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Seminar

Institute for Plasma Research

Title : Plasma Catalysis for NO_x and THC Removal using Industrial Wastes

Speaker: Dr. Nishanth Katam

Indian Institute of Science, Bangalore

Date : 06th May 2022 (Friday)

Time : 03.30 PM

Venue : Online - Join the talk:

https://lobby.ipr.res.in/Dr.NishanthKatam_PDFTalk

Abstract :

The gaseous pollutants emitted from the diesel engine can be reduced by applying control strategies at the level of engine design (pre-combustion) or as an after treatment technique of the exhaust stream (post-combustion). Although the pre-combustion control strategies are limited by the possible engine design modifications, the post-combustion approach allows for greater flexibility and scope by utilizing a variety of plasma discharges, catalysts and adsorbents. One such post-combustion strategy which involves treatment of NO_x/THC using non-thermal plasma (NTP) generated from dielectric barrier discharge (DBD), has yielded promising results at the laboratory level. Non-thermal plasma produces an oxidative environment containing several charged species, which include energetic electrons, excited species, ions, and radicals, at atmospheric pressure and ambient temperature conditions. Diesel exhaust exposed to such a non-thermal plasma environment has been found to cause the formation of higher oxides of nitrogen and oxidized hydrocarbon intermediates, which necessitates exposing them further to adsorbents or catalysts for effective removal of the harmful pollutants. In recent years, a treatment technique which involves filling a plasma reactor with catalytic materials that enhance reactions in the presence of plasma, referred to as plasma catalysis, has given promising results at laboratory level in terms of pollutant removal efficiency, on par with conventional thermal catalysis. The highly reactive environment produced by the interaction between reactive species in the plasma and the surface of the catalytic material can facilitate reactions that usually occur only at high temperatures in conventional (thermal) catalysis. The literature on plasma catalysis for several gas treatment applications reveals the utilization of expensive, commercially available catalytic materials. The expensive rare metals used in such catalysts and the need for replacement due to choking of the catalytic material, makes their usage an economically non-viable option. It is at this juncture that the utilization of freely available industrial wastes as potential catalysts appears to be an economically feasible alternative. Such environmentally safe and inexpensive treatment techniques for NO_x/THC abatement are a desirable and welcoming option for exhaust treatment in the long run.

In my PhD work, gaseous pollutants from a stationary diesel engine exhaust were exposed to an electrical discharge plasma in a reactor packed with pellets made from industrial wastes, in a carefully controlled laboratory condition. Oxides of nitrogen and the total hydrocarbons are the two components of the diesel exhaust that were studied as the gaseous pollutants. The pellets were made from solid industrial wastes such as foundry sand, fly ash, red mud, oyster shells, bagasse, and mulberry residue. The plasma was either volume discharge type or surface discharge type during the study. The results of NO_x and THC removal through plasma catalysis experiments were analyzed to ascertain the dominance of plasma catalysis over other pollutant removal processes, such as plasma-cascaded adsorption and plasma-only treatment.

It was observed that among the solid industry wastes studied, red mud showed better NO_x and THC removal efficiencies compared to the other industrial waste pellets. Further, plasma catalysis showed moderate to significant increase in NO_x and THC removal when compared to the plasma-cascaded and plasma-only methods, for all the pellets studied. Possible reaction pathways associated with conversion or removal of NO_x/THC under plasma catalysis were identified.
