

Abstract

The purpose of this work is to identify an affordable and simple chromatographic technique to perform dynamic carbon monoxide chemisorption on supported metal catalysts for dispersion calculations.

Background

Supported Metal Catalysts

- Used in a variety of industries from pharmaceuticals to the automotive industry
- Consist of metal catalyst nanoparticles loaded onto a support of a different material.

Catalyst Dispersion

- Ratio of exposed surface metal moles to the total amount of metal moles loaded on the support
- Only the surface of a catalyst can play a role in a reaction, thus greater dispersion creates greater catalytic reactions

Dynamic Chemisorption

- Catalyst is exposed to a probe molecule gas in repeated pulses, CO in our experiment
- Pulses allow probe molecules to adsorb to unoccupied surface metal molecules
- Unadsorbed molecules are detected at the outlet

Methods

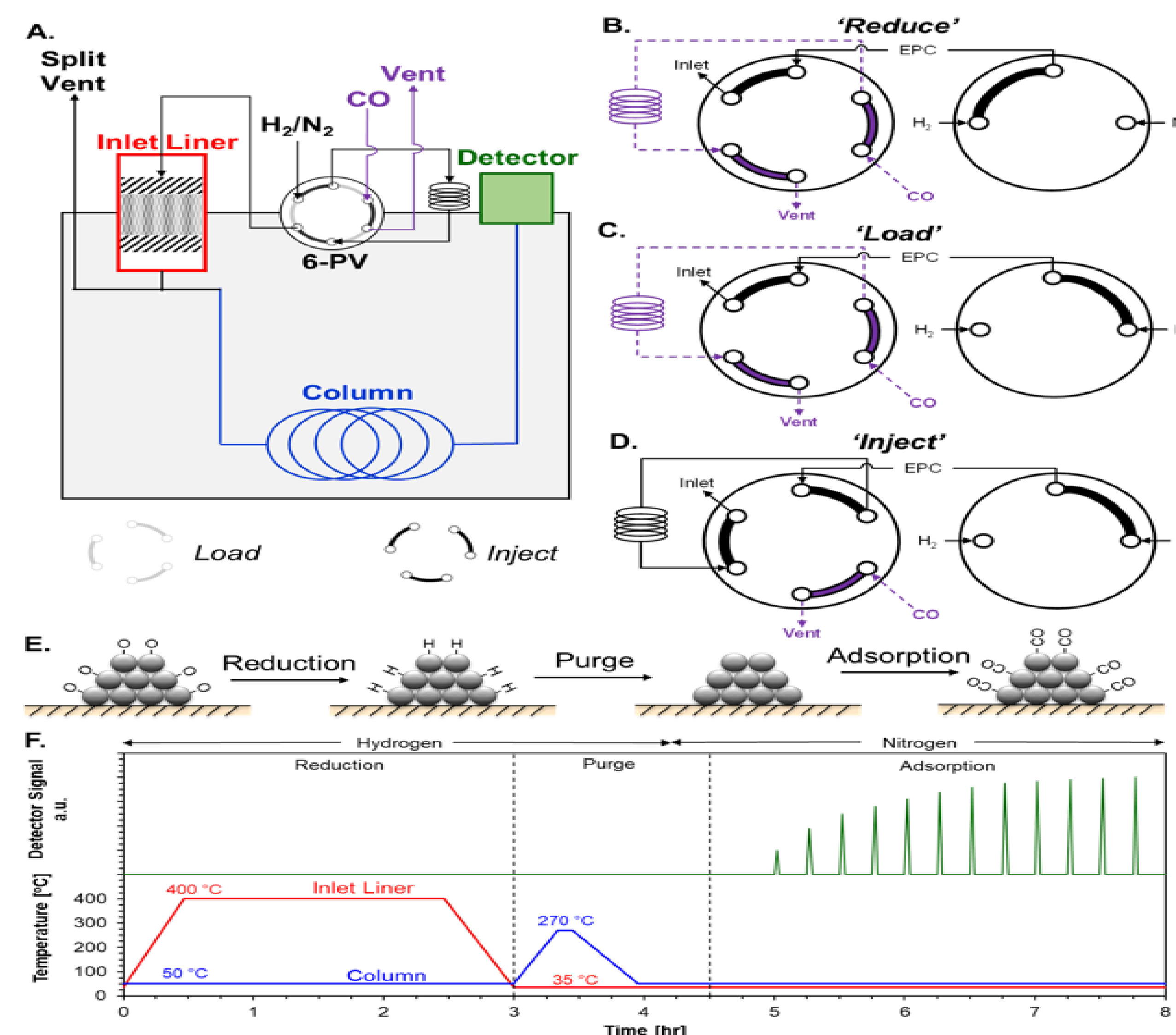


Figure 1: (A) Schematic of Gas Chromatograph with a 6-port valve for CO pulsing over the catalyst housed in inlet liner. (B) Valve position to perform reduction. (C) Load position, filling sample loop with CO sample. (D) Inject position, pulsing CO by pushing nitrogen gas through sample loop. (E-F) Three stages for Dispersion estimation of catalyst.

Technology Comparison

Gas Chromatograph

- Cost: \$15K
- Requires additional port valves for multiple probe gases
- Can be used for other experiments

Micromeritics AutoSorb

- Cost: \$70K
- Simultaneous sample preparation
- Perform physisorption as well as chemisorption

Results

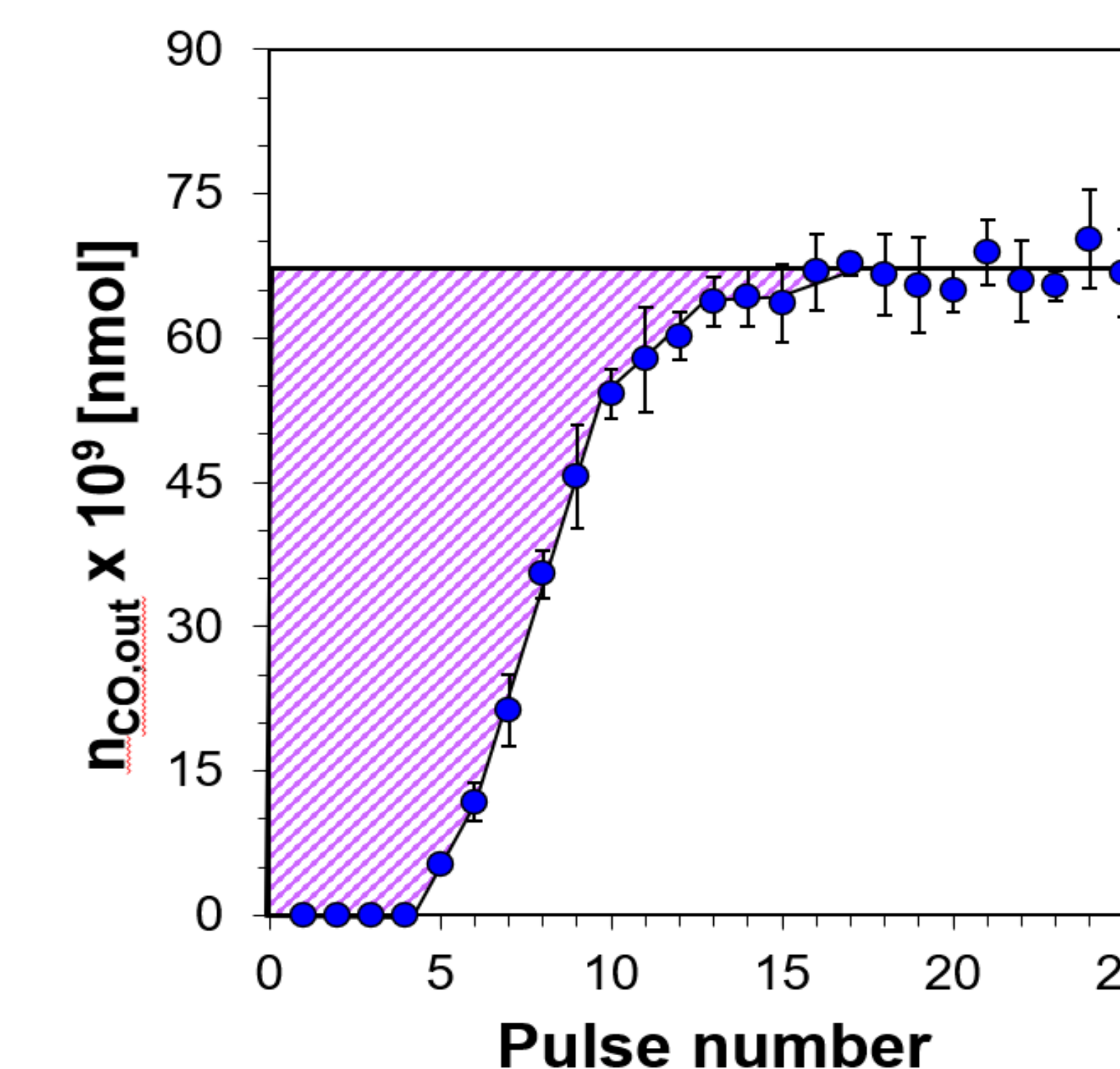


Figure 2: Breakthrough curve of 1wt% Platinum on Silica at 35° C

Catalyst	Dispersion (%)
1 wt% Pt/SiO ₂	27 ± 2
1 wt% Pt/Al ₂ O ₃	32 ± 3
5 wt% Pt/C	19 ± 1
0.12 wt% Pt/SiO ₂	52 ± 5

Table 1: Dispersion measurements for supported Metal Catalysts

Automation

- Existing Chromatograph software automates the process
- Port-valves are electronically actuated via signals sent to the apparatus to vary gases for pulsing and pre-treatments
- Integration of peaks can be automatically taken

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