SUMMARY REPORT

TEACHING OF UNDERGRADUATE

MASS TRANSFER

A Mini-Session Presented at the
Annual Meeting

American Institute of Chemical Engineers
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Houston, Texas
INTRODUCTION

A preliminary survey was made in 1976 to estimate classroom time allocations to those topics generally referred to as the unit operations. This survey indicated that 1/4 of the total time was devoted to heat transfer, 1/4 to fluid flow, 3/8 to mass transfer and the remaining 1/8 to all other topics. The 1977 survey covered heat transfer and fluid flow. This year's survey deals with mass transfer and the other unit operations.

A three-page questionnaire was sent in May, 1978 to the Chairman of each chemical engineering department in the United States and Canada, together with a cover letter asking that the appropriate faculty member(s) complete and return the questionnaire. A follow-up letter was sent in August to those schools which had not responded. Of the 156 schools contacted, 111 returned completed questionnaires. This is the highest number of responses in the seven years this survey has been conducted.

SI SYSTEM OF UNITS

Both the American Chemical Society and the AIChE require that dimensions in their journals be expressed in SI units. Last year's survey showed that 2/3 of the heat transfer and fluid flow courses employ both English and SI units. 27% use only English units and 5% use only SI units. The question on dimensions in this year's questionnaire was included to discover the relative popularity of these two systems.

The results show a marked preference for the English system in mass transfer problem assignments. In 38% of the schools, the SI system is used in less than 10% of the assignments. Almost 70% of the schools use the English system in at least 75% of the assignments. From another viewpoint, the fact that about 2/3 of the schools use both systems is in close agreement with last year's study.
<table>
<thead>
<tr>
<th>Percent of Assignments using SI Units</th>
<th>No. of Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10%</td>
<td>42</td>
</tr>
<tr>
<td>About 25%</td>
<td>36</td>
</tr>
<tr>
<td>About 50%</td>
<td>24</td>
</tr>
<tr>
<td>About 75%</td>
<td>8</td>
</tr>
<tr>
<td>Over 90%</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>111</strong></td>
</tr>
</tbody>
</table>

**TEXTBOOKS**

Seventeen textbooks were mentioned in the 192 courses reported by the responding universities. In 11 courses, either no text was used or personal notes by the instructor constituted the text. The texts by McCabe and Smith and by Treybal were used in over half the courses. The six most popular texts were used in 87% of the courses which used texts. The other 11 books were scattered through the remaining 13% of the courses.

<table>
<thead>
<tr>
<th>Authors (Publication Year)</th>
<th>No. of Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>McCabe and Smith (1976)</td>
<td>53</td>
</tr>
<tr>
<td>Treybal (1968)</td>
<td>45</td>
</tr>
<tr>
<td>Bird, Stewart and Lightfoot (1960)</td>
<td>22</td>
</tr>
<tr>
<td>Bennett and Myers (1974)</td>
<td>20</td>
</tr>
<tr>
<td>King (1971)</td>
<td>10</td>
</tr>
<tr>
<td>Welty, Wicks and Wilson (1969)</td>
<td>7</td>
</tr>
<tr>
<td><strong>Other texts</strong></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>181</strong></td>
</tr>
</tbody>
</table>

**COURSE ORIENTATION**

Instructors were asked to judge whether their mass transfer course textbook was oriented toward the unit operations or toward transport theory. It appears that transport theory is less frequently applied to
mass transfer than to heat transfer or fluid flow. The transport approach was used in 35% of the heat transfer courses and 30% of the fluid flow courses, but only 17% of the mass transfer courses. The unit operations approach was correspondingly more popular in mass transfer (53%) than in heat transfer (40%) or fluid flow (38%).

<table>
<thead>
<tr>
<th>Course Orientation</th>
<th>% of Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Operations</td>
<td>53%</td>
</tr>
<tr>
<td>Transport Theory</td>
<td>17%</td>
</tr>
<tr>
<td>Some of both</td>
<td>30%</td>
</tr>
</tbody>
</table>

COURSES AND COURSE LEVEL

The 110 schools responding reported a total of 192 courses devoted wholly or in part to mass transfer. This total excludes courses devoted entirely to laboratory. There were slightly more schools offering two mass transfer courses than one course.

<table>
<thead>
<tr>
<th>Mass Transfer Courses</th>
<th>No. of Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>43</td>
</tr>
<tr>
<td>Two</td>
<td>53</td>
</tr>
<tr>
<td>Three</td>
<td>13</td>
</tr>
<tr>
<td>Four</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>110</td>
</tr>
</tbody>
</table>

Slightly more mass transfer courses are taught in the junior year than the senior year.

<table>
<thead>
<tr>
<th>Course Level - Semester Basis</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sophomore year</td>
<td>4%</td>
</tr>
<tr>
<td>Junior, Semester 1</td>
<td>25%</td>
</tr>
<tr>
<td>Junior, Semester 2</td>
<td>31%</td>
</tr>
<tr>
<td>Senior, Semester 1</td>
<td>30%</td>
</tr>
<tr>
<td>Senior, Semester 2</td>
<td>10%</td>
</tr>
</tbody>
</table>
Course Level - Quarter Basis

<table>
<thead>
<tr>
<th>Sophomore year</th>
<th>0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior, Quarter 1</td>
<td>11%</td>
</tr>
<tr>
<td>Junior, Quarter 2</td>
<td>16%</td>
</tr>
<tr>
<td>Junior, Quarter 3</td>
<td>27%</td>
</tr>
<tr>
<td>Senior, Quarter 1</td>
<td>31%</td>
</tr>
<tr>
<td>Senior, Quarter 2</td>
<td>13%</td>
</tr>
<tr>
<td>Senior, Quarter 3</td>
<td>2%</td>
</tr>
</tbody>
</table>

**COMPUTERS IN MASS TRANSFER COURSES**

Design of multicomponent distillation columns is usually done by a computer program rather than by hand calculations. Questions about the access to multicomponent distillation programs and the relative number of assignments requiring computer solutions were placed on the questionnaire. Only 30% of the schools make a multicomponent computer program available to their mass transfer students. About 85% of the schools require 10% or less of the course problem assignments to be solved by the computer.

<table>
<thead>
<tr>
<th>Percent of Assignments Requiring Computer Solution</th>
<th>No. of Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>33</td>
</tr>
<tr>
<td>1-10%</td>
<td>59</td>
</tr>
<tr>
<td>11-50%</td>
<td>15</td>
</tr>
<tr>
<td>TOTAL</td>
<td>107</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Access to Multicomponent Distillation Program</th>
<th>No. of Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>31</td>
</tr>
<tr>
<td>No</td>
<td>78</td>
</tr>
<tr>
<td>TOTAL</td>
<td>109</td>
</tr>
</tbody>
</table>
COURSE ADMINISTRATION

Five questions were asked regarding the conduct and content of the course.

1. Do you require students to turn in assigned problems?

<table>
<thead>
<tr>
<th>Reply</th>
<th>% of Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most of the time</td>
<td>92%*</td>
</tr>
<tr>
<td>Sometimes</td>
<td>5%</td>
</tr>
<tr>
<td>Rarely</td>
<td>2%</td>
</tr>
<tr>
<td>Never</td>
<td>1%</td>
</tr>
</tbody>
</table>

* 9% wrote in "All of the time".

2. Do you use articles from the chemical engineering literature in your course?

<table>
<thead>
<tr>
<th>Reply</th>
<th>% of Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>52%</td>
</tr>
<tr>
<td>No</td>
<td>48%</td>
</tr>
</tbody>
</table>

3. How is your course time apportioned?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Average of Replies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>59%</td>
</tr>
<tr>
<td>Problem solving</td>
<td>26%</td>
</tr>
<tr>
<td>Questions and answers</td>
<td>15%</td>
</tr>
</tbody>
</table>

4. Do your quizzes emphasize theory or applications?

<table>
<thead>
<tr>
<th>Quiz Emphasis</th>
<th>% of Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mainly theory</td>
<td>5%</td>
</tr>
<tr>
<td>Mainly application problems</td>
<td>50%</td>
</tr>
<tr>
<td>About evenly split between theory and application</td>
<td>45%</td>
</tr>
</tbody>
</table>
5. What methods do you present for design of distillation columns?

<table>
<thead>
<tr>
<th>Method</th>
<th>% of Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponchon-Savarit</td>
<td>85%</td>
</tr>
<tr>
<td>McCabe-Thiele</td>
<td>81%</td>
</tr>
<tr>
<td>Thiele-Geddes</td>
<td>33%</td>
</tr>
<tr>
<td>Other multicomponent</td>
<td>19%</td>
</tr>
<tr>
<td>methods</td>
<td></td>
</tr>
</tbody>
</table>

* Most schools teach several methods

The replies to these questions show the emphasis placed on mass transfer as a practice-oriented subject. A number of instructors indicated use of the chemical engineering literature as sources of problem assignments and sources of data on new developments such as tower packing. At least half the schools teach a multicomponent distillation method in the undergraduate mass transfer course, although only 1/3 of the schools have access to an appropriate computer program in this area.

COURSE STRUCTURE

About two dozen topics were selected from textbooks recently used in mass transfer and unit operations. Instructors were asked to show the number of class sessions spent on each of these topics. Each school spent an average of 53 sessions on these topics. A 40-session course plan assumes a 15-week course meeting three times a week, with 5 sessions for quizzes. Thus, the replies indicate about 1 1/3 courses devoted to mass transfer. While a number of schools devoted two or more courses to mass transfer, few of these second and third courses were devoted exclusively to mass transfer. This is especially true for transport-oriented courses, where one course covers mass, heat and momentum transfer.
## MASS TRANSFER

### TOPIC TIME ALLOCATIONS

<table>
<thead>
<tr>
<th>Topic</th>
<th>Time (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular Diffusion</td>
<td>5.5</td>
</tr>
<tr>
<td>Gases</td>
<td>2.8</td>
</tr>
<tr>
<td>Liquids</td>
<td>2.0</td>
</tr>
<tr>
<td>Solids</td>
<td>0.7</td>
</tr>
<tr>
<td>Mass Transfer Coefficients</td>
<td>6.0</td>
</tr>
<tr>
<td>Laminar Flow</td>
<td>2.0</td>
</tr>
<tr>
<td>Turbulent Flow</td>
<td>2.0</td>
</tr>
<tr>
<td>Local/Overall</td>
<td>2.0</td>
</tr>
<tr>
<td>Equilibrium Stage Operations</td>
<td>7.5</td>
</tr>
<tr>
<td>Principles</td>
<td>4.0</td>
</tr>
<tr>
<td>Equipment</td>
<td>2.2</td>
</tr>
<tr>
<td>Heat and Mass Transfer</td>
<td>1.3</td>
</tr>
<tr>
<td>Humidification</td>
<td>2.4</td>
</tr>
<tr>
<td>Gas Absorption</td>
<td>6.9</td>
</tr>
<tr>
<td>Single Component, Isothermal</td>
<td>4.9</td>
</tr>
<tr>
<td>Multicomponent</td>
<td>0.9</td>
</tr>
<tr>
<td>Non-isothermal</td>
<td>1.1</td>
</tr>
<tr>
<td>Distillation</td>
<td>12.3</td>
</tr>
<tr>
<td>Differential</td>
<td>1.7</td>
</tr>
<tr>
<td>Multistage</td>
<td>6.9</td>
</tr>
<tr>
<td>Multicomponent</td>
<td>2.9</td>
</tr>
<tr>
<td>Azeotropic</td>
<td>0.8</td>
</tr>
<tr>
<td>Liquid Extraction</td>
<td>6.2</td>
</tr>
<tr>
<td>Equipment</td>
<td>0.9</td>
</tr>
<tr>
<td>Equilibria</td>
<td>1.2</td>
</tr>
<tr>
<td>Single Stage</td>
<td>1.1</td>
</tr>
<tr>
<td>Multistage</td>
<td>2.6</td>
</tr>
<tr>
<td>Multicomponent</td>
<td>0.4</td>
</tr>
<tr>
<td>Other Unit Operations</td>
<td>3.6</td>
</tr>
<tr>
<td>Adsorption</td>
<td>0.38</td>
</tr>
<tr>
<td>Ion Exchange</td>
<td>0.13</td>
</tr>
<tr>
<td>Drying</td>
<td>1.21</td>
</tr>
<tr>
<td>Leaching</td>
<td>1.07</td>
</tr>
<tr>
<td>Crystallization</td>
<td>0.21</td>
</tr>
<tr>
<td>Membrane Separations</td>
<td>0.18</td>
</tr>
<tr>
<td>Filtration</td>
<td>0.43</td>
</tr>
<tr>
<td>Other Topics</td>
<td>2.5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>52.9 hours</td>
</tr>
</tbody>
</table>


The replies to the Mass Transfer questionnaires received from each school are summarized on the following pages. The following form is used:

**NAME OF UNIVERSITY**

**TX:** Authors of text(s). Complete listings are given in the bibliography.

(Year/Semester/Class hours - lab hours)

Jr/S2/3-0 indicates a course with 3 hours classroom, 0 hours lab given in the second semester of the junior year.

**ORIENTATION:** Unit operations or transport theory.

**SI PROBLEMS:** Percent of problem assignments requiring SI units.

**TEXT COMMENTS:** Comments on how the text could be improved.

**DIFFICULT TOPICS:** What subject areas seem most difficult for the students to grasp.
UNIVERSITY OF AKRON
TX: 1. McCabe & Smith (Sr/3/0)
   2. Bird, Stewart & Lightfoot (Sr/3/0)

SI PROBLEMS: Less than 10%
TEXT COMMENTS: Cover less material with more examples and explanations.
Most texts are good reference books but not very good for instruction.
DIFFICULT TOPICS: Heat effects in gas absorption.

UNIVERSITY OF ALABAMA
TX: 1. Troybal (Jr/3/0)
   2. Troybal (Jr/3/0)

SI PROBLEMS: Less than 10%
TEXT COMMENTS: Cover less material with more examples and explanations.
Most texts are good reference books but not very good for instruction.
DIFFICULT TOPICS: Heat effects in gas absorption.

UNIVERSITY OF ARIZONA
TX: 1. McCabe & Smith (Jr/3/0)
   2. McCabe & Smith (Sr/3/0)

SI PROBLEMS: About 1/4
TEXT COMMENTS: Make material simpler to understand.
DIFFICULT TOPICS: Diffusion theory.

UNIVERSITY OF ARKANSAS
TX: 1. Troybl or McCabe & Smith (Jr/3/0)
   2. Smith (Sr/3/0)

SI PROBLEMS: About 1/4
TEXT COMMENTS: Simple exercise problems are needed prior to the more difficult comprehensive problems at the end of the chapter.
DIFFICULT TOPICS: Diffusion, Gas Absorption.

AUHAN UNIVERSITY
TX: 1. McCabe & Smith (Sr/4/0)
   2. McCabe & Smith (Sr/4/0)

SI PROBLEMS: Less than 10%

UNIVERSITY OF CALIFORNIA-BERKELEY
TX: 1. Sherwood, Pigford & Wilke (Jr/3/0)
   2. King (Sr/3/0)

ORIENTATION: Both
SI PROBLEMS: About 1/2
TEXT COMMENTS: More emphasis on solving design and operating problems in mass transfer controlled separations.
DIFFICULT TOPICS: Extraction using ternary diagrams; simultaneous mass and heat transfer.

UNIVERSITY OF CALIFORNIA-DAVIS
TX: 1. Bird, Stewart & Lightfoot (Sr/3/0)
   2. Troybal (Sr/3/0)

ORIENTATION: Both
SI PROBLEMS: Less than 10%
TEXT COMMENTS: Better correlation between transport phenomena and applications.
DIFFICULT TOPICS: Diffusion theory.

UNIVERSITY OF CALIFORNIA-LOS ANGELES
TX: 1. Edwards, Denny & Mills, "Transfer Processors" (Jr/4/0)
   2. McCabe & Smith (Sr/4/0)

SI PROBLEMS: About 1/4
TEXT COMMENTS: Extend section on humidification (cooling tower design) in McCabe & Smith.
DIFFICULT TOPICS: Diffusion theory.

CLEVELAND STATE UNIVERSITY
TX: 1. Troybl (Jr/4/0)
   2. Troybl (Sr/4/0)

ORIENTATION: Both
SI PROBLEMS: About 1/2
TEXT COMMENTS: More theoretical discussion of transport phenomena is needed.
DIFFICULT TOPICS: Simultaneous heat, mass and momentum transport.

CALIFORNIA INSTITUTE OF TECHNOLOGY
TX: 1. Bird, Stewart & Lightfoot (Jr/3/0)

ORIENTATION: Both
SI PROBLEMS: About 1/2

CITY UNIVERSITY OF NEW YORK
TX: 1. Bird, Stewart & Lightfoot (Jr/3/0)
   2. Foust (Sr/3/0)

ORIENTATION: Both
SI PROBLEMS: About 1/2
TEXT COMMENTS: Less than 10%
DIFFICULT TOPICS: Application of the equations of change of multi-component systems by picking boundary conditions.

CLARKSON COLLEGE OF TECHNOLOGY
TX: 1. Troybal (Sr/3/0)
   2. Troybal (Sr/3/0)

SI PROBLEMS: Less than 10%
TEXT COMMENTS: Use SI units.
DIFFICULT TOPICS: Diffusion theory.

CLEMSON UNIVERSITY
TX: 1. Littlejohn: Notes on Distillation & Extraction (Sr/3/0)
   2. McCabe & Smith (Jr/3/0)

SI PROBLEMS: About 1/4
TEXT COMMENTS: Extend section on humidification (cooling tower design) in McCabe & Smith.
DIFFICULT TOPICS: Diffusion theory.

COLEGE OF TECHNOLOGY
TX: 1. Troybl (Jr/3/0)
   2. Troybl (Sr/3/0)

ORIENTATION: Both
SI PROBLEMS: About 1/2
TEXT COMMENTS: More theoretical discussion of transport phenomena is needed.
DIFFICULT TOPICS: Simultaneous heat, mass and momentum transport.

COLUMBUS UNIVERSITY
TX: 1. Bennett & Myers (Sr/3/0)
   2. Holty, Wicks & Wilson (Sr/3/0)

SI PROBLEMS: About 1/4
TEXT COMMENTS: Make texts more readable.
DIFFICULT TOPICS: Diffusion, convective transport.

COLUMBIA UNIVERSITY
TX: 1. Bird, Stewart & Lightfoot (Jr/3/0)

ORIENTATION: Both
SI PROBLEMS: About 1/2

ORIENTATION: Both
SI PROBLEMS: About 1/2
TEXT COMMENTS: More theoretical discussion of transport phenomena is needed.
DIFFICULT TOPICS: Simultaneous heat, mass and momentum transport.

COLUMBIA UNIVERSITY OF NEW YORK
TX: 1. Bird, Stewart & Lightfoot (Jr/3/0)
   2. Foust (Sr/3/0)

ORIENTATION: Both
SI PROBLEMS: About 1/2
TEXT COMMENTS: Less than 10%
DIFFICULT TOPICS: Application of the equations of change of multi-component systems by picking boundary conditions.

CLARKSON COLLEGE OF TECHNOLOGY
TX: 1. Troybal (Sr/3/0)
   2. Troybal (Sr/3/0)

SI PROBLEMS: Less than 10%
TEXT COMMENTS: Use SI units.
DIFFICULT TOPICS: Diffusion theory.

CLEMSON UNIVERSITY
TX: 1. Littlejohn: Notes on Distillation & Extraction (Sr/3/0)
   2. McCabe & Smith (Jr/3/0)

SI PROBLEMS: About 1/4
TEXT COMMENTS: Extend section on humidification (cooling tower design) in McCabe & Smith.
DIFFICULT TOPICS: Diffusion theory.

COLEGE OF TECHNOLOGY
TX: 1. Troybl (Jr/3/0)
   2. Troybl (Sr/3/0)

ORIENTATION: Both
SI PROBLEMS: About 1/2
TEXT COMMENTS: More theoretical discussion of transport phenomena is needed.
DIFFICULT TOPICS: Simultaneous heat, mass and momentum transport.

COLUMBUS UNIVERSITY
TX: 1. Bennett & Myers (Sr/3/0)
   2. Holty, Wicks & Wilson (Sr/3/0)

SI PROBLEMS: About 1/4
TEXT COMMENTS: Make texts more readable.
DIFFICULT TOPICS: Diffusion, convective transport.
UNIVERSITY OF COLORADO
TX: 1. Notes (Jr/3/1)

GROVE CITY COLLEGE
TX: 1. Troybal (Jr/3/0)
2. Troybal (Sr/3/0)
SI PROBLEMS: About 1/4
DIFFICULT TOPICS: Continuous contact modeling.

UNIVERSITY OF CONNECTICUT
TX: 1. Bennet & Myers (Jr/3/0)
ORIENTATION: Both
SI PROBLEMS: About 3/4
DIFFICULT TOPICS: Continuous contact modeling.

TEXT COMMENTS: More illustrative problems.

CORNELL UNIVERSITY
TX: 1. McCabe & Smith (Jr/3/2)
2. Smith & Van Ness (Jr/3/0)
SI PROBLEMS: Less than 10%
DIFFICULT TOPICS: Multicomponent operations in general.

UNIVERSITY OF DELAWARE
TX: 1. King (Sr/2/0)
2. Bird, Stewart & Lightfoot (Jr/3/0)
ORIENTATION: Both
SI PROBLEMS: Less than 10%
DIFFICULT TOPICS: More diverse illustrations; Treat all stage equilibrium processes alike.

DIFFICULT TOPICS: Relating triangular solvent-free phase diagrams.

DREXEL UNIVERSITY
TX: 1. Bennet & Myers (Jr/3/0)
2. McCabe & Smith (Jr/3/0)
SI PROBLEMS: Less than 10%
DIFFICULT TOPICS: Gas absorption with chemical reaction; Multicomponent distillation.

UNIVERSITY OF IOWA
TX: 1. McCabe & Smith (Jr/3/0)
2. McCabe & Smith (Sr/2/0)
SI PROBLEMS: About 3/4
DIFFICULT TOPICS: Mass transfer-heat transfer analogy; humidification.

IONA STATE UNIVERSITY
TX: 1. McCabe & Smith (Jr/4/0)
2. McCabe & Smith, Bennet & Myers (Sr/4/0)
ORIENTATION: Both
SI PROBLEMS: 1. Less than 10%
2. About 1/2
DIFFICULT TOPICS: Non-ideal vapor-liquid equilibria.

UNIVERSITY OF KANSAS
TX: 1. Troybal (Jr/3/3)
SI PROBLEMS: Less than 10%
DIFFICULT TOPICS: Distillation seems a mystery to some.

KANSAS STATE UNIVERSITY
TX: 1. Troybal (Sr/2/0)
SI PROBLEMS: About 1/2

UNIVERSITY OF KENTUCKY
TX: 1. Troybal (Jr/2/0)
2. Troybal (Jr/3/0)
SI PROBLEMS: Less than 10%
DIFFICULT TOPICS: Separate the stages and rate portions into separate sections of the book. Introduce a number of computer-oriented problems.

DIFFICULT TOPICS: Simultaneous heat and mass transfer.

LAFAYETTE COLLEGE
TX: 1. Troybal (Sr/4/3)
SI PROBLEMS: About 1/4

LAMAR UNIVERSITY
TX: 1. Troybal (Sr/3/3)
ORIENTATION: Both
SI PROBLEMS: About 1/4
DIFFICULT TOPICS: Give more illustrations and problems in SI units.

DIFFICULT TOPICS: Mass transfer coefficient under different conditions.

LOUISIANA STATE UNIVERSITY
TX: 1. Bennet & Myers or Walty, Wicks & Wilson (Jr/4/0)
ORIENTATION: Transport
SI PROBLEMS: About 1/2
DIFFICULT TOPICS: More realistic problems on absorption and extraction.
DIFFICULT TOPICS: Multicomponent diffusion.

UNIVERSITY OF LOUISVILLE
TX: 1. McCabe & Smith and Troybal (Jr/3/0)
SI PROBLEMS: About 1/4

MANHATTAN COLLEGE
TX: 1. McCabe & Smith (Jr/3/0)
SI PROBLEMS: Less than 10%
DIFFICULT TOPICS: Redo over 1/2 of the mass transfer material.

UNIVERSITY OF MARYLAND
TX: 1. Troybal (Jr/3/0)
DIFFICULT TOPICS: Diffusion

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
TX: 1. Bird, Stewart & Lightfoot (Jr/4/0)
2. King (Sr/3/0)
ORIENTATION: Both
SI PROBLEMS: Less than 10%

UNIVERSITY OF MASSACHUSETTS
TX: 1. McCabe & Smith and Bird, Stewart & Lightfoot (Jr/3/0)
2. King (Sr/3/0)
ORIENTATION: Both
SI PROBLEMS: About 1/4

MC NESE STATE UNIVERSITY
TX: 1. Sherwood, Pigford & Wilke (Jr/3/0)
2. King (Jr/3/0)
SI PROBLEMS: About 3/4
DIFFICULT TOPICS: Better integration of unit operations and transport phenomena.

DIFFICULT TOPICS: Multicomponent diffusion.
UNIVERSITY OF ROCHESTER

TX: 1. Troybal (Sr/1)/0
2. Bennett & Myers (Jr/3)/0

ORIENTATION: Transport

ST PROBLEMS: About 1/2

TEXT COMMENTS: Material on order-of-magnitude estimates to identify controlling phenomena.

DIFFICULT TOPICS: Bridge between exact equations and empirical correlations for transfer coefficients.

SAN JOSE STATE UNIVERSITY

TX: 1. McCabe & Smith (Sr/2)/0
2. Smith (Jr/5)/0

ORIENTATION: Both

ST PROBLEMS: About 1/4

TEXT COMMENTS: Clean up the mass transfer coefficient stuff. It appears unnecessarily intimidating in Troybal.

DIFFICULT TOPICS: Various types of mass transfer coefficients.

SOUTH DAKOTA SCHOOL OF MINES

TX: 1. McCabe & Smith (Sr/2)/0
2. McCabe & Smith (Sr/2)/0


ST PROBLEMS: About 1/4

TEXT COMMENTS: Additional example problems needed.

DIFFICULT TOPICS: Distillation, extraction.

UNIVERSITY OF SOUTHERN CALIFORNIA

TX: 1. McCabe & Smith (Jr/4)/0


ST PROBLEMS: About 1/4

TEXT COMMENTS: Eliminate the errors.

DIFFICULT TOPICS: Molecular Diffusion, Absorption.

STEVEN'S INSTITUTE OF TECHNOLOGY

TX: 1. Troybal (Jr/3)/0
2. Geankoplis (Jr/3)/0

ORIENTATION: Transport

ST PROBLEMS: 1. Less than 10%
2. About 1/4

TEXT COMMENTS: Change notation; pay more attention to thermodynamics.

DIFFICULT TOPICS: Phase equilibria; convective and diffusive contributions to mass flux in a fixed coordinate frame.
UNIVERSITY OF WISCONSIN-MILWAUKEE
TX: 1. Sherwood, Pigford & Wilke (Sr/3/0)
ORIENTATION: Both
SI PROBLEMS: About 1/2
DIFFICULT TOPICS: Emphasize similarities between operations rather than treating each topic as unique.

WORCESTER POLYTECHNIC INSTITUTE
TX: 1. McCabe & Smith and Bird, Stewart & Lightfoot (Jr/5/0)
ORIENTATION: Both
SI PROBLEMS: About 3/4
TEXT COMMENTS: Needs more "real life" problems.
DIFFICULT TOPICS: Getting a physical feel for reference frames.

UNIVERSITY OF WYOMING
TX: 1. Foust, et al (Sr/3/0)
SI PROBLEMS: About 1/4

UNIVERSITY OF PUERTO RICO
TX: 1. Treybal (Jr/4/0)
ORIENTATION: 1. Unit Op.; 2. Transport
SI PROBLEMS: Less than 10%
DIFFICULT TOPICS: Diffusion / Humidification.

UNIVERSITY OF ALBERTA
TX: 1. Treybal (Sr/2/2)
ORIENTATION: Both
SI PROBLEMS: About 3/4
TEXT COMMENTS: Should have more worked-out problems.
DIFFICULT TOPICS: Correct usage of k and P values.

UNIVERSITY OF CALGARY
TX: 1. McCabe & Smith (Sr/3/0)
SI PROBLEMS: About 3/4
TEXT COMMENTS: Add furnace design.
DIFFICULT TOPICS: Humidification.

LAVAL UNIVERSITY
TX: 1. Treybal (Sr/3/0)
2. Treybal (Sr/3/0)
ORIENTATION: Both
SI PROBLEMS: About 3/4
TEXT COMMENTS: Thorough discussion on distillation first, then analogies of other processes.
DIFFICULT TOPICS: Batch distillation tray towers and gas-liquid operations in packed towers.

MC MASTER UNIVERSITY
TX: 1. Treybal and Bennett & Myers (2 1/2/0)
ORIENTATION: Both
SI PROBLEMS: About 1/4
TEXT COMMENTS: Need a single unified book (not too long) on both Unit Operations and transport phenomena.

UNIVERSITY OF NEW BRUNSWICK
TX: 1. Bird, Stewart & Lightfoot (Jr/3/0)
2. Treybal (Sr/3/0)
ORIENTATION: Both
SI PROBLEMS: About 1/4
DIFFICULT TOPICS: Convexion driving forces and mass transfer coefficients.

UNIVERSITY OF SASKATCHEWAN
TX: 1. Bennett & Myers (Sr/3/0)
ORIENTATION: Both
SI PROBLEMS: Less than 10%
DIFFICULT TOPICS: Continuous contacting concentrated solutions.

NOVA SCOTIA TECHNICAL COLLEGE
TX: 1. McCabe & Smith (Sr/3/3)
2. Treybal (Sr/2/3)
3. Bird, Stewart & Lightfoot (Sr/3/3)
ORIENTATION: 1.2. Unit Op.; 3. Transport
SI PROBLEMS: About 1/2
TEXT COMMENTS: More theoretical treatment in course 1.

UNIVERSITY OF OTTAWA
TX: 1. Treybal (Sr/3/0)
ORIENTATION: Both
SI PROBLEMS: About 1/4
TEXT COMMENTS: Convert part of course to SI units.
DIFFICULT TOPICS: Significance of the mass transfer coefficient.

UNIVERSITY OF QUEEN'S
TX: 1. None (Jr/5/0)
SI PROBLEMS: About 1/4
TEXT COMMENTS: Thorough discussion on distillation first, then analogies of other processes.
DIFFICULT TOPICS: Batch distillation tray towers and gas-liquid operations in packed towers.

ROYAL MILITARY COLLEGE
TX: 1. Treybal (Sr/2/0)
SI PROBLEMS: Less than 10%
DIFFICULT TOPICS: Convexion driving forces and mass transfer coefficients.

UNIVERSITY OF WATERLOO
TX: 1. Treybal (Jr/3/3)
ORIENTATION: Both
SI PROBLEMS: Less than 10%
DIFFICULT TOPICS: General continuing equation.

UNIVERSITY OF WESTERN ONTARIO
TX: 1. McCabe & Smith (Sr/3/3)
2. McCabe & Smith (Sr/3/3)
ORIENTATION: Both
SI PROBLEMS: About 1/2
LICHARD UNIVERSITY

TX: 1. McCabe & Smith (Sr/4/0)

SI PROBLEMS: About 1/4
TEXT COMMENTS: Stress more analytical techniques, including computer analysis of mass transfer systems.
DIFFICULT TOPICS: Distillation (Enthalpy-concentration).

ILLINOIS INSTITUTE OF TECHNOLOGY

TX: 1. Treybal (Jr/4/2)

SI PROBLEMS: About 1/4
TEXT COMMENTS: Provide introductory chapter on transport phenomena approach to mass transfer.
DIFFICULT TOPICS: Vector notation; Similarity transformation.

STATE UNIVERSITY OF NEW YORK-BUFFALO

TX: 1. Belnot & Myers; Welty, Wicks & Wilson (Jr/3/1)

ORIENTATION: Transport
SI PROBLEMS: About 1/4
TEXT COMMENTS: Some organizational changes.

UNIVERSITY OF UTAH

TX: 1. Treybal (Jr/3/0)
   2. Bird, Stewart & Lightfoot (Jr/3/0)

ORIENTATION: 1. Both; 2. Transport
SI PROBLEMS: Less than 10%
TEXT COMMENTS: Treatment of degrees of freedom for equipment and processes.
DIFFICULT TOPICS: Treatments of interfacial conditions, nature and direction of mass transfer driving forces.
BIBLIOGRAPHY


# ST I - GENERAL INFORMATION

## Course Identification

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Catalog Number</th>
<th>Title</th>
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<th>Year (Circle)</th>
<th>Sem/Qu (Circle)</th>
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## Course Resources/Class Data (Please attach a course outline)

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Text (Author, Title, Ed.)</th>
<th>Class Size</th>
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* Required (R) or Elective (E) Course  
** % of Course Allocated to Mass Transfer (if other than 100%)

## Time Allocations

<table>
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<tr>
<th>Weeks per (Semester/Quarter) (Circle 1)</th>
<th>Minutes per Class Session (based on three sessions/week)</th>
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<td>(do, do not) plan to attend the Miami meeting.</td>
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Do you use any demonstrations or films in the classroom? If so, please elaborate.

Would you classify the text as unit operations oriented (e.g. McCabe & Smith) or transport phenomena (e.g. Bird, Stewart & Lightfoot) oriented? (Circle 1)

- Unit Op.  
- Transport  
- Some of Both  
- Neither  

What portion of the problem assignments are solved in SI units (as contrasted with English units)? (Circle 1)

- Less than 10%  
- About 1/4  
- About 1/2  
- About 3/4  
- More than 90%

Is this text used as the principal text for another course? If so, please give course title.
5. About what percent of the assignments require use of a digital or analog computer? (Express to nearest 10%) __________% 

6. Do you require students to turn in assigned problems? (Circle 1)
   Most of the time Sometimes Rarely Never

7. Do you supplement your lectures with articles from the chemical engineering literature? (e.g. Chemical Engineering, I/EC, CEP) If so, how are these articles used?

8. Approximately what percent of your course time is devoted to lecture_____%, problem solving_____%, questions and answers_____%.

9. Are your tests
   a. mainly theory
   b. mainly application problems
   c. about evenly split between a and b.

10. What are some typical students' reactions upon completion of the course?

11. What topics, if any, seems particularly difficult for the student?

12. If you were revising the text for the course, what additions or changes would you make?

13. Which methods do you cover in distillation (e.g. Ponchon-Savarit, Thiele-Geddes)?

14. Do students have access to a multi-component distillation computer program? If so, which?
<table>
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<tr>
<th>Molecular Diffusion</th>
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<th>Liquid Extraction</th>
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\( a \) From Part IA