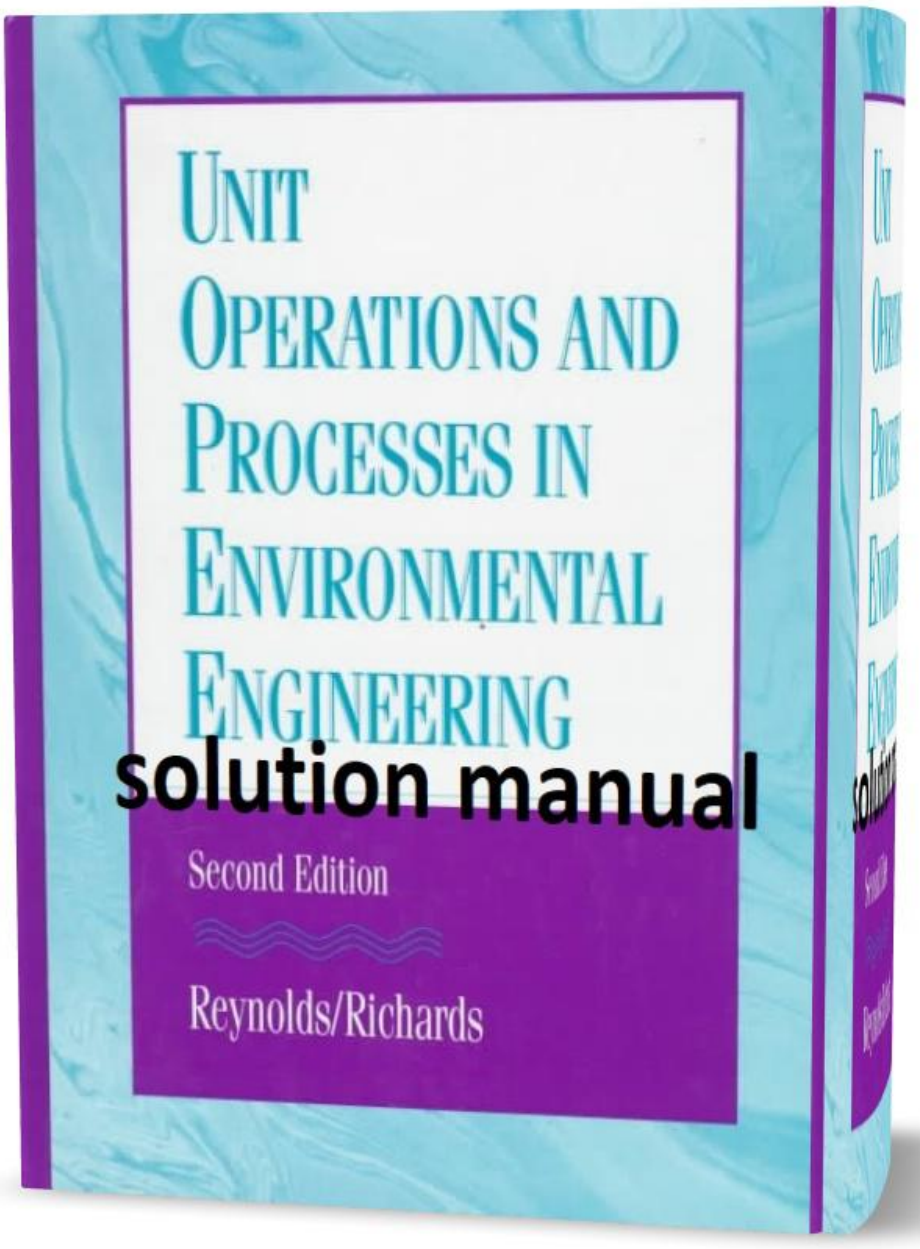
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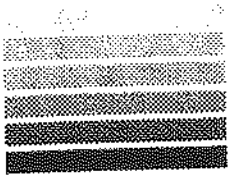

Instructor's Manual

UNIT OPERATIONS AND PROCESSES IN ENVIRONMENTAL ENGINEERING

Second Edition

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PWS Publishing Company

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PWS PUBLISHING COMPANY
20 Park Plaza, Boston, MA 02116-4324

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ISBN: 0-534-94885-5

Printed and bound in the United States of America by Financial Publishing
1 2 3 4 5 6 7 8 9 10 — 00 99 98 97 96

Contents

[1] No quantitative problems in Chapter 6 or Chapter 24 - hence no worked solutions

Problem 1.1

Na^+ AW = 23 Eq. wt. = 23/1 = 23 gm

Ca^{+2} AW = 40 Eq. wt. = 40/2 = 20 gm

Na^+ meq wt = 23 mg

Megs = (102 mg/L) ÷ 23 mg/meq = 4.93 megs/L

Ca^+ meq wt = 20 mg

Megs = (68 mg/L) ÷ 20 mg/meq = 3.40 megs/L

Problem 1.2

$CaCl_2$ MW = $40 + 2(35) = 110$

Meq wt = $110/2 = 55$ mg

Meqs = $(168\ mg/L) \div 55\ mg/meq = \underline{3.05\ meq/L}$

Problem 1.3

1 ppm = 1 mg/L if specific gravity = 1.00

134 parts per million = 134 mg/L

Problem 1.4

$pH = 7.6$

$pH = \log \frac{1}{[H^+]}$

$[H^+] = \underline{10^{-7.6} \text{ moles/l}}$

$[H^+][OH^-] = 10^{-14}$

$[10^{-7.6}][OH^-] = 10^{-14}$

$[OH^-] = \underline{10^{-6.9} \text{ moles/l}}$

Problem 1.5

It goes to completion because an insoluble product is formed.

Problem 1.6

Carbonate CO_3^{-2}

Bicarbonate HCO_3^-

Hydroxyl OH^-

Problem 1.7

$CaCO_3$ Meq wt = $[40 + 12 + 3(16)]/2 = 50$

Meqs/ℓ = (185 mg/ℓ) ÷ 50 mg/meq = 3.70 m.

Problem 1.8

$CaCO_3$ Meq wt = $[40 + 12 + 3(16)]/2 = 50$

Meq/L = (225 mg/L) ÷ 50 mg/meq = 4.50 meq.

Problem 1.9

a. Second

b. Zero

c. First