

Experimental study of the intrinsic kinetics of steam methane reforming on a thin Ni coating

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Structured catalytic reactors have shown potential to intensify catalytic processes. When properly designed, an optimized flow pattern allows increased heat transfer efficiency and reduced pressure drop compared to conventional packed bed reactors [1-2]. The use of a thin catalyst coating allows increased effectiveness factors. But the application of such a coating that is expected to be stable under severe operating conditions is challenging. Alloy Surfaces Co. Inc. developed an intrinsically bound thin-layered catalyst adhered on a metal substrate. The material has a uniform coating thickness which allows physical structuring into the desired geometry and avoiding a posteriori washcoating [3]. The intrinsic kinetics of steam methane reforming and water-gas shift reactions were experimentally studied on this new catalyst.

The experiments were carried out in a tubular packed bed micro-reactor. The reactor was specifically designed and operating conditions selected to have plug flow, isothermal operation, negligible pressure drop and negligible interfacial and intra-particle transport limitations [4]. Methane steam reforming experiments were carried out at temperature ranging from 450 and 600°C, pressure between 1 and 25 bars and steam-to-carbon ratios between 3 and 5. Hydrogen was co-fed and the catalyst bed diluted to guarantee isothermal operation. Methanation and reverse of water-gas shift experiments were performed at temperatures between 300 and 450°C and pressure between 1 and 25 bars. Different reaction mechanisms with potential rate determining steps were investigated and rate equations were derived following the Langmuir-Hinshelwood-Hougen-Watson approach. The integral method of kinetic analysis was applied. Estimation of the rate parameters was made by linear and non-linear regression. The models containing non-physically meaningful parameters were eliminated. Discrimination between the remaining models followed from statistical

testing, based on F-test and R^2 value [5-6]. Comparison with a conventional SMR catalyst was made [7-9]. Intra-catalyst diffusion limitations were investigated based on the pseudo-continuum model and the optimal catalyst coating thickness was evaluated [10].

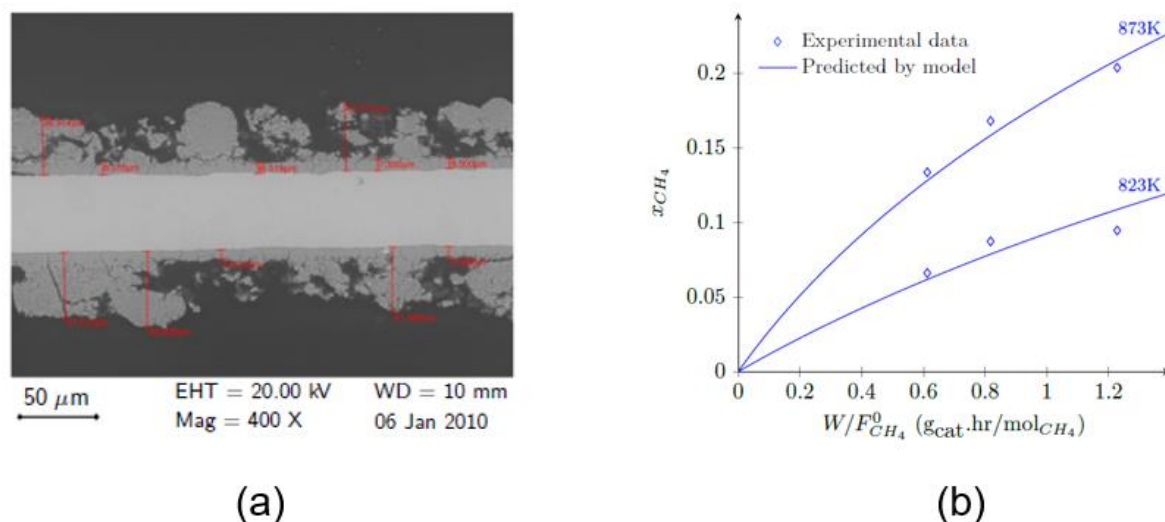


Figure 1: (a) SEM cross section of the catalyst and (b) molar conversion of methane versus space time at 3 bar and $S/C = 3.5$.

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