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CARBON CAPTURE AND STORAGE FROM AUTOMOBILE EXHAUST TO REDUCE CO_2 EMISSION

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ABSTRACT: Every time we burn fossil fuels such as gas, coal or oils, carbon dioxide is released into the atmosphere. In a natural carbon cycle, carbon dioxide is re-absorbed by plants and trees. However, we are burning fuels where the carbon dioxide has been trapped under the earth's surface for millions of years, and we're doing it so quickly that plants and trees that are alive now have no chance of soaking it up and it doesn't help that we're cutting down rainforests as well. The effect of all this extra carbon dioxide in the atmosphere is that the overall temperature of the planet is increasing global warmingThe existing technology involves the capture of carbon dioxide at a large industrial plant, its transport to a geological storage site and its long-term isolation in a geological storage reservoir. The technology has aroused considerable interest because it can help reduce emissions from fossil fuels which are likely to remain the dominant source of primary energy for decades to come. Current technologies require several times the theoretical energy requirement to separate CO_2 from fossil fuel conversion effluent. The intensive research in the feasibility study of CO_2 capture from Automobile Engines will help in the reduction of CO_2 emission to the atmosphere.

KEYWORDS- Carbon dioxide emission, Global warming, CCS process.

I. INTRODUCTION

Carbon dioxide emissions are the common type of gas emitted from the burning of fossil fuels. When this CO_2 is released in to the atmosphere it remains there until it is absorbed in some form. 50% of CO_2 emission released in to the atmosphere is absorbed by oceans The ocean absorbs half of all carbon released into the atmosphere. CO_2, like all greenhouse gases does not absorb light waves from the sun where it absorbs heat waves because they have longer wave lengths than sun light does, thus stopping the heat from being reflected into space. This is called the "greenhouse effect" and has been linked by scientists to global climate change. if we reduce CO_2 emissions the air we breathe will be cleaner and that has got to be good for everyone. . Global concentrations of CO_2 in the atmosphere have increased from pre-industrialization levels of approximately 280 parts per million by volume in around 1860 to approximately 316 in 1958 and rapidly to approximately 369 today. Global CO_2 concentration is predicted to rise to above 750 by 2100. if no action is taken to address the current situation. CO_2 emissions have an impact on global climate change. Effective CO_2 emission abatement strategies such as Carbon Capture and Storage (CCS) are required to combat this trend.

II. CARBON CAPTURE AND STORAGE

The Carbon capture and storage(CCS) is the process of capturing waste carbon dioxide CO_2 from large point source such as fossil fuel power plants and transporting in to storage sites. Carbon capture and storage is mostly used to describe the methods for removing CO_2 emission from large stationary source such as electricity generation and some industrial processes, and storing it away from the atmosphere. The aim is to prevent the release of large quantities of CO_2 into the atmosphere. The fossil fuels coal, oil and natural gas currently supply around 85 per cent of the world's energy needs, however they are a major source of CO_2. Carbon dioxide is the most common greenhouse gas after water vapour and the gas contributing most to global warming. The International Energy Agency predicts that fossil fuels will continue to be heavily used around the world for many years to come, especially as the demand for energy is increasing. The urgent need to reduce atmospheric concentrations of CO_2 means we need a portfolio of solutions to tackle our emissions, including energy efficiency, using less carbon-intensive fuels, enhancing natural carbon sinks (vegetation), and harnessing renewable energy from the wind, earth, sun and tides. CCS is an important part of this portfolio.CCS is currently the only technology that will allow us to decrease greenhouse gas emissions while using fossil fuels and retaining our existing energy-distribution infrastructure. CCS can reduce emissions from fossil fuel-burning power stations, whether gas or coal-fired, by as much as 90 percent.By implementing CCS technology in automobile exhaust we reduce the global Carbon emissions caused by automobiles. where Automobiles are the second largest reason for increase of the global CO_2 emission.

III.POSSIBLE CARBON CAPTURE TECHNIQUES

Carbon-capture techniques are most highly developed in the power-generation industry. There, carbon capture may occur at three different points in the combustion cycle

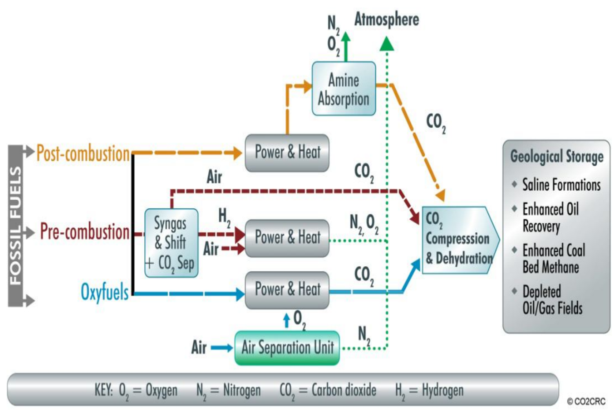

***Fig.*1 Various combustion phase of fossil fuels**

A.PRE-COMBUSTION

In pre-combustion a fossil fuel is partially oxidized to produce syngas(CO and H_2O) and then shiftedto produce CO_2 and H_2.TheCO_2 is then selectively removed leaving only the hydrogen gas to support combustion. This method is most highly developed in commercial applications .In this method exhaust gas is allowed to pass through a liquid solution in which CO_2 selectively dissolves and removes the carbon dioxide from the solution. This is generally done by heating the solution to remove the carbon dioxide for storage. But this technique is applicable for small scale capture process and it is also difficult to use a liquid solution in the exhaust pipe.

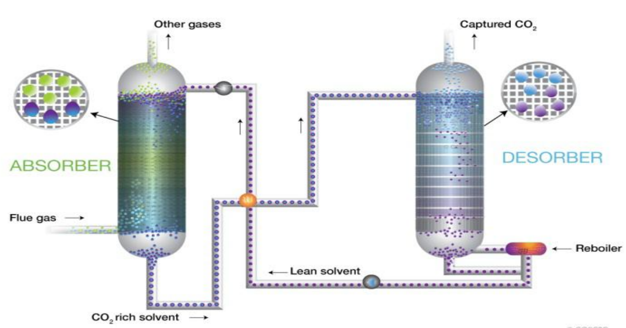

Fig.2 Absorption

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B.POST-COMBUSTION

In post combustion a mixture of carbon dioxide, oxygen, and nitrogen compounds is produced, requiring a post-combustion separation process. In this process exhaust gas is allowed to pass throughsolid adsorbents where the gas molecules in the exhaust are captured by pores present in the adsorbents. The mechanism involved in this process s known as Adsorption. Post-combustion-capture methods have an advantage that they may be more easily retrofitted to existing combustion systems.If a carbon-capture process is implemented in automobiles, it would be the first employ post-combustion capture, since this could be appended to the downstream management of exhaust gases without directly affecting the inputs to the internal combustion engine.

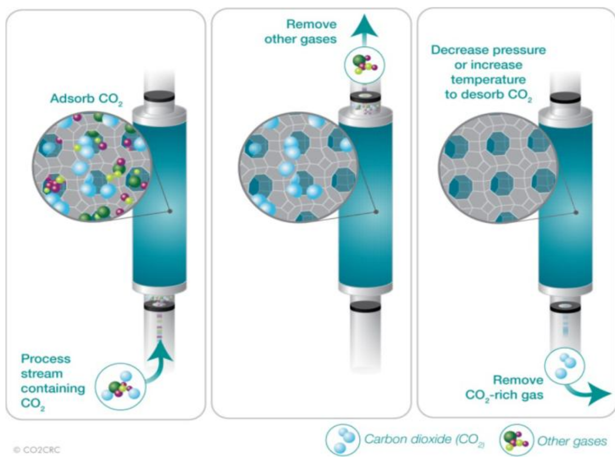

Fig.3 Adsorption

IV.MATERIAL FOR CO_2 ADSORPTION

A.ZEOLITES

In CCS technology various adsorbents such as Zeolite, Membranes and activated carbons are used to control the CO_2 emission. Zeolites are the most effective and recent technology used to control CO_2.Zeolites were formed from ancient volcanic ash flows settling in seas and lakes. Zeolite is the world's only mineral with a naturally-occurring negative charge. it simply lock and hold many positive ions, absorbing a multitude of environmental contaminants such as sodium, potassium; barium and calcium, and positively charged groups such as water and ammonia. Nearly every application of Zeolites has been driven by environmental concerns, or plays a significant role in reducing toxic waste and energy consumption. It is the highly porous and consistent matrix of zeolite that provides the adsorption qualities. The high thermal and chemical stability of these inorganic crystals make them ideal materials for use in high temperature applications such as catalytic membrane reactors. Zeolites also have the potential to achieve precise and specific separation of gases including the removal of H_2O, $CO_2$and $SO_2$from low-grade natural gas streams, as separation experiments through zeolite-containing membranes indicate that competitive adsorption can selectively separate light gas mixtures.

B.ZEOLITE PELLETS

Zeolite adsorbents have played a major role in the development of Adsorption technology. The three major areas of applications are:

1) Removal of trace or dilute impurities from a gas
2) Separation of bulk gas mixtures
3) Gas analysis

Commercial zeolites are generally available in bound forms where the zeolite crystals (1–5 mm) are formed in regular particle shapes (beads, pellets, cloverleaf design, etc.) using a binder material (clay, alumina, polymers, etc.). The purpose of the bound forms (diameters of 0.5–6.0 mm are common) is to reduce the pressure drop in adsorbent columns. The binder phase of the bound particles generally contains a network (arteries) of meso- and macro pores (0.5–5.0 Am in diameter) to facilitate transport of the adsorbate molecules from the external gas phase to the mouths of the zeolite crystal pores. Pore formers, such as starch or organic chemicals, are often added to the binder and then removed by combustion after the particles are formed.

V.DESIGN MODEL

A.MODEL CONSTRUCTION

The tailpipe is designed for the single cylinder diesel engine using CATIA 5.The tail pipe has two sections of perforated sheet mesh known as the trap to adsorb the carbon emissions . Zeolite pellets are filled in the middle of two perforated sheet mesh (trap).The inner section of the trap has perforated sheets of thickness1mm.Zeolite pellets are filled on the clear between the two perforated sheet mesh. The clearance is to be maintained are based on the size of the pellet. Zeolite pellets chosen for CO_2 adsorption has size 5mm.the available size of zeolite pellets are 0.5mm to 5mm.The maximum size is choose for maximum exposer of zeolite surface over the passing exhaust gas. The inner trap is sealed after filling of pellets. Then the trap is fixed into the centre portion of the tail pipe model where it is the reaction portion of the tailpipe. The tail pipe material is chosen as stainless steel to avoid corrosion of the material. The tail pipe is designed in such a way to minimize the backpressure. Conical sections are considered in designing the tail pipe to reduce the back pressure. Conical length of the pipe is designed for 90mm .which reduces the back pressure to maximum. The tail pipe is designed on the basis of previously designed models of catalytic converter for testing in the engines.

B.WORKING PRINCIPLE

The exhaust gas is allowed to pass into the inlet of the tailpipe. Pressure gets reduced and velocity of the gas increases because of the conical section. The flowing exhaust gas is free to move in all directions inside the tailpipe. As the movement of exhaust gas is not abruptly obstructed anywhere in its path, the back pressure is limited to minimum level. The flowing gas passes over the trap which is fixed at the inner of the tailpipe. Gas entering the perforated sheet mesh holes gets exposure to the zeolite pellets. The exposure of the exhaust gas is maximum by increased in size of the pellets. Zeolite pellets are highly porous and consistent matrix of zeolite that provides the adsorption of impurities. The exhaust gas containing $CO_2$and other particles are adsorbed by the zeolite pellets .adsorptions takes place by locking of gaseous CO_2 molecules over the porous layer of the zeolite. Adsorption quality of CO_2 is depends on the type of zeolite used. Maximum adsorption limit of zeolite is depends on the amount of exhaust produced from the engine. The material for sheet mesh is considered as steel which has high thermal properties. Sheet mesh also has filtration efficiency .which will also filters the black carbon particles up to certain extent. As this is the first device to be designed to reduce CO_2 emission. Its limitations will be considered. The Carbon emission levels will be reduced to maximum by implementing this device on the exhaust manifold.

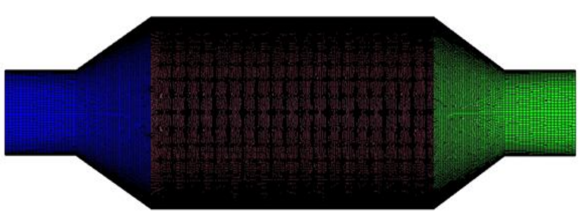

Fig.4Tail pipe model

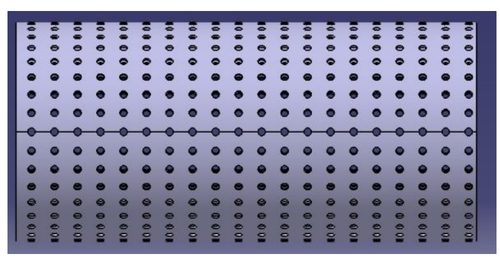

Fig.5 Trap

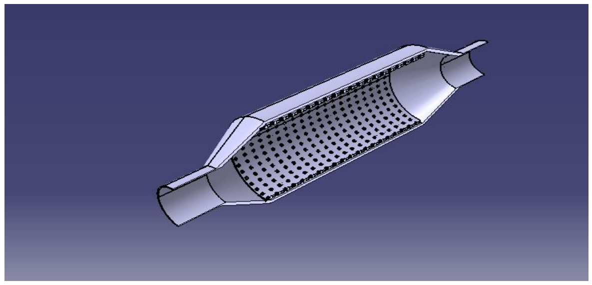

Fig.6 Assembled cross sectional view of tail pipe

VI.RESULTS AND DISCUSSION

The CO_2 trap was designed using modelling software CATIA V5 and the exhaust flow stimulation was done using CFD. In this, the flow of gas over the tail pipe is stimulated and studied. The effects of back pressure were analyzed in the simulated output model.Fig.7s shows the stimulated model and the flow of gas over the exhaust in the tailpipe.The Fig. 8 shows the flow velocity and the pressure contours in the tail pipe. The graph shows the pressure distribution in the exhaust while using the CO_2 trap.

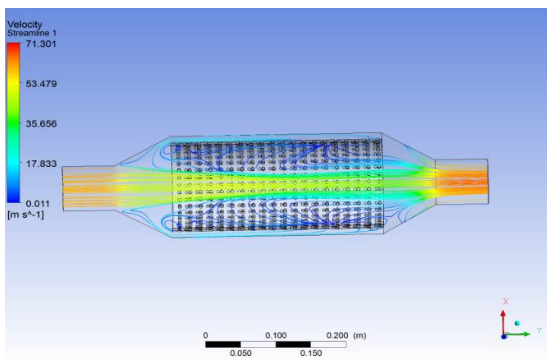

Fig.7 CFD Model

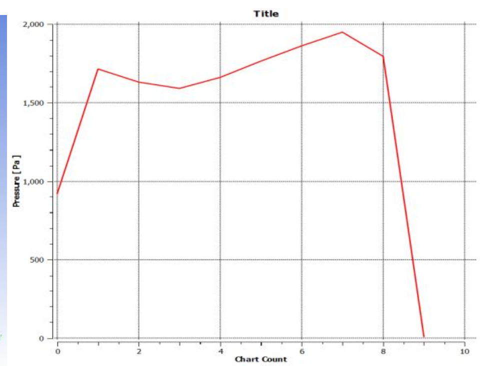

Fig.8 Pressure Graph

VII.CONCLUSION

In this work it has been presented a dynamic work effort to reduce CO_2 emissions through Carbon capture and storage mechanisms .Adsorption technique is followed to control the Carbon emissions from the exhaust gas. The solid adsorbent used in this work is zeolite, were it locks and holds the carbon molecules from the exhaust. The carbon capture storage is successively designed for automotive emission control. It is the first action taken from automobile sector for controlling co_2 emission from the automobile exhaust. The design model is analyzed for its fluid flow inside the system. The Computational fluid (CFD) results show that the back pressure is very less and the design is safe.

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