UNIVERSITI TEKNOLOGI MARA

V_2O_5 deNO_x CATALYST DEVELOPMENT FOR NO_x REDUCTION IN THE SOLID WASTE COMBUSTION FLUE GAS

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Thesis submitted in fulfillment of the requirements
for the degree of
Doctor of Philosophy

Faculty of Chemical Engineering

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Candidate's Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as reference work. This thesis has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

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ABSTRACT

Nitrogen Oxide (NO) in stationary flue gas is a major cause of air pollution and its reduction is thus of great importance. Selective Catalytic Reduction (SCR), primarily using V_2O_5-WO_3/TiO_2 or V_2O_5-MoO_3/TiO_2 in the presence of ammonia, is a promising method for the removal of NO. Catalyst deposition, by means of a ceramic washcoat, which is primarily used in SCR, has been attributed to catalyst blockage and undesirable higher pressure drops. An alternative more efficient method is sought using dispersed V_2O_5 on Woven Stainless Steel Wire Mesh (WSSWM) multi-channel monoliths. The WSSWM is initially coated with an alumina/silica (Al_2O_3-SiO_2) mixture using the dip-slurry method. Impregnation of the catalyst is achieved using V_2O_5 precursor solutions of concentration 0.2, 0.4 and 0.6 M and calcination for 24, 48 and 72 hours at 500°C. Catalyst loadings varied between 2.63% and 50.58% w/w. The physical and chemical properties of the impregnated WSSWM monoliths were determined using TGA, XRD, N_2 Adsorption, TPR and SEM-EDX. Results indicate that the catalyst is thermally stable up to 900°C and TPR profiles also indicate that there are three distinct reductions in NO concentration in the range 340-862°C. Surface analysis reveals that the catalyst surface morphology is heterogeneous irrespective of the precursor concentration and impregnation duration. The results from *KH-Adhesion Testing* for the prepared catalyst has excellent vibration resistance and is thus highly suited for flue gas application. NO reduction activity of mV_2O_5/Al_2O_3-SiO_2 *(x)* was performed on the in-house bench scale municipal solid waste incinerator (BS-MSWI) using cafeteria waste combustion to simulate NO emission. The % NO conversion was investigated according to flue gas temperature and excess air ratio at operating air flow rate of 100, 150 and 200 ℓ/min respectively. The optimum NO reductions of 82.1, 87.8 and 88.7% are achieved at 400°C and with an airflow rate of 200 L min^{-1} for precursor catalyst concentrations of 0.2, 0.4 and 0.6 M, respectively. The NO conversion effectiveness of developed catalyst of 88.7% is found to be comparable to that conventional SCR which shows that the NO conversion effectiveness is in the range of 90 – 92 %. MLR performed on the experimental data has enabled prediction of NO conversion over the studied range of independent variables and experimental conditions.

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