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Solutions Manual for

Kinetics of Catalytic Reactions

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Kinetics of Catalytic Reactions



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Preface

This manual of solutions to the problems in “Kinetics of Catalytic Reactions” has been prepared to assist those who use this book in a teaching function. However, these solutions should also benefit those outside the classroom who want to apply the principles and concepts that are discussed in the book. By studying and observing the approaches used in solving these problems, it is very likely that similar applications can be envisioned in different kinetic problems that the investigator might face. Thus the availability of these solutions is a good learning tool for everyone. Additional details and insight about the solutions provided can be obtained by reading the cited references.

I have tried to eliminate all errors, both conceptual and typographical, in these solutions; however, the probability is high that I have not succeeded completely. Should any errors of commission (or omission) be found, I would greatly appreciate being informed. I can be reached at this email address: mavche@engr.psu.edu, or mail can be sent to me at: 107 Fenske Laboratory, Department of Chemical Engineering, The Pennsylvania State University, University Park, PA 16802.

Albert Vannice

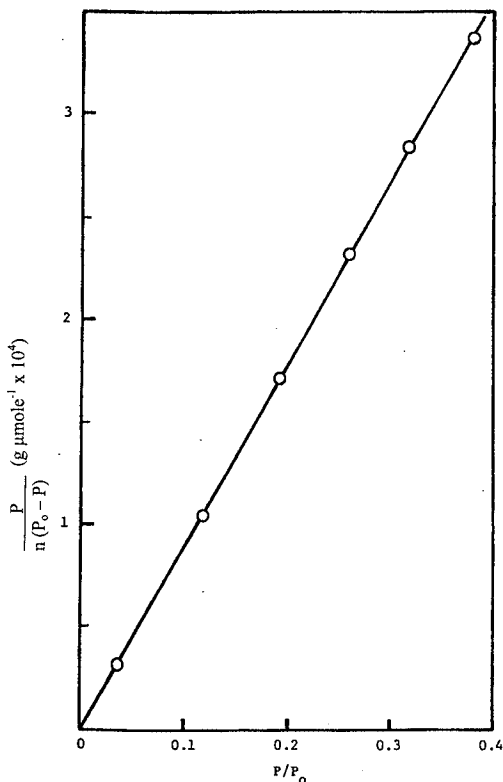
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Problem 3.1 Solution



N₂ BET Plot for BC-1

From slope and intercept:

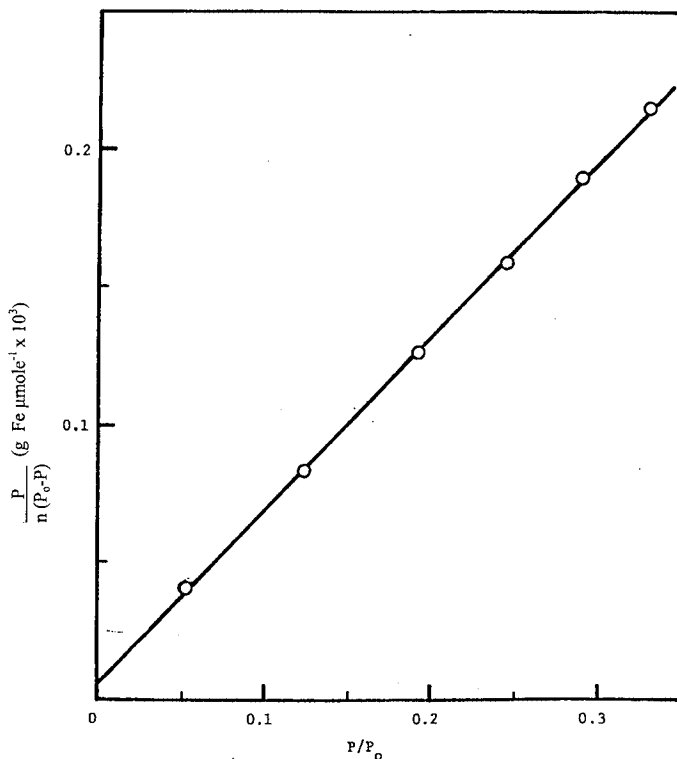
$$n_m = 1120 \mu\text{mole N}_2/\text{g}$$

$$C \approx 1000$$

$$A_m = \left(\frac{1120 \times 10^{-6} \text{ mole}}{\text{g}} \right) \left(\frac{6.023 \times 10^{23} \text{ molecule}}{\text{mole}} \right) \left(\frac{16.2 \text{ \AA}^2}{\text{molecule}} \right) \left(\frac{10^{-20} \text{ m}^2}{\text{\AA}^2} \right) = \frac{110 \text{ m}^2}{\text{g}}$$

$$\ln C = \frac{q_1 - q_L}{RT} \Rightarrow q_1 = 6.9 \left(\frac{1.987 \text{ cal}}{\text{mole} \cdot \text{K}} \right) (80 \text{ K}) + 1340 = \frac{2440 \text{ cal}}{\text{g mole}}$$

Problem 3.2(c) Solution



Ar Bet Plot for Used Bulk Iron

From slope and intercept:

$$n_m = 1.60 \mu\text{mole Ar/g}$$

$$C = 47$$

$$A_m = \left(\frac{1.60 \times 10^{-6} \text{ mole Ar}}{\text{g}} \right) \left(\frac{6.023 \times 10^{23} \text{ molecule}}{\text{mole}} \right) \left(\frac{13.9 \text{ \AA}^2}{\text{molecule}} \right) \left(\frac{10^{-20} \text{ m}^2}{\text{\AA}^2} \right) = \frac{0.134 \text{ m}^2}{\text{g}}$$

$$\ln C = \frac{q_1 - q_L}{RT} = 3.85$$

$$q_1 = 3.85 (1.987 \text{ cal/mole} \cdot \text{K}) (77 \text{ K}) + 1550 = 2.14 \text{ kcal/mole}$$

Problem 7.2 Solution

$$r = -\frac{d[A]}{dt} = \frac{d[B]}{dt} = k_3 [B-S]$$

$$K_1 = \frac{[A-S]}{[A][S]}, \quad K_2 = \frac{[B-S]}{[A-S]}$$

Site balance: $L = [S] + [A-S] + [B-S]$

(a) If $[B-S]$ is the MARI, then $L = [S] + [B-S]$ and

$$L = [S] + K_2 [A-S] = [S] + K_1 K_2 [A][S] \Rightarrow [S] = \frac{L}{(1 + K_1 K_2 [A])}$$

$$r = k_3 K_2 [A-S] = K_1 K_2 k_3 [A][S] = \frac{L k_3 K_1 K_2 [A]}{(1 + K_1 K_2 [A])}$$

(b) If $[A-S]$ is the MARI, then $L = [S] + [A-S]$ and $L = [S] + K_1 [A][S] \Rightarrow [S] = \frac{L}{(1 + K_1 [A])}$

$$r = k_3 K_2 [A-S] = K_1 K_2 k_3 [A][S] = \frac{L k_3 K_1 K_2 [A]}{(1 + K_1 [A])}$$

The mathematical forms are identical.