PERFORMANCE OF IC ENGINE WITH VARYING NUMBER OF NOZZLE HOLES AND COMPRESSION RATIO WITH WCO BIODIESEL BLENDS AS FUEL

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Abstract : The current study investigates the performance and emission characteristics of a four stroke single cylinder diesel engine with 3 hole and 5 hole nozzle holes and with varying compression ratio with waste cooking oil (WCO) biodiesel blends. The WCO samples were collected from the restaurants in and around ballari and converted to biodiesel fuel with a two-step transesterification reaction. The fuel property tests showed that the properties of the WCO biodiesel were within the biodiesel standards. Diesel and diesel-WCO biodiesel blend (B10, B20 & B30) was used as fuel in a IC engine. The performance and emission characteristics of the engine were measured under varying load conditions. The experimental results showed that break thermal efficiency of 5 hole 18 cr(compression Ratio) B10 is maximum, SFC is minimum for 3 hole 18 cr Diesel, CO was found minimum for 5 hole 18cr B30, HC is found to be reduced for 3 hole 18 cr B20 and NOx is found to be reduced for 3 hole 17cr Diesel.

***IndexTerms* – Nozzle holes, WCO, Transesterification, Emissions, Biodiesel.**

I. INTRODUCTION

Biodiesel fuels have become a viable alternative to traditional fue1 on the world energy market. This energy is made by growing it rather than drilling it out of the ground. Because it's made from plants and other organic products, it can be produced anywhere where there is usable land and it benefits farmers as well as its users. Biodiesel fuel production is growing rapidly at around 40% per year. Soy, sunflower and rapeseed are the most common sources of oils that are used in the production of fuels. Many other products including animal fats, palm oil, and coffee grounds are used as well, although the latter is a recent development These products are often produced specifically for the fuel, but are often found in the wastes of other industries as with fryer oil found in many restaurants. Much of the refined oils are used as a mix with other petroleum based products. This means that these fuels aren't completely replacing gasoline in automobiles. Furthermore, usually automobile must be adapted or purchased especially for running on these fuels as they burn at different temperatures and handle emissions differently. But it's not just used in automobiles, but also in railroad cars and airplanes as well as a source of heating. Still this technology is still in need of innovation to resolve problems, but will most likely have a bright future. Waste cooking oil is defined as any edible oil that has become unsuitable for its original purpose due to the presence of impurities or loss of original properties through frequent heating or cooking. Approximately 2.2x106 tons of waste cooking oil (WCO) is available around the world and a large amount of this is illegally dumped into rivers and landfills causing environmental pollution. Management of such waste cooking oils poses a significant challenge due to disposal problems its possible contaminating characteristics of water and land resources. Even though certain amount of waste cooking oil is used for soap production, it still remains a pollutant. The amount of WCO available per year mainly depends upon the quantity of consumption of edible oil. In India, edible oil consumption was $9x10^6$ tons during the year 2012-2013. Indian edible oil industry is expected to grow 6% annually and reach 20x106 tons of oil consumption by 2020.

This is because of high demand and lower production of edible oils. India will continue to depend on imports going forward. India is dependent on palm oil imports for over 30% of its annual edible oils needs and 65% of India's annual edible oil imports. Edible oil from restaurants then goes to secondary restaurants or to individuals for food preparation in India.

II. BIODIESEL PREPARATION AND PROPERTIES

The following steps are performed in a small, home based biodiesel processor for the production of biodiesel. The transesterification is carried out in a 1 kg of waste cooking oil (WCO) and it is filtered by cloth filter to remove the suspended particles. The filtered WCO is heated to the required temperature (110^0C) under agitation to remove the occurrence of water and it is cooled to room temperature. 3.5 grams of the required catalyst Sodium Hydroxide (NaOH) is mixed with 200 grams of methanol. The catalyst is made into powder and mixed with methanol. For efficient mixing magnetic stirrer is used so that the catalyst is completely mixed with the methanol. Then the mixture of catalyst and methanol is poured slowly into the filtered WCO and then stirred well with magnetic stirrer, taking this moment as the starting time of the reaction. The products of the reaction are allowed to settle for 8 hours producing two distinct liquid phases. The bio fuel is found at the top and glycerin at the bottom. The bio fuel is separated from glycerin. The required quantity of water (1 litre) is mixed thoroughly with 0.3ml sulphuric acid. Then the mixture o water and sulphuric acid is poured slowly into the bio fuel and stirred well and the whole mixture is allowed to settle. The bio fuel is found at top, soap in middle and water is found at the bottom. The bio fuel is separated and it is heated up to 110^0C to remove the water.

Figure 4.1: shows the various stages of biodiesel production.

Properties	Diesel	WCO
Calorific value(kj/kg)	42000	40100
Cetane number	45-50	54-61
Density(kg/m^3)	0.830	0.880
Viscosity(mm^2/sec) at 40^0c	1.4	5.3

Table 4.2 Fuel properties of diesel and biodiesel blends

III. FUEL INJECTOR NOZZLE

Fuel injection nozzle utilized mainly for the purpose of atomization and for the metering of the fuel into the combustion chamber. it is used for size of the droplet preparation and required spray to achieve for complete combustion within in a specified time and provided space. Other than nozzle all parts of the injector called nozzle holder, nozzle holder function is to hold and for proper assembly positioning of the fuel injection nozzle in the cylinder head.

These are having some types as mentioned below

- Pintel type
- Single hole

- Multi hole

Single hole: On center it consists only one orifice fuel will be dispersed from that single exit orifice ,spray of the fuel in vertically directions towards downwards.

Multi hole : It is having many no of holes they are arranged around the nozzle in the circular form or in a zig zag these are holes size vary according to the engine requirements and to the engine to engine varies.

Type of injector pump	No of holes
EURO 2	5
EURO 1	6
HINO	6

Table 1.1: No of Holes

Pintel type: pin or pintel is provided to the tip of the valve of the nozzle and it is called as pintel nozzle, when pintel is lifted the fuel will be scattered uniformly from the nozzle to the walls of the combustion chamber of piston head . its advantage is to prevent carbon deposit in the holes of the nozzle.

IV METHODOLOGY

- Study of performance of 4-stroke single cylinder diesel engine is carried out by using 3 hole and 5 hole fuel injector nozzle and by using diesel and waste cooking oil blends of 10% , 20% and 30% as fuel and with VCR.
- WCO samples were collected from restaurants in and around Bellary and converted to biodiesel fuel with a two-step transesterification reaction. The fuel property tests showed that the properties of the WCO biodiesel were within the biodiesel standards.

V OBJECTIVES

- To study the performance and emission of 4 stroke single cylinder diesel engine with 3 hole and 5 hole nozzle and diesel as fuel and with VCR .
- To study the performance and emission of 4 stroke single cylinder diesel engine with 3 hole and 5 hole nozzle and WCO 10% blend as fuel and with VCR.
- To study the performance and emission of 4 stroke single cylinder diesel engine with 3 hole and 5 hole nozzle and WCO 20% blend as fuel and with VCR.
- To study the performance and emission of 4 stroke single cylinder diesel engine with 3 hole and 5 hole nozzle and WCO 30% blend as fuel and with VCR .

VI EXPERIMENTAL SETUP

Figure shows 4 Stroke single cylinder test rig

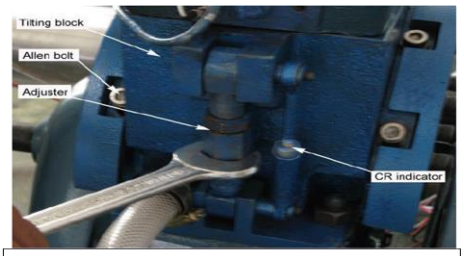
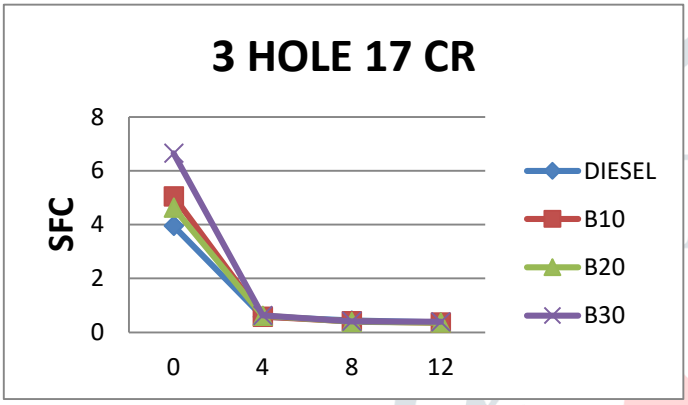
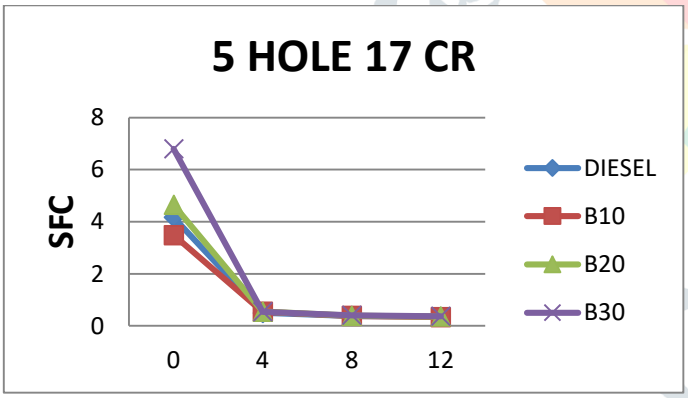


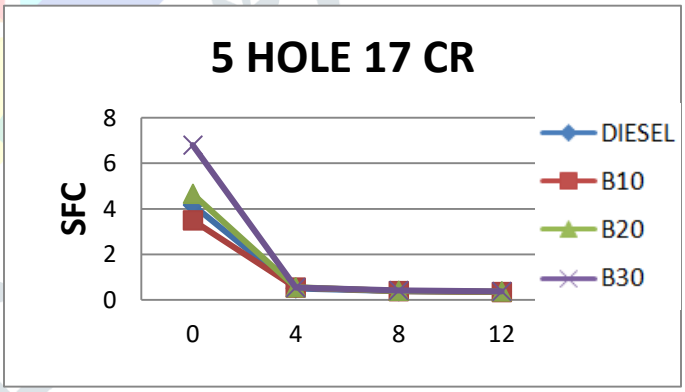
Figure shows Compression Ratio Adjustment

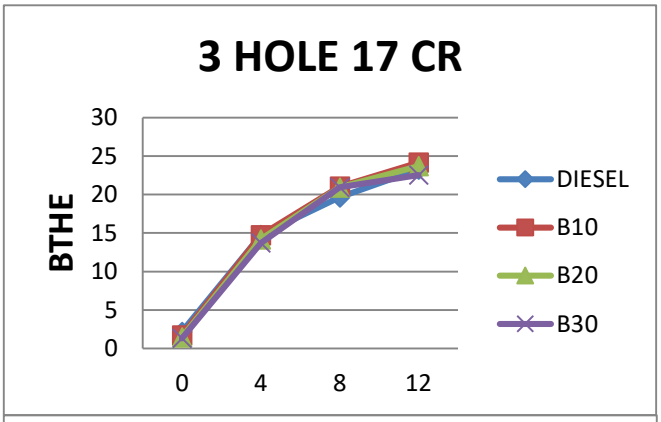
Engine	Make Kirloskar, Type 1 cylinder, 4 stroke Diesel, water cooled, power 3.5 kW at 1500 rpm, stroke 110 mm, bore 87.5 mm. 661 cc, CR 17.5, Modified to VCR engine CR range 12 to 18

VII RESULTS AND DISCUSSION








3 HOLE 17 CR
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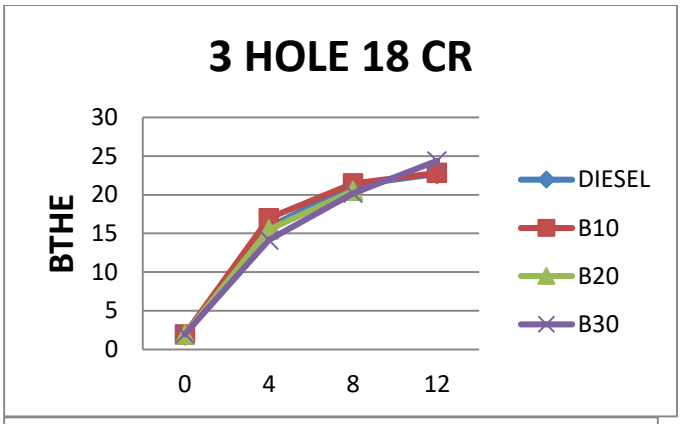
0
4
8
12
DIESEL
B10
B20
B30


3 HOLE 18 CR
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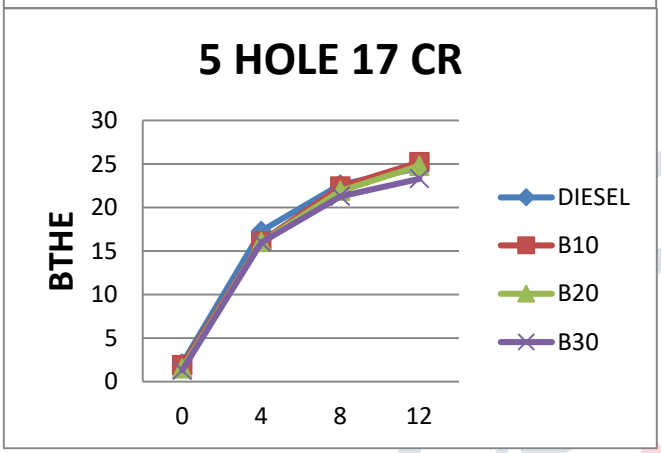
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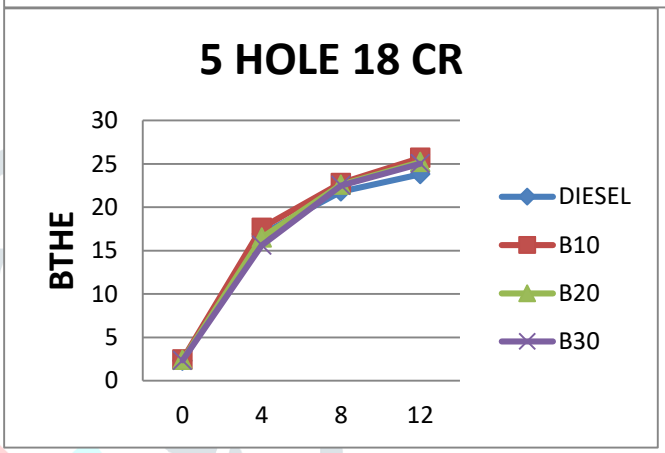
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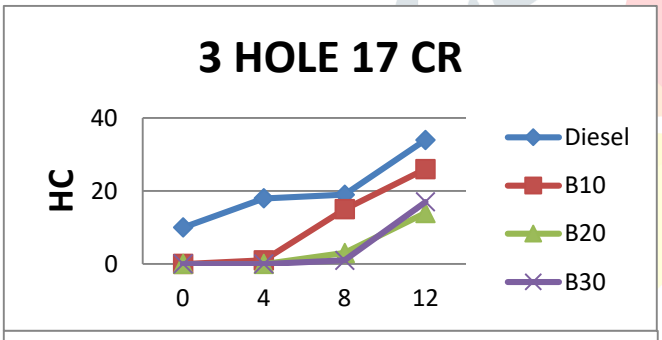
3 HOLE 17 CR
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Diesel
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3 HOLE 18 CR
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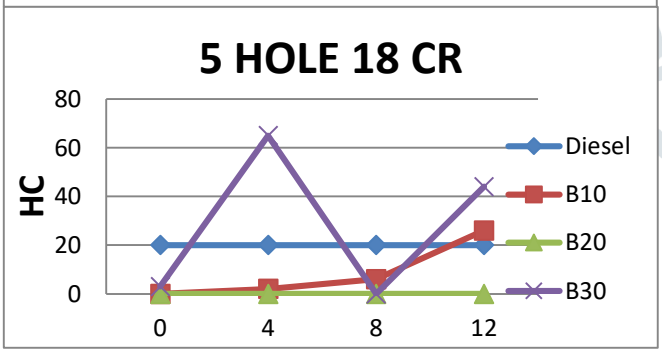
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HC
80
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Diesel
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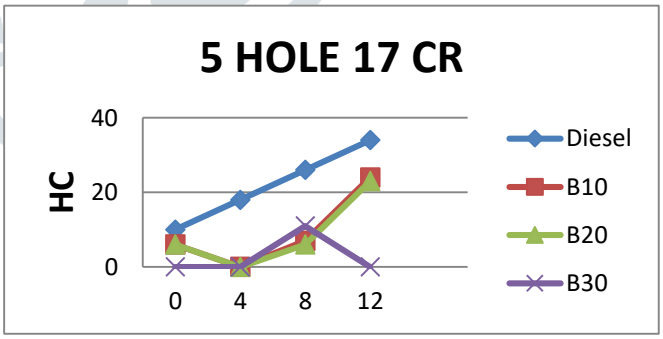
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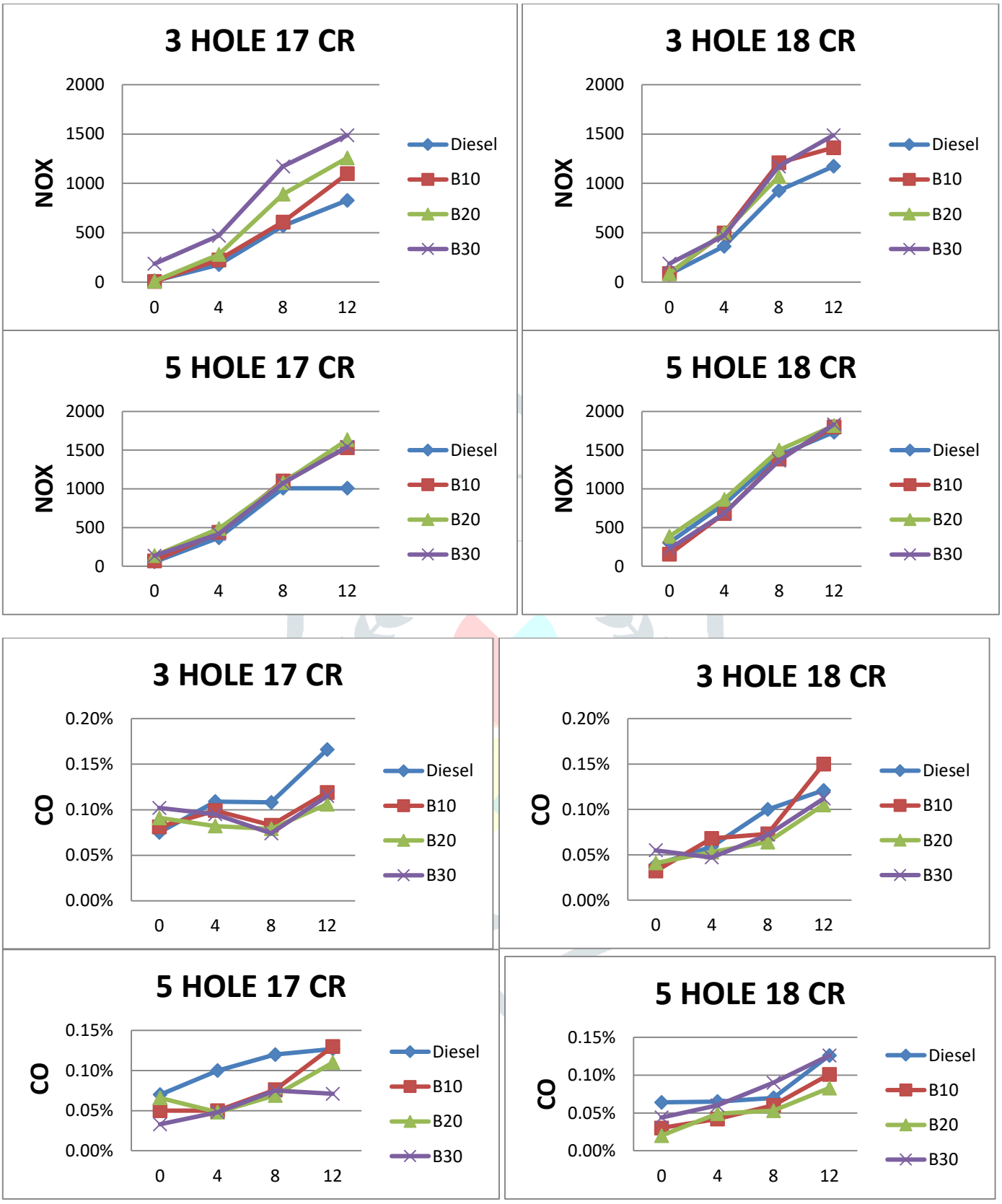

CONCLUSION

- By increasing the number of holes in nozzle the fuel gets dispersed in different angles resulting in better air fuel mixture which in turn results in better combustion and improved efficiencies and reduced emissions.
- It was found that break thermal efficiency of 5 hole 18 cr B10 is maximum(i,e 25.68%) (diesel 23.4%)
- SFC is minimum for 3 hole 18 cr DIESEL i.e 0.33
- The emission of CO was found minimum for 5 hole 18cr B30 i.e 0.11%
- The emission of HC is found to be reduced for 3 hole 18 cr B20 i.e 12ppm

- The emission of NOx is found to be reduced for 3 hole 17cr DIESEL i.e 829ppm

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