Laboratory Manual

For

Process Equipment Design

(3170502)

LUKHDHIRJI ENGINEERING COLLEGE, MORBI
MORBI

This is to certify that

Mr./Ms. ……………………………………………………………………………. Enrollment Number: ………………………….. Branch: Chemical, Semester: …….. Has satisfactorily completed the term work in the subject code..................and Name……………………………. from Lukhdhirji engineering college, Morbi.

Date of Submission: …………………… Staff in charge: ………….

Head of Department……………………………………………

LUKHDHIRJI ENGINEERING COLLEGE, MORBI

VISION

To provide quality engineering education and transforming students into professionally competent and socially responsible human beings.

MISSION

1. To provide a platform for basic and advanced engineering knowledge to meet global challenges.
2. To impart state-of-art know- how with managerial and technical skills.
3. To create a sustainable society through ethical and accountable engineering practices.

LUKHDHIRJI ENGINEERING COLLEGE, MORBI
CHEMICAL ENGINEERING DEPARTMENT

VISION

To develop professionally competent & socially responsible chemical engineers by providing quality education.

MISSION

1. To provide sound basic engineering knowledge to have a successful career in a professional environment.
2. To develop skill sets among the students to make them professionally competent.
3. To cater ethically strong engineers who shall be able to improve the quality of life and to work for sustainable development of society.

<u>PEO's</u>

PEO-1 To impart knowledge and skills in students to make them professionally competent in chemical process industries.
PEO-2 To motivate students for higher studies in technical and management fields.
PEO-3 To prepare students having soft skills along with leadership quality and management ability to make them successful entrepreneurs.
PEO-4 To implant the ethical principle and norms of engineering practices in terms of health, safety, and environmental context for the sustainable development of society.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO

1) Apply the knowledge of chemical engineering to accomplish the contemporary need of chemical & Allied Industries.
2) To execute the chemical engineering principle and modern engineering tools to design system by considering safety, cost, health, legal, cultural and environmental aspects.

Chemical Engineering Department

Laboratory Safety Rules

1. Behave in a responsible manner at all times in the laboratory.
2. Ask your teacher before preceding any activity.
3. Keep silence.
4. Do not touch any equipment, chemicals, or other materials in the laboratory area until you are instructed to do so.
5. Perform only those experiments authorized by your teacher.
6. Do not eat food, drink beverages, or chew gum in the laboratory.
7. Always work in a well-ventilated area.
8. Work areas should be kept clean and tidy at all times.
9. Wash your hands after performing all experiments.
10. Dress properly during a laboratory activity. Long hair, dangling jewelry, and loose or baggy clothing are a hazard in the laboratory.
11. Never look into a container that is being heated.
12. Obey safety rules.
13. After Completion of Experiments turn off equipment properly.
14. Drain Water After Compilation of Experiments.
15. Before Living the Laboratory turns Off Light/Fan.

Undertaking of Ethics

1. I, hereby, promise to abide by the admissible rules and regulations, concerning discipline, attendance, etc. of the L.E.C.MORBI, and also to follow the Code of Conduct prescribed for the Students of the Institute, as in force from time to time and subsequent changes/modifications/amendment made thereto. I acknowledge that, the Institute has the authority for taking punitive actions against me for violation and/or non-compliance of the same.
2. I have performed all the experiments and their calculation done myself.

Signature of Student

Enrollment of Student

INDEX

Sr. No.	Experiment No./Assignment No./Project Work.	Title of Experiment/Project	Due Date	Date of Submission	Page No.	Teacher's Sign	Remarks/ Marks obtain	Experiment/ Project Mapping with CO	Set up
1	Experiment	Draw sketches of types of heat exchanges and various parts of HE.						3170502.3	Not Required
2	Experiment	Draw sketches of TEMA type designation for shell and tube heat exchanger.						3170502.3	Not Required
3	Experiment	Draw sketches of different type's flanges, flange facings.						3170502.5	Not Required
4	Experiment	Draw sketches of different types of head.						3170502.5	Not Required
5	Experiment	Open Ended Problem for design of piping, pressure drop, select suitable pump and find NPSH and power requirement.						3170502.1	Not Required
6	Experiment	Open Ended Problem for design of piping, pressure drop, select suitable pump and find NPSH and power requirement.						3170502.1	Not Required
7	Experiment	Open Ended Problem for Design of distillation column with complete tray design.						3170502.2 3170502.4	Not Required

Sr. No.	Experiment No./Assignment No./Project Work.	Title of Experiment/Project	Due Date	Date of Submission	Page No.	Teacher's Sign	Remarks/ Marks obtain	Experiment/ Project Mapping with CO	Set up
8	Experiment	Open Ended Problem for Design of distillation column with complete tray design.						3170502.2 3170502.4	Not Required
9	Experiment	Open Ended Problem for Design of Heat exchanger (Condenser and/or reboiler)						3170502.2 3170502.4	Not Required
10	Experiment	Open Ended Problem for Design of Heat exchanger (Condenser and/or reboiler)						3170502.2 3170502.4	Not Required
11	Experiment	Design of different types of head						3170502.5	Not Required

Draw sketches of types of heat exchanges and various parts of HE

Experiment No: 01

Draw sketches of different types of heat exchanger with nomenclature in Sketch-book given in following book and page no.

Book Name: Introduction to Process Equipment Design Book
Authors: S B Thakore and B I Bhatt
Page No: 135 and 136

Draw sketches of TEMA type designation for shell and tube heat exchanger.

Experiment No: 02

Draw sketches of TEMA type designation for shell and tube heat exchanger with nomenclature in Sketch-book given in following book and page no.

Book Name: Introduction to Process Equipment Design Book
Authors: S B Thakore and B I Bhatt
Page No: 156

Draw sketches of different type's flanges, flange facings.

Experiment No: 03

Draw sketches of different type's flanges, flange facings with nomenclature in Sketch-book given in following book and page no.

Book Name: Illustrated Process Equipment Design
Authors: S B Thakore and D A Shah
Page No: 64 to 66 and 68 to 70

Draw sketches of different types of head.

Experiment No: 04

Draw sketches of different types of head in Sketch-book given in following book and page no.

Book Name: Illustrated Process Equipment Design
Authors: S B Thakore and D A Shah
Page No: 36 to 47

Open Ended Problem for design of piping, pressure drop

Experiment No: 05

Design various equipment used for Production of Acetone from Iso-Propanol.

(Ref.: Analysis, Synthesis and Design of Chemical Processes by Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwits)

Refer Page No. 1027 of above ref. for details of process and collect flow rate, temperature and pressure data from the given ref.

Find suitable physical and thermodynamic properties and Design following equipment based on the data given in above reference:

1. Piping design for reflux – Steam No. 9 for Feed, Steam 10 for reflux to column, Stream 11 for distillate, Stream 12 bottom product.
2. Select suitable pump and find NPSH and Power requirement for selected pump for reflux stream.

Take the necessary assumption for design

Table B.9.3 Utility Summary for Unit 1000

Utility	cw	cw	lps	rw	lps	cw	lps	cw	lps	cw
Equipment	E-1001	E-1002	E-1003	E-1004	E-1005	E-1006	E-1007	E-1008	E-1009	E-1010
Flow (tonne/h)	1995.0	1682.0	48.5	5182.0	1.07	54.5	10.19	378.0	3.85	16.7

going to the organic phase (in this case DIPE). Distribution coefficients for the organic acids in water and DIPE as well as mutual solubility data for water/DIPE are desirable. The process given in Figure B.2 was simulated using a UNIFAC thermodynamics package and the latent heat enthalpy option on CHEMCAD and should give reasonable results for preliminary process design. Much of the process background material and process configuration was taken from the 1986 AIChE student contest problem in Reference [5]. The kinetics presented above are fictitious but should give reasonable preliminary estimates of reactor size.

B.9.4 References

1. Kurland, J. J., and D. B. Bryant, "Shipboard Polymerization of Acrylic Acid," *Plant Operations Progress* 6, no. 4 (1987): 203–207.
2. *Kirk-Othmer Encyclopedia of Chemical Technology*, 3rd ed., vol. 1 (New York: John Wiley and Son, 1978), 330–354.
3. *Encyclopedia of Chemical Processing and Design*, ed. J. J. McKetta and W. A. Cunningham, vol. 1 (New York: Marcel Dekker, 1976), 402–428.
4. Sakuyama, S., T. Ohara, N. Shimizu, and K. Kubota, "A New Oxidation Process for Acrylic Acid from Propylene," *Chemical Technology* (June 1973): 350.
5. "1986 Student Contest Problem," *The AIChE Student Annual 1986*, ed. B. Van Wie, and R. A. Wills (AIChE, 1986), 52–82.

B.10 PRODUCTION OF ACETONE VIA THE DEHYDROGENATION OF ISOPROPYL ALCOHOL (IPA) [1, 2, 3, 4], UNIT 1100

The prevalent process for the production of acetone is as a by-product of the manufacture of phenol. Benzene is alkylated to cumene, which is further oxidized to cumene hydroperoxide and finally cleaved to yield phenol and acetone. However, the process shown in Figure B.10.1 and discussed here uses isopropyl alcohol (IPA) as the raw material. This is a viable commercial alternative, and a few

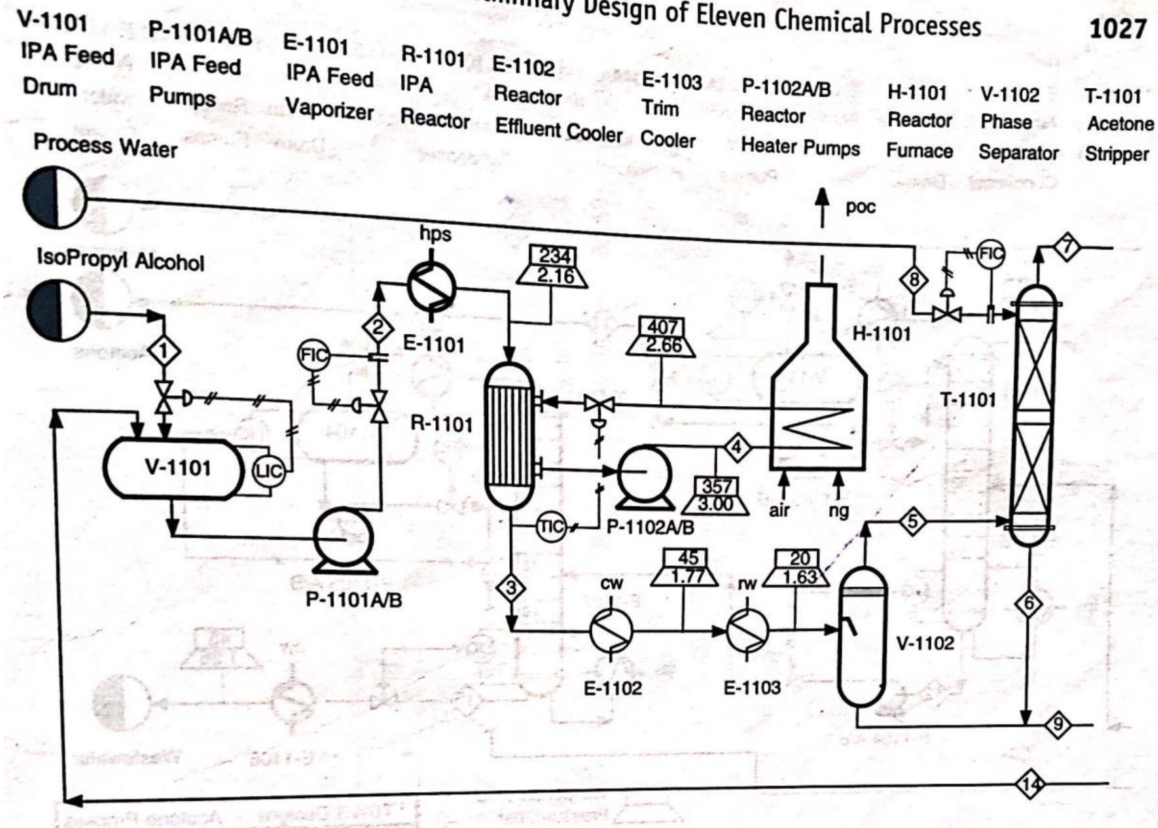

Figure B.10.1 Unit 1100: Production of Acetone from Isopropyl Alcohol PFD

plants continue to operate using this process. The primary advantage of this process is that the acetone produced is free from trace aromatic compounds, particularly benzene. For this reason, acetone produced from IPA may be favored by the pharmaceutical industry due to the very tight restrictions placed on solvents by the Food and Drug Administration (FDA). The reaction to produce acetone from IPA is as follows.

$$\underset{\text{Isopropyl Alcohol}}{(CH_3)_2CHOH} \rightarrow \underset{\text{Acetone}}{(CH_3)_2CO} + H_2$$

The reaction conditions are typically 2 bar and 350°C, giving single-pass conversions of 85%–92%.

B.10.1 Process Description

Referring to Figure B.10.1, an azeotropic mixture of isopropyl alcohol and water (88 wt% IPA) is fed into a surge vessel (V-1101), where it is mixed with the recycled unreacted IPA/water mixture, Stream 14. This material is then pumped and

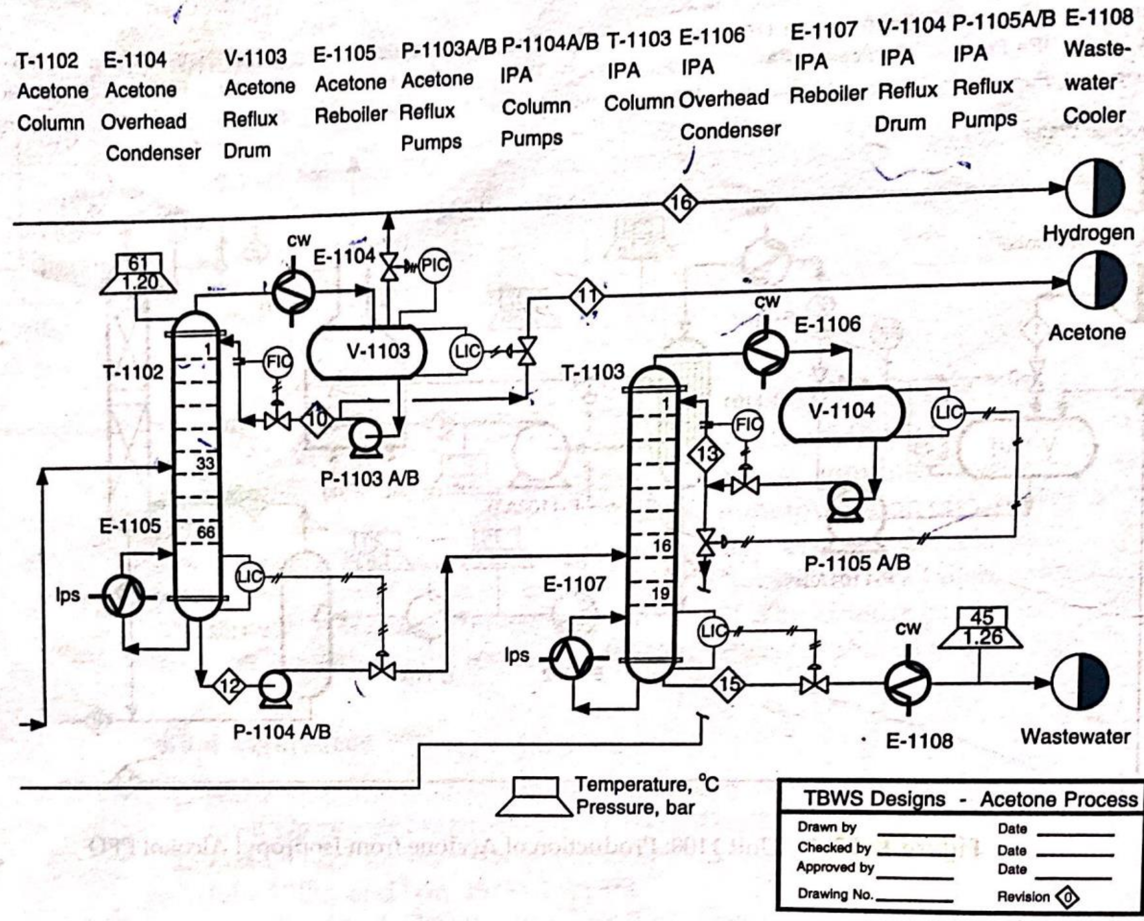

Figure B.10.1 *(Continued)*

vaporized prior to entering the reactor. Heat is provided for the endothermic reaction using a circulating stream of molten salt, Stream 4. The reactor effluent, containing acetone, hydrogen, water, and unreacted IPA, is cooled in two exchangers prior to entering the phase separator (V-1102). The vapor leaving the separator is scrubbed with water to recover additional acetone, and then this liquid is combined with the liquid from the separator and sent to the separations section. Two towers are used to separate the acetone product (99.9 mole %) and to remove the excess water from the unused IPA, which is then recycled back to the front end of the process as an azeotropic mixture. Stream summaries, preliminary equipment and utility summaries are given in Tables B.10.1, B.10.2 and B.10.3, respectively.

Table B.10.1 Flow Table for Acetone Process in Figure B.10.1

Stream Number	1	2	3	4	5	6	7	8
Temperature (°C)	25	32	350	357	20	27	33	25
Pressure (bar)	1.01	2.30	1.91	3.0	1.63	1.63	1.50	2.0
Vapor fraction	0.0	0.0	1.0	0.0	1.0	0.0	1.0	0.0
Mass flow (tonne/h)	2.40	2.67	2.67	35.1	0.34	0.46	0.24	0.36
Mole flow (kmol/h)	51.96	57.84	92.62	0.00	39.74	21.14	38.60	20.00
Component mole flow (kmol/h)				Molten Salt				
Hydrogen	0.00	0.00	34.78	0.00	34.78	0.00	34.78	0.00
Acetone	0.00	0.16	34.94	0.00	4.44	1.93	2.51	0.00
Isopropyl alcohol	34.82	38.64	3.86	0.00	0.12	0.10	0.02	0.00
Water	17.14	19.04	19.04	0.00	0.40	19.11	1.29	20.00

(*continued*)

Table B.10.1 Flow Table for Acetone Process in Figure B.10.1 (*Continued*)

Stream Number	9	10	11	12	13	14	15	16
Temperature (°C)	22	61	61	90	83	83	109	33
Pressure (bar)	1.63	1.5	1.5	1.4	1.2	1.2	1.4	1.2
Vapor fraction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Mass flow (tonne/h)	2.79	4.22	1.88	0.92	8.23	0.27	0.65	0.24
Mole flow (kmol/h)	74.02	72.51	32.29	41.73	177.18	5.88	35.85	38.60
Component mole flow (kmol/h)								
Hydrogen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	34.78
Acetone	32.43	72.46	32.27	0.16	4.82	0.16	0.00	2.51
Isopropyl alcohol	3.84	0.05	0.02	3.82	115.10	3.82	0.00	0.02
Water	37.75	0.00	0.00	37.75	57.26	1.90	35.85	1.29

le B.10.2 Preliminary Equipment Summary Table for Acetone Process

quipment	P-1101 A/B	P-1102 A/B	P-1103 A/B	P-1104 A/B	P-1105 A/B	V-1101	V-1102
MOC	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel
Power (shaft) (kW)	0.43	2.53	1.75	0.06	1.45	0.00	0.00
Efficiency	40%	50%	40%	40%	40%	0.00	0.00
Type/drive	Centrifugal/ Electric	Centrifugal/ Electric	Centrifugal/ Electric	Centrifugal/ Electric	Centrifugal/ Electric	0.00	0.00
Temperature (°C)	25	400	61	90	83	0.00	0.00
Pressure in (bar)	1.13	1.83	1.41	1.93	1.42	0.00	0.00
Pressure out (bar)	3.00	3.00	4.48	2.78	3.25	0.00	0.00
Diameter (m)	0.00	0.00	0.00	0.00	0.00	0.80	0.75
Height/length (m)	0.00	0.00	0.00	0.00	0.00	2.40	2.25
Orientation	0.00	0.00	0.00	0.00	0.00	Horizontal	Vertical
Internals	0.00	0.00	0.00	0.00	0.00	0.00	SS Demister
Pressure (barg)	0.00	0.00	0.00	0.00	0.00	0.0	0.63

(continued)

Table B.10.2 Preliminary Equipment Summary Table for Acetone Process (*Continued*)

Equipment	V-1103	V-1104	T-1101	T-1102	T-1103	H-1101	R-1101
MOC	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel
Diameter (m)	0.83	0.93	0.33	1.25	1.36	0.00	1.85
Height/length (m)	2.50	2.80	3.20	37.0	18.6	0.00	8.0
Orientation	Horizontal	Horizontal	Vertical	Vertical	Vertical	0.00	Vertical
Internals	0.00	0.00	2.5 m of Packing 1″ Ceramic Rashig Rings	66 SS Sieve Plates @ 18″ Spacing	19 SS Sieve Plates @ 24″ Spacing	0.00	448 2″ Diameter, 20′ Long Catalyst Filled Tubes
Pressure (barg)	0.2	0.2	1.0	0.4	0.4	0.00	2.0
Type	0.00	0.00	0.00	0.00	0.00	Fired Heater	0.00
Duty (MJ/h)	0.00	0.00	0.00	0.00	0.00	2,730	0.00
Area radiant (m^2)	0.00	0.00	0.00	0.00	0.00	10.1	0.00
Area convective (m^2)	0.00	0.00	0.00	0.00	0.00	30.4	0.00
Tube pressure (barg)	0.00	0.00	0.00	0.00	0.00	2.0	0.00

(*continued*)

Table B.10.2 *(Continued)*

Equipment	E-1101	E-1102	E-1103	E-1104	E-1105	E-1106	E-1107	E-1108
Type	Float. Head Vaporizer	Float. Head Partial Cond.	Float. Head Partial Cond.	Fixed TS Condenser	Float. Head Reboiler	Fixed TS Condenser	Float. Head Reboiler	Double Pipe
Duty (MJ/h)	3,550	3,260	563	3,095	3,500	7,340	7,390	174
Area (m^2)	70.3	77.6	8.5	39.1	30.9	50.2	65.1	1.6
Shell side								
Max. temp (°C)	234	350	45	61	90	83	109	109
Pressure (barg)	1.0	1.0	1.0	0.2	0.4	0.2	0.4	0.4
Phase	Boiling Liq.	Cond. Vapor	Cond. Vapor	Cond. Vapor	Boiling Liq.	Cond. Vapor	Boiling Liq.	L
MOC	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel
Tube side								
Max. temp (°C)	254	40	15	40	160	40	160	40
Pressure (barg)	41.0	3.0	3.0	3.0	5.0	3.0	5.0	3.0
Phase	Cond. Steam	L	L	L	Cond. Steam	L	Cond. Steam	L
MOC	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel	Carbon Steel

1033

Table B.10.3 Summary Table Unit 1100

Utility	hps	cw	rw	cw	lps	cw	lps	cw
Equipment	E-1101	E-1102	E-1103	E-1104	E-1105	E-1106	E-1107	E-1108
Flow (tonne/h)	2.09	77.90	13.50	74.00	1.68	176.00	3.55	4.16

B.10.2 Reaction Kinetics

The reaction to form acetone from isopropyl alcohol (isopropanol) is endothermic, with a standard heat of reaction of 62.9 kJ/mol. The reaction is kinetically controlled and occurs in the vapor phase over a catalyst. The reaction kinetics for this reaction are first order with respect to the concentration of alcohol and can be estimated from the following equation [3,4]:

$$-r_{IPA} = k_0 \exp\left[-\frac{E_a}{RT}\right] C_{IPA} \quad \frac{\text{kmol}}{\text{m}^3\text{reactor s}}$$

where $E_a = 72.38\text{MJ/kmol}$, $k_0 = 3.51 \times 10^5 \frac{\text{m}^3\text{gas}}{\text{m}^3\text{reactor s}}$, $C_{IPA} = \frac{\text{kmol}}{\text{m}^3\text{gas}}$

In practice, several side reactions can occur to a small extent. Thus, trace quantities of propylene, diisopropyl ether, acetaldehyde, and other hydrocarbons and oxides of carbon can be formed [1]. The noncondensables are removed with the hydrogen, and the aldehydes and ethers may be removed with acid washing or adsorption. These side reactions are not accounted for in this preliminary design.

For the design presented in Figure B.10.1, the reactor was simulated with catalyst in 2-in (50.4 mm) diameter tubes, each 20 feet (6.096 m) long, and with a cocurrent flow of a heat transfer medium on the shell side of the shell-and-tube reactor. The resulting arrangement gives a 90% conversion of IPA per pass.

B.10.3 Simulation (CHEMCAD) Hints

Isopropyl alcohol and water form a minimum boiling point azeotrope at 88 wt% isopropyl alcohol and 12 wt% water. Vapor-liquid equilibrium (VLE) data are available from several sources and can be used to back-calculate binary interaction parameters or liquid-phase activity coefficients. The process presented in Figure B.3 and Table B.6 was simulated using the UNIQUAC VLE thermodynamics package and the latent heat enthalpy option in the CHEMCAD simulator. This package correctly predicts the formation of the azeotrope at 88 wt% alcohol.

B.10.4 References

1. *Kirk-Othmer Encyclopedia of Chemical Technology*, 3d ed., vol. 1 (New York: John Wiley & Sons, 1976), 179–191.

Open Ended Problem for design of piping, pressure drop

Experiment No: 06

Design various equipment used for Production of Acetone from Iso-Propanol.

(Ref.: Analysis, Synthesis and Design of Chemical Processes by Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwits)

Refer Page No. 1027 of above ref. for details of process and collect flow rate, temperature and pressure data from the given ref.

Find suitable physical and thermodynamic properties and Design following equipment based on the data given in above reference:

1. Piping design for reflux – Steam No. 9 for Feed, Steam 10 for reflux to column, Stream 11 for distillate, Stream 12 bottom product.
2. Select suitable pump and find NPSH and Power requirement for selected pump for reflux stream.

Take the necessary assumption for design

Open Ended Problem for Design of distillation column with complete tray design.

Experiment No: 07

Design various equipment used for Production of Acetone from Iso-Propanol.

(Ref.: Analysis, Synthesis and Design of Chemical Processes by Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwits)

Refer Page No. 1027 of above ref. for details of process and collect flow rate, temperature and pressure data from the given ref.

Find suitable physical and thermodynamic properties and Design following equipment based on the data given in above reference:

1. Design Distillation Column including tray hydraulic design – E-1102

Take the necessary assumption for design

Open Ended Problem for Design of distillation column with complete tray design.

Experiment No: 08

Design various equipment used for Production of Acetone from Iso-Propanol.

(Ref.: Analysis, Synthesis and Design of Chemical Processes by Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwits)

Refer Page No. 1027 of above ref. for details of process and collect flow rate, temperature and pressure data from the given ref.

Find suitable physical and thermodynamic properties and Design following equipment based on the data given in above reference:

1. Design Distillation Column including tray hydraulic design – E-1102

Take the necessary assumption for design

Open Ended Problem for Design of Heat exchanger (Condenser and/or reboiler)

Experiment No: 09

Design various equipment used for Production of Acetone from Iso-Propanol.

(Ref.: Analysis, Synthesis and Design of Chemical Processes by Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwits)

Refer Page No. 1027 of above ref. for details of process and collect flow rate, temperature and pressure data from the given ref.

Find suitable physical and thermodynamic properties and Design following equipment based on the data given in above reference:

1. Design condenser – E-1104
2. Design reboiler – E-1105

Take the necessary assumption for design

Open Ended Problem for Design of Heat exchanger (Condenser and/or reboiler)

Experiment No: 10

Design various equipment used for Production of Acetone from Iso-Propanol.

(Ref.: Analysis, Synthesis and Design of Chemical Processes by Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwits)

Refer Page No. 1027 of above ref. for details of process and collect flow rate, temperature and pressure data from the given ref.

Find suitable physical and thermodynamic properties and Design following equipment based on the data given in above reference:

1. Design condenser – E-1104
2. Design reboiler – E-1105

Take the necessary assumption for design

Design of different types of head

Experiment No: 11

Design of different types of head given in following book and page no.

Book Name: Illustrated Process Equipment Design
Authors: S B Thakore and D A Shah
Page No: 36 to 47