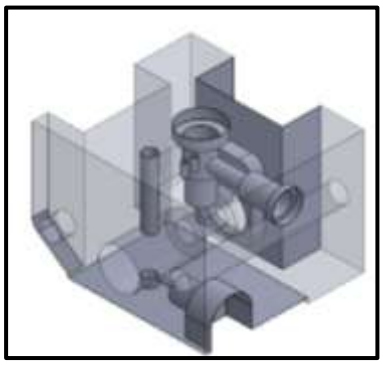


Figure 6. Design of gas converters

Gas Converter Design Results

Figure 7. Converter Gas

Schematic Gas Converter mounting

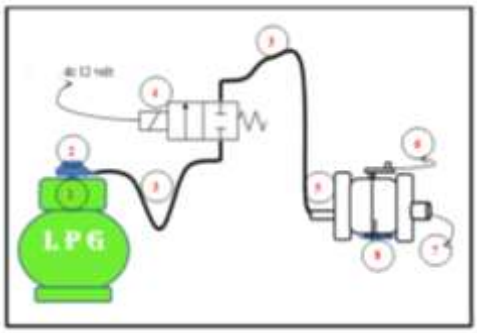


Figure 8. The schematic Converter Gas

Information :

1. LPG 3 Kg
2. Regulators High Preasure
3. The gas hose
4. Selenoid valve 2/2 NC
5. converter Gas
6. Handle / towing comparison of gas and air
7. Channel into the combustion chamber (GX270 starter motors)
8. Gears

Data Results

Testing the performance of gas converters on gasoline motor honda General GX270 T2 using LPG fuel with a torque test equipment vonry break with variations round 1500 - 2200 rpm.

Table. 1. Data of test results

Rotation No load (rpm)	Braking Load (Kg)	Rotation with the load (rpm)	Time Minute	The use of fuel gas (g)	Temperatures		
					air Inlet (°C)	air outlet (°C)	Engine (°C)
1577.2	0.63	1334.5	5.33	30	30	248	70
1603.8	0.72	1402.5	5.33	30	30	249	79
1804.1	0.74	1506.7	5.33	30.67	30	254	80
1909.5	0.84	1680.0	5.33	36.67	30	300	80
2201.1	0.97	1804.6	5.33	38.67	30	375	85

The test data to get the braking load torque

Torque calculation obtained by providing load on engine rotation (rpm) issued by the engine shaft to Prony brake. Torque is the multiplication of the braking load (kg) with sleeve length (meters) Prony brake and the force of gravity, using equation Moment of torque (Nm), then:

$$T = m.g.l$$

Where,

m = Style Weight (kg).
g = Gravity Earth (m / s^2)
l = Torque Arm Length (m)

$$T = m.g.l$$
$$T = 0.63\ x 9.807 x\ 0.81$$
$$= 5.005\ Nm$$

Table. 2. Data on test results to get the braking load torque

Rotation No load (rpm)	Braking Load (Kg)	Rotation with the load (rpm)	Torque (Nm)
1577.2	0.63	1334.5	5,005
1603.8	0.72	1402.5	5,719
1804.1	0.74	1506.7	5,878
1909.5	0.84	1680.0	6,673
2201.1	0.97	1804.6	7,705

Brake Horse Power Calculation

Power is obtained using the equation BHP (kW) spindle power effective

$$BHP = T\frac{2\pi.n}{60}$$

Where,

BHP = Brake Horse Power (kW).

T = Torque (Nm)

N = Crankshaft rotation (rpm)

$$BHP = 5{,}005\frac{2\pi\ x\ 1334{,}5}{60}$$

$$= 699{,}019\ watt$$

$$= 0{,}699\ kW$$

Table 3. Calculation of the horse power

Rotation No load (rpm)	rotation with the load (rpm)	torque (Nm)	Horse Power (kW)
1577.2	1334.5	5,005	0,699
1603.8	1402.5	5,719	0,840
1804.1	1506.7	5,878	0,927
1909.5	1680.0	6,673	1,173
2201.1	1804.6	7,705	1,455

Fuel consumption of LPG

Calculation of fuel consumption is calculated from the difference between the weighing selama16 minutes divided by 3 times the weighing with the average time of 5.33 minutes.

Table. 4. Fuel consumption of LPG

Rotation with the load (rpm)	Torque (Nm)	Horse Power (kW)	Time Minute	The use of fuel gas (g)
1334.5	5,005	0,699	5.33	30
1402.5	5,719	0,840	5.33	30
1506.7	5,878	0,927	5.33	30.67
1680.0	6,673	1,173	5.33	36.67
1804.6	7,705	1,455	5.33	38.67

The air temperature engine, inlet and exhaust

Table. 5. The temperature of the engine, air inlet, and the air outlet

Rotation with the load (rpm)	Torque (Nm)	Horse Power (kW)	Temperatures		
			Air inlet (°C)	Air outlet (°C)	Engine (°C)
1334.5	**5,005**	**0.19**	**30**	**248**	**70**
1402.5	**5,719**	**0.23**	**30**	**249**	**79**
1506.7	**5,878**	**0.26**	**30**	**254**	**80**
1680.0	**6,673**	**0.33**	**30**	**300**	**80**
1804.6	**7,705**	**0.40**	**30**	**375**	**85**

Research result

Gas from existing converters, to start early to be using fuel oil after the engine is running and then do the transfer of fuel gas through the gas valve is opened. The use of vacuum membrane on the converter gas is not the maximum. The results of this research design that uses LPG fuel directly without the use of fuel oil for the initial engine starting. The system is made using a pneumatic flow control valve, do not use a vacuum membrane. Its use pure gas and LPG 3kg. The disadvantage use less precision valves for gas flow hiccup. Of the converter kit that is already there, to start early to be using fuel oil after the engine is running and then do the transfer of fuel gas through the gas valve is opened.

Performance Analysis Engine

The chart shown below is a chart of the character test engine, calculations are achieved as the motor rotation (rpm), torque (Nm), engine power (kW), by means of Prony brake test.

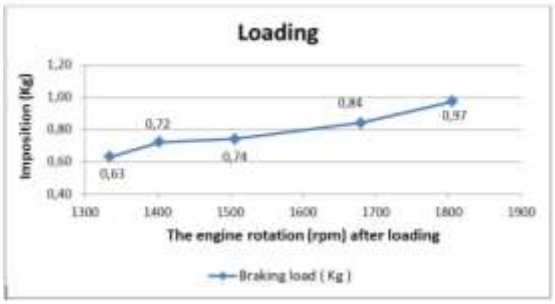


Chart. 1. Turn the engine with load

Torque analysis

Torque calculation obtained by providing load on engine rotation (rpm) issued by the engine shaft to Prony brake.

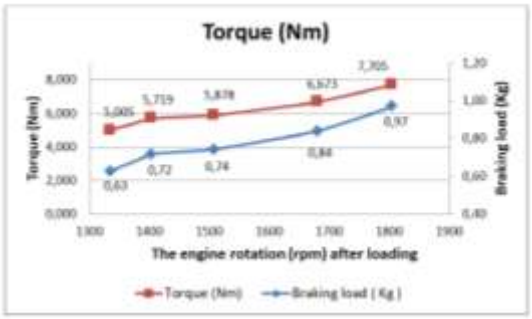


Chart. 2. Torque (Nm)

Chart 2 shows that an increase in engine torque in accordance with the increase of rotation (rpm) and the braking load it in accordance with the theory.

Horse Power Analysis

From the chart 3 shown it can be seen that the results of the analysis indicate that the Horse Power Motor torque value greater then the horse power is also large and vice versa if small loading the small torque which also affect the horse power.

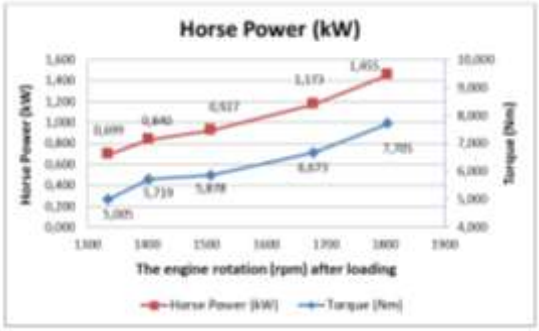


Chart. 3 Horse Power (kW)

Analysis of LPG gas fuel consumption

Chart 4 shows that increasing rpm, the greater the fuel consumption. Average fuel consumption - average on the test fuel is the total amount of 166 grams divided by 5 times the experiment 33.202 grams and then divided by the time 5.33 minutes so the average - average fuel digunkan is 6.23 grams per minute.

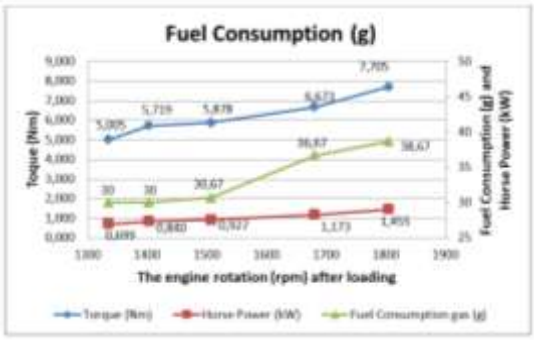


Chart. 4. Fuel Consumption (g)

Engine Temperature Analysis, Air inlet and air outlet

Engine temperature, air inlet and air outlet. The temperature data taken at the engine speed of the charge is to look at the manometer scale that has been installed on the converter gas to the intake air temperature, engine temperature manometer scale mounted on the body of the engine and for the exit air temperature is mounted on the exhaust flue gases.

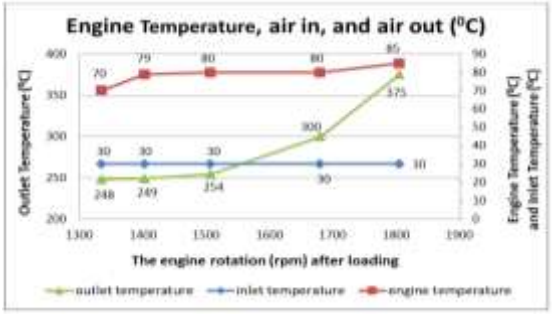


Chart. 5. Temperature Engineering, Air inlet and outlet (^{0}C)

Conclusion

1. The results of this research first design using LPG fuel directly, two systems created using pneumatic flow control valves, and the use is purely 3kg LPG gas. The third material gas converter using aluminum in order to make corrosion resistant, because this gas converter application to the tangent of motor fishing boat with sea water. Fourthly there are still weaknesses in the control valve that lack of precision. While the converter kit that is already there, to start early use of fuel oil after running the displacement of fuel gas conducted through the valve, and a vacuum membrane on the converter kit has not been maximum.
2. From lab scale test results show that the converter gas to function properly. With 270 cc test engine torque of 7.71 Nm So we get, and motor power of 1.46 kW at 1800 rpm, the motor rotation with the LPG consumption of 7.26 grams / minute. While the test results of a long gas converter is 5.783 g / min with a test engine 192 cc, so validated more efficient with gas converter design newly designed.

References

[1] Anonymus_ministry of maritime affairs and fisheries, "the Law of the Republic of Indonesia No. 31 on Fisheries p.4," 2004.
[2] Anonymus_ministry of maritime affairs and fisheries, "Structure of the National Fishing Fleet," pp. 1-10, 2011.
[3] B. Baruno, "Performance of Liquefied Petroleum Gas (LPG) At 6.5 Hp Motor Fuel As Alternative Fuels, "2014.
[4] A. Kuncoro and S. Wisnugroho, "Design Converter Kit Dual Fuel (LPG - SOLAR)," no. November 2016, pp. 1-8, 2016.
[5] A. Amadhayanti, "Identification of Factors Affecting PCilincing Fishermen Strengthening SMEs Performance Using Converter Kit, "pp. 1-6, 2017.
[6] Arismunandar W, *At Motor Fuel mover piston*, *ITB*, 1988.
[7] Wiratno T., S. Rahardjo, IC Engine, and M. Gasoline, "Calculation Power and Fuel Consumption Motor Gasoline YAMAHA LS 100 CC," vol. 12, no. 2, pp. 58-75, 2012.
[8] A. Kuncoro and S. Wisnugroho, "LPG As Alternative Energy To Fuel Diesel Dual-Fuel Engines Boat Fishermen," No. November, pp. 1-12, 2016.
[9] Gulbrandsen O, "Small-Scale Fisherfolk Communities in the Bay of Bengal. Food and Agriculture Organization (FAO) Fisheries Technical Paper. Madras. India. Gunarto, "1990.
[10] S. Bhuiyan, "Dual Fuel Performance of a Small Diesel Engine for Applications with Less Frequent Load Variations," no. 10, 2009.
1. [11] W. Pahl, G and Beitz, Engine