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Diesel-biodiesel fuel exhaust gas-reformer for on-board H_2 production to improve the HC-SCR catalyst NOx reduction activity

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In this work, the exhaust-gas reformer was used to provide hydrogen-rich reformate to the NOx selective catalytic reduction (SCR) unit, in order to improve its NOx reduction activity at low exhaust-gas temperatures. The reformer configuration and operating parameters was examined in order to optimize the performance of the hydrocarbon-SCR catalyst, which was promoted by the presence of H_2 but inhibited by CO. The aim of this proposed work was to improve both combustion characteristics (fuel economy, thermal efficiency) and engine emissions (CO, CO_2, NOx and PM) by recycling part of the reformed exhaust gas to the diesel engine directly using REGR system, and on the other hand, to provide guidelines for optimization of the REGR process, specifically as a mean of supplying hydrogen-rich gas to a hydrocarbon-SCR catalyst, in order to promote its low temperature NOx reduction activity. In this study, the effect hydrogen-rich reformate operation under real exhaust gas conditions operated with diesel-biodiesel blends under different gaseous fuel compositions (25%, 50%, and 75% H_2) on the combustion characteristics, engine emissions, and selective catalytic reduction (SCR) after treatment was experimentally examined at two engine conditions; low, and high loads. A Pt/Al_2O_3-SCR reactor was used and operated at different exhaust gas temperatures (100 – 500°C). At the high engine load of 75% there was a considerable influence appeared as an increase of the premixed combustion phase and a significant decrease of the total combustion duration. In terms of emissions, it was observed that at high engine load, fuels with low H_2 content tend to reduce NOx formation, whereas, fuels with high H_2 content tend to reduce PM formation, The hydrocarbon-SCR catalyst has shown satisfactory performance in NOx reduction under real diesel exhaust gas (use of the unburnt HC) in a temperature window of 100 – 250 oC for all engine loads. At low load the combustion of the hydrogen-rich reformate showed an outstanding influence on the HC-SCR activity, whereas at high load condition the combustion of hydrogen-rich reformate showed almost no influence on the HC-SCR activity, since most of H_2 and were burned.

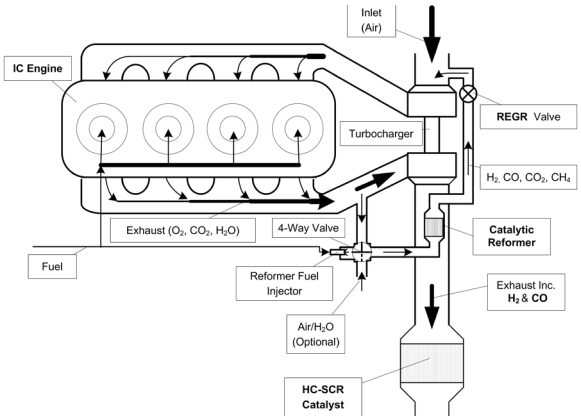

Figure 1: Major components of integrated REGR and HC-SCR system

Biography

Ahmad Abu Jrai, is the Professor at the Departments of Environmental Engineering and Mechanical Engineering, Al-Hussein Bin Talal University in Jordan, and currently he is the Chairman of Admission and Registration Unit at the university. Dr. Abu jrai received his PhD degree in Mechanical Engineering from Birmingham University, United Kingdom in 2007. In May 2007, he has joined AHU as an Assistant Professor in Environmental Engineering Department. In 2012 he was promoted to Associate Professor and in 2017 he was promoted to Full professor, His current research interests and expertise are in the field of emission control, alternative fuel, and Hydrogen reforming where he managed to publish over (30) scientific papers in different high impact factor Journals.

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