Comparative Study of Effect of Ammonium Bi Carbonate and Acetamide in NOx Reduction in the Exhaust of Diesel Engine

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ABSTRACT

Many techniques are being tried to control NOx emission from diesel engine. Variation in engine design, modifying the operating parameters, variation of fuels, is tried on the input side. Exhaust gas treatment is tried on the output side. In this paper, investigation of NOx reduction by using two different chemicals in the exhaust path is presented. A comparative analysis is made to find the effect of Ammonium bi carbonate and Acetamide in NOx reduction in diesel engine.

KEY WORDS: Diesel engine, Exhaust emission, NOx, Ammonium bi carbonate and Acetamide.

1. INTRODUCTION

This project mainly focuses in reducing the NOx content present in the exhaust of diesel engine. Now a day's diesel engines are widely used in all countries due to high power output as well as economical use. Though it gives more benefits/advantages it also releases the harmful exhaust NOx, which is not suitable for human inhale. Oxides of nitrogen react with environmental air to form nitric acid, which causes harmful effect to the agricultural land, water source etc. So we propose to minimize the Nox by chemical reaction, into nitrogen, which is harmless.

2. NOx REDUCTION METHODS

There are many techniques used to reduce the nitrogen oxide in exhaust, but we have preferred the ammonia NH3 in the form of ammonium bicarbonate / acetamide to reduce the nitrogen oxide in the exhaust of engine. This technique is termed as dry sorption method in which the flue gas along with nitrogen oxide is treated with ammonia. To reduce the nitrous oxide, the exhaust chamber is attached with the filter which is coated with ammonium bi carbonate / acetamide. Nitrous oxide reacts with ammonia to give nitrogen and water. The water molecule produced as byproduct is evaporated into the gaseous form due to high temperature produced in the combustion chamber.

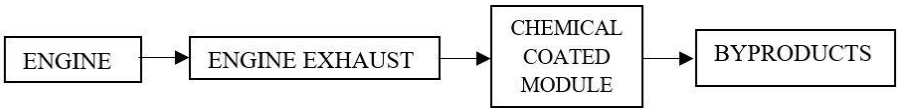

Figure.1. Block Diagram

Using Ammonium Bicarbonate: In our project we coated the ammonium bicarbonate on the air filter and fitted in the muffler side of a van and took the exhaust gas analysis readings. The readings are tabulated.

Properties of Ammonium Bicarbonate:

- Appearance - crystalline
- Colour - white
- Molecular formula- NH_4HCO_3
- Molar mass - 79.056 g/mol
- Density - 1.586 g/cm^3
- pH – 7.0 – 8.5 at 25 °C
- Used as an inexpensive nitrogen fertilizer
- Used as a component in the production of fire-extinguishing compounds.

Reaction: $NH_4HCO_3 \longrightarrow NH_3 + H_2O + CO_2$

Table.1. Readings taken from the four cylinder engine exhaust

SI. No.	Description	Idling		Half racing		Full racing	
		Ordinary exhaust	Treated with ammonium bicarbonate	Ordinary exhaust	Treated with ammonium bicarbonate	Ordinary exhaust	Treated with ammonium bicarbonate
1	O_2 (%)	18.9%	18.8%	18.8%	18.7%	17.7%	17.8%
2	F_{temp}(°C)	62.2°C	60°C	89°C	72°C	156°C	101°C
3	NO (ppm)	30ppm	37ppm	34ppm	29ppm	40ppm	32ppm
4	NO_2(ppm)	20ppm	36ppm	38ppm	37ppm	10ppm	6ppm
5	SO_2 (ppm)	Nil ppm	Nil ppm	Nil ppm	Nil ppm	44ppm	36ppm
6	CO (%)	0.055%	0.058%	0.055%	0.059%	0.192%	0.196%

By Using Acetamide: The same process is done in muffler by using acetamide instead of Ammonium Bicarbonate. The Acetamide Ethanal solution is coated on the air filter. After that the filter was fitted in the muffler side of the four cylinder engine and the exhaust gas analysis was done using gas analyser. The readings are tabulated below.

Properties of Acetamide:

- Appearance - Crystalline solid
- Solubility - Soluble in water
- Density - 1.159 g/cm3
- Chemical formula : C_2H_5NO;
- Molecular weight :59.07 g/mol
- Vapor pressure:1 mm Hg at 65 °C
- Used as a solvent, plasticizer, and a wetting and penetrating agent.

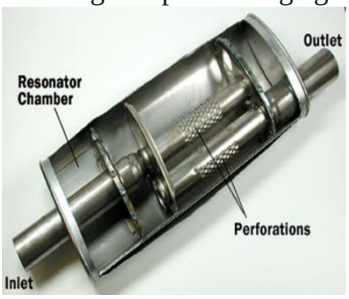

Figure.1. Muffler Design and Four Cylinder Engine

Four Cylinder Engine Details:

- Van - Mahindra Van
- Van No. - TN58 A 5059
- Model - 1997
- Cubic Capacity - 3330.00 cc.
- BHP - 20.70
- Fuel used - Diesel
- Injection type - Direct Injection

3. RESULT AND DISCUSSION

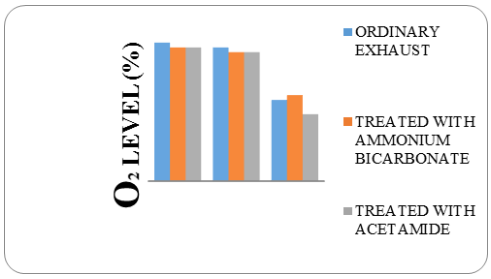

Figure.2. O_2% Level

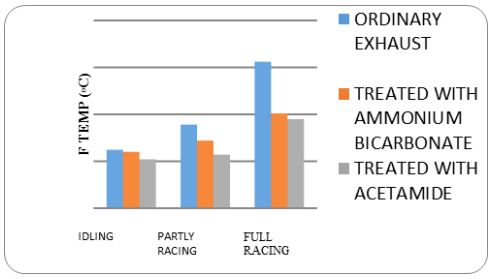

Figure.3. Temperature level

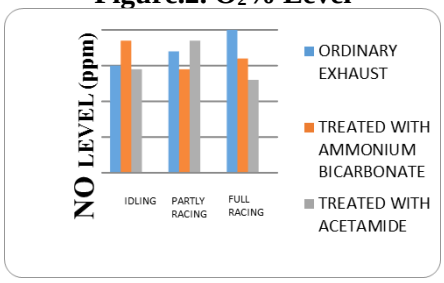

Figure.4. NO Level

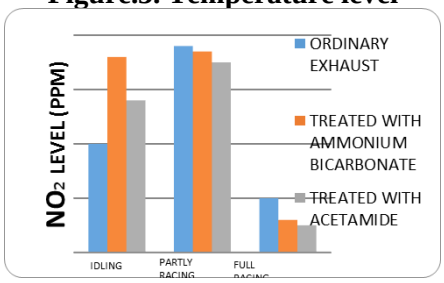

Figure.5. NO_2 Level

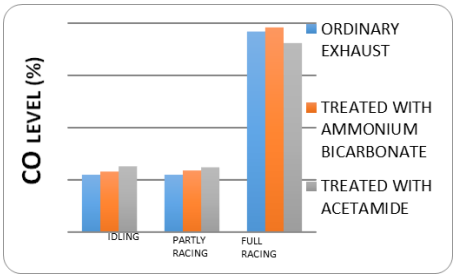

Figure.6. CO Level

Table.2. Readings taken from the four cylinder engine exhaust

SI.No.	Description	Idling		Half racing		Full racing	
		Ordinary exhaust	Treated with acetamide	Ordinary exhaust	Treated with acetamide	Ordinary exhaust	Treated with acetamide
1	O_2 (%)	18.9%	18.8%	18.8%	18.7%	17.7%	17.4%
2	F_{temp}(°C)	62.2°C	52°C	89°C	57°C	156°C	95°C
3	NO (ppm)	30ppm	29ppm	34ppm	37ppm	40ppm	26ppm
4	NO_2(ppm)	20ppm	28ppm	38ppm	35ppm	10ppm	5ppm
5	SO_2 (ppm)	Nil ppm	Nil ppm	Nil ppm	Nil ppm	44ppm	25ppm
6	CO (%)	0.055%	0.063%	0.055%	0.062%	0.192%	0.181%

4. CONCLUSION

From the above analysis, it is found that Acetamide has better NOx reduction capabilities than Ammonium Bicarbonate. In addition to NOx reduction, the filter muffler also acts as Diesel Particulate Filter (DPF).The exhaust temperature is also reduced which is a supporting point against Global Warming effect.

Future Work: This is an initial attempt to think about simpler, easier methods when compared to costlier, complicated methods like urea injection method, ceramic reactor method etc. The life study of the filter muffler will open a new market for replaceable cartridge type NOx reduction mufflers.

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