

Catalytic Methanation

Winter 2007

TO: Engineering Development Branch

FROM: Engineering Division

SUBJECT: Catalytic Hydrogenation of CO₂ to Methane

The company is considering using the waste CO₂ and H₂ streams from the plant to produce methane. In order to design a reactor to do this, basic kinetic data for the reaction of CO₂ and H₂ over nickel catalysts are needed.

A laboratory reactor designed to measure these data has been recently renovated in the UO lab. It is your assignment to **obtain kinetic data** (reaction orders and activation energies) for one nickel catalyst (Harshaw G-87). Limit your study to compositions that are stoichiometric or excess in hydrogen and contain from 1.0 to 4.0% CO₂. The temperature range of your study will probably be around 250 to 330 °C, but you only need to determine the concentration dependencies at one temperature.

I would also like you to determine at what temperature **pore diffusion limitations** begin to come into play, if at all. Also, please comment on the catalyst's **stability with time**, both during a run and over long periods of time.

Design problem: 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 1.0×10^4 SLM containing 4.0% CO₂ and 20% H₂?

Hints:

- 1) Be sure to learn how to use the gas chromatograph by reading the manual and discussing it with Mr. M. Beliveau.
- 2) 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.

- 3) You will want to refer to the work of Weatherbee and Bartholomew [J. Catalysis **77**, 460 (1982)] with regard to the previously measured kinetics for this reaction.