Effect of Storage Time of Boosted Pertalite Fuel on Its Physical Properties to Improve Performance on a Single Cylinder 108.2 cc Petrol Engine

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Abstract: This study aims to investigate the use of octane booster on pertalite (gasoline with an octane number of 90), analyze the effect of mixed storage time, and compare it with Pertamax (gasoline with an octane number of 92). The selected storage times are 0 weeks, two weeks, and four weeks. This research was started by adding an octane booster to pertalite, and a portion of the pertalite and octane booster mixture was stored for two weeks and four weeks. Samples were characterized by octane number, density, viscosity, torque, and engine power. The results showed that the performance of boosted pertalite increased, then decreased with increasing fuel storage time. The original Pertalite has an octane number of 89.9 and strengthened pertalite at 90.8. Then, after two weeks, it dropped to 90.5, then 90.4 in the fourth week. Pertalite viscosity was 0.630 cP, pertalite boost 0.589 cP, 0.593 cP in the second week, and 0.612 cP in the fourth week. Pure Pertalite 7.54 HP, boosted pertalite increased by 7.80 HP, in the second week 7.69 HP and 7.66 HP in the fourth week.

Keywords: detonation; octane booster; petrol engine; storage time

1. Introduction

To participate in reducing global warming, internal combustion engines (ICE), especially gasoline engines that dominate global transportation engines[1)], are sought to have good efficiency[1,2)]. The use of good quality fuel in a gasoline engine will result in more energy efficient and cleaner combustion. The addition of additives to fuel can contribute to increasing the economic value of fuel, as well as reducing greenhouse gas emissions and other pollutants[3)]. The high-octane number allows it to be used in engines with high compression ratios to increase performance, efficiency and eliminate detonation[4)]. In line with the recent trend of motorcycle manufacturers using new engines with high compression ratios[5–10)].

In the last ten years, the number of motorbikes has grown rapidly in Indonesia[11)]. For convenience and fuel efficiency, users will consider replacing their motorbike with a new one or a used motorbike that is in better condition after six years of use[11)]. Indonesia is currently dependent on fossil energy sources; on the other hand, the increasing number of vehicles has an impact on fuel consumption which also increases[12)]. Circulating liquid fuels based on fossil fuels contribute 95% of all energy sources for transportation[13)].

Gasoline as a fuel is a complex compound containing several hydrocarbons fractions whose main components are olefins, isoolefins, paraffins, isoparfins, naphthenes, and aromatics[6,14–19)]. Additives are added to gasoline to increase the octane number of the fuel[20–24)]. To reduce exhaust emissions into the environment, it is recommended to improve the compression ratio of gasoline engines and improve the physicochemical properties and combustion characteristics[25–31)].

The use of additives in fuel can be effective when used in lower amounts compared to the volume of fuel. The way to increase the octane number by additives is to add high-octane components to gasoline to get high-octane number of fuel, so that the economic value increases, and is environmentally friendly[24)].

There are many choices of fuel types on the Indonesian market, consumers can be trapped in choosing fuel with an octane number that does not match the specifications of the gasoline engine they have, which has an impact on decreasing engine performance and increasing fuel consumption[32)]. One solution is to change the ignition timing to reduce detonation tendencies, but this can reduce torque, power, and fuel efficiency[33)].

From these conditions, it is very important to find replacement fuels or add additives to fuels that can

improve engine performance and reduce exhaust emissions[34,35]. Good energy efficiency will result in less fuel consumption and reduced greenhouse gas effects so that it can support environmental sustainability[13].

This research was conducted to analyze the effect of octane booster on Pertalite fuel for several aspects, namely changes in octane number, density, viscosity, torque, power, and percentage of transmittance of functional groups by FT-IR. In this study, a comparison of the effect on fuel storage with time variables of 0 weeks, two weeks and four weeks was also carried out. All of the above parameters are compared with Pertamax, a fuel on the Indonesian market which has a higher octane number than Pertalite

2. Materials and methods

To test the effect of booster octane on engine performance, octane number, density, viscosity, and torque, and power were tested on pertalite + octane booster-x and booster-y fuels with storage effects of 0 weeks, two weeks and four weeks and compared them with pure pertalite.

The octane number is tested to compare the tested fuel variables to the octane number. Octane number in gasoline indicates its usefulness in avoiding detonation when burning fuel in the combustion chamber, which can cause damage to the vehicle engine[4].

Density testing is carried out to analyze the ratio of the fuel variable to the density, and the density data obtained are used to calculate viscosity. Density can be calculated using the following equation.

$$\rho = \frac{m}{v} \quad (1)$$

With:

ρ = density (kg/m^3)
m = mass (kg)
v = volume me (m^3)

Viscosity testing in this study was conducted to analyze the ratio of fuel to viscosity variables. The low viscosity will result in the fuel entering the combustion chamber becoming smoother and mixing air and fuel more homogeneous, which results in increased pressure in the combustion chamber[5]. Viscosity testing was carried out using an Ostwald viscometer and distilled water as a comparison fluid with a viscosity of 0.8705 cP. Viscosity can be calculated using the following equation.

$$v = \frac{t \times \rho}{ta \times \rho a} \times \eta_a \quad (2)$$

With:

v = viscosity of the liquid sought (cP)
t = fluid time (s)
ρ = density of the liquid sought (g/ml)
ηa = viscosity of reference liquid (cP)
ta = time of reference liquid (s)
ρa = density of the reference liquid (g/ml)

The dyno test was carried out to analyze the ratio of the fuel variable to torque and power. The test results taken are the most considerable torque and power in each test. Each fuel variable was tested three times, and then the average was calculated.

3. Results and discussion

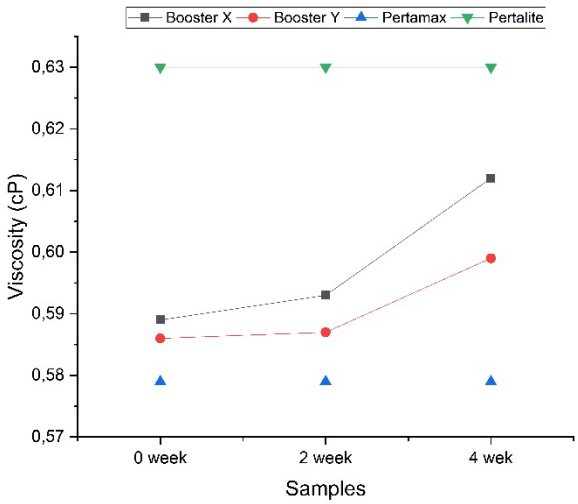

Fig 1: Effect of booster octane and fuel storage time on viscosity

In Pertalite + octane booster-y 0 Weeks, there was a decrease in viscosity compared to Pertalite, which was originally 0.630 cP to 0.586 cP. The Fig 1. shows that the octane booster-y can reduce the viscosity of Pertalite, which causes pressure in the combustion chamber. The decrease in viscosity occurs because the octane booster-y makes the mass and flow time of the Pertalite decrease. The low viscosity will result in the fuel entering the combustion chamber becoming smoother and mixing air and fuel being homogeneous, which results in increased pressure in the combustion chamber. In Pertalite + octane booster-y for two weeks, there was an increase in viscosity to 0.587 cP and continued to increase in Pertalite + octane booster-y for four weeks to 0.599 cP. This increase in viscosity occurred because the density and flow time increased (0 weeks = 0.736 g/ml and 30.9 seconds, 2 weeks = 0.744 g/ml and 30.99 seconds, 4 weeks = 0.748 g/ml and 31.59 second).

In Pertalite + octane booster-x (0 weeks), viscosity decreased compared to Pertalite from 0.630 cP to 0.589 cP. This shows that octane booster-x can reduce the viscosity of Pertalite, which causes the pressure in the combustion chamber to increase. The decrease in viscosity occurs because the octane booster-x decreases the mass and flow time of Pertalite. The low viscosity will result in the fuel entering the combustion chamber becoming smoother, and the mixing of air and fuel is more homogeneous, which results in increased pressure in the combustion chamber. In Pertalite + octane booster-x (2 weeks), there was an increase in viscosity to 0.593 cP and continued to increase in Pertalite + octane booster-x (4 weeks) to 0.612

cP. This increase in viscosity occurred because the density and flow time increased (0 weeks = 0.736 g/ml and 30.72 seconds, 2 weeks = 0.740 g/ml and 30.79 seconds, 4 weeks = 0.744 g/ml and 31.57 second). The Fig. 2 shows that the longer the storage time will increase the density.

It causes an increase in viscosity which causes the pressure in the combustion chamber to decrease. The increase in viscosity occurs because the fuel undergoes precipitation during storage, resulting in decreased fuel quality.

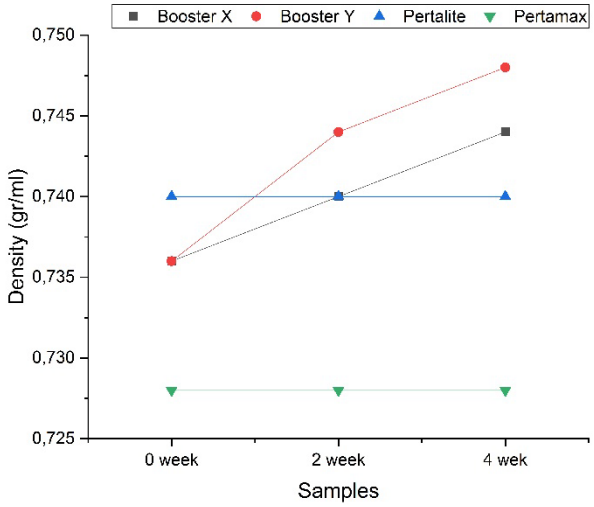

Fig 2: Effect of booster octane and fuel storage time on density

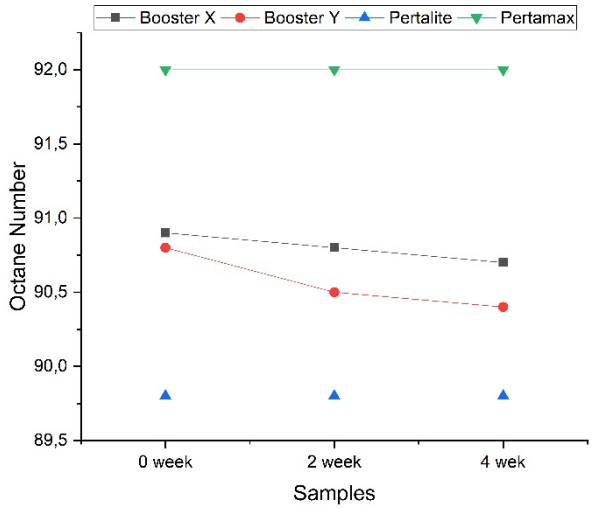

Fig 3: Effect of booster octane and fuel storage time on octane number

In Pertalite + octane booster-x (2 weeks), the octane number decreased to 90.8 as shown in Fig.3. It continued to decrease in Pertalite + octane booster-x (4 weeks) to 90.7. That shows that the longer storage time in pertalite + octane booster-x causes a decrease in the octane number, which makes it more susceptible to knocking. This decrease in octane number occurs because the fuel undergoes oxidation during storage, resulting in decreased fuel quality.

In Pertalite + octane booster-y two weeks, there was a decrease in octane number to 90.5 and continued to experience a decrease in Pertalite + octane booster-y four weeks to 90.4. That shows that the longer storage time of pertalite + octane booster-y causes a decrease in the octane number, which makes it more susceptible to knocking. This decrease in octane number occurs because the fuel undergoes oxidation during storage, resulting in decreased fuel quality.

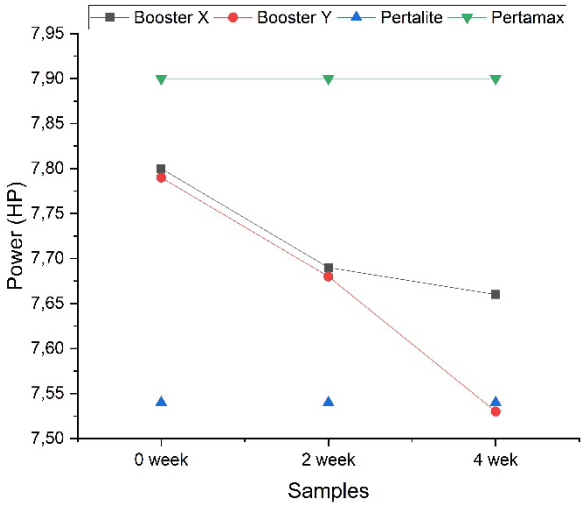

Fig 4: Effect of booster octane and fuel storage time on engine power

As shown in Fig 4. the Pertalite + octane booster-Y 0 weeks, there is an increase in power compared to Pertalite, which was originally 7.54 HP to 7.79 HP. This increase in power occurs because pertalite + octane booster-Y has a lower transmittance percentage (fig 6), higher octane number, lower density, and lower viscosity than Pertalite. Pertalite + octane booster-Y for two weeks experienced a decrease in power to 7.68 HP and continued to experience a decrease in Pertalite + octane booster-Y for four weeks to 7.53 HP. This shows that the longer the storage time causes, the more power decreases. This decrease in power occurs because the fuel quality decreases during storage, resulting in an increase in transmittance percentage, a decrease in octane number, an increase in density, and an increase in viscosity.

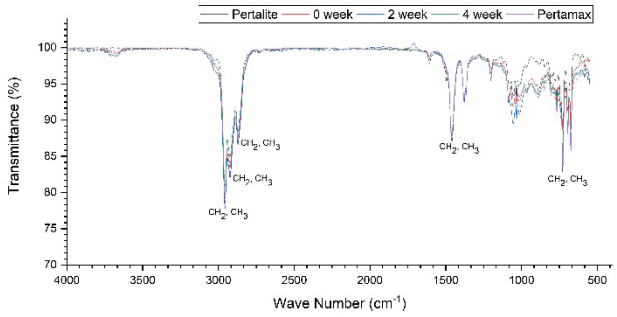

Fig 5: FT-IR characterization of octane booster X

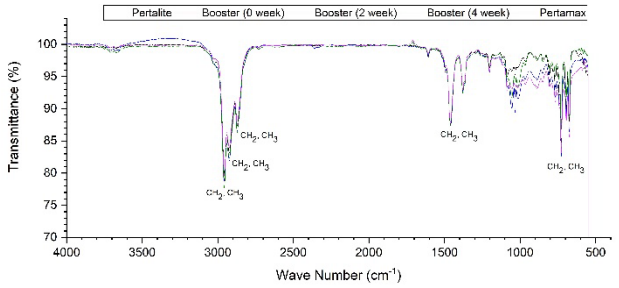

Fig 6: FT-IR characterization of octane booster Y

Fig.4 also shows that Pertalite + octane Booster-X (0 weeks) increases power compared to Pertalite from 7.54 HP to 7.80 HP. That show the octane Booster-X can increase the power of Pertalite even though it does not exceed Pertamax. This increase in power occurs because Pertalite + octane Booster-X has a lower transmittance percentage (fig 5), higher octane number, lower density, and lower viscosity than Pertalite. Pertalite + octane Booster-X (2 weeks) experienced a decrease in power to 7.69 HP and continued to experience a decrease in Pertalite + octane Booster Booster-X (4 weeks) to 7.66 HP. That shows that the more prolonged the storage time causes, the more power decreases. This decrease in power occurs because the fuel quality decreases during storage, resulting in an increase in transmittance percentage, a decrease in octane number, an increase in density, and an increase in viscosity.

4. Conclusion

The results showed an increase in the performance of boosted pertalite. The power produced by pure pertalite is 7.54 HP and boosted pertalite (3.38%) is higher than pure petalite. Pertalite has an octane number of 89.8, and boosted pertalite is 1.17% higher than pure pertalite. The viscosity value of pure pertalite is 0.630 cP, boosted pertalite is 6.75% lower than the original fuel. The density of pertalite is 0.740 g/ml, and the boosted pertalite is 0.54% lower than pure pertalite.

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