Dry Reforming of Landfill Gas Using Precious Metal Catalysts

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Landfill Gas – Production and Composition

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About 50% CH₄ and 50% CO₂
Other important components: 21 ppmv Hydrogen Sulfides

Previous Reforming Work

• Steam Reforming
  – CH₄ + H₂O → CO + 3 H₂  \( \Delta H = + 226 \text{ kJ/mol} \)
  – Most important industrial process to make syn gas
  – Problems:
    • Superheated steam is expensive
    • Water-gas shift reaction produces CO₂
    • H₂-to-CO ratio too high for some downstream processes
• Partial Oxidation of Methane
  – CH₄ + ½ O₂ → CO + 2 H₂  \( \Delta H = - 44 \text{ kJ/mol} \)
  – Problem: At the stoichiometric CH₄-to-O₂ ratio there is significant carbon formation on catalysts other than noble metal catalysts
• Dry Reforming
  CH₄ + CO₂ → 2 CO + 2 H₂  \( \Delta H = + 261 \text{ kJ/mol} \)
• Combinations of the above

Dry Reforming

Order of reactivity for precious metal catalysts:
Ru, Rh, Ni, Re>> Ir > Pt > Pd
Other catalysts that have been investigated: Fe, Co, Ca, Mn

Reaction is thermodynamically favored above 913 K

Problems:
Carbon deposition
Energy intensive (more endothermic than steam reforming)

Conclusions:

Platinum
• Reduction enhances the production of syn gas and decreases the rate of deactivation
• The higher the reduction temperature, the more syn gas produced
• There is a period of interesting weight change followed by a drastic weight increase for the 900°C tests
• The weight increase on the catalyst reformed at 900°C is due to deactivation by carbon deposition
• The support itself has some sort of catalytic properties at high temperatures

Gold
• Sinters at 400 before reforming reaction can begin

Current Work:

BET analysis
Kinetic Analysis
Increasing CO₂ flow to see effects on Carbon deposition
Catalyst regeneration through Carbon burn-off

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