

Analysis of CO₂, CO and HC emission reduction in automobiles

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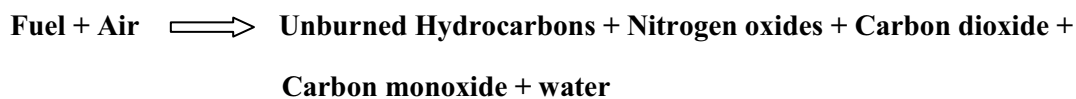
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Abstract. In the present scenario, the emission from automobiles is becoming a serious problem to the environment. Automobiles, thermal power stations and Industries majorly constitute to the emission of CO₂, CO and HC. Though the CO₂ available in the atmosphere will be captured by oceans, grasslands; they are not enough to control CO₂ present in the atmosphere completely. Also advances in engine and vehicle technology continuously to reduce the emission from engine exhaust are not sufficient to reduce the HC and CO emission. This work concentrates on design, fabrication and analysis to reduce CO₂, CO and HC emission from exhaust of automobiles by using molecular sieve 5A of 1.5mm. In this paper, the details of the fabrication, results and discussion about the process are discussed.

1. Introduction

Pollution is becoming a challenging problem in our environment. It is not an exaggeration to say that the advancement in science and technology had caused an uncontrollable change in the environment along with an alarming increase in the pollution. Among all the pollutions, air pollution is considered as a major constituent which is causing diseases, damaging food crops and causing ecological imbalance. Air pollution can be caused by both anthropogenic and natural sources. Air pollution is causing stratospheric ozone depletion which is recognized as a threat to human health as well as to the Earth's ecosystem. Air pollution is defined as emission of harmful gases like CO₂, CO, HC, SO₂ and NO_x from the industrial chimneys, automobiles and aircrafts. Worldwide air pollution is caused due to the emission of hydrocarbons, nitrogen oxides, carbon monoxide and carbon dioxide. Emission of these gases takes place mainly due to the incomplete combustion of fuel and air mixture.





1.1 CO₂ sequestration process

It is a process involving the carbon dioxide capture and long term storage of CO₂. It has been proposed as a way to slow the atmospheric and marine accumulation of greenhouse gases, which are released by burning fossil fuels. There are two major types of CO₂ sequestration: Terrestrial and geological.

- Terrestrial sequestration
- Geological sequestration

2. Literature review

Shuichi Yamamoto [1] conducted experiments on CO₂ sequestration and found that sequestration in deep aquifers is one of the options for reducing the emission of green house gases an axis symmetric horizontal aquifer- cap rock system is modeled, to study various factors such as injection rate, permeability, stiffness and stability of the cap rock and aquifer. Koji Kadono [2] in collaboration with Kansai electric power and Mitsubishi heavy industries limited developed an economical process to reduce the CO₂ emissions by carbon capture choosing MEA as solvent. It will capture approximately 150000 tons of CO₂ annually at a CO₂ capture rate of over 90%. Nikolett Sipocz [3] conducted experiments on low temperature CO₂ capture using MEA 30% Wt solvent, in the desorbed the absorbed CO₂ is heated up and stripped from the solution. Eventually the purified CO₂ is sent for compression while the regenerated solvent is sent back to absorber.

Jillian Dickinson [4] determined that sequestration process is a two stage process which consists of absorption and desorption columns. The process relies on the reversible reaction between the CO₂ and MEA, at lower temperature CO₂ is absorbed and at higher temperatures CO₂ is released. Xu [5] studied sequestration process on by injecting CO₂ into high permeability sand stone and found that there is sharp decrease in Ph value with an increase in HCO₃. The CO₂ solubility will increase enhancing the solubility trapping with a decrease in density of aqueous phase. Anggit Raksajati [6] studied sequestration using phase change solvent by considering few samples of L-CLASS solvent and S- CLASS solvent which will form carbonate ions and bicarbonate ions on reacting with CO₂. Takashi Nakamoto [7] conducted experiments on aqueous solutions of amine in high pressure conditions to study CO₂ absorption among three samples RH-X, MDEA aqueous solution and DEPG solutions, he found that RH-X has the highest CO₂ absorption performance.

3. Experimental work

Literature suggests that CO₂ sequestration process is one of the methods to reduce CO₂ emission rate from thermal power station and industries. However, limited information is available in contribution of CO₂ sequestration process. The present study has chosen to investigate the interactions of various gas reductions from automobile exhaust. The various gases include CO₂, CO and HC.

3.1. Experimental setup

The assembled exhaust unit consists of stainless steel cylinder, fan, SS mesh. Inside the cylinder a stainless steel mesh is provided at the middle height from the base, in which the mesh is to support the chemical and it doesn't allow falling down. Base of the cylinder is fitted with a fan in which it circulates air equally in all direction inside the cylinder. At the base of the cylinder is tapered to reduce the pressure. Assembled exhaust unit



Figure 1. Assembled exhaust unit

3.2. Plan of experiment

NETEL auto exhaust/multi gas analyzer offers the greatest benefit of having the need to conduct the experiment and to study the measurement of CO, CO₂, HC gases. Hence it is used to measure the relative volumes of certain gaseous constituents in the exhaust of automobile vehicles. The gases are Carbon monoxide (CO), Carbon dioxide (CO₂), Hydrocarbons (HC). In this study, experiment has conducted on three control parameters (CO, CO₂, and HC) at seven levels.



Figure 2. NETEL Auto exhaust / multi gas analyzer



Figure 3. Exhaust unit attached to the petrol engine

3.2.1 Molecular sieve 5A of 1.5mm

The aim of the present study is to propose a chemical to reduce the emission rate from auto mobile exhaust and compare its effectiveness against the normal exhaust silencer is taken into under consideration. The chemical used in this study is molecular sieve 5A of 1.5mm.

Upon including the chemical of molecular sieve 5A of 1.5mm, a series of experiment was conducted by inserting the chemical in the assembled exhaust unit, in which the experiment was carried out for the consideration of molecular sieve 5A of 1.5 mm and compared with normal engine exhaust.



Figure 4. Molecular sieve 5A crystals of 1.5mm

4. Results and discussion

By using the NETEL auto gas analyzer, two experiments were carried out for the two wheeler, four stroke petrol engine without using molecular sieve exhaust unit and by using molecular sieve 5A of 1.5mm and their results are recorded at relative volume at a speed range of 1000 rpm to 7000 rpm shown in table :

Table 1. Emissions at different speeds with and without using Molecular sieve 5A of 1.5mm.

S.no	Speed in rpm	Without using Molecular sieve 5A of 1.5mm			Using Molecular sieve 5A of 1.5mm		
		HC in ppm vol	CO in % vol	CO ₂ in %vol	HC in ppm vol	CO in % vol	CO ₂ in %vol
1	1000	240	1.3	1.1	110	1.20	1.6
2	2000	260	1.5	1.4	130	1.38	2.1
3	3000	280	1.7	1.8	160	1.69	2.3
4	4000	341	3.7	3.9	179	2.0	2.5
5	5000	478	7.9	8.2	190	3.0	2.9
6	6000	639	8.9	8.9	250	4.1	3.2
7	7000	752	9.8	9.5	271	4.4	3.3

4.1 Comparison of CO emission rate

The comparison of the CO emission rate for both experimental values obtained using molecular sieve and without using molecular sieve for a speed range of 1000 to 7000 rpm shown in Table 1.

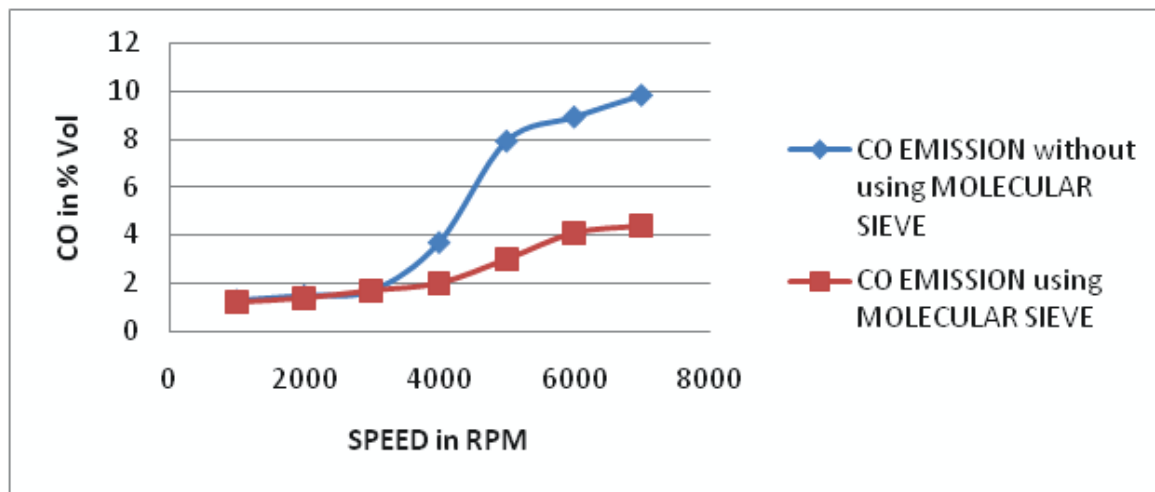


Figure 5. Comparison of CO emission rate

4.2 Comparison of CO_2 emission rate

The comparison of the CO_2 emission rate for both experimental values obtained using molecular sieve and without using molecular sieve for a speed range of 1000 to 7000 rpm shown in above Table 1.

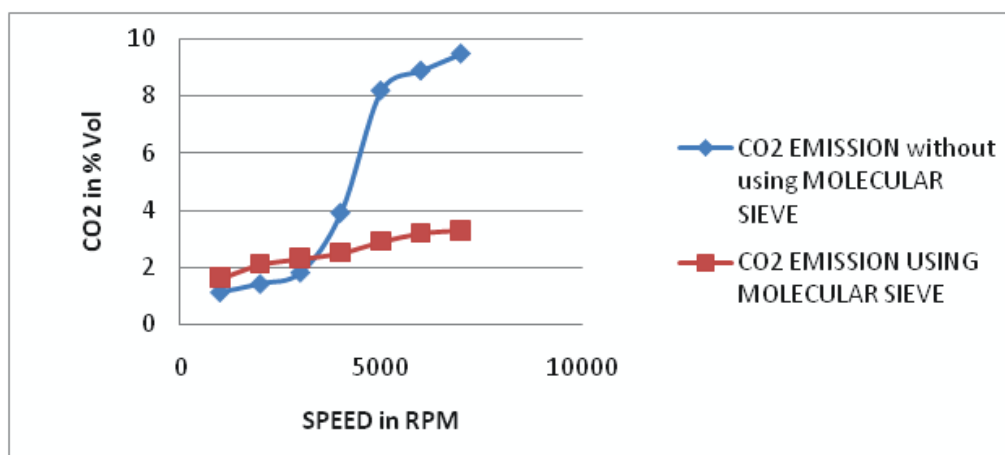


Figure 6. Comparison of CO_2 emission rate

4.3 Comparison of HC emission rate

The comparison of the HC emission rate for both experimental values obtained using molecular sieve and without using molecular sieve for a speed range of 1000 to 7000 rpm shown in above Table 1.

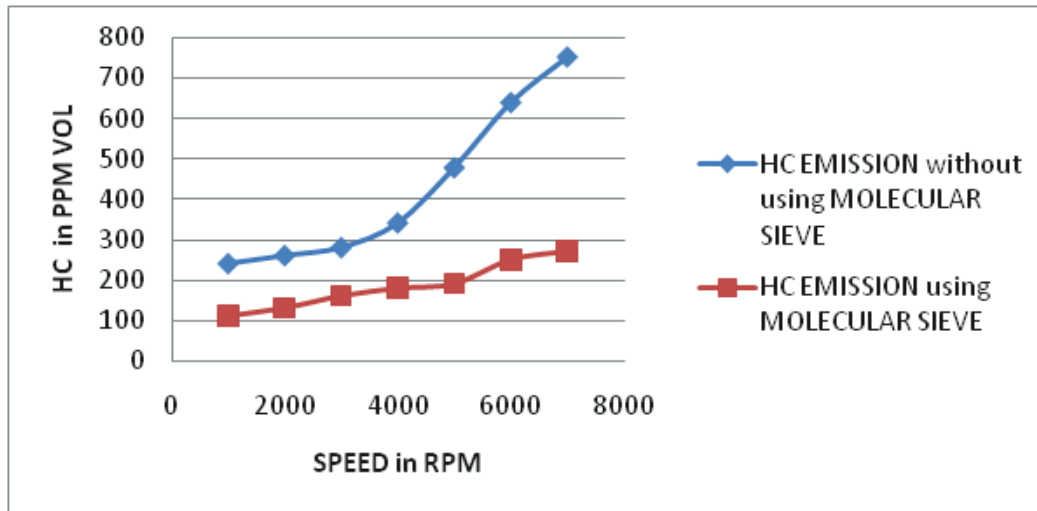


Figure 7. Comparison of HC emission rate

From the above graphs it is concluded that the emission of CO₂, CO and HC was optimized successfully.

5. Conclusions

In this work it has been presented a dynamic effort to reduce HC, CO and CO₂ 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 molecular sieve 5A of 1.5mm, in which it locks and holds the carbon molecules from the exhaust. The carbon capture storage is successively applied for automotive emission control. It is the action taken for the automobile sector for controlling HC, CO, CO₂ emission rate from the automobile exhaust. Finally it is concluded that the emission of HC, CO, CO₂ gases for four stroke petrol engine was reduced successfully by using molecular sieve 5A.

References

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