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RESEARCH ARTICLE

EMISSION REDUCTION BY UREA INJECTION AND ACTIVATED CARBON IN SCR.

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Abstract

The carbon emissions from the diesel engines is not so high but after the reduction of NOX emissions the pollutants present in the exhaust gas is carbon and particulate matter. The stringent emission norms lead to maximum possibility of reduction of pollutants in exhaust gas so activated charcoal or activated carbon is used to adsorb the carbon emissions from the engine. Activated charcoal is grained into fine pieces they should be the size that they could not pass through the metal mesh fixed at the both the ends of the carbon container. The activated charcoal particulates should be heavy that they should not be carried away by the exhaust flow. The particulate matter or HC emissions are reduced at the catalytic converter so the exhaust emissions are mostly reduced and exhaust gasses are free from pollutants. The engine is operated for different load conditions like 100%, 75%, 50%, 25%, and 0% and the different emissions like CO, HC, CO2 and NOx. The activated carbon is linked with the catalytic converter to further reduce the emissions from the engine. The surface area of the activated carbon also plays a major role in reducing carbon emissions by allowing better adsorption of carbon.

Introduction:-

The reduction of carbon emissions from the engine has become major unit of operation in recent times. The adsorption of the carbon from the exhaust is considered as the most efficient and cheapest way for reducing carbon emissions from the engine. Activated carbon or charcoal is used to adsorb the carbon emissions from the engine, activated carbon has low volume micro pores which increases the surface area to provide more time to carbon to get adsorb. The adsorption of carbon by the charcoal is carried out in chemical and photochemical reactions. The amount of CO2 emissions reduced depends on the surface area of the activated carbon and the flow velocity of the exhaust gases if the flow velocity is high the CO2 adsorption is low and more CO2 is adsorbed when the flow of exhaust gases is low. The size of the granules of the charcoal also plays a major role in the adsorption of carbon but the size of the granules should not be very small because they will be driven by the flow of exhaust gases.

Experimental Setup:-

The engine was calibrated for every variable load of 0%,25%,50%,75%,100% at a constant RPM. Once the engine and the setup was calibrated using the components. The testing was initiated by the checking the supply of fuel for a

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periodic time and the behavioral of the dynamometer, current supply and temperature difference was noted to provide the graphical representation.

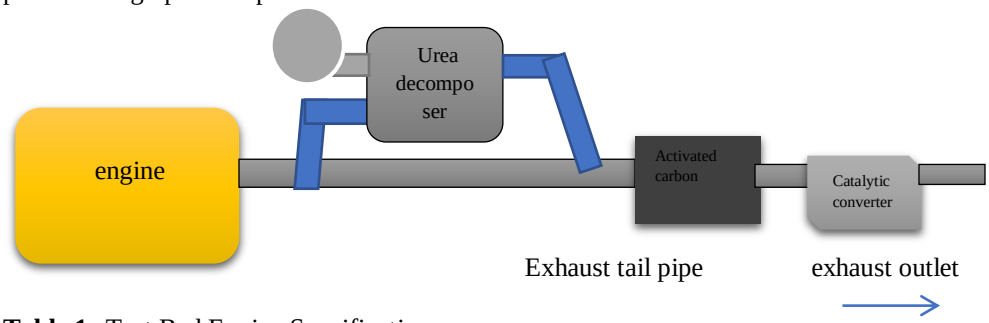

Table 1:-Test Bed Engine Specification:

MODEL	S 217
Capacity	21 kW (28 bhp @ 2000 rpm)
Type / Configuration	Vertical in-line Diesel Engine
Bore	91.44 mm
Stroke	127 mm
No. of Cylinders	2
Displacement	1670 cc
Compression ratio	18.5:1
Cycle	4 Stroke
Rotation	Clockwise (viewed from front)
Aspiration	Natural

The Adblue Urea is used it has constituents of parts of urea, water and other chemicals. Pump is being used to supply the urea into the mechanical injector with required pressure. It is a pump from kirloskar with 0.25 HP its modified for usage we have incorporated a cam into the setup. The cam is powered by the shaft from the motor. A full revolution of the cam will lead to one injection of urea via the urea injector. The injector used in our setup is a CRDI Diesel injector which is calibrated to 120 bars for providing the best suitable pressure for the mixture of urea with the gases. The urea absorbs NOx emissions from the exhaust gases. The gases are allowed to pass through the activated carbon tank where the carbon in the exhaust gases adsorbed to the activated carbon present in the carbon tank. So, the gases coming out of the engine are free from Nox and Carbon emissions.

Analysis Results and Discussion:-

The decomposer chamber and the nozzle is designed in the “CATIA V5” software. A valve is provided to control the flow of exhaust gases into the decomposer the valve can be set in different positions to control the flow of the exhaust gases into the carbon container to avoid the charcoal granules flow away along the exhaust gases. The

carbon container is sealed on the both sides with the metal wire mesh to allow the exhaust gases to flow freely and avoid the activated carbon to blow away along the exhaust line. The SCR urea injection and the carbon container is fixed to the exhaust system and the exhaust gases are tested by a "AVL 5 gas analyzer" to determine the amounts of different exhaust gases coming out of the engine.

Analysis:-

The flow analysis of the exhaust gases in the exhaust is determined by designing the exhaust line in CATIA V5 and the flow analysis of the exhaust gases is determined by using CFD simulation. The flow analysis of the exhaust gases in the decomposer gives the amount of exhaust gases entering into the decomposer it helps to determine the size of the carbon granules for maximum surface area and to avoid the flow along exhaust gases. The gases entering the carbon container are driven from the main exhaust line and they are allowed to flow through the decomposer the design of decomposer has a major role in determination of the velocity of the gases.

Exhaust gas Flow:

The exhaust from the engine is been flown through the exhaust tail pipe. Velocity of the exhaust gas seems to vary for different load condition because It provides an excessive torque. The tail pipe is connected with the decomposer with pipes which have l bends at the ends they allow the exhaust gases from the engine. The exhaust gas is passed through the pipes to the decomposer when the valve is opened in order to acquire the base emission reading of the setup. The valve present at the end of inlet pipe into decomposer determines the amount of exhaust gases to pass through the decomposer, it has its impact on the exhaust gases flowing through carbon container and the amount of carbon reduction.

Activated Carbon offer a large spectrum of pore structures and surface chemistry for absorption of gases, which are being used design practical pressure swing and thermal swing adsorption processes for separation and purification of gas mixtures.

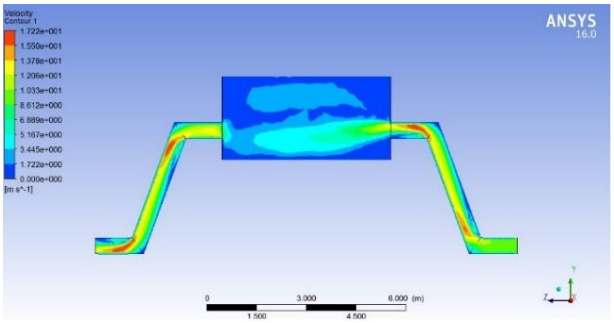

Fig 2:- Exhaust Gas Flow Analysis

The gases from the carbon container is allowed to flow through catalytic converter which is filled with titanium and vanadium catalysts coated to the plates. The gases flowing through catalytic converter experiences a little reduction in the velocity.

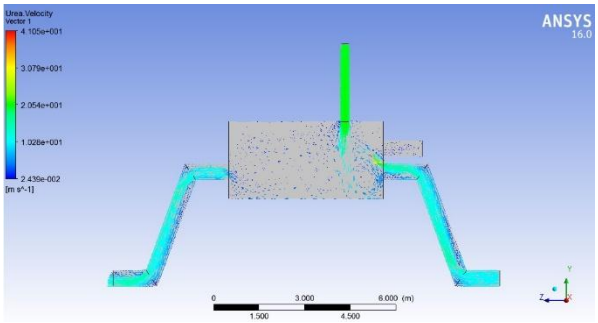

Fig 4:- Adsorption of exhaust gases

Results:-

The engine is operated for different load conditions i.e. 100%75%50%25%0% and the emission readings for different gases at different loads is noted. The processes are carried out for activated carbon and catalytic converter combined with activated carbon. The catalytic converter is employed in the reduction of HC and CO emissions where activated carbon involves in adsorbing CO2 emissions from the exhaust.

Table 2:- Engine conditions when activated carbon is combined with urea injection.

load (Nm)	Exhaust temp (deg C)	Fuel consumption(S)	Radiator		Oil temp	Current
			water in	water out		
100-81.2	485	8.57	42	72	62	1.66
75-60.1	375	11.04	40	71	69	1.44
50-40.1	319	14.98	42	71	75	1.14
25-20.3	215	23.25	40	69	77	0.9
0-0	150	36.96	38	66	79	NIL

Table 3:- Emission readings with activated carbon and urea injection.

S.No	Load(%)	CO(%)	HC(%)	CO2(%)	O2	NOx (PPM)
1	100	0.2	13	11.1	21.13	1673
2	75	0.05	4	8.8	21.15	1532
3	50	0.04	6	6.4	21.15	1261
4	25	0.03	1	4	20.95	793
5	0	0.03	2	2.2	20.95	365

Table 4:- Smoke properties of exhaust gas with activated carbon and urea injection.

Load (%)	**100**	**75**	**50**	**25**	**0**
Opacity(%)	2.6	21.4	42.3	56.7	95.9
ABS / m	0.06	0.55	1.27	8.94	7.42

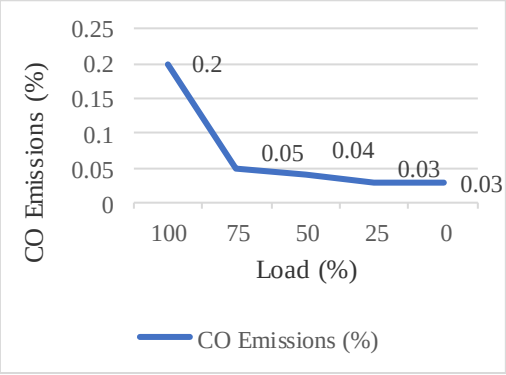

Fig 6:- CO Emissions for different loads with activated carbon and urea injection.

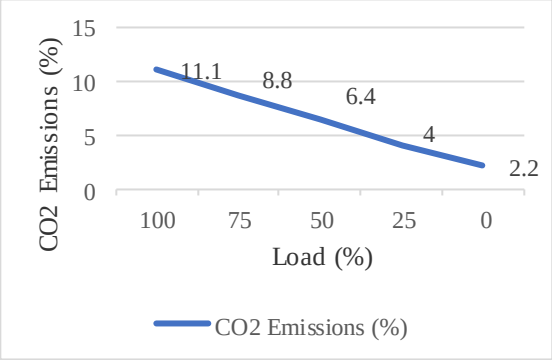

Fig 7:- CO2 Emissions for different loads with activated carbon and urea injection.

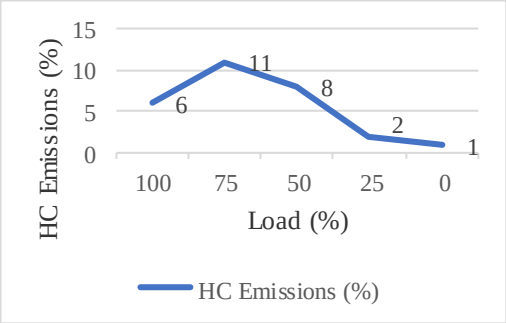

Fig 8:- HC Emissions for different loads with activated carbon & urea injection.

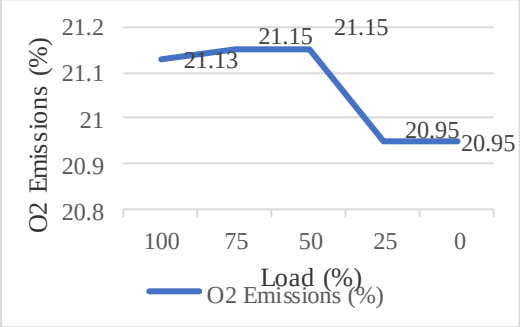

Fig 9:- O2 Emissions for different loads with activated carbon & urea injection.

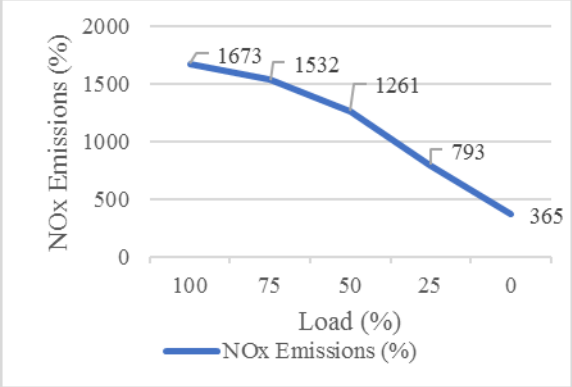

Fig 10:- NOx Emissions for different loads with activated carbon and urea injection

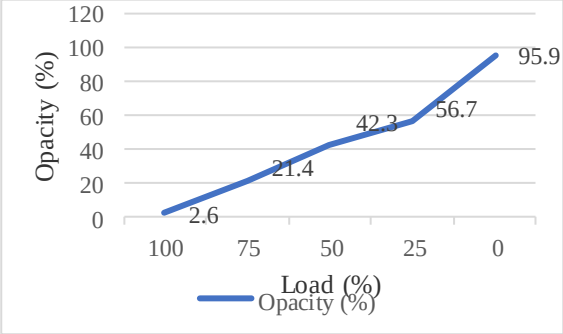

Fig 11:- Opacity of exhaust gas for different loads with activated carbon and urea injection

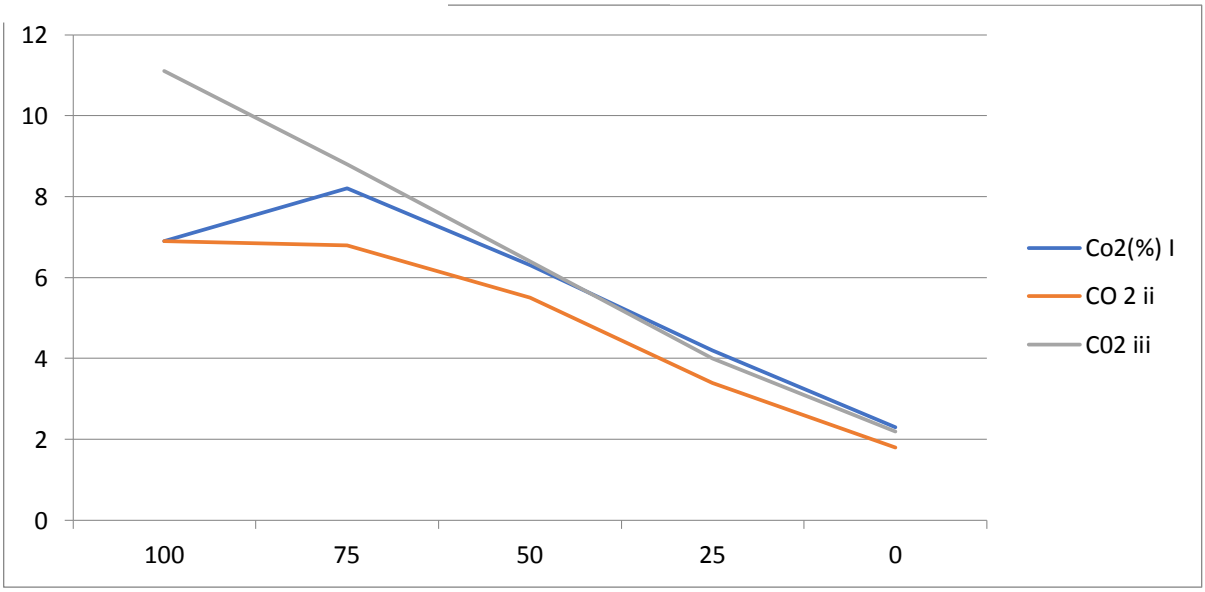

Fig 12:- Comparison of CO2 emissions for different loads with different conditions.

The above graph (Fig:12) gives a comparison analysis of carbon emissions when activated carbon is combined with urea injection, activated carbon combined with catalytic converter and urea injection into the decomposer. The better reduction of carbon is observed when the activated carbon is combined with catalytic converter.

Conclusion:-

Activated carbon in the was filled into a coupling shaped container and fitted into the end of the exhaust line and the powder was poured into the container and was sealed with mesh on the both ends so that the powder doesn't escape the container. The work done in this project determines using the technique of urea injection into decomposer to reduce the NOx emissions from the exhaust gases of the engine. The urea employed emission reduction technique uses a pump coupled with an injector to spray the urea into the decomposer. Each system employed is tested for different load conditions i.e. 100%, 75%, 50%, 25%, 0%. The activated carbon is combined with catalytic converter to further reduce CO and HC emissions.

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