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Study on Effect of Heating Inlet Air Temperature on Emissions and Performance of Diesel Engine

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ABSTRACT

Experiments were conducted with a TD212 four cylinder, air cooled, direct injection diesel engine operated over a range of inlet air temperatures. Air flow rate decreased and fuel flow rate increased with an increase in inlet air temperature, which reduced the air-fuel ratio of the engine. Engine efficiency decreased and exhausts gas temperature increased with an increase in inlet air temperature Injector needle lift data also confirmed that the fuel consumption increased with an increase in inlet air temperature. Results also showed that the brake specific HC and CO emissions increased with an increase in inlet air temperature. Average in-cylinder temperature increased with an increase in inlet air temperature, which might be a reason for higher NOx emissions. It also decreased the NOX emissions by 25.55% at the normal state of intake air temperature. The experiments have done in constant speed 2100 rpm and variable torque. We get lower fuel consumption by 15% and increasing in air fuel equivalence ratio by 30% as compared with the normal state.

Keywords: Diesel, Combustion, Emissions.

INTRODUCTION

Diesel engines used as prime movers are exposed to the varying climatic temperature conditions that prevail in different parts of the world, and must therefore be able to operate under all ambient conditions from winter to summer and from arctic to tropical areas [8]. As the temperature variations on the surface of the earth are rather limited, the diesel engine will not normally be exposed to really extreme temperatures. However, the changes that do occur in the ambient conditions will, among other things, cause a change in the specific fuel oil consumption, the exhaust gas amount and the exhaust gas temperature of the diesel engine. These changes are already described in our Project and will therefore be discussed in this paper [6].

Also the scavenge air, compression and maximum firing pressures of the diesel engine will change with climatic changes and, at very low ambient air temperatures, unrestricted engine operation requires adjustments of individual engine parameters [2].

This paper describes our recommendations of load-up procedures on engine start up, the supply of ventilation air to the engine room and engine operation under normal, high and extremely low intake temperature conditions.

Experimental Work:

Four cases were taken in this study with constant speed 2100 (rpm) and variable Torque (2,4,6,8 and 10) Nm and variable intake air temperature (normal ,20Cº,30Cº and 40 Cº)and make comparison with the normal state and study how to choose the perfect state**.**

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Table 1: Technical specifications of the engine.

Item	Specification
Engine Manufacturer	TQ TD 212, UK
Fuel Type	Diesel
Maximum Power	3.5kW at 3600 rev/min
Maximum Torque	16 Nm at 3600 rev/min
Bore	69 mm
Connecting Rod Length	104 mm
Engine Capacity	232 cm3
Compression Ratio	22:1
Oil Type	Multi grade SAE 5W-40

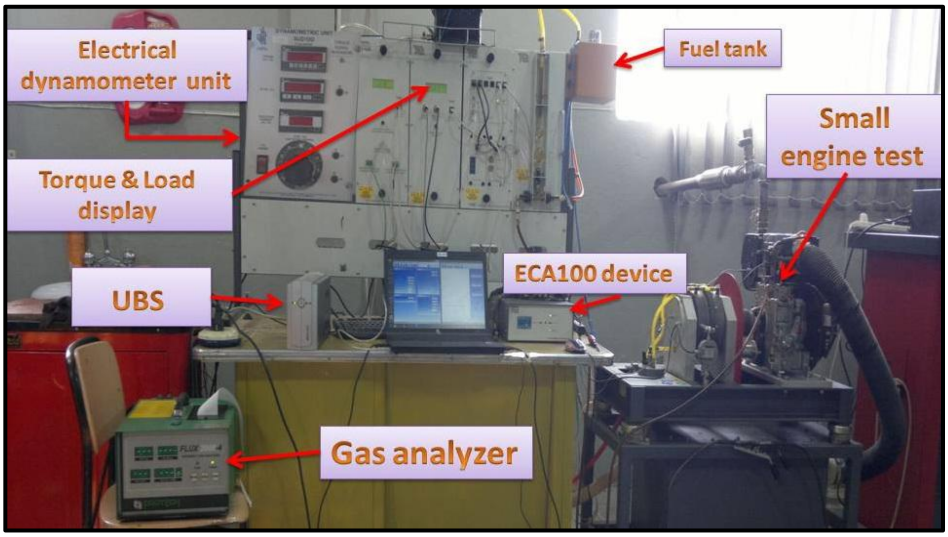

Fig. 1: the rig instruments.

Figure (1) shows the rig which we used it in our experimental at the internal combustion engine laboratory – department of machines and equipment Baghdad Technology Institute from October 2013 to February 2014.and at ambient air room at 16Cº. The experiments are Summarize experiences including the following:

1. Running the engine for 10 minutes to get to stability, and then try to reach speed in 2100rpm and raise the value of torque at the wanted value by hydraulic dynamometer . And it is calculated by the amount of exhaust gase emissions through the use of gas analyzer, which in turn measures the four types of emissions and recorded and stored on computer.
2. Raise the air intake temperature to 20Cº by electrical heater (2×1500watt) which is fixed on the intake air box, and rebate the previous steps.
3. Raise the intake air temperature to the 30Cº and rebate the same steps .
4. Raise the intake air temperature to the 40Cº and rebate the same steps. All the data are saved to the computer by the programs VDAS & ECA100.Figure 2 show the Components of heating system of our rig.

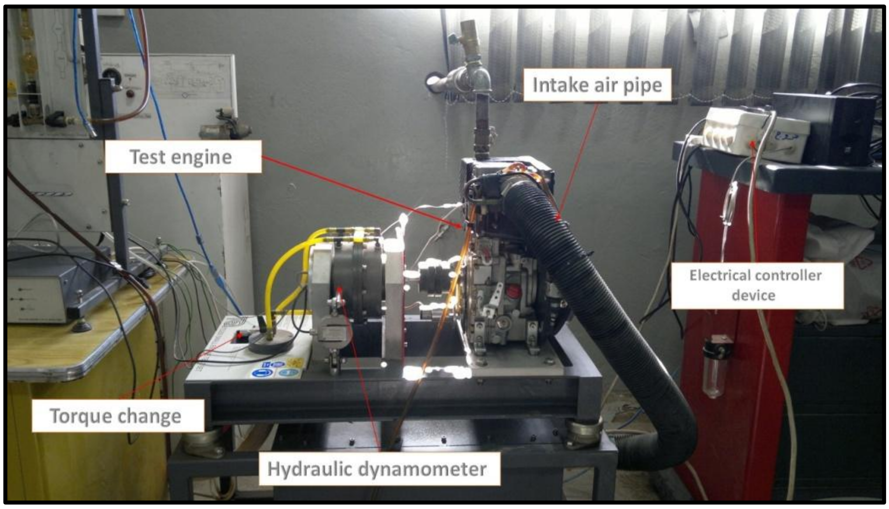

Fig. 2: Components of heating system of our rig.

Results And Discussions

Figure 3 show the relationship between the NO_X concentration (ppm) and variable torque at speed 2100rpm with variable intake air temperature. The case of 30C° recorded the lowest value of NO_X at high loads followed by the case of 20C° and the others.

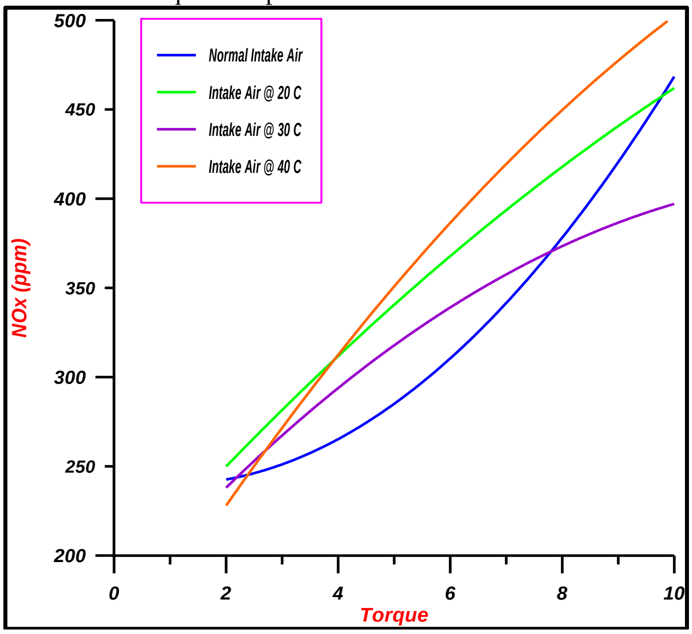

Fig. 3: The effect of heating intake air on NO_X concentration.

The reason may be due to the higher temperature which increase the flame temperature and then increasing the NO_X this will agree with [5]. The effect of increasing load on NO_X emissions comes about primarily through the decrease in the fraction of residual gases due to the higher pressures prevailing during the valve overlap period. Therefore, increasing load leads to higher NO_X emissions. Huls and Nickol measured a pronounced increase in NO_X with load at lean conditions, and a very moderate increase under stoichiometric conditions [3].

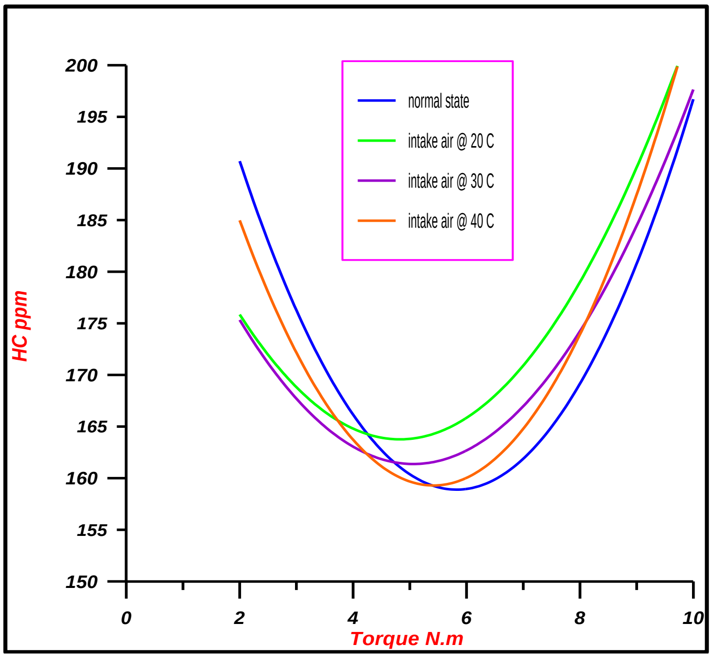

Fig. 4: The effect of heating intake air on HC concentration.

Figure 4 show the effect of heating intake air on HC concentration. The case of 30Cº recorded the lowest value of HCat low loads followed by the case of 20Cº and the others. The normal intake air recorded the lowest value at high loads followed by the case of 30Cº and the others. the unburned HC in exhaust gas burns because of sufficient O2 available in combustion chamber and reasonably high intake temperatures [4].

Most of the processes leading to HC emissions-here called HC sources result from contact of the fuel or fuel-air mixture with cold surfaces or layers, which prevents oxidation of the fuel during the main flame passage. After flame passage, and especially during expansion, unburned hydrocarbons emerge from the sources and are partially oxidized in the burned gas mixture. A fraction of the remaining HC is retained in the cylinder, while the remainder leaves the cylinder as engine-out emissions. (www.flux india.com)

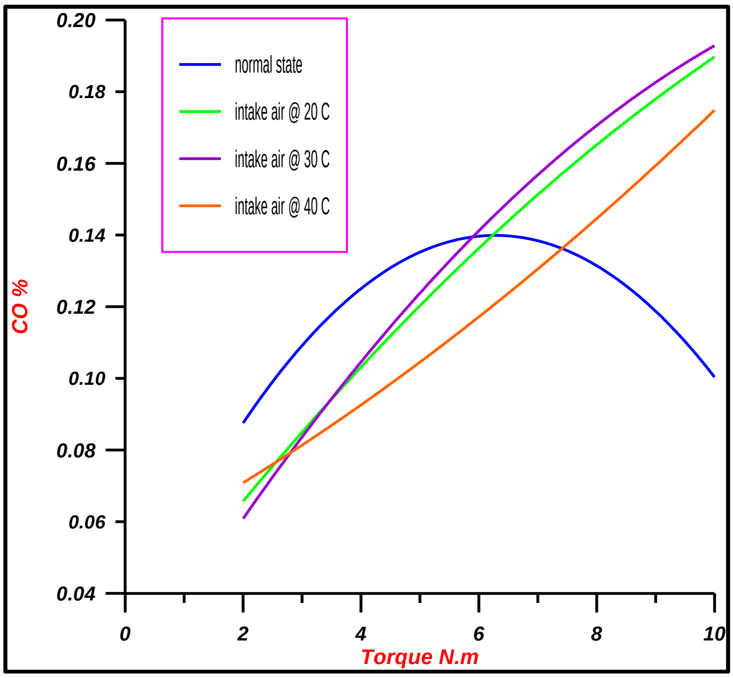

Fig. 5: the effect of heating intake air on CO concentration.

Figure 5 explain the effect of the heating intake air temperature on CO concentration at speed 2100rpm and variable torque .the normal intake air recorded the lowest value at the high loads followed by the case of 40Cºand the other. At the low load the case of 30Cº recorded the lowest value followed by the case of 20Cº and the others.

The reason may be due to the reduction in O_2which make the deformation of CO is more rapid than the normal state [7].

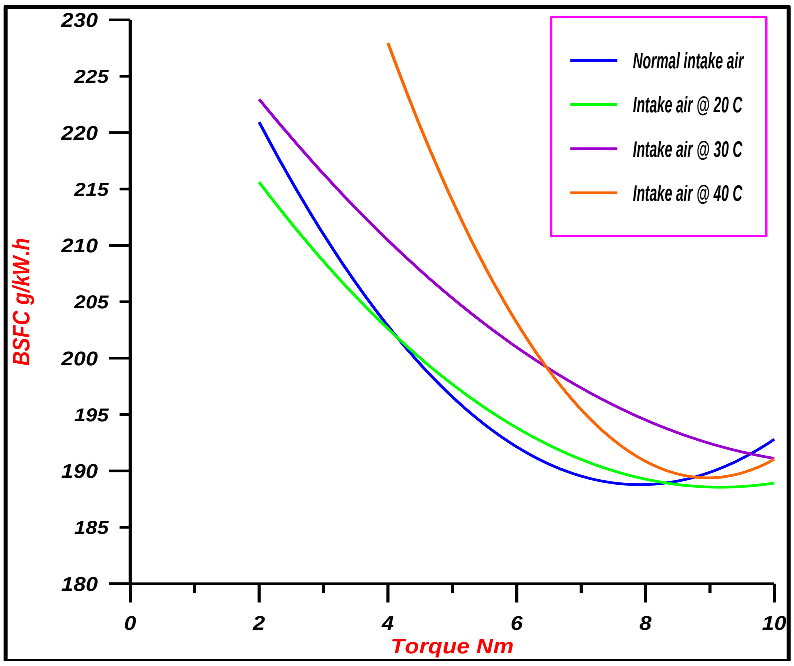

Fig. 6: the effect of heating intake air on BSFC.

Figure 6 state the effect of the heating intake air on BSFC values at 2100rpm and variable torque. The case of 20C° recorded the lowest value at high load followed by the case of the case of 30C° and the others. The reason may be due to the fuel consumption which was decreased with torque increasing [1].

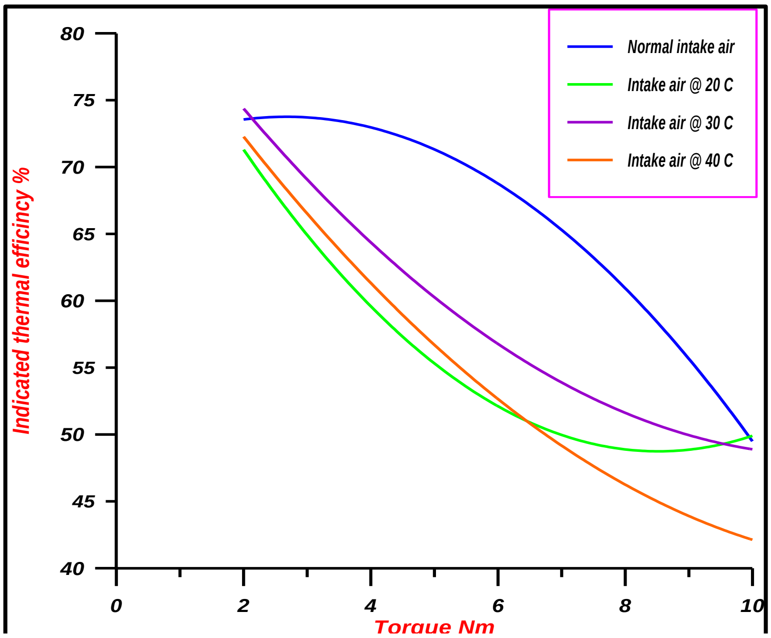

Fig. 7: the effect of heating intake air on η_{Ith}.

Figure7 state the effect of the heating intake air on η_{Ith} values at 2100rpm and variable torque. Generally the $\boldsymbol{\eta_{Ith}}$ is decrease with the temperature increasing. (www.flux india.com)

The case of 40C° recorded the lowest value followed by the case of 30C° and the others.

Figure 8 show the effect of the heating intake air on air fuel equivalence ratio. The case of 20C° registered the highest value at high load followed by the normal case and the other.

The case of 30C° recorded the lowest value of Φ at the high load but it recorded the highest value at low load. The reason may be due to the magnitude of fuel consumption which is perpendicular inversely with **Φ** values [3].

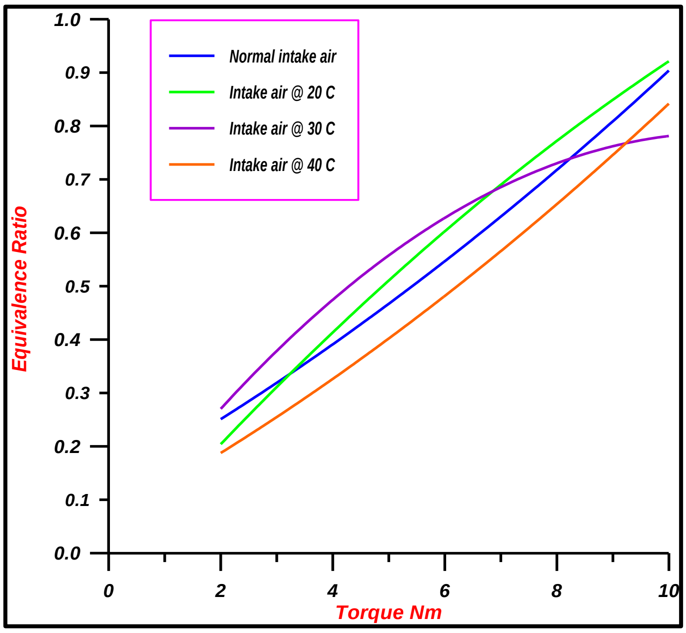

Fig. 8: the effect of heating intake air on Φ.

Conclusion:

From previous we estimate that with heating intake air we get :

1. Have a reduction in NO_X emissions by 25.55% if it compared with the normal state .
2. Reduction in HCvalues in part of load by 35%.
3. Reduction of fuel consumption by 15%.
4. Increasing fuel air equivalence ratio by 30%.

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