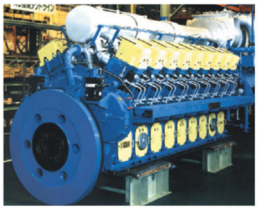
KU30A Engine for Palm Oil Power Plants




Mitsubishi Heavy Industries Engine & Turbocharger, Ltd,

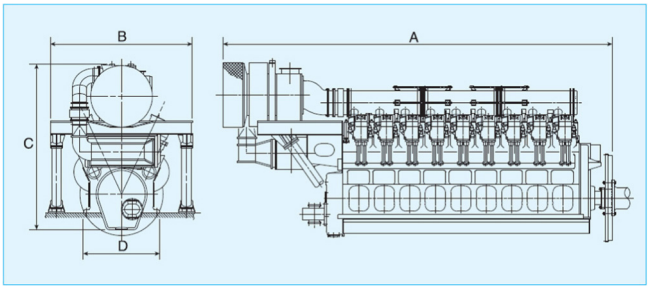
Facing concerns about energy shortages and demand to reduce the environmental impact in recent years, renewable biofuels are attracting attention as alternatives to fossil fuels. Palm oil, which is principally composed of vegetable oil, is a kind of biofuel and an alternative energy to fossil fuel that results in lower carbon emissions (CO_2 reduction). In the countries of origin of vegetable oils in Southeast Asia, (including Indonesia, Thailand and Malaysia), the increase in the use of palm oil as biofuel for power generation has been considered as a priority measure among energy saving policies. Diesel engines for power generation using mainly conventional heavy fuel oil are basically used to maintain high power generation efficiency, and the additional use of palm oil as fuel for the engines can provide the aforementioned advantages while also responding to the need for the use of biofuels.

1. KU30A diesel engine

The lineup of Mitsubishi KU diesel engines (KU30A), which are medium-speed diesel engines for power plants, consists of engines with 12V to 18V cylinders covering power generation outputs ranging from 3.8 MW to 5.9 MW. More than 400 units were delivered in Japan and overseas, and the actual field operating time has exceeded 150,000 hours. Conventionally, we delivered power plants using diesel oil or heavy fuel oil. To respond to the recent need for the use of biofuels, we have established technology for using palm oil as fuel. **Table 1** gives the main specifications of the KU30A and **Figure 1** shows its structure.

Table 1 Main specifications of the KU30A engine

		12KU30A		14KU30A		16KU30A		18KU30A	
Frequency	Hz	60	50	60	50	60	50	60	50
Number of cylinders		12		14		16		18	
Cylinder bore x piston stroke	mm	300×380							
RPM	min^{-1}	720	750	720	750	720	750	720	750
Rated output (generating end)	kW	3760	3920	4390	4570	5020	5230	5650	5880
Equipment weight	t	40		48		54		60	
NOx	ppm	950 or less (at 13% O_2 level)							
Exhaust gas boiler steam generation (0.69MPa)	kg/h	1470		1670		1800		2100	



Unit: mm

	A	B	C	D
12KU30A	6355	2900	3400	1700
14KU30A	7145	2900	3720	1700
16KU30A	7685	2900	3720	1700
18KU30A	8225	2900	3720	1700

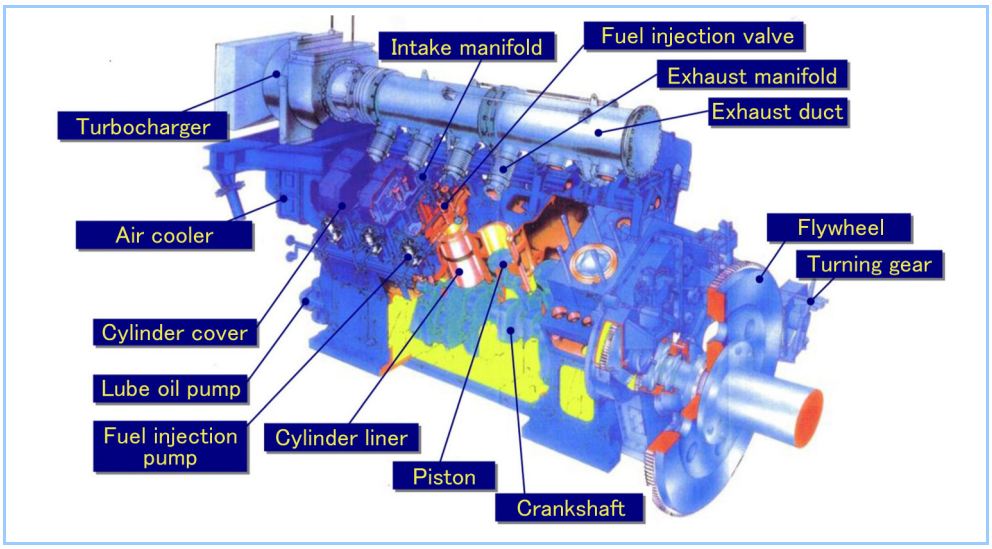


Figure 1 Structure of the KU30A engine

2. Palm oil fuel

Palm oil is a vegetable oil distributed throughout the world and produced from the pulp of the palm fruit mainly in Southeast Asia (Indonesia, Malaysia, etc.). **Figure 2** presents the refining process of palm oil for use as fuel. The palm oil used as fuel for the KU30A is a non-edible oil called palm stearin which is refined through the processes of removing impurities from extracted oil, degumming, decolorizing, etc. Figure 2 depicts samples of palm oil. Palm oil is a waxy solid at room temperature, and when it's heated to about 60°C, it can be used as liquid fuel. We applied the power generation plant technologies that were developed through actual field operations using heavy fuel oil, which has temperature characteristics similar to those of palm oil, making it possible to use palm oil in the KU30A.

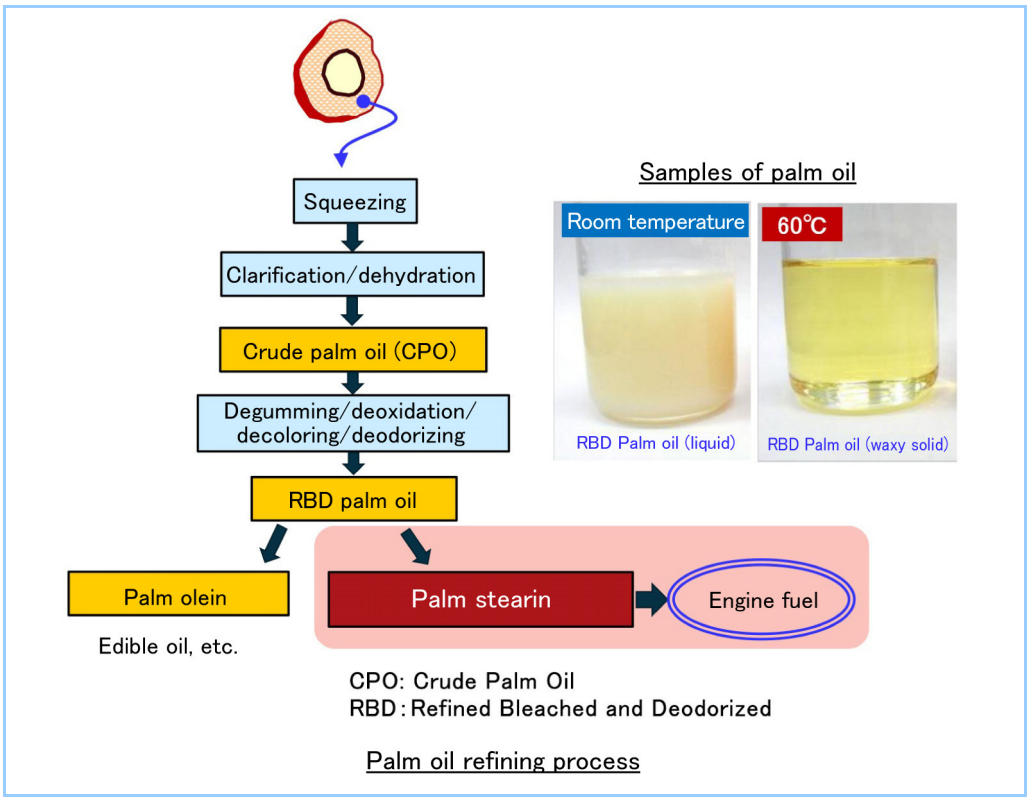


Figure 2 Refining process of palm oil and samples of palm oil

3. Technologies for using palm oil

The technologies for operating power plants using palm oil, which is a biofuel, are described below.

(1) Engine

The properties of biofuels vary by derivation, but generally, biofuels tend to have low kinematic viscosities and low heating values. Palm oil also tends to have a 15 to 20% lower heating value compared to conventional diesel oil. The KU30A adopts fuel injection pumps, fuel cams and fuel injection valves that can be operated with low heating value fuel, and provide the same output as that of engines for power plants using diesel oil. In addition, the plunger in the fuel injection pump for feeding oil to the injection valve has a coating applied so that it can deliver good sliding performance even when a low kinematic viscosity fuel is used.

Some palm oil has a high pour point. Therefore, as with the case of heavy fuel oil, the fluidity is secured by heating the fuel system piping. Differing from heavy fuel oil, palm oil deteriorates through excessive heating, causing condensation of the fuel, and deposits may be produced. For the KU30A, appropriate temperature control and fuel circulating volume reduction were implemented. Furthermore, the fuel drainpipes from the cylinders are also heated to prevent the adhesion of fuel to the inside of the pipes.

(2) Plant auxiliary

One of the problems in operation using palm oil is early blocking of the fuel oil filter. In operation using palm oil, asphaltene and sludge are generated and the filter becomes blocked in a short period of time. Therefore, an automatic back-flushing type wire net filter is used. To make it possible to optimize the filter area and clean the elements during operation, the installation of a by-pass filter is also effective.

To cope with the higher pour point of palm oil, a system is adopted in which diesel oil is used at the time of engine start and stop or during low-load operation, and palm oil is used under more than 50% load. Through this system, the palm oil does not adhere to the inside of the engine during stop, allowing the easy overhaul and servicing of parts during maintenance. Furthermore, not only by heating the fuel system pipes but by applying a heating system technology for engine coolant and lubricant, it is expected that the fluidity of the fuel in the engine can be secured even during emergency stoppages.

4. Actual operation using palm oil

Four KU30A engines have been in actual operation using palm oil for about 16,000 hours (a cumulative total of 64,000 hours for 4 engines), and as of March 2019, the engines are still in operation.

The amount of residue that has adhered to the cylinder cover and piston, which are components of the combustion chamber, is almost the same as in the case of operation using conventional heavy fuel oils, and the sliding surface of the cylinder liner and bearing have no abnormalities and are in good condition. The clearances of the sliding parts such as the fuel pump plunger in the fuel injection system are within the specified values of new parts and no abnormal abrasions, etc., have been found.

5. Future prospective

The technologies developed through operations using heavy fuel oil were applied to the KU30A to realize stable operation using palm oil. After about 16,000 hours of operation, an overhaul of the components of the combustion chamber and the parts of the fuel injection system was conducted, and it has been confirmed that the conditions of the KU30A are almost the same as in the case of the use of diesel oil or heavy fuel oil.

Biofuels such as palm oil have attracted attention as alternatives to fossil fuels, and they are expected to contribute to the efficient use of energy and reducing the environmental impact.

The KU30A engine, which has field-proven performance and can be operated using palm oil in addition to diesel oil or heavy fuel oil, will contribute to reducing the environmental impact and the efficient use of energy, while also addressing various customer needs in the future.