Nano zeolite supported bimetallic catalyst for nitrate reduction in water

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The increase of nitrate in water bodies has raised serious concenrns to the health of human and ecological cycle. Recently, catalytic nitrate reduction using bimetallic catalysts has been found as a promising technology to safely and selectively reduce nitrate to nitrogen. The key challenge in catalytic nitrate reduction research is to enhance the reactivty and selectivity of bimetallic catalysts. Hence, extensive research have been reported to improve the reactivity and selectivity using various combinations of bimetals and support materials. For example, TiO_2 and Al_2O_3 supported bimetallic catalysts have been found highly reactive, and selective towards nitrogen. However, such metal oxide support materials are expensive, soluble, and unstable during the reduction process. The leaching of trace metals is toxic to aquatic life and also against economic feasibility. On the other hand, inexpensive support materials such as NZVI and iron oxides are eco-friendly but have relatively low reduction kinetics and nitrogen selectivity. These drawbacks have limited the field scale application of catalytic nitrate reduction technology. Hence, there is still a huge room for the development of highly reactive, selective, and eco-friendly catalysts for the removal of nitrate. Nano ZSM-5 (NZSM5) zeolite was selected as support material in this study, due to its high chemical and thermal stability, high surface area, eco-friendly nature, and insolubility in water. A highly reactive and selective NZSM5 supported bimetalic catalyst was developed by extensive optimiztion of promoter metals, noble metals, and calcination temperatures. Interestingly, Sn-Pd combination was found to be most reactive and selective for nitrae reduction, unlike widely reported Cu-Pd combination. Optimal catalyst composition was 1%Sn-1.6%Pd/NZSM5 resulting in fast nitrate reduction kinetics (k = 15.79 $\times10^{-2}$ min^{-1} ; k'= 60$\times10^{-2}$ min^{-1} g $catalyst^{-1}$), and high nitrogen selectivity (85%) and removal (100%).