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Advantages of a wire gauze structured reactor with a zeolite (Cu-USY) catalyst for NH_3-SCR of NO_x

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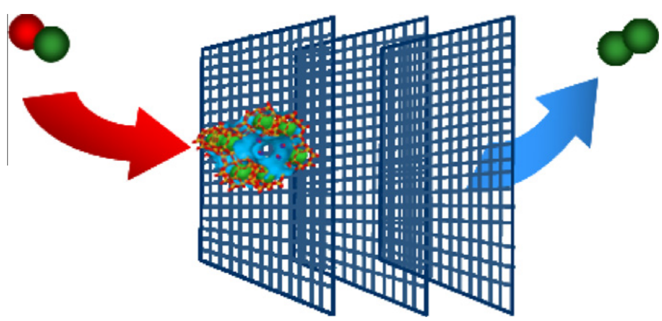
HIGHLIGHTS

- Plug-flow model with temperature suitable for description of wire-gauze reactor.
- Wire gauze internals decrease reactor length by 10 times comparing to monolith.
- Cu-USY catalyst highly active and stable in NH_3-SCR of NO_x.
- Cu-USY activity of higher than commercial vanadium catalyst.

GRAPHICAL ABSTRACT



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ABSTRACT

Metal wire gauzes as catalyst supports and structured reactor internals offer a number of advantages over monolithic reactors. Structured catalytic reactors based on wire gauzes are explored in this study for the control of NO_x emissions from a stationary engine fuelled with gas generated from a biomass gasification process. Simulations are performed on reactors filled with (a) wire gauzes, (b) multi-channel monoliths, and (c) a packed bed with 2 mm beads, for the NH_3-SCR process using the kinetic data obtained for copper-exchanged ultra-stabilized zeolite Y catalyst (Cu-USY). The purpose of this procedure is to select the most efficient reactor internals and to assess the necessary reactor length allowing maximum conversion of NO_x. These simulations show that optimum performance is obtained when the wire gauze support is employed. The results also show that when the Cu-USY catalyst (very active in SCR) is used in combination with a wire gauze structure, the combined effects of higher rates of reaction with higher rates of heat and mass transfer may significantly increase the NO_x conversion.

1. Introduction

The motivation for the present investigation was the observation that renewable sources of biomass (e.g. forestry residue, municipal waste) can be gassified to obtain a product, which contains H_2 and CO (with some hydrocarbons) as the desirable components. Various approaches to gasification together with a discussion of the problems associated with the development of this technology are widely described in [1]. Depending on the process type, other gases such as CO_2, N_2, and CH_4 may be present in biogas. In addition, biogas may contain water vapour and a range of trace contaminants including sulphur. Since biogas is used in a wide range of applications including gas engine, gas turbine and fuel cell, these contaminations need to be previously removed. Biogas engines are increasingly exploited to produce electricity and hot water/oil, thereby providing energy at the local level. In Europe, gas emissions must meet new stricter environmental regulations. An example of such a policy is the Waste Incineration Directive (2000/76/EC) also known as the WID limit. In light of

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