

A Review Paper on Exhaust Gas Treatment System

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ABSTRACT

Air pollution and heating are the two biggest threats to human and animal health. Energy insecurity and economic process of standard energy sources also are major threats to economic and political stability. Many alternatives to standard energy sources are projected, however, analyses of such choices are restricted broad and depth. Indoor plus outdoor air pollution is the sixth-leading cause of death, WHO estimates that around 7 million people die every year. Air pollution also increases asthma, respiratory illness, cardiovascular disease, cancer, hospitalizations, emergency-room visits, work-days lost, and school-days lost all of which decrease economic output, divert resources, and weaken the security of nations. Global warming increase the heat stress, disease, severity of tropical storms, the acidity of the ocean, sea levels, and the melting of glaciers, snowpack, and sea ice. Further, it shifts the situation of viable agriculture, harms ecosystems and animal habitats, and changes the temporal order and magnitude of installation. This project aims to reduce as well as vanish air pollution created from automobile, industry and thermal power plant by introducing the exhaust gases into liquid nitrogen. The exhaust gases coming from engine or plant is stored and cooled instead of ejecting it to the atmosphere, this exhaust gas mainly consists of carbon dioxide gas, carbon monoxide, methane gas, hydrocarbons, nitrogen oxide gas. The liquid nitrogen having a temperature $-196\text{ }^{\circ}\text{C}$ is subjected to vacuum. As pressure decreases the temperature decreases and it becomes solid-liquid nitrogen and when gases pass through it, it is expected that the carbon dioxide and carbon monoxide will become solid as they have a surface temperature $-75.8\text{ }^{\circ}\text{C}$ and collected at the base. The nitrogen oxide gas will become liquid when it comes in contact with solid nitrogen.

Keywords: Exhaust Gas Treatment system, liquid nitrogen, Cryogenic gas separator.

1. INTRODUCTION

There's nothing quite like opening the door and breathing clean, fresh, air but how clean is the air you're breathing right now? Unless you're a scientist with a chemistry lab at your fingertips, there's no real way of determining this. The gases you're sucking up through your nose could be slowly killing human beings according to the World Health Organization around two million people die prematurely from the effects of polluted air every year. Air pollution is a huge problem in the world and not just for people living in smog-choked cities, through such things as global warming and damage to the ozone layer, it's the potential to have an effect on us all. Air lets our living planet breathe it is the mixture of gases that fill the atmosphere, giving life to the plants and animals that make Earth such a vibrant place. Broadly speaking, air is almost entirely made up of two gases (78 % nitrogen and 21 % oxygen), with a few other gases (such as carbon dioxide and argon) present in absolutely minute quantities. We can breathe standard air all day long with no sick effects.

According to the WHO, air pollution is one of the world's biggest killers, it causes around three million people to die prematurely each year. Many of those deaths happen in developing countries, but wealthier industrial

nations suffer too in the United States, for example, around 41,000 people a year are die early as a result of pollution.

The increase in atmospheric carbon dioxide now causing climate change and global warming is expected to have a major impact on the world's agriculture. When rain falls through polluted air, it can pick up some of the pollutions and turn more acidic producing acid rain. Simply speaking, the air pollution converts the rain into a weak acid. When acid precipitation accumulates in lakes or rivers, it gradually turns the entire water more acidic. That's a true drawback as a result of fish thrive solely in water that's neutral or slightly acidic (typically with a pH of half-dozen.5–7.0). Once the acidity reduced about pH 6.0, fish soon start to die and if the pH reduces about 4.0 or less, all the fish will be killed. It also causes the death of forests, reduces the quality and fertility of soil, and damages buildings by eating away stonework. With the help EGTS, we expected that these main pollutants are converted into less harmful for a human being and our environment.

2. LITERATURE REVIEW

Robert Bennett (2016) This research work aims that CO₂ may be removed from a CO₂ absorbent using light in place of heat. This represents a way of cyclically absorbing and desorbing CO₂ without the large heat requirement of rapture swing amine-based absorption system. Currently, the usefulness of this concept is limited by the availability of light and portion of the solar spectrum. This concept also limited to CO₂ gas only.

D. Ravi (2014) The research work addressed that rapidly increasing global environmental pollution forced environmental agencies of many countries to enforce very strict emission norms. This is achieved by after emission treatment devices like EGR, SCR, NCR, SNR. Experimental Investigation processes of during Pre-oxidation with Urea-SCR setup of the diesel engine is carried out and it concluded that 59.2% NO_x emission is reduced, 24.7% reduction in HC emission and also 25% Carbon monoxide is reduced but because of complete oxidation Carbon dioxide is increased by 40.8%.

Tugberk Hakan Cetin (2019) The research work is based on cryogenic energy storage powered by geothermal energy. Its conclusion is cryogenic energy storage is an effective and viable option for load shifting of geothermal power plants.

Rodrigo F. Abdo (2015) The research work concluded that CES-Claude and CES-Collins having greater efficiency when compared with CES-Linde-Hampson. It was also concluded that CES-Claude and CES-Collins both systems are very similar result and in terms of cost benefits Claude system is the best option.

Jingxuan Xu (2017) The research work aims to the proposed recovery of CO₂ is achieved up to 80% and without excessive gasification of LNG, it is possible to set up cryogenic ccs system with a gas temperature lower than -130 °C. Development of a more energy efficient system is still needed.

R.S. Elias (2018) in this research carbon capture and storage achieved by using gas-fired based load power plant and it reduces CO₂ up to zero or non-zero emissions. CCS is not only for power plants but successfully used to the other industrial sector. In CCS with the help of burning of fossil fuel emission reduction is achieved. This captured emission can be transported and used to produce ammonia and urea.

Ahmed M. (2014) In this research reduction of NO_x and unburnt hydrocarbons achieved. The NO_x reduction is achieved at low temperature (150-220°C). CI engine are cost effective, efficient and widely used but NO_x of CI engine is higher than SI engine due this reason suppression and recirculation of NO_x is takes place. In selective catalyst polymer chain is used for emission reduction and advantage of polymer chain is at high temperature it becomes softer.

Rong Xue (2018) In this research work an open-cycle liquid nitrogen spray cooling system was established for study. When mass flow rate and coefficient of discharge is increases as the outlet diameter of the nozzle and pressure difference increases. This relation is used for the safety of operation and inside requisite temperature the cryogenic wind tunnel.

Xin-Rong Zhang (2011) The research work in the paper an experimented setup is designed, constructed, and tested to measure characteristics of heat transfer of CO₂ solid-gas two-phase flow inside the horizontal circular tube. It concluded that the present experimented setup successfully measures the heat transfer of CO₂ solid-gas two-phase flow. The Nusselt number is slightly increased along the length of the tube in the sublimation area.

Gang Xu (2014) In this method CO₂ separation & purification proposed with the help of refrigeration & multistage compression and a major amount of CO₂ from the exhaust gas separated. Due to the harmful effect of the exhaust on the environment like global warming, ozone depletion and specially affected by CO₂, so the main aim of the system is to reduce the CO₂ from the exhaust gases. Currently, several methods are available for capture CO₂ of emissions. Among this method, chemical absorption separates a large amount of CO₂ from the exhaust. Another method of CO₂ separation is cryogenic separation, separates CO₂ at low temperature.

3. IDENTIFIED GAPS IN THE LITERATURE AND OBJECTIVES OF THE RESEARCH

On the idea of research of theoretical issues, and analysis contributions created by completely different researchers, following gaps within the analysis are being identified:

- 1) D. Ravi, Selective Catalytic Reduction – An Effective Emission Controller in CI Engine Suggested There is almost nil research available which reduces the CO₂ emission. By using SCR only NO_x, HC and CO are reduced but CO₂ is increased.
- 2) Robert Bennett, Carbon Capture powered by solar power suggested there is almost nil research available which capture the exhaust gases. Currently, the usefulness of this concept is limited by the availability of light and portion of the solar spectrum. This concept also limited to CO₂ gas only.

On the idea of on top of the mentioned gaps objectives of the analysis work are developed, as follows:

- 1) D. Ravi, Selective Catalytic Reduction – An Effective Emission Controller in CI Engine Suggested Harmful Exhaust gases like NO_x, CO, should be reducing.
- 2) Ahmed M., NO_x removal efficiency and N₂ selectivity during selective catalytic reduction processes over Al₂O₃ supported highly cross-linked polyethylene catalysts suggested It should be highly efficient. It should be simple in construction and inexpensive.
- 3) R.S. Elias, retrofitting carbon capture and storage to natural gas-fired power plants suggested It should be reducing the CO₂. Carbon capture and storage achieved by using gas-fired based load power plant and it reduces CO₂ up to zero or non-zero emissions.

4. METHODOLOGY

In the present research work, methods are proposed for the solution of the research problem, and proposed analysis are as follows:

There are currently three major available technologies to control the CO₂ emission from various sources like automotive vehicles, power plants, industries etc. These technologies are post-combustion CO₂ capture, pre-combustion CO₂ capture, and oxy-fuel combustion. In post-combustion CO₂ operation is performed after the combustion of fuels. In which exhaust gas is passed through a chemical solvent, such as ammonia or monoethanolamide (MEA) in an absorption tower to contact or mixed CO₂ out of the flue gas. The ammonia or MEA solvent mix with CO₂ is then pumped to a regeneration unit where CO₂ and solvent separated. The captured CO₂ is then compressed and transported for storage.

Pre-combustion carbon capture involves operations before combustion. In this process, a solid fuel like coal is converted into a synthetic gas (syngas). High temperature and pressure, coal is oxidized with early 50% of oxygen and steam to produce syngas. The syngas composition is mainly carbon monoxide (CO) and hydrogen (H₂). In a water gas shift reactor, synthetic gas is converted into H₂ and CO₂. And by physical sorbent CO₂ is separated. In the

oxy-fuel combustion process, oxygen is separated from the rest of the component of the air in the air separation unit. Separation oxygen from air is done with help of cryogenic oxygen separation technology.

The emission control in the internal combustion engine should be achieved by controlling combustion or by treating the exhausted flue gases. so the SCR system used, which is a Selective Catalyst Reduction system. SCR process mainly used or work as reduces the NO_x molecules into molecules of nitrogen and water vapour. NO_x reduction reactions take place effectively only when with a given temperature range, which mainly depends upon the type of catalyst used and flue gases composition as temperature range (250°C to 427°C).

firstly, the urea is converted into ammonia before injected into the combustion unit. The exhaust gases from the engine are passing through the catalytic converter, due to the partial combustion the gas inside the catalytic converter consists of a mixture of CO, HC, NO_x, which are harmful to the environment. catalytic converter there consists of two ceramic blocks with micro ducts consist of 'platinum & Rhodium' in one block, while platinum & palladium in other block acting as catalysts. After that toxic gases enter first and second block simultaneously, this causes the catalyst to react with toxic gases which cause oxides of nitrogen to reform into nitrogen(N₂) and oxygen(O₂) respectively. In second block CO reacts with oxygen molecules to form CO₂, the unburned HC also reacts with oxygen to form water and carbon. Hence after that, the toxic gases become less toxic and then after coming out of catalytic converter the DEF (Diesel Engine Fluid) solution to transform NO_x into harmless gases, and these harmless gases pass through muffler and high wave sound reduced by passing through muffler. Hence the system works efficiently.

From above methods Carbon Capture and Storage is best suitable method for our solution because CCS is one the method which gives reduction in Carbon dioxide & also NO_x, CO and HC very effectively as compared to other emission control methods

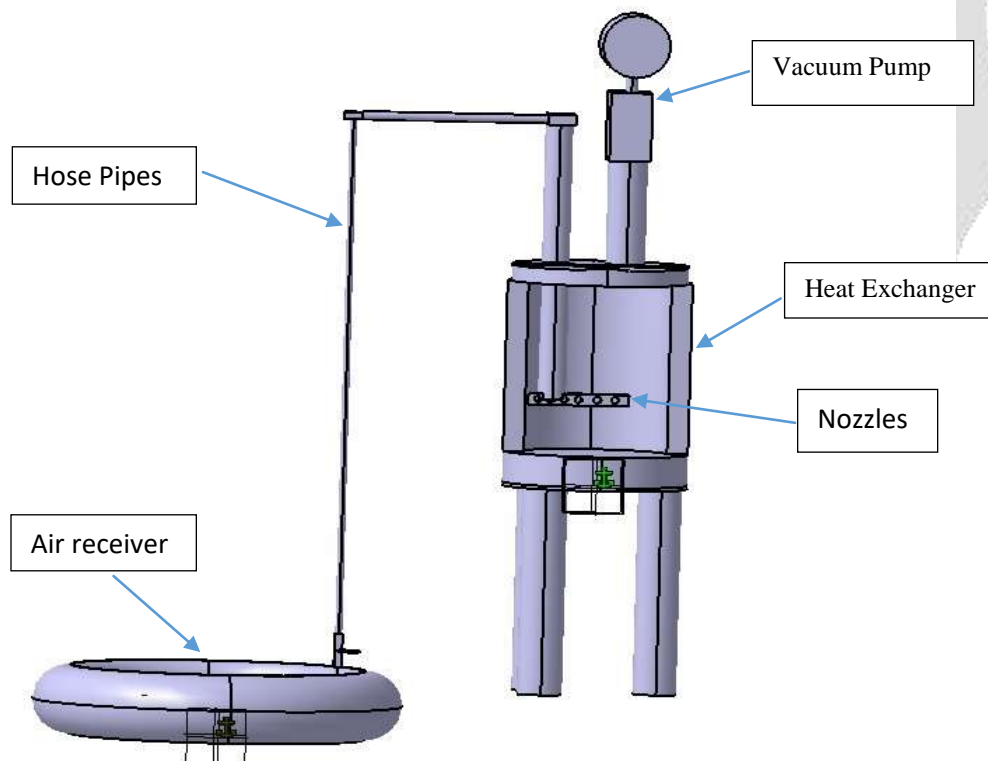


Fig -1 Exhaust Gas Treatment System Setup

Exhaust Gas Treatment System Setup is shown in Fig. In which exhaust gas coming from the engine is compressed with the help of the compressor. The compressor is battery operated and is having the capacity of 150

psi. The compressed gases are stored in a tyre. This tyre is easily loadable and unloadable and it performs the function of air receiver and accumulator. The tyre is unloaded from the vehicle and connected to the gas chamber which is stationary. When gases will pass through it, the exhaust gases will change its phase and become less harmful. It is expected that in Exhaust Gas Treatment System NO_x becomes liquid nitrogen, CO and CO_2 will become solid nitrogen will result from complete harmless gases as an output.

5. CONCLUSION

After investigating many research paper, we conclude that the design of EGTS is possible, which emits no pollution for its operation and contributing towards the increasing the productivity of the world. It is expected that in EGTS NO_x becomes liquid nitrogen, CO and CO_2 will become solid nitrogen will result from complete harmless gases as an output.

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