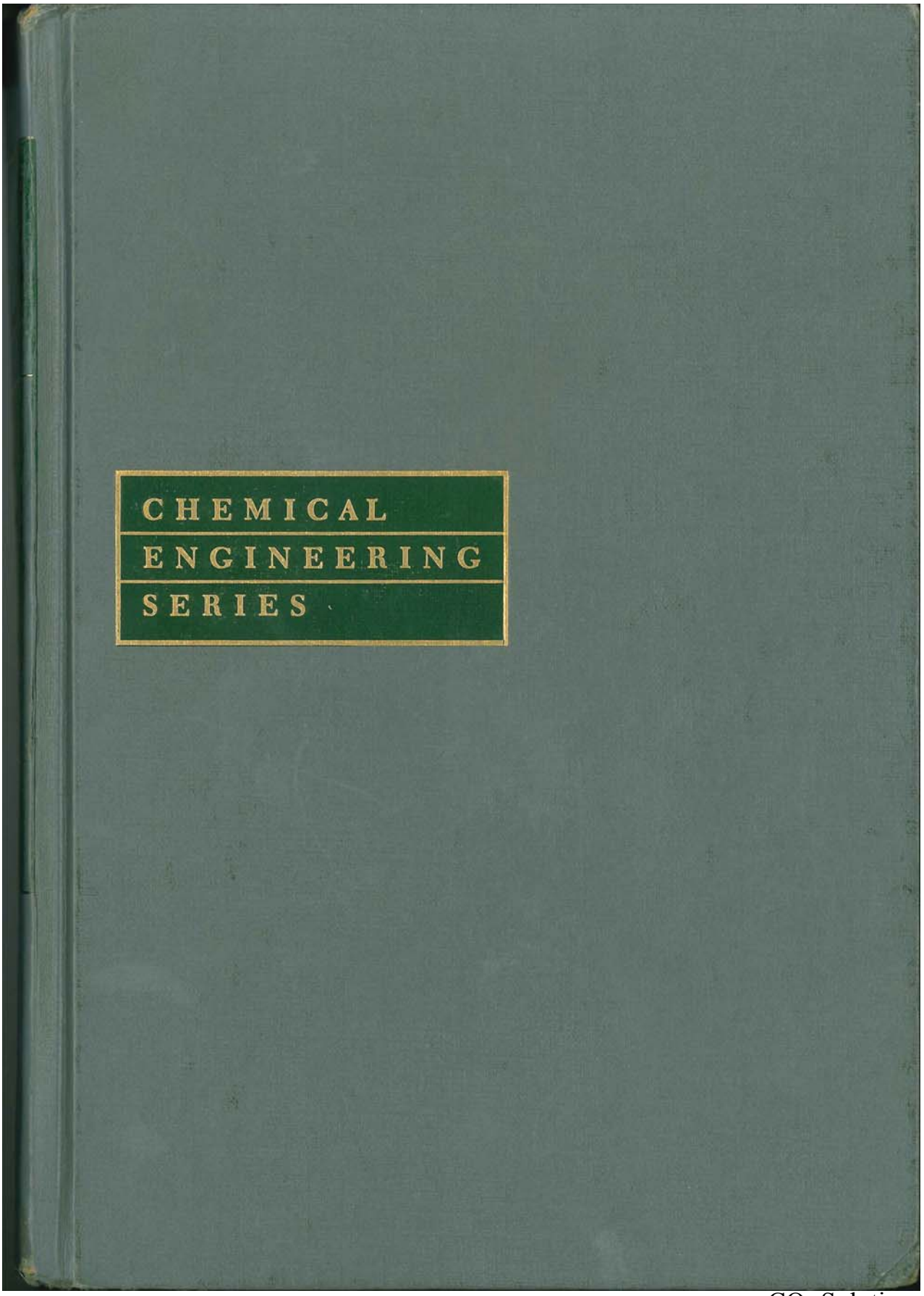

This book was set in Times Roman.
The editors were Kiran Verma and Madelaine Eichberg;
the production supervisor was Leroy A. Young.
New drawings were done by J & R Services, Inc.
R. R. Donnelley & Sons Company was printer and binder.

UNIT OPERATIONS OF CHEMICAL ENGINEERING

7 8 9 0 DOC/DOC 9 9 8 7 6 5 4 3 2 1

ISBN 0-07-044828-0

Library of Congress Cataloging in Publication Data

McCabe, Warren L. (Warren Lee), date
Unit operations of chemical engineering.

(McGraw-Hill chemical engineering series)
Includes index.
1. Chemical processes. I. Smith, Julian C. (Julian Cleveland), date . II. Harriott, Peter. III. Title. IV. Series.
TP155.7.M3 1985 660.2'842 84-10045
ISBN 0-07-044828-0

UNIT OPERATIONS OF CHEMICAL ENGINEERING

Fourth Edition

Warren L. McCabe

Late R. J. Reynolds Professor in Chemical Engineering
North Carolina State University

Julian C. Smith

Professor of Chemical Engineering
Cornell University

Peter Harriott

Fred H. Rhodes Professor of Chemical Engineering
Cornell University

McGraw-Hill Publishing Company

New York St. Louis San Francisco Auckland Bogotá Caracas
Hamburg Lisbon London Madrid Mexico Milan
Montreal New Delhi Oklahoma City Paris San Juan
São Paulo Singapore Sydney Tokyo Toronto

CHAPTER

TWENTY-TWO

GAS ABSORPTION

This chapter deals with the mass-transfer operations known as *gas absorption* and *stripping*, or *desorption*. In gas absorption a soluble vapor is absorbed from its mixture with an inert gas by means of a liquid in which the solute gas is more or less soluble. The washing of ammonia from a mixture of ammonia and air by means of liquid water is a typical example. The solute is subsequently recovered from the liquid by distillation, and the absorbing liquid can be either discarded or reused. Sometimes a solute is removed from a liquid by bringing the liquid into contact with an inert gas; such an operation, the reverse of gas absorption, is desorption or gas stripping.

At the end of this chapter is a section on the application of packed towers, used chiefly in gas absorption, to distillation and liquid-liquid extraction.

DESIGN OF PACKED TOWERS

A common apparatus used in gas absorption and certain other operations is the packed tower, an example of which is shown in Fig. 22-1. The device consists of a cylindrical column, or tower, equipped with a gas inlet and distributing space at the bottom; a liquid inlet and distributor at the top; gas and liquid outlets at the top and bottom, respectively; and a supported mass of inert solid shapes, called *tower packing*. The support should have a large fraction of open area, so that flooding does not occur at the support plate. The inlet liquid, which may be pure solvent or a dilute solution of solute in the solvent and which is called the *weak liquor*, is distributed over the top of the packing by the distributor and, in ideal operation, uniformly wets the surfaces of the packing. The solute-containing gas, or rich gas, enters the distributing space below the packing and flows upward through the interstices in the packing countercurrent to the flow of the liquid. The packing provides a large area of contact between the liquid and gas and encourages intimate contact between the phases. The solute in the rich gas is absorbed by the fresh liquid entering the tower, and dilute, or lean, gas leaves the top. The liquid is enriched in solute as its flows down the tower, and concentrated liquid, called *strong liquor*, leaves the bottom of the tower through the liquid outlet.

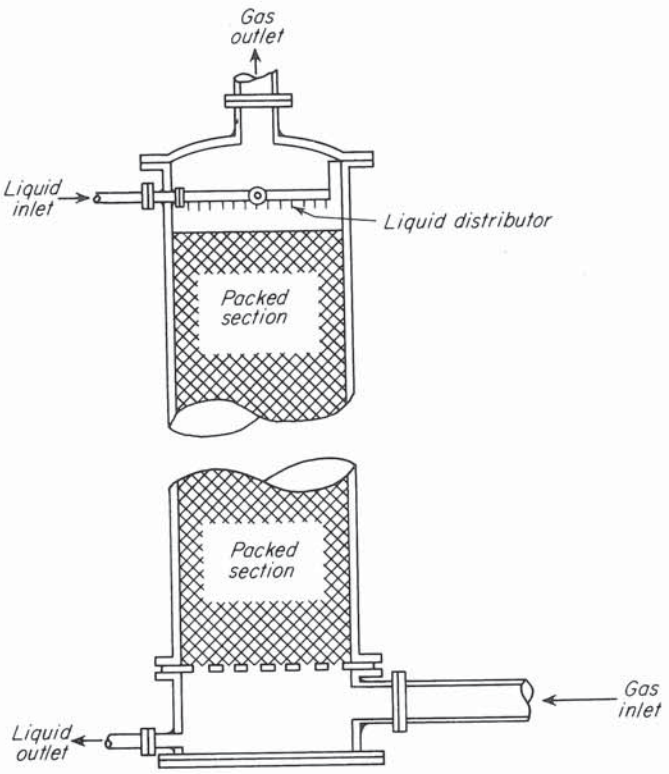

Figure 22-1 Packed tower.

Many kinds of tower packing have been invented, and several types are in common use. Packings are divided into those which are dumped at random into the tower and those which must be stacked by hand. Dumped packings consist of units $\frac{1}{4}$ to 3 in. in major dimension; packings smaller than 1 in. are used mainly in laboratory or pilot-plant columns. The units in stacked packings are 2 to about 8 in. in size. Common packings are illustrated in Fig. 22-2.

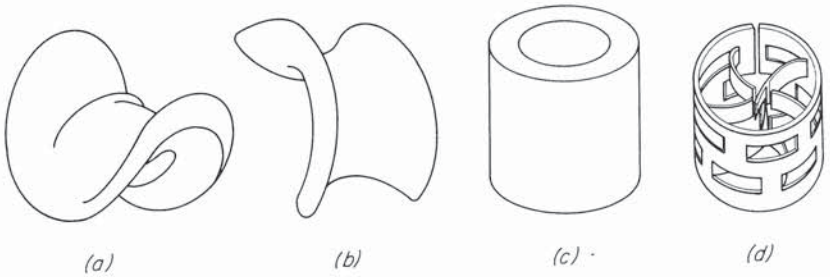

Figure 22-2 Typical tower packings: (*a*) Berl saddle; (*b*) Intalox saddle; (*c*) Raschig ring; (*d*) Pall ring.

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.