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Tian Gu, Vemuri Balakotaiah

PII: S1385-8947(17)30213-9
DOI: http://dx.doi.org/10.1016/j.cej.2017.02.056
Reference: CEJ 16495

To appear in: *Chemical Engineering Journal*

Received Date: 5 December 2016
Revised Date: 7 February 2017
Accepted Date: 8 February 2017

Please cite this article as: T. Gu, V. Balakotaiah, Analysis of Upstream Creeping Reaction Zones in Catalytic Monolith Reactors, *Chemical Engineering Journal* (2017), doi: http://dx.doi.org/10.1016/j.cej.2017.02.056

Analysis of Upstream Creeping Reaction Zones in Catalytic Monolith Reactors

Tian Gu and Vemuri Balakotaiah*

Department of Chemical and Biomolecular Engineering, University of Houston, Houston, TX 77204, USA

Abstract

Monolith reactors are widely used in catalytic after-treatment systems (e.g. TWC, DOC, LNT and SCR). One major challenge in exhaust after-treatment is reducing cold-start emissions which account for a significant fraction of the total emissions. While front-end ignition is technically possible with high PGM loading and/or transient heating of the monolith, it may not be economical or feasible, especially for low exhaust gas temperature. In such cases, back-end ignition followed by a fast upstream creeping reaction zone provides a feasible way to reduce cold-start emissions. In this work, the upstream creeping reaction zone is investigated in detail using modeling approach. The influence of various design parameters (e.g. solid thermal conductivity and heat capacity) and operating conditions (gas velocity, inlet temperature/concentrations) on the creep velocity is determined and summarized. Phase diagrams and analytical criteria for reaction zones to creep upstream are also presented. The phase diagrams and criteria can provide guidance for design and control of reactors used in after-treatment systems.

Keywords: Catalytic after-treatment; Monolith reactor; Cold-start; Creeping reaction zone; Temperature fronts

*Corresponding author. E-mail address: bala@uh.edu (V. Balakotaiah)