344b Stratified Catalysts for Methane Partial Oxidation

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The catalytic partial oxidation process has proven to be a viable alternative to steam reforming for hydrogen production. The millisecond residence time and small thermal mass make catalytic partial oxidation well suited for small, mobile hydrogen fueled applications. In general, rhodium has proven to be the most active and stable metal to catalyze the reaction. Unfortunately, rhodium pricing is often much more expensive than conventional catalysts and much less stable. This work uses stratified catalysts with the goal of outperforming rhodium.

A stratified, dual bed catalyst has produced hydrogen in yields in excess of 85% from methane and air in a millisecond contact time reactor. The dual bed consisted of a platinum (combustion) catalyst followed by a nickel (reforming) catalyst. The platinum catalyst oxidized one-quarter of the methane to create heat, water, and carbon dioxide to reform the remaining methane on the nickel catalyst. The process is favored at the high space velocities achieved in the millisecond reactor due to fast convective transfer of heat from the upstream, exothermic catalyst to the downstream, endothermic catalyst. The catalyst achieved hydrogen yields as good as or better than rhodium. The stratified catalyst was run for an extended period of time and did not display any signs of deactivation. Comparison of different stratified and mono-metallic catalysts run at varying feed conditions will be presented.