

Catalytic Methanation

TO: Engineering Development Branch
FROM: Engineering Division
SUBJECT: Catalytic Hydrogenation of CO₂ to Methane

Develop basic kinetic data for the reaction of CO₂ and H₂ over nickel catalysts. A laboratory reactor designed to measure these data has been recently renovated in the UO lab. Your assignment is to obtain kinetic data (reaction orders, pre-exponential factors, and activation energies) for the methanation reaction over one nickel catalyst (Harshaw G-87) at compositions that are stoichiometric or excess in hydrogen and contain from 1.0 to 4.0 % CO₂. The temperature range should be around 250 to 330 °C.

Determine at what temperature pore diffusion limitations begin to become significant, if at all. Comment on the catalyst's stability with time, both during a run and over long periods of time.

Determine how much methane can be produced in an isothermal CSTR containing one ton of the G-87 catalyst if you operate at 270 °C and 1 atm with a feed of 10⁴ SLM containing 4.0 % CO₂ and 20 % H₂.

Hints:

Be sure to learn how to use the gas chromatograph by reading the manual and discussing it with Mr. M. Beliveau.

You will probably want to keep CO₂ conversion levels below 20% in order to use the assumption of differential reactor performance. Staying in this conversion range can be done by finding the right temperature and flowrate ranges in which to operate.

Weatherbee and Bartholomew [J. Catalysis **77**, 460 (1982)] provide some previously measured kinetics for this reaction.