SALAGA Journal
Vol. 01, No. 1, June 2023, pp. 1~7
ISSN: 3032-2677
DOI:https://doi.org/10.70124/salaga.v1i1.1102

Comparative Analysis of the Performance of Gasoline and LPG-Powered Water Pumps in Shallow Wells

Muh. Rama Pien[1], Haerani Haerani[1] and Ahmad Munir[1]

[1]Department of Agricultural Engineering, Hasanuddin University, Makassar, Indonesia.

Article Info

Keywords:

Water pumping
LPG
Fuel efficiency

ABSTRACT

One application of technology in agriculture is the use of water pumping machines to provide water for plants. Various innovations have been made to reduce the operation costs of water pumps. One example is to use Liquifield Petroleum Gas (LPG) to replace gasoline fuel. This study aimed to compare the performance and efficiency of gasoline and LPG water pumps. The observation parameters included calculating water discharge, analyzing gasoline and gas fuel requirements, calculating the power generated by the pump when raising water, and calculating engine torque. The results showed that water discharge obtained for the gasoline fuel engine was 0.002808 m^3/second, while for the LPG engine was 0.002961 m^3/second. The cost required for the operation of the gasoline pump engine was Rp.23,615 / hour, while for LPG pump engine was Rp.11,920 / hour. In terms of power generated by the pump engine, the gasoline produced 80.808 W, while the LPG produced 83.882 W. The water pump engine in this study operated at a torque of 7.84 Nm. Based on the results of this study, it can be concluded that the use of LPG gas fuel in the rice field water pump engine is more efficient and produced longer water discharged than the gasoline pump.

Corresponding Author (s):

Haerani haerani
Department of Agricultural Engineering, Hasanuddin University, Makassar, Indonesia.
Email: haerani@agri.unhas.ac.id

1. INTRODUCTION

Meeting water needs to increase the productivity of agricultural land or paddy fields can be done by utilizing existing water sources. The increasing number of paddy fields and also the need for other staple food led to the increase of water and land need. Therefore, as addition to river water and reservoirs, groundwater is one of water resources that has an important role in fullfil this need. One example of utilizing the groundwater is by using a water pump machine to move water to irrigate agricultural land.

In general, a water pump machine is a device that used to move water, liquid or (fluid) countinously from one place to another through a pipeline using gasoline as a power source. According to [1] a pump is a device that functions to convert mechanical power from a power source (drive) into kinetic power (speed), where this power is useful for flowing liquids and overcoming obstacles that exist along the flow.

In addition to the problems of fertilizers, water, etc., one of the problems experienced by farmers in rice fields is the provision of fuel for water pump engines. Water pumps that are commonly used by farmers to irrigate rice fields is gasoline pump engine. Since gasoline fuel prices are getting more expensive, farmers' production cost is increase [2]. Therefore, alternative energy for running farmers' water pump is needed. One of the alternatives is by utilizing Liquifield Petroleum Gas (LPG). Therefore, water pump can be modified by changing the carbulator to enable the use of LPG to operate the pumps. This study was conducted to examine the performance of LPG water pumps in shallow ground water wells, by comparing with gasoline water pumps.

2. MATERIALS AND METHODS

2.1. Research materials and tools

Tools used in this research are a gasoline fueled water pump, gas stove regulator hose, high pressure regulator, scales, four 50-liter basins, a screwdriver plus, a stopwatch, a camera, a laptop, a measuring cup, a tachometer, two tongs, and stationeries. In addition, this research use pertalite gasoline and 3 kg of LPG.

2.2. Modifying Pump Drive Power

The studied pump is a single cylinder engine using gasoline fuel and has a power of 5.5 HP. This pump has a power 5.5 depend on the wide agricultural land or paddy ricefield. The energy source of this pump was modified into LPG through several steps. First, the hose to the high-pressure regulator was connected to the clamp, and then tightening using a screwdriver plus to ensure that the regulator was installed perfectly and gas leak was avoided. Second, removed several parts on the carburetor of the water pump engine, opened the gasoline reservoir using a ring fitting screwdriver, then removed the float, rubber coupling, and needle in the carburetor, and ensured that the gasoline tap is closed. Lastly, attached hose that has been connected to the regulator to the channel where the gasoline enters, then installed and tightened the clamp.

2.3. RPM synchronization of gasoline and gas-fueled engines

To ensure the same condition, the comparison between LPG and gasoline water pumps was carried out at the same rpm. The rpm synchronization was carried using a laser digital tachometer.

2.4. Pumping

In this study, rice fields were divided into 2 groups, namely land A which used a gasoline water pump machine, and land B which used an LPG water pump machine. Three research treatments were carried out, with three repetitions for each treatment, as follows:
P1 = the pump engine operates for 10 minutes with the water pump 3 meters away from the well,
P2 = the pump engine operates for 10 minutes with the water pump 5 meters away from the well,
P3 = the pump engine operates for 10 minutes with the water pump 7 meters away from the well.

2.5. Research Parameters

2.5.1. Water discharge

Measurement of discharge data was carried out by collecting water released by the pump engine using a 50-liter container. Stopwatch was used to determine the discharge time. The discharge of water released per unit of time was calculated using the following formula:

$$Q = \frac{V}{t} \tag{1}$$

where:
Q = Flow discharge (m^3/s)
V = Water volume (m^3)
t = Time (s)

2.5.2. Gasoline use

Gasoline use consumption in the operation of water pump was calculated by using Formula 2. The amount of gasoline use was obtained by filling full the fuel tank before operating the pump, then after pump operation, the tank was filled full again. Here, the additional fuel was recorded as the amount of gasoline use.

$$\mathrm{KB} = \frac{\mathrm{B}}{\mathrm{t}} \tag{2}$$

where:
KB = fuel consumption (1/hour)
B = fuel use (liter)
T = operation time (hour)

2.5.3. LPG use

LPG use consumption was calculated by using Formula 3. The amount of LPG used was determined by calculating the weight differences of LPG gas before and after the operation of the water pump.

$$M_f = \frac{M_b}{t} \quad (3)$$

where:

M_f = fuel consumption (kg/hour)
M_b = fuel mass (kg)
T = iqnition time (hour)

2.5.4. Power produced by gasoline and gas fueled pumps.

Power generated by pump engine was calculated using:

$$P_{out} = \rho \times g \times H \times Q \quad (4)$$

where:

P_{out} = power generated by the pump (W)
ρ = density of water (kg/m^3)
g = acceleration of gravity above the earth (m/s^2)
H = high rise on pump (m)
Q = water discharge (m^3/s)

2.5.5. Engine torque

Motion power generated from a combustion motor is called torque which calculating using:

$$T = (5252 \times P) / N \quad (5)$$

where:

T = torque (Nm)
5252 = determination value (constant) for motor power unit HP
P = power (Hp)
N = number of rotations per minute (RPM)

3. RESULTS AND DISCUSSION

3.1. Water pump Modification

Figure 2 shows the modification of the water pump machine. Water pump should be modified due to the farmers irrigate ricefield using gasoline pump engine, these are more expensive, therefore, the farmer have to reduce the production cost. The type of water pump used was a Katana GWP 80, 3" (80 mm) water pump. In order to use water pump using LPG, modification of the driving force was carried out by dismantling the carbulator, removing and adding several components. The first step was to connect the hose to the high-pressure regulator and attached the clamps with a plus screwdriver to ensure that the regulator was securely attached and not easily shaken. Aftre that, some parts of the carburetor and gasoline reservoir were removed. Finally, attached the hose that has been connected to the regulator to the channel where the gasoline enters and tightened the clamps.

Figure 1. Water pump modification

3.2. Synchronizing the RPM of Gasoline and LPG Engines

Figure shows the synchronization of the engine RPM. The purpose of this rpm synchronization was to ensure that the engines operateed under the same conditions. If the rpm on the two machines were different, the outcomes can not compare. In this study, the rpm applied to gasoline and gas-fueled engines were 1400 rpm.

Figure 2. Synchronizing the RPM

3.3. Water Discharge Measurement

Water discharge is the volume of liquid that flows in a cross section or that can be accommodated per unit time. In general, discharge is expressed with the symbol Q. It means that the discharge is influenced by the volume of a liquid and the time it takes for the fluid to flow.

Table 1 shows the measurement results of the average water discharge released by the water pumps in this study. In a well with a depth of 10 meters and a water depth of 9 meters, the use of LPG fuel pump provided higher engine performance compared to the use of gasoline fuel. This phenomenon can be seen from the water discharge released by each fuel pump. The suction power generated when the pump used LPG fuel was more powerful, thus the water discharge was high. The difference in water pumping discharge between LPG fuel and gasoline fuel was quite a lot for each distance of the water pump from the well. This showed that LPG fuel pump was superior in lifting water to the surface.

This was in accordance with the experience of farmers in the study area, which said that compared to gasoline pump, the use of LPG pump will produce more flow rate of water and more stronger water throw. To get maximum results in irrigation it is recommended to use LPG gas, because besides being more economical, it also affects the volume of water discharge.

Table 1. water discharge

Pump to well distance	Debit (m^3/second)	
	Gasoline	LPG gas
3 meters	0.002908	0.003027
5 meters	0.002805	0.002974
7 meters	0.002711	0.002882

Based on Table 1, the difference in water discharge between gasoline and gas engines was distinct. The water discharge released by the gas engine is higher than the gasoline engine. This is because the octane number (RON/Research Octane Number) in gasoline fuel is higher, which is 110, while in pertalite gasoline fuel the octane number is only 90.

When high-octane fuel is used, the engine pull will be lighter than when using low-octane fuel. Thus, the use of the engine will be lighter and more powerful, result in optimization of engine performance. However, it should be noted that the temperature in gas-fueled engines is hotter than gasoline engines [4].

3.4. Fuel Requirements

Based on the results of this study, gasoline fuel requirements for each pump distance can be seen in Table 2.

Table 2. Gasoline Fuel requirements.

Pump to well distance	Gasoline consumption (m^3/hour)
3 Meters	0.002837
5 Meters	0.003024
7 Meters	0.003164

Table 2 shows the results of the average use of pertalite gasoline fuel in water pumps before modifications were made. The average fuel use if converted to rupiah with the price of gasoline per liter of Rp. 7,850, was Rp. 22,270 / hour (for 3 meters distance), Rp. 23,738 / hour (for 5 meters distance), and, Rp. 24,837 / hour (for 7 meters distance). The results showed that the deeper the water pumping, the greater the gasoline fuel consumption. This is because the distance traveled to drain water affects the size of fuel usage and engine performance. [5] stated that the far the water source is from the pump engine, the fuel consumption will increase. From the results of the study, it is suggested that if you want to pump water it would be better if the pump is closer to the water source, if the water source is a well and the water is far into one of the good options is to hang the pump, so that the distance between the pump and the water source is not too far. Another positive thing if the distance of the pump is close to the water source, the water will be quickly sucked up.

[6] argues that one of the things that affects the increase in fuel consumption is the level of engine speed. The faster the acceleration of an engine, the higher the process of adding fuel to the combustion chamber because the engine requires a lot of energy to operate, so the level of fuel consumption increases. In this study, the operation of the pump engine was carried out constantly at 1,400 rpm, so the increase in fuel consumption was not too significant because there was no sudden jump in engine speed.

Table 3. LPG consumption

Pump to well distance	LPG consumption (m^3/hour)
3 Meters	0.58380
5 Meters	0.64099
7 Meters	0.66816

LPG consumption for each pumping distance was provided in Table 3. With the price of LPG at Rp. 7,666/kg, the costs incurred to operate the LPG pump for 3 meters, 5 meters, and 7 meters of the water pump from the well were Rp. 11,016/hour, Rp. 12,135/hour, and, Rp. 12,610/hour respectively.

Comparing the results of gasoline fuel consumption with LPG, the use of LPG water pump engine was 49% cheaper (economical) in operating costs than a gasoline-fueled water pump engine. In terms of engine performance, LPG fuel pump have an increase of power. This was proved when the pump operated for 10 minutes. Engines that use LPG was faster at lifting water to the surface, with more water discharge and a stronger water throw than gasoline engines. This indicated that starting from suction until the water rises to the surface the performance of the LPG pump engine was better. This is in accordance with the opinion of [7] which states that when the water pump uses gas fuel, the engine power and water discharge produced will increase compared to the gasoline water pump engine. This is due to the different characteristics of the two fuels gasoline and gas.

3.5. Power Generated by The Pump

Table 4. Power Generated by the pump

Pump to well distance	Power (W)	
	Gasoline	LPG
3 meters	88.374	89.021
5 meters	77.889	81.632
7 meters	76.162	80.993

Power is defined as the rate or speed of an effort. Power is the effort per unit time. In Table 4 the results of the power calculation between the LPG and gasoline engines show varying values, but the power of the LPG engine showed a greater value than the gasoline engine. The sound of the engine produced by LPG was quieter but the volume of water produced was more and the water throw was also stronger than the fuel engine.

[8] argue that power is one of the parameters to determine the performance of an engine, power exists because of the results of combustion in the cylinder to overcome all engine loads. In this study on the calculation parameter of the power generated by the water pump engine, the value obtained had a considerable amount between the gas-fueled water pump engine and gasoline fuel. If the water pump engine pumps at a longer distance, the power produced by the engine is greater, this coincides with the fuel required by the engine also increasing, as in the research of [9] which states that the power and fuel of the engine will increase continuously over a period of time if the engine works to reach a certain hard point.

3.6. Torque

Torque is a mechanism of movement between the crankshaft and the piston to produce a movement called torque, in other words torque is a measure of the engine's ability to do work, so torque is an energy. In this study, the GWP 8 mm katana water pump engine torque result obtained was 7.84 Nm.

4. CONCLUSION

The conclusions obtained from this research are:

1. LPG-fueled water pump engines are able to produce better engine performance than gasoline-fueled engines. This is based on the water discharge, fuel consumption and, power generated by the gas-fueled water pump engine, higher than the gasoline engine.
2. In terms of fuel consumption, the use of an LPG-fueled water pump is more economical than a gasoline-fueled water pump engine. The cost required for a gas-fueled water pump engine is cheaper than the cost required for a gasoline-fueled engine.

REFERENCES

[1] Rihendra, D., & Arya, W. (2017). Rancang Bangun Mesin Pompa Air dengan Sistem Recharging. *Jurnal Jurusan Pendidikan Teknik Mesin*, 8(2).

[2] Handoko, M. T., Ahmad, T., & Ridwan. (2015). Modifikasi Pompa Air Berbahan Bakar Gas Untuk Irigasi Sprinkler Portable. *Jurnal Teknik Pertanian Lampung*, 4(4), 275–280.

[3] Pratama, M. (2018). Analisa Perbandingan Debit Air Pada Mesin Pengair Sawah Menggunakan Bahan Bakar Pertalite dan Gas LPG 3kg. *Jurnal Teknik Mesin*, 2(6), 2599-3011.

[4] Jusnita, & Indra, H. (2016). Penggunaan Bahan Bakar Gas terhadap Sistim Bahan Bakar Injeksi dan Menggunakan Selenoid Valve 12 Volt Sebagai Pengaman Untuk Konversi Energi Alternatif Pada Sepeda Motor yang Ramah Lingkungan. Jurnal