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A REVIEW OF EMISSION CONTROL BY UREA AND AMMONIA SOLUTION IN DIESEL ENGINE

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ABSTRACT: *Emission control is one of the biggest challenges in today's automobiles and for various industries. The selective catalyst reduction (SCR) Is very expensive and hence it can't work for lower duty vehicle as well as in industry. The present investigation deals with the reduction of NOx, SO2, CO, CO2, particulate matter with urea and ammonia solution in a diesel engine. The most harmful pollutants human health and global warming are an oxide of nitrogen. The world is facing tremendous challenges due to increases in greenhouse gas emissions (mainly carbon dioxide), which causes a major global warming problem. Emissions of nitrogen oxides (NOx) Contribute seriously air pollution, the NOx react with moisture in the air to form nitric acid this is a major environmental problem, contributing to soil and water acidification in sensitive areas. In theater treatment method, urea solution sprays either exhaust reach at a temperature of 300°C to 450°C. The area starts to rot and for ammonia at a high temperature of exhaust gas. The ammonia convert the oxides of nitrogen (NO and NO2) Into free nitrogen (N2) And water vapor (H2O) Also, it has a high SO2 removing efficiency. There are various techniques been tried to control NOx, SO2 and CO emission from a diesel engine and the industries. This research work reports the control of emissions in a diesel engine by after treatment of chemical reaction with urea and ammonia solution.*

Keywords- Sulphur dioxide, nitrogen dioxide, carbon monoxide and dioxide, urea, ammonia, SCR

I. INTRODUCTION:

The diesel engine cycle is the most efficient of the internal combustion engine. NOx, SO2 and variable valve timing, use of a turbocharger and aftercooler technology. To reduce emissions from the engine the recent developments are obtaining such as exhaust gas recirculation and various turbocharging. Though it is very good if we remove them on their production stage, they affect the efficiency and performance of the engine. By introducing SCR can be provided better efficiency and reduced emissions. Exhaust after-treatment on diesel vehicles will be being in and become obligatory in the next few years. Due to which the engine can manage the fuel efficiency, and the SCR system can reduce the devastate NOx and SO2. However, NOx attentiveness must be measured exclusively by linger from exhaust chamber to control the rate of urea solution. The scramble of aqueous urea solution in the prohibitive of the exhaust gas is an impacting solution for removing SO2 and NOx. The aqueous urea distance into ammonia and carbon dioxide. The ammonia acts in response with NOx to create inoffensive nitrogen gas and water vapor. The urea a downgraded cause in SCR technology has been at fully applied productively to the stationary applications and to mobile Diesel engines in the application of ships and locoexsclusively. This method gives an outstanding result of a reduction in emissions and the reduction in efficiency of the engine is insignificant. This is a fully developed after-treatment process based on the injection of urea in the upstream of the exhaust gas. The urea in SCR system was developed to meet the demand for low NOx emissions without compromising the engine efficiency from the existing diesel vehicles.

II. Review

1: NOx Removal by Selective noncatalytic Reduction with Urea Solution in a Fluidized Bed Reactor:

A fluidized bed reactor is used to compensate the plugging problem of urea injection in the reactor is injection by employing a Spurger instead of nozzles in the SNCR process for simultaneous removal of SO2 and NOx. The optimize temperature to remove NOx is switched to lower values by an advanced fluidized bed reactor and the reaction temperature window is widened with the presence of CO in the flue gas, and NO conversion is higher than that in a flow reactor. The optimum amount of urea is found to be above 1.2 based on the normalized stoichiometric molar ratio with respect to NO conversion. In the concurrent taking away of SO2/NO, change of SO2 and NO reach 80-90%. In these reacting process, a chemical reactant matter is administered into flue gas stream. SCR processes are more complicated, expensive and require higher upstream pressures than SNCR processes. Also, the SNCR process is a useful method for NOx reduction by injecting amines or cyanides containing selective reducing agents such as NH3, urea, cyanuric acid and ammonium sulfate into the flue gas. This process could rapidly and effectively reduce NO to N2 and N2O at 1,073-1,373 K. SNCR processes have some drawbacks to overcome difficulties of reaction temperature control and formation of ammonium salt by the reaction of reducing agent with SO2 in the flue gas. In a fluidized bed reactor, Urea, Selective

Noncatalytic Reduction, Nozzle, Fluidized Bed the effect reaction temperature, regularized stoichiometric molar ratio, O2 attention, gas flow rate and SO2 on NO reduction have been obtained successively.

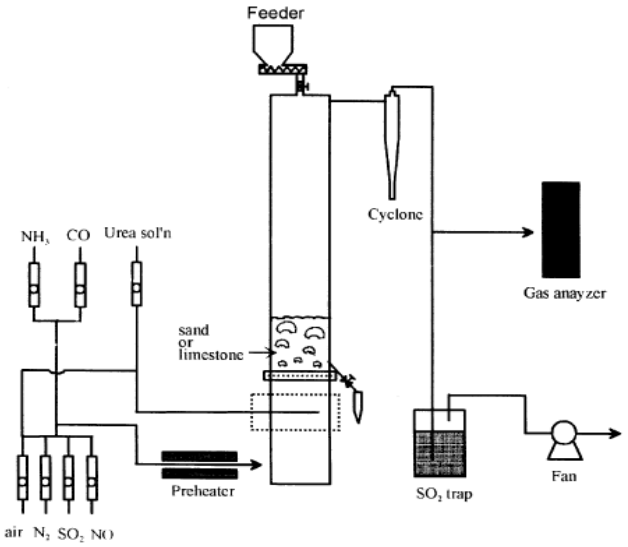

Figure 1: Experimental Apparatus (Fluidized Bed Reactor).

2: Removal of NO from flue gas by wet scrubbing with NaClO2/(NH2)2CO solutions: In a countercurrent packed column in a continuous mode to study the absorption of nitric oxide in sodium chloride/urea solutions. To oxidize NO to NO2 the sodium chloride work as the main perspective SO2/NO removal system was in additional testing. Among the operating variables such as initial NaClO2 concentration, urea concentration, temperature and initial pH value, the pH value of the fascinating liquid was found to have a wider impact on both NO removal efficiency and NO2 attentiveness. To reduce the amount of SO2 and NOx, several dry, wet and bio-treatment processes have been studied. The advanced air pollution control technologies are nothing but a wet scrubbing system. The major wet processes for the removal of NOx where gas phase oxidation followed by absorption with liquid phase reduction, and absorption where it liquid phase oxidation. Among them, NaClO2 shows high absorption rates, and its wastewater is relatively easier to handle. Therefore, pH is a crucial parameter to oxidize NO to NO2 and to absorb NO2 thereafter. In order to obtain a high pH value of the NaClO2 aqueous solution, many researchers have used NaOH as an additive. Although the absorption rate of SO2/NO2 increased greatly with NaOH, the absorption rate a high pH value markedly with an increase in NaOH. The attendance of diluted NaOH blockade the production of ClO2 which can help the oxidation of NO to more water-soluble NO2. The absorption rate of NO decreased logarithmically with the sodium hydroxide attentiveness. In the flue gas, more than 90% of NOx are NO. So the efficiency of NO removal has a direct effect on the NOx removal efficiency. Being into consideration that urea is a faintly alkaline reagent and extensively used in the wearer gas treatment, the effect of urea substituted for NaOH on NO/SO2 removal efficiency. SO2 can be removed more easily compared to NO and the mechanism of NO removal in the wet scrubbing has plenty of unknown areas to be developed, so the authors paid more attention to the removal of NO by using NaClO2/(NH2) 2CO solutions. When the NaClO2 concentration is above 0.005 Mol almost all of NO is absorbed into the solution.

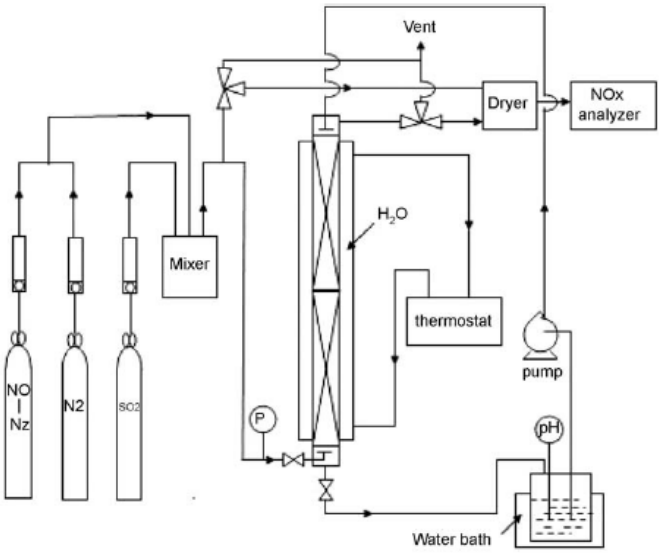

Figure 2: Experimental Set Up.

3: SIMULTANEOUS removal of SO2 and NOX by wet scrubbing, using urea solution :

The various influencing factors for high SO2 and NOX removal efficiencies, such as urea concentration, temperature, initial pH value, and the oxidation degree of nitrogen oxides, SO2 concentration and additive on removal efficiencies of NOX were studied experimentally, and the optimal conditions were established. The effective outcome was analyzed, and reaction mechanism and total chemical reaction equalization for concurrent desulfurization and denigration using urea solution were cogitation. By the thermodynamic method, the molar reaction enthalpy, molar formation Gibbs function and chemical reaction equilibrium constant had been measured. In general, additives have to be added to the scrubbing system either to convert relatively water-insoluble NO to soluble NO2 that can then be removed by alkaline absorbents or to bind and activate NO, including NaClO2, FeSO4, KMnO4, Na2SO3, FeSO4/Na2SO3, H2O2, ClO2 and so on. In the NOX control process the treatment cost using strong oxidation has been too high. The SO2 and NOX removal cost simultaneously reduced, and improve NOX removal efficiency, urea solution was used. Urea is a slightly alkaline reagent, it is also a strong reducing agent. Meanwhile, reaction products of simultaneous desulfurization and denigration using urea solution in the liquid phase are ammonium sulfate and gases ammonium sulfate can be recycled, and gases can be directly released into the atmosphere. Investigated the NO removal characteristics by wet scrubbing with NaClO2/(NH2)2CO

solutions, with NO removal efficiency the urea play almost no negative effect, and it aided the diminish of NO2 importantly. Investigated the absorption characteristics of SO2 and NOx using urea and additive solutions in a packed column, they found that SO2 and NOx had synergistic effect each other in the process, and the removal efficiency of SO2 and NOX from flue gas was more than 95% and 60% respectively.

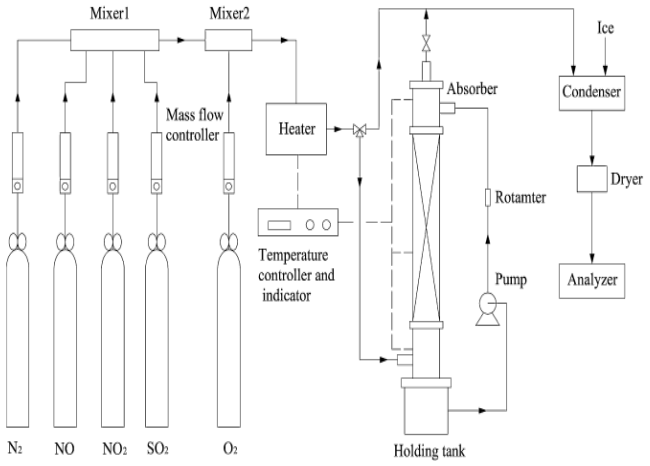

Figure 3: Experimental Equipment.

4: Life cycle assessment of ammonia utilization in city transportation and power generation

To reduce the environmental impacts of conventional fuels the carbon-free fuel ammonia is proposed to be utilized in the city transportation and for power generation. Ammonia is electrochemically produced where required hydrogen is supplied from the wind-driven water electrolysis. The processes are analyzed from raw material extraction to vehicle disposal using life cycle assessment methodology. The greenhouse gas emissions from an ammonia driven vehicle are in the range of 100 g carbon dioxide, which is considerably lower than gasoline (270 g) and diesel (230 g) driven vehicles. Ammonium one of the main trivializers in the world which is mainly produced by steam methane reforming method from natural gas. Ammonia is another form of hydrogen fuel containing three atoms of hydrogen and one atom of nitrogen. Ammonia may also be burned directly in the internal combustion engine and generators with minor modifications. Investigates the ammonia combustion with ammonia vapor, which was introduced into the intake manifold and diesel fuel was injected into the cylinder to initiate combustion. The injection timing is also important to note especially for dual fuel applications which were investigated for ammonia/diesel/kerosene fuels. Ammonia was introduced into the engine via fumigation and pilot injection was used to ignite the premixed ammonia. In order to eliminate the difficulty of combusting ammonia, some researchers prop injection, ignitions offered by using either diesel injection, ignition plus port/direct injection of the ammonia, or jet ignition of a gasoline-like fuel (gasoline, methane, propane, hydrogen). The life cycle assessment studies for ammonia production routes have been performed and reported where the source of hydrogen varies from conventional to renewable resources. For 1 MJ electricity generation, ammonia-fired power plant emits about 0.083 kg CO2 eq. Whereas natural gas-fired power plant releases about 0.13 kg CO2 eq. About 97% of global warming potential of natural gas-based electricity production occurs during combustion in the plant, however, the main source of GHG emissions for ammonia-based electricity production is the production process of ammonia 93%.

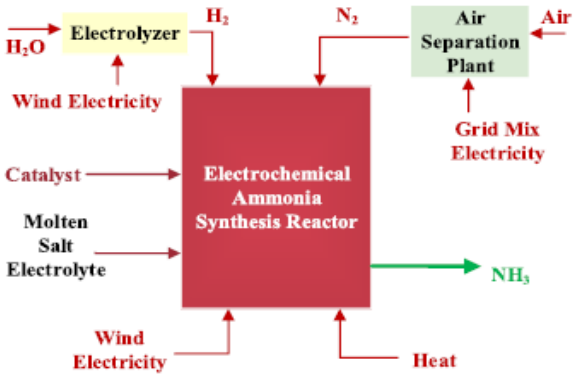

Figure 4: The Electrochemical Ammonia Synthesis Process

5: Carbon dioxide absorption using ammonia solution in a microchannel:

This work deal with the application of microchannel for CO2 absorption by using ammonia solution. The analytical analysis was used to consider the main and cumulative effects of pressure, temperature, attentiveness and flow rate of ammonia solution. The provision gas was 10 vol.% of CO2 in nitrogen and a T-type small channel($0.5\times0.5\times60$ mm^3) Was used. At 30°C, the ammonia concentration of 10% with the flow rate of 0.0003 m^3h^{-1} and 300 kPa, the absorption efficiency was 96.45%. Not only that ammonia solution is cheaper, it also has the highest CO2 capacity, high absorption efficiency, compatibility with the Sox and NOx. As compared to that of amine solution, it takes much less energy. Furthermore, the outcome of chemical absorption using the ammonia solution can be applied for fertilizer such as urea and ammonium sulfate. The chemical separation process for CO2 absorption relies heavily on the interface mass transfer. The microchannel reactor can improve the absorption efficiency for gas-liquid absorption due to high surface-to-volume ratio, short transportation distances, and high driving force gradients, resulting in rapid rates of reaction, heat transfer, and mass transfer. The physical and the chemical absorption will take place due to using the ammonia solution asana absorbent.

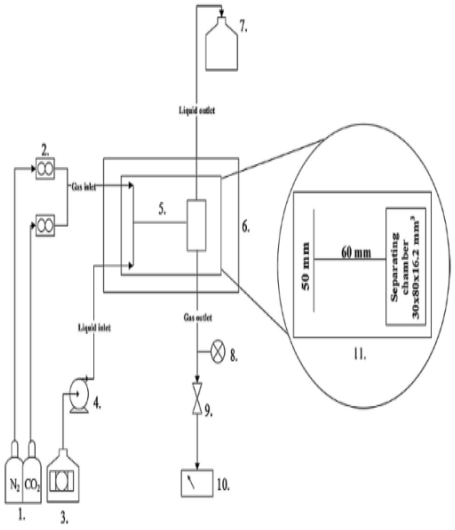

Figure 5: Schematic Diagram Of Set Up

The reaction product includes CO2-containing ammonium salts such as ammonium bicarbonate, ammonium carbonate, ammonium carbonate. The form of ammonium carbonate reaction is fast and exothermic in nature. The main product of CO2 absorption by using the ammonia solution will be ammonium carbonate. The formation of urea due to dehydration of ammonium carbonate. The molecular transfer of CO2 from the gas phase to liquid phase involves 3 steps. First, the bulk CO2 in gas phase moves to the gas film that is adjacent to the liquid film sharing the interface area. Then the CO2 transfers across this interface into the liquid film. Finally, the dissolved CO2 diffuses into the bulk of the liquid phase. The absorption efficiency represents the ability to absorb CO2 from the CO2-rich gas stream which can be calculated from the molar flow rate of CO2 at the inlet and outlet of the microchannel. CO2 is the molar flow rate of CO2 at the inlet of the reactor and out CO2, is the molar flow rate of CO2 at the outlet of the reactor.

6: Simultaneous Removal Of So2 And Nox Using Amine Based Aqueous Solution In A Pilot-Scale Liquid Column Tower

In a self-designed pilot-scale liquid column tower in a continuous model to investigate NOx and SO2 removal efficiency using a novel mixture amine-based aqueous solution. Operating parameters, such as swirl plate, superficial velocity, liquid-gas ratio, NOx concentration and SO2 concentration were widely studied and optimized in separate denitrogenation and simultaneous removal process, respectively. The successive influence of swirl plate was intensively discussed and the effect of removing NOx was enhanced by a half due to the additive swirl plate. The optimal operation condition for denitrogenation was summed as follows: the superficial velocity was set as 1.5 m/s, the liquid-gas ratio was set as 14.3 L/m3 and the swirl plate was added to the mass transfer enhancement. Simultaneous desulfurization and denitrogenation process is an original conception meant, at absorbing SO2 and NOx in one setup. Compared with many techniques, the wet-scrubbing method shows its promising prospect due to the feasible application on the traditional scrubbing tower. Lots of absorbents such as oxidant, chalets, and urea are tested in recent reports. In those absorbents urea behaving as an environmental-benign absorbed in a simultaneous process attracts researcher's attention. The amine-based absorbent consisting of urea, NH4HCO3 and Triethanolamine aqueous solution shows a high removal efficiency in a bench-scale experiment. However, a furthermore of absorption device plays a significant role in the concurrent absorption. Evaluation with accounting devices, the structure of the liquid column tower provides its numerous advantages, such as simple structure and desirable mass-transfer ability. Thus, it's necessary to apply the mixture porous in pilot scale liquid column tower to evaluate its performance in the scale-up process. The main reason for this paper is to verify the viability of concurrent desulfurization and denitrogenation using the tower

Figure 6: The schematic of the swirl plate in liquid column tower

7: REMOVAL of Nitrogen Dioxide and Sulfur Dioxide from Air Streams by Absorption in Urea Solution:

The osmosis rates of NO2, SO2 and a mixture of these two acid gases into urea solution in packs bed column. The function studied by the absorption rate of absorbing temperature, urea concentration, and acid gas concentration. The manipulation of liquid temperature between 10 - 40°C, urea attentiveness between 0.1 - 0.5 M and acid gas attentiveness NO2 between 100 - 1000 ppm (191 - 1910 mg/m^3), SO2 between 500 - 2500 ppm (1310 - 6530 mg/m3) Were examined. The mass flow rate of gas at 25°C is 20.646 (kg/m^{2}min) And the osmosis rate was founded by measuring the NO2 and SO2 attentiveness in the inlet and outlet streams of the osmosis column. The osmosis rate of SO2 increases and with the decrease of temperature of the absorbent (urea solution) And with the injection, which urea attentiveness. The osmosis rate of NO2 decreases as the urea concentration exceeds 0.4 Mol/land for the NO2 gas concentration of 100 ppm due to the decrease the diffusivity

of the gas. For controlling the release of SOx, It reacts with ammonia injection, which relies solely on the gas phase reaction in the occurrence of moisture to produce ammonium sulfate solid particles that can be captured by any other particulate collection device. The reduction of SOx into hydrogen sulfide the methane can be used on alumina as the catalyst. Catalytic oxidation of SOx with air, via the heterogeneous contact process or the homogeneous chamber process, also serves to improve the collection efficiency of the SO2. The scrubbing of SO2 in dilute ammonium hydroxide gives ammonium sulfate that can be a valuable constituent of fertilizer formulations. In an effective and relatively low-cost SO2 removal method is the use of limestone or lime slurry in water in a suitable design scrubber. The empathy of set in motion carbon for the acid gases is, in increasing order, CO2 < SO2 < NO2. The SO2 reacts with solid lime to form solid particles of calcium sulfite and calcium sulfate, which are captured in electrostatic precipitators. Three methods are used to control and reduce NOx emission, namely: absorption, selective catalytic reduction, and non-sélective catalytic reduction. For methane reduction, the polluted gas stream is preheated to about 400°C and then blended with the appropriate proportion of methane before passage over platinum or palladium catalytic surface for reduction. Selective catalytic abatement uses a catalyst and ammonia fuel to reduce NOx in preference to combustion with the much higher levels of oxygen in the gas at temperatures in the range 210 - 410°C. SA slight excess of ammonia may be used to leave 5 - 20 (ppm) In the treated gas stream. Studied the NOx removal from simulated flue gas by the chemical absorption-biological reduction integrated approach in a biofilter.

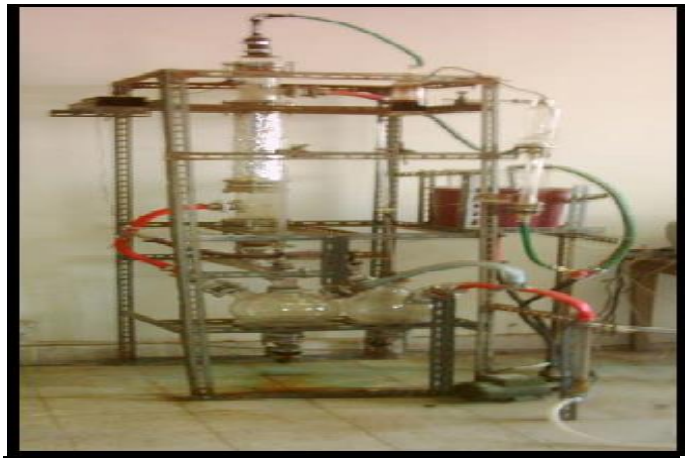

Figure 7: A photograph of the experimental Rig.

III. CONCLUSIONS:

Many investigations have been carried out the field for emission control in automobile and industries. From the inclusive reviews of emissions control mostly on SO2, NOx, and PM the following can be interpreted:

a) SCR technology by using urea injection is one of the most cost-effective and fuel-efficient technologies available to help reduce emissions.

b) The wet scrubbing urea solution can reduce NOx emissions up to 90 percent while simultaneously reducing HC and CO emissions by 50-90 percent.

c) The fluidized bed reactor in SNCR can remove NOx at low temperature than SCR process.

d) The output product from chemical absorption using the ammonia solution can be used for fertilizer such as urea and ammonia sulfate.

e) The urea solution is sprayed in the exhaust gas stream which is at high temperature the urea is to decompose and form ammonia, which acts as a reducing agent and converts the oxide of nitrogen into free nitrogen and water vapor.

f) Airstreams by absorption in urea solution have high SO2 and NOx removing efficiency.

g) The reduction in emissions to a great extent by using ammonia solution, it also has the highestCO2 capability. This solution helpful for the natural life cycle.

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