Short Communication

Heat utilization of a multi-cylinder CI engine on diesel and renewable fuel

RAJESH U MODI[1], JAYANT SINGH[2], SHARAD KUMAR NAMDEV[3] and BHABANI SHANKAR DASH[4]

[1]*Department of Farm Machinery and Power Engineering, Punjab Agricultural University, Ludhiana,*
[2]*Department of Farm Machinery and Power Engineering, G. B. Pant University of Agriculture and Technology, Pantnagar-263145 (U.S.Nagar, Uttarakhand), 3Zila Parishad Krishi Mahavidhalaya Banda, Bundelkhand University Jhansi, Uttar Pradesh,4Department of Farm Machinery and Power, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha*

Key words: CI engine, diesel, heat utilization, renewable fuel

The massive growth of world population increased economic development and standard of living in the industrial nations. This led to a complex situation in the field of energy supply and demand. In India, the crude oil production for the year 2016-17 was more than 36 million metric tonnes (MMT) as against 36.94 MMT for the previous year viz. 2015-16 (Anon, 2018).Fossil fuels will continue to play a dominant role in the energy scenario in the next few decades. However, conventional or fossil fuel resources are limited, non-renewable, polluting and therefore, need to be used prudently. On the other hand, renewable energy resources are indigenous, non-polluting and virtually inexhaustible. Country has endowed with abundant renewable energy resources. Scientists have explored several alternative energy resources, which have the potential to quench the ever-increasing energy thirst of today's population. Various biofuel energy resources explored include biomass, biogas, primary alcohols, vegetable oils, biodiesel, etc. As a result, depletion of fossil fuels and environmental considerations led to investigate on the renewable fuels such as biodiesel and ethanol. It will be beneficial to utilize cottonseed oil in fuel production, especially in countries where cotton is used intensively in some industries (Karaosmanoglu *et al*., 1999). Hence, usage of cottonseed oil as a fuel is an important alternative resource. Drastically, employing a biodiesel on CI (Compression Ignition) engine needs to be checked in every possible way.

A new renewable fuel obtained from refined cottonseed oil gives fuel properties comparable with diesel fuel (Modi *et al.,* 2017; Modi *et al.,* 2018). The biodiesel mixed with ethanol in the proportion of 90:10 can be utilized as a fuel for internal combustion engine (Modi *et al.,* 2019). This is a new renewable fuel which can replace diesel fuel in future but the heat utilization is to be understood for its proper application. Therefore, efforts were made to get the heat utilization pattern of multi-cylinder CI engine (37.3kW) on Cotton seed based renewable and compared with diesel. The experiments were carried out at Tractor Laboratory of College of Technology, Pantnagar. The renewable fuel was a mixture of biodiesel-ethanol in the proportion of 90:10. Selected fuel was tested and compared with high-speed diesel on full load condition (100 % load) at rated speed (2000 rpm) of multi-cylinder Compression Ignition (CI) engine. The performance test of the engine was conducted as per IS: 10000 [P: 5]: 1980. Fig.1 Shows engine test rig set up used for the experiment.The distribution of heat energy produced in the engine in terms of heat equivalent to brake power (HBP), heat carried away by water jacket (HJW), heat carried away by exhaust gas (HGas) and heat unaccounted (HUn) was observed.

The result of heat input (Table 1) shows that, the heat input on diesel and renewable fuel at full load (100%

Fig. 1: Engine Test Rig Set Up

Table 1: Heat distribution on different loading condition

Brake Load	Heat input (kW)		HBP (%)		HJW(%)		HGas(%)		HUn(%)	
	Diesel	Renewable fuel	Diesel	Renewable fuel	Diesel	Renewable fuel	Diesel	Renewable fuel	Diesel	Renewable fuel
No Load	30.71	27.21	0.00	0.00	9.52	9.20	0.23	0.75	90.26	90.05
20	44.33	40.07	16.51	18.55	9.93	10.29	1.14	0.79	51.68	42.62
40	59.90	50.66	25.05	29.18	10.40	11.02	1.76	0.82	46.02	30.57
60	73.38	62.84	30.53	35.10	11.24	11.60	2.91	2.21	44.24	30.33
80	87.69	75.59	34.04	38.79	14.14	14.75	3.38	3.66	43.66	30.27
100	99.64	90.16	37.42	41.42	16.25	19.88	3.44	3.93	42.76	30.25
110	107.29	98.35	38.20	41.63	19.37	21.62	3.52	4.25	41.49	31.80

load) was 99.64 and 90.16kW, respectively. It may be because of renewable fuel allowed lower heat input due to its lower calorific value (40.98 MJ/kg) as compared to diesel(46.93 MJ/kg). The heat input to the engine on both the diesel and renewable fuel at different brake loads shown that the heat input was increased with increase in brake load. The value of heat input was found to be higher at overloading (110% load) condition on both the fuel types. Also, the total heat input to the engine was increased as the brake loads increased, due to the increase in fuel consumption and reduction in power loss at higher loads.

The observed value of heat equivalent to brake power onrenewable fuel was found to be 41.42 % while on diesel it was 37.42 % at full load condition. The heat equivalent to brake power increased as the brake loads increased due to increase in brake power with increase in load. A renewable fuel had higher heat equivalent to brake power as compared to diesel fuel.The heat carried away by water jacket of engine on diesel and renewable fuel at full load (100% load) was found to be 16.25 and 19.88 % respectively. Furthermore, increase in load the heat carried away by water jacket was increased in all the fuel types. The heat carried away by water jacket from the engine for both the fuels was found to almost same at lower loads. The heat carried away by exhaust gas of engine on diesel and renewable fuel at full load (100% load) was found to be 3.44 and 3.93 % respectively. It is also observed that the heat carried away by exhaust gas on renewable fuel was lower than that of renewable fuel and higher at maximum or full load.

The unaccounted heat of engine on diesel and renewable fuel at full load (100% load) was found to be 42.76 and 30.25 % respectively. At all the brake loads the unaccounted heat of engine on renewable fuel was less as compared to diesel.The fuel heat unaccounted from the engine on both the fuel types decreased with increase in brake load and is observed to be the lowest at 110 percent brake load. The distribution of heat in engine on diesel and renewable fuel is shown in Fig. 2 and Fig 3, respectively. From these figure it is seen that there is better utilization of heat for brake power with renewable fuel as compared to than that of diesel fuel.

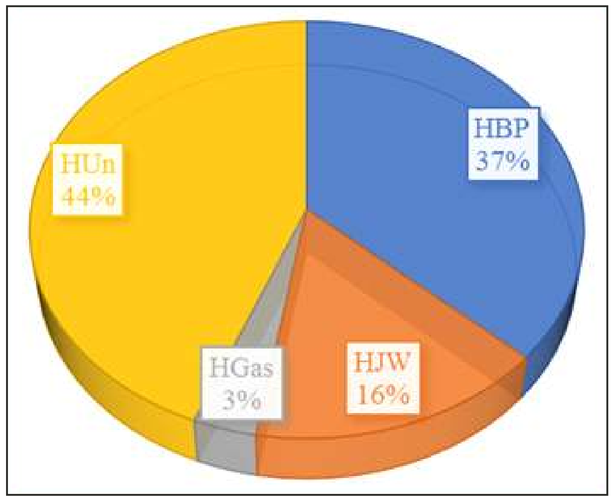

Fig. 2: The distribution of heat produced in the engine on diesel fuel

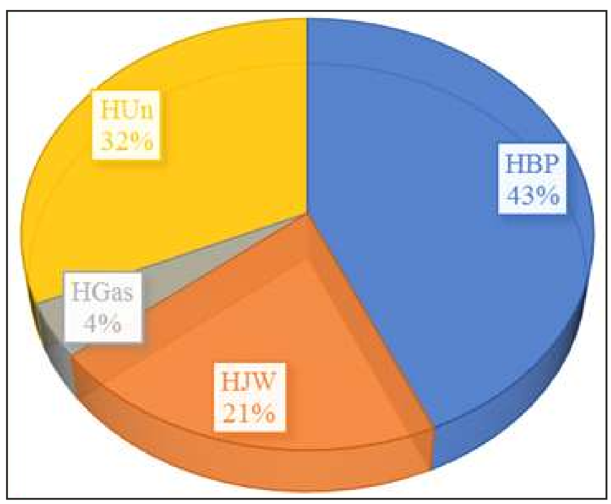

Fig. 3: The distribution of heat produced in the engine on a renewable fuel

CONCLUSION

The distribution of heat energy produced in the engine in terms of heat equivalent to brake power, heat carried away by water jacket, heat carried away by exhaust gas and heat unaccounted was observed. The heat input using diesel was 99.64 kW whereas 90.16 kW on renewable fuel. The percentage of heat equivalent to break power for renewable fuel was 43 % whereas diesel had 37 %. However, the heat carried out by water jacket was almost same while the heat unaccounted on renewable fuel was less than that of diesel which indicated better usage of heat with minimum losses.

REFERENCES

Anon (2018). Indian Petroleum & Natural Gas Statistics, 2017-18. Ministry of Petroleum & Natural Gas, Government of India, New Delhi. pp9.

Karaosmanoglu, F., Melek, T., Emre, G., Sakine, Y. and Esra, A. (1999) Fuel properties of cottonseed oil, *Energy Sources*, 21(9), 821-828.

Modi, R. U., Singh, J. and Bhattacharya, T. K. (2018) Fuel properties of methyl ester of cottonseed oil blended with ethanol. *International Journal of Chemical Studies*, 6 (1), 102-109.

Modi, R. U., Singh, J., Bhattacharya, T. K. and Dash, B. S. (2017) Optimization of process parameters for cottonseed oil methyl ester production from refined cottonseed oil using RSM. *International Journal of Basic and Applied Agricultural Research*, 15 (3), 186-193.

Modi, R. U., Singh, J., Bhattacharya, T. K. and Singh, T. P. (2019) Methyl ester of cottonseed oil blended with ethanol as a renewable fuel on a multi-cylinder CI engine. *Agricultural Engineering Today*, 43 (1), 20-26.

Received: May 24, 2019
Accepted: July 13, 2019