

LOCOMOTIVE EMISSION ELIMINATOR

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Abstract—This project aims to save the environment from the emission of the vehicles which contains harmful gases namely Sulphur dioxide, the oxides of Nitrogen, Carbon monoxide which are the main cause for the global warming. The concept deals with removal of the harmful gases which are emitted from the vehicles, locomotives etc. with the equipment involving combination of catalytic converter and limestone scrubber. This unique instrument eliminates the above described gases and leaves only carbon dioxide which can be later removed by charcoal coating or the carbon dioxide will be absorbed by the plants by reducing the pollution by 99%.

Keywords—Catalytic Converter, Limestone Scrubber.

INTRODUCTION

This project is designed in such a way that it would be installed in almost all fueled locomotives. As the deforestation has dominated nowadays, even carbon dioxide has also become a big problem, due to which its increase has caused the mark for the global warming. The harmful emissions from engines of locomotives, metal industries (producing toxin gas due to smelting process). Coming to the locomotive, its diesel emissions are associated with an increase of lung cancer and other cardiovascular disease which leads to serious trauma.

This equipment contains majorly two parts, the catalytic converter and the limestone scrubber. Catalytic converter is mainly used to convert the toxic gases into non-harmful gases. Limestone Scrubber is used to eliminate sulphur dioxide.

SURVEY

One of the most energy efficient transportation mode is via rails. It is responsible for almost 9% of the global motorized movement of passengers and 7% of freight but only 3% of transportation energy is used. From the transportation sector the contribution of diesel emissions has increased 3.5 times since 1990 and is almost 250 million tons of CO₂ or equal to 13.5% of emissions in 2013. Adverse health and environmental effects are caused due to the pollutants present in diesel emission. These pollutants are originated due to various non-ideal processes during combustion of the fuel such as incomplete combustion and certain reaction between mixture components under extreme temperature

and pressure. It is also produced due to combustion of lubricating oil and additives added to the oil as well as combustion of diesel fuel containing non-hydrocarbons components such as sulfur components and fuel additives unburned Nitrogen Oxides (NO_x), Hydrocarbons (HC), Particulate Matter (PM) and Carbon Monoxide (CO) and are the most common pollutants.

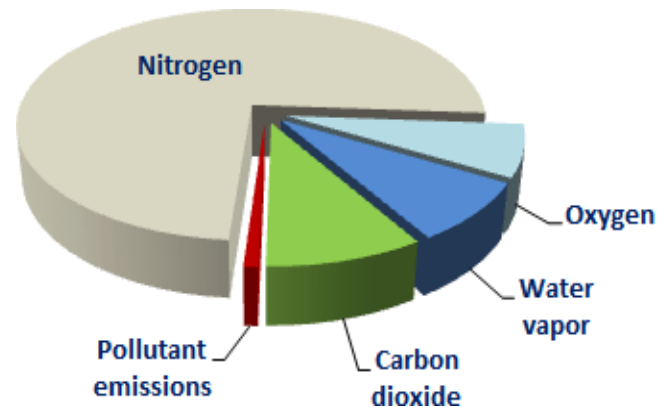


Fig.1 Composition of Atmosphere

The other contribution to a pollutant emission from the internal combustion engine are sources usually are in small concentration but in some cases it has materials having high toxicity. Metals and other compounds from engine wear or components emitted from the emission control catalysts are causes for some additional emissions. Sometimes catalysts facilitate to the formation of new products which are usually not found in engine exhausts when they are introduced to the combustion chamber. The quality of fuels being low for example the residual fuels used in large marine engines with heavy metals and other compounds lead to adverse health and an environmental effects some of the pollutants are:

Fine particulate matter (PM_{2.5}): Respiratory diseases, i.e., asthma and chronic bronchitis which are associated with cardiac arrhythmias, heart attacks and premature deaths are caused due to these particulate matter. The highest risk is for elderly and children with heart and lungs diseases when exposed to particulate pollution.

Smog-forming nitrogen oxides (NO_x): Emission of NO_x develops the formation of smog and ozone where they undergo reaction with sunlight. Smog reduces visibility and also damages plants and animals lives adversely. Ozone are harmful when they are near to ground causing major respiratory diseases such as asthma and emphysema, also causes itchy and burning sensation in the eyes. It also promotes acid rain which is again has major effects on environment.

Sulfur dioxide (SO₂): Harmful particulate pollution is formed by SO₂ which reacts with water molecules in the air to accomplish acid rain. Acid rain causes deforestation, corrode building materials, paints and destroy aquatic lives by acidifying waterways.

Proposed Method

Toxic pollutants (gases) from exhaust contain harmful particles. However these molecules are formed by the non-toxic substances or elements. The idea is to split these toxic molecules into harmless elements and then the resulting gases can be released into atmosphere.

This idea is to reduce the pollution caused by locomotives.

The ideology here is to put this in form of diagram as show in figure 2. This equipment mainly contains two parts i.e. catalytic converter and lime stone scrubber.

CATALYTIC CONVERTER

The toxic gases involving oxides of nitrogen, sulphur and carbon monoxide are passed through the catalytic converter. The material inside catalytic converter is made of ceramic with the mixture of catalytic elements such as platinum, rhodium and palladium. The ceramic is moulded into a honey-comb like structure such that gases can move easily. The ceramic structure in the catalytic converter is divided into two halves. First half of ceramic is mixed with platinum and rhodium. Second half of ceramic structure is mixed with platinum and palladium. Reduction reaction takes place at first half of the converter where platinum and rhodium splits the nitrogen oxides present in the gases into oxygen and nitrogen.

Oxidation reaction takes place at the second half of the converter where platinum and palladium combines carbon monoxide with oxygen to form carbon dioxide. It also converts unburnt hydrocarbons to carbon dioxide.

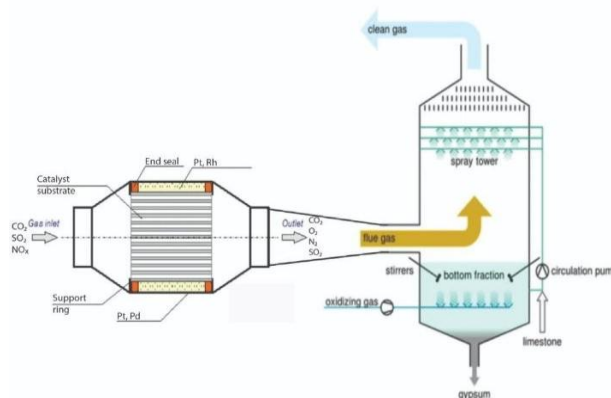
At the outlet of the catalytic converter the resultant products are nitrogen, oxygen, carbon dioxide and toxic gas sulphur dioxide which escapes without being filtered through catalytic converter. In order to eliminate sulphur dioxide, limestone scrubber is used.

REACTIONS INSIDE CATALYTIC CONVERTER

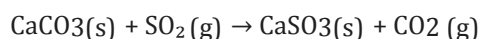
Oxidation	$2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$ $\text{HC} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
Reduction/three-way	$2\text{CO} + 2\text{NO} \rightarrow 2\text{CO}_2 + \text{N}_2$ $\text{HC} + \text{NO} \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{N}_2$ $2\text{H}_2 + 2\text{NO} \rightarrow 2\text{H}_2\text{O} + \text{N}_2$
Water Gas Shift	$\text{CO} + \text{H}_2\text{O} \rightarrow \text{CO}_2 + \text{H}_2$
Steam Reforming	$\text{HC} + \text{H}_2\text{O} \rightarrow \text{CO}_2 + \text{H}_2$

LIMESTONE SCRUBBER

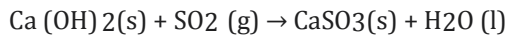
Limestone scrubbers is an equipment which eliminates sulphur dioxide through certain chemical reactions. This includes the concept of double decomposition reaction. The gases which contain certain amount of oxides of sulphur are eliminated and converted into non-toxic particles and are collected at the base. When sulphur dioxide containing gas is received by the scrubber, the sprayer in the scrubber sprays the aqueous solution of calcium carbonate. This compound is used as it is abundant in nature. To control the flow rate of calcium carbonate Rousemount analytical pH equipment is used. As sulphur dioxide reacts with calcium carbonate which results in the formation of calcium sulphite and water. This is again made to react with oxygen to form calcium sulphate which is also called gypsum. Gypsum gets settled down at the bottom of equipment and it is removed. This can be further used in paints and industrial purposed. As gypsum does not react instantaneous with calcium carbonate slurry, it can be directed to a circulating pump for reuse of the compound. Hence by combining these two parts we can effectively eliminate oxides of nitrogen and sulphur, unburnt hydrocarbons and carbon monoxide .



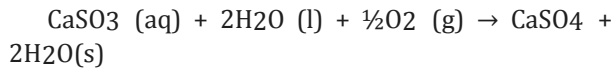
REACTIONS INSIDE LIMESTONE SCRUBBER



Sulphur dioxide reacting with aqueous calcium carbonate producing calcium sulphite and carbon dioxide.



Particularly dry sorbent injection systems, further oxidize the CaSO₃ (calcium sulphite) to produce marketable CaSO₄·2H₂O (gypsum) that can be used in paint and other products. Forced oxidation is the name of process by which this synthetic gypsum is created.



Calcium sulphite further reacts with oxygen producing gypsum

Approach of Project

In this project by the above mentioned method is possible to fuse the catalytic converter and the limestone scrubber so that the toxic gases from the exhaust which involves oxides of nitrogen, sulfur and carbon monoxide will be eliminated efficiently.

ADVANTAGE

- The used sorbent, limestone is very cheap
- Most of the toxic gases are eliminated except carbon dioxide which can be removed by coating the exhaust with carbon.
- High efficiency is observed (90%).

CONCLUSION

By employing this method we can clear up many problems face in real time situations. Usage of the method proposed will increase the efficiency of the Locomotives and decreases the harmful content in pollution.

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