216g Novel Low Temperature Nox Removal for Diesel Exhaust

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One major obstacle preventing widespread introduction of diesel engines is the lack of a suitable catalyst/reductant combination for this process. Hydrocarbons present in engine exhaust are generally less active and selective compared to ammonia. Although the NH_3-SCR is very effective, the requirement of a separate NH_3 source and injection system, combined with issues relating to NH_3 slip, make this approach unappealing. Another effective reductant, urea, also has its shortcomings such as its high freezing point and the lack of urea distribution infrastructure. However, recent studies indicate that hydrogen is a promising reductant that achieves high NO_x conversion over a wide temperature window[a].

We are currently investigating a new strategy to achieve high NO_x removal at low temperatures in an oxygen rich atmosphere. This approach involves a coupled system: an ethylene glycol (EG) reforming unit to convert a mixture of ethylene glycol and water into hydrogen and CO followed by a H_2-deNO_x unit. The group of Dumesic has found that aqueous phase reforming of ethylene glycol with high H_2 selectivity can be achieved using a 3% Pt/Alumina or Raney Ni-Sn catalyst at 500K[b]. Their experiments are conducted at higher pressures, near the bubble point of the solution, whereas our gas phase reforming is carried out near atmospheric pressure. Therefore, our low temperature reforming unit requires simple equipment that would be easy to operate. We have studied the performance of modified Pt supported catalyst for gas phase EG reforming at 230^{o}C. Prior to testing, the samples were calcined in air followed by reduction in H_2 at 250^{o}C. Modification of the Pt supported catalysts with Na produce a twofold effect, an increase in the reforming activity and also stability of the catalyst. At a low EG concentration of 420 ppm, our results indicate complete conversion of ethylene glycol into hydrogen, mainly via decomposition. At higher EG concentrations (2.15% EG in the feed), oxidative reforming produced 1.4 H_2/EG. We plan to couple this EG reforming unit to a de-NO_x unit. Based on our calculations, 0.551 kg of reforming catalyst would be needed to deliver the amount of H_2 for complete NO_x removal[a]. Under realistic engine operating conditions, the amount of EG required for 100% NO_x removal would be 1.8 l/hr, which suggests that such a coupled system would be feasible for practical application.

[a] N. Macleod, R. Cropley, J.M. Keel, R.M. Lambert, J. Catal. 221 (2004) 20-31.

[b] G.W. Huber, J.W. Shabaker, J.A. Dumesic, Science, 300 (2003) 2075.