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Solutions Manual for

Kinetics of Catalytic Reactions

M. Albert Vannice

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M. Albert Vannice
William H. Joyce Chaired Professor
Department of Chemical Engineering
The Pennsylvania State University
University Park, PA 16802
mavche@engr.psu.edu

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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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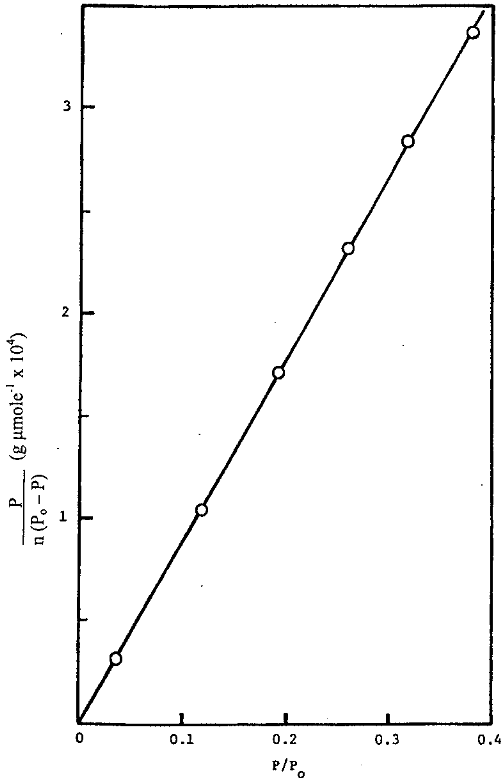
Problem 3.1 Solution



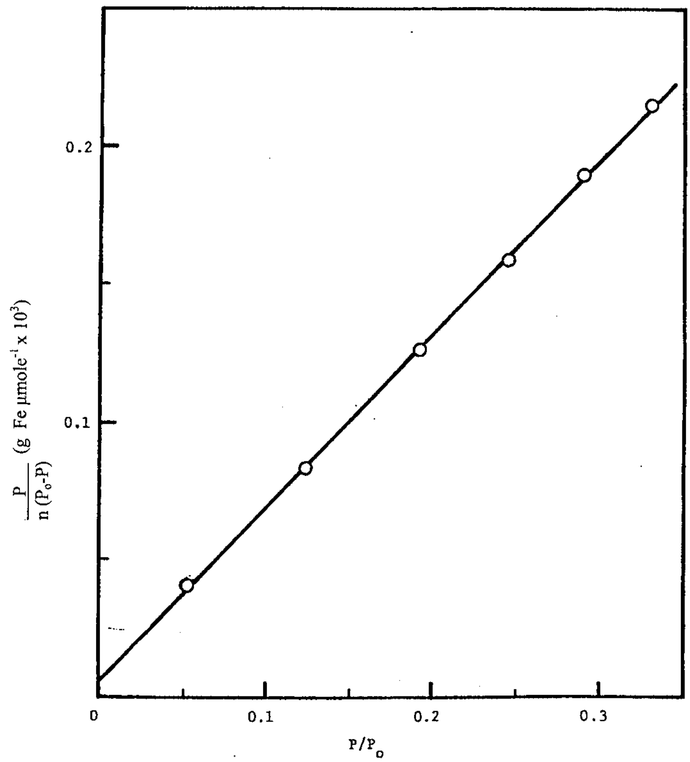
N_2 BET Plot for BC-1

From slope and intercept:
$n_m = 1120$ μmole N_2/g
$C \cong 1000$

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

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

Problem 3.2(c) Solution



Ar Bet Plot for Used Bulk Iron

From slope and intercept:

$n_m = 1.60$ µmole Ar/g

$C = 47$

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

$$\ell\text{n}\ C = \frac{q_1 - q_L}{RT} = 3.85$$

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

Problem 7.2 Solution

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

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

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

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

$$L = [S] + K_2[A-S] = [S] + K_1K_2[A][S] \Rightarrow [S] = \frac{L}{(1 + K_1K_2[A])}$$

$$r = k_3K_2[A-S] = K_1K_2k_3[A][S] = \frac{Lk_3K_1K_2[A]}{(1 + K_1K_2[A])}$$

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

$$r = k_3K_2[A-S] = K_1K_2k_3[A][S] = \frac{Lk_3K_1K_2[A]}{(1 + K_1[A])}$$

The mathematical forms are identical.