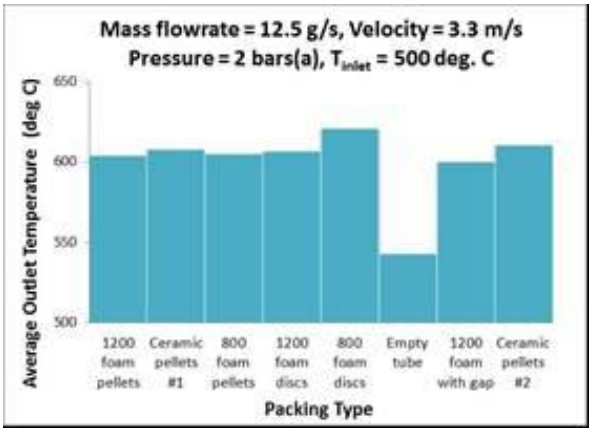
Performance Characteristics of Metal Foams as Catalytic Substrates

Babak Saberi, Green Twirl Energy, Ottawa, Canada; Shadi Saberi, Consultant, Ottawa, Canada; Dirk Naumann, Juniper Associates, Mississauga, Canada; Frank Deisel, Alantum Europe GmbH, Munich, Germany

The potential advantages of metal foam substrates as catalyst support in heterogeneous fixed bed reactors have been subject of significant attention in the chemical process industry. Some of the well-known characteristics of these foams are: large interfacial area that promotes mass and heat transfer, thin catalyst washcoat layer minimizing diffusion resistance in the catalyst, high thermal conductivity, and mechanical strength. However, little attention has been paid to the optimization of the shape or configuration that can best take advantage of all the benefits of these foams as a suitable replacement for the conventional ceramic-based catalyst pellets.



In the present work, different metallic foam packing configurations have been compared with commercial ceramic pellets for their wall heat transfer and pressure drop characteristics in tubular reactors. The foam configurations considered are: (a) monolithic cylinder made of stacked discs filling the whole reactor volume; (b) cubic pellets; and (c) chips or flakes. The reactor consists of a tube of 0.076 m diameter and 0.6 m length. The tube wall is externally heated by an electric furnace. Air flow heated to 500 °C enters the tube. The outlet gas temperature profile is measured by using a matrix of thermocouples fixed on a short piece of ceramic monolith, providing accurate spatial positions for the thermocouples. Furthermore, the effect of contact quality such as existence of a small (continuous or intermittent) gap between the monolithic foam discs and the reactor wall is studied experimentally and also theoretically by performing CFD simulations at both microscopic scale and reactor scale.