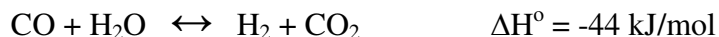


New Water Gas Shift Catalyst Technology for IGCC
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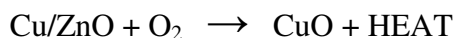
An essential catalytic step in fuel processing is to maximize H₂ production by reacting CO and H₂O in the water gas shift reaction.



Traditional hydrogen plants utilize FeCr - containing catalysts for high temperature shift (HTS) operating > 350°C (6 x 6 mm tablet or rings) and CuZn - containing catalysts called low temperature shift (LTS) which operate ~ 200°C and are commercially available as spheres or tablets (3-5 mm size). These materials have a long history of successful use especially in large scale plants equipped with extensive safety and process control equipment. Both of these catalysts require activation to a reduced state to generate active sites. Reduction is highly exothermic and is carried out in the reformer by slow and careful addition of H₂ carefully controlling the exotherm to avoid temperatures above which catalyst sintering occurs.



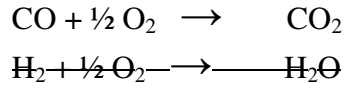
While in the activated (reduced) state both HTS and the LTS catalysts will react spontaneously with the O₂ in air resulting in a high temperature exotherm that unless controlled can destroy the catalyst. Furthermore condensation of water, which may occur during shutdown or upset conditions, will re-oxidize the metal surface leading to deactivation.



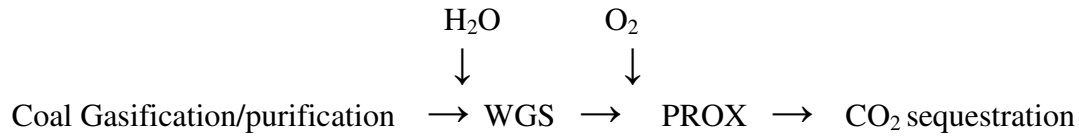
Upon discharging both of these catalysts a thin protective layer of oxide or carbonate is generated on the surface for safe removal. Since this reaction is exothermic low operating temperatures are required for favorable thermodynamics. The low catalyst activity densities mandate low space velocities (~ 2,500 - 5,000 h⁻¹) requiring large catalyst volumes. Finally, packed beds of particulate materials are prone to attrition and high pressure drop.

Precious metal monolith catalyst structures, successfully used for emission control in automobiles since the mid 1970's, have recently been commercialized for hydrocarbon reforming for hydrogen generation for distributed applications (1). They offer many advantages over Fe and Cu - containing catalysts in that they are activated immediately in reformat process gas, are insensitive to air and liquid water exposure, have high activity densities, making them suitable for monolith washcoats, with low pressure drop and structural stability and in some cases are tolerant to low levels of H₂S. They operate as low-mid temperature shift catalysts generating CO levels of ~ 1-2% with space velocities as high as 25,000 h⁻¹. Washcoats may be deposited on heat exchangers for control of the exotherm and steam generation.

If reductions to a few ppm CO are required it is cost effective to use newly developed monolithic PROX catalysts positioned immediately downstream from the WGS reactor. A small amount of O₂ (O₂/CO ~ 1-1.3) is injected at the inlet of the PROX catalyst.



The catalyst is formulated to be highly selective towards the oxidation of CO in while oxidizing a minimum of H₂. It can be deposited on heat exchangers for heat recovery.



Monolithic structures catalyzed with precious metals are now being introduced into advanced hydrocarbon fuel processors for hydrogen generation for fuel cells and distributed hydrogen. A variety of designs for heat management for all reactors are being utilized.

Today's seminar will compare traditional base metal oxide particulate catalysts with precious metal monoliths for application in water gas shift catalysis.

(1) Farrauto, R., Liu, Y., Ruettinger, W., Ilinich, I. Shore, L. and Giroux, T. "Precious Metal Catalysts Supported on Ceramic and Metal Monolithic Structures for the Hydrogen Economy" *Catalysis Reviews* 49: 141-196 (2007)