《化工原理课程设计》教学大纲

一、基本信息

课程名称：化工原理课程设计	英文课程名称：Course Design of Unit Operations' Principles of Chemical Engineering
课程代码：100305P009	总学分：4
总学时：64	课内学时：64
实验学时：0	上机学时：0
开课学院：工学院	适用专业：化学工程与工艺、能源化学工程
课程性质：必修	先修课程：化工原理

二、课程简介

《化工原理课程设计》是《化工原理》教学体系中最重要的实践环节，应用面广、实用性强、注重理论与现场实际相结合，是化工类本科生的专业基础课、必修课。

教学总体目标是让学生在掌握化工生产中精馏等单元操作的基本原理及典型设备构造的基础上，对具体生产任务进行过程计算和设备设计、选型，使学生了解设计的基本过程；对初步设计后的设备能够进行简单的操作分析、评估及优化，从而建立起学生的工程意识；提高用所学化工原理知识和工具解决实际生产问题的能力，为以后学习专业知识，从事现场技术工作和科学研究打下良好的基础。

教学内容包括四讲。第一章为工艺计算，着重介绍设计任务要求，如何确定压力 P、温度 T、回流比 R、塔板数 N 等条件，进行全塔物料衡算和热量衡算，确定塔径 D；第二章为塔板设计及水力学核算，着重介绍塔板初步设计、水力学校核、单板负荷性能图分析及设计结果讨论；第三章为塔体机械设计和辅助设备的选取，着重介绍筒体、封头、人孔、塔高、裙座等塔体机械设计和接管设计，进行换热器、泵等辅助设备的选取；第四章为塔设备图的绘制。第五章为答辩

三、教学目标

（根据课程性质，写明学生通过学习该课程在知识、能力、素质等方面应达到的具体目标，学生应掌握的 4-6 项最重要的知识或技能。）

目标 1：掌握精馏、传热、流动各单元操作的基本原理，熟悉设计任务的工艺要求，能够完成精馏过程的物料衡算、热量衡算、水力学计算等工艺计算，并完成冷凝器、泵等附属设备的核算与选型；能够掌握塔板及其他内构件的机械结构、尺寸以及主要设计参数的意义，了解塔内件设计参数对塔板操作性能的影响

目标 2：掌握精馏、传热、流动各单元操作的基本原理，熟悉设计任务的工艺要求，能够对所设计塔设备进行简单操作分析与设计结果优化分析，寻找适宜的操作条件以适应生产的要求，评述强化过程的途径、设计过程中存在的问题；

目标 3：能够独立完成精馏塔设备图、塔板组装图的绘制，强化学生对设备及操作过程的理解；

目标 4：能够按照要求独立撰写设计任务书，按照要求绘制图表；

目标 5：具备较强的口头交流能力（讨论、陈述发言、回答问题等），能够通过答辩形式对设计内容进行介绍与评述，并提出改进的方法

四、教学内容与学习要求

（可按章节顺序或教学单元顺序编写，要详细说明具体教学内容、教学重点和难点，应

清楚地表达知识、技能的范围和深度，充分反映课程的知识和技能要求，体现课程特点。）

章节/教学单元		教学内容、重点、难点	学时	学习要求
第一章 工艺计算	一、课程设计简介 二、全塔物料衡算 三、确定操作条件 P、T 四、确定操作条件 R、N、 五、全塔热量衡算 六、确定 D	教学内容：确定压力 P、温度 T、回流比 R、塔板数 N 等条件，进行全塔物料衡算和热量衡算，确定塔径 D； 重点：回流比 R、理论版数计算； 难点：全塔热量衡算	1 周	☐记忆 ☐理解 ☑应用 ☐综合分析
第二章 塔板设计及水力学校核	一、塔板初步设计 二、塔板水力学校核 三、单板负荷性能图及设计结果讨论	教学内容：（1）溢流内构件（固定件）设计、塔板块（可拆件）设计 （2）操作点和适宜操作区、鼓泡区和降液管区的匹配、塔径和负荷的匹配、操作弹性 重点：单板负荷性能图 难点：塔板水力学校核	1 周	☐记忆 ☐理解 ☑应用 ☐综合分析
第三章 塔体设计及辅助设备选取	一、塔体机械设计 二、接管设计 三、辅助设备的选取	教学内容：（1）筒体、封头、人孔、塔高、裙座设计 （2）冷凝器、冷却器、再沸器、泵 重点：冷凝器、再沸器设计 难点：冷凝器、再沸器设计	1 周	☐记忆 ☐理解 ☑应用 ☐综合分析
第四章	绘制塔设备图	教学内容：（1）塔板布置图 （2）排阀草图 （3）全塔装配图 重点：塔板布置图、全塔装配图 难点：塔板布置图	6 天	☐记忆 ☐理解 ☐应用 ☑综合分析
第五章	答辩	-	1 天	☐记忆 ☐理解 ☐应用 ☑综合分析

注：在“学习要求”一栏补充选项，可以多选，无要求可不填，也可自定要求。**记忆，**指能从记忆库中找到相关的知识、概念、术语或材料与当前的信息进行比较、确认，能记住并能不加理解的列出、描述这些知识、概念、术语或材料；**理解，**指能对所学的内容作归纳、分类、解释、总结、推断和一定程度的发挥；**应用，**指能选择正确的程序应用、实施所学到的内容，并能进行必要的计算或决断；**综合分析，**指能将所学的内容分解并找出它们的相互关系和构成，或能计划、创造、建造、有改变的重构，或能作评论、总结、估计、预测、评估、论证和答辩。

注：实验类型指演示性、验证性、综合性、设计性、创新性。实验类别指基础实验、专业基础实验、专业实验。

五、教学方法

本课程采用教师讲授重点，学生自己动手查资料、设计计算、绘制图纸，并最终答辩的模式，实行课堂讲授、DIY 设计与答辩相结合的教学方法。

六、考核方式

写明考核方式与分数构成。

考核内容及方式		分数	对指标点的支撑			
			3-2	3-3	5-2	10-1
考勤		5 分				√
设计说明书	工艺设计与计算	20 分	√			
	塔体设计与计算	20 分	√			
	附属设备选项与计算	10 分	√		√	
	书面表达规范、认真	5 分		√		
	设计评述（结论）	5 分	√			
设备图准确规范		25 分			√	
答辩		10 分				√

七、教材与参考书

（一）教材

《化工原理课程设计》，刘学暖、汤景宁主编，中国石油大学出版社，2008；ISBN：9787116064911。

（二）参考书目或文献

1) 《石油化学工程原理》,李阳初、刘学暖主编,中国石化出版社,2008,第二版； ISBN：9787802295261。

2) 《石油炼制及石油化工计算方法图表集》，石油大学炼制系，中国石油大学出版社，1990； ISBN ：9787511434715

3) 《机械制图》，邹宜侯、窦墨林、潘海东，清华大学出版社，2012，第六版；ISBN ：9787302292975

4) 《化工设备机械基础》，喻建良，大连理工大学出版社，2014，第二版；ISBN ：9787561146255

5) 《现代塔器技术》，兰州石油机械研究所，中国石化出版社，2007，第二版;ISBN: 9787801644299

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《Course Design of Unit Operations' Principles of Chemical Engineering》Syllabus

I. Basic Information

Course Name: Course Design of Unit Operations' Principles of Chemical Engineering	Name in Chinese: 化工原理课程设计
Course No.: 100305P009	Total Credits: 4
Total Hours: 64	Lecture Hours: 64
Lab Hours: 0	Computer Lab Hours: 0
Offering College: Faculty of Engineering	Corresponding Majors: Chemical Engineering and Technology、Energy chemical engineering
Course Type: Required	Prerequisite: Unit Operations' Principles of Chemical Engineering

II. Course Introduction

Course Design of Unit Operations' Principles of Chemical Engineering is the most important practical link in the teaching system of *Unit Operations' Principles of Chemical Engineering*. It has wide application, strong practicability and pays attention to the combination of theory and field practice. It is a professional basic course and compulsory course for chemical engineering undergraduates.

The overall teaching goal is to enable students to carry out process calculation, equipment design and type selection for specific production tasks on the basis of mastering the basic principles of unit operations such as distillation in chemical production and typical equipment structure, so as to enable students to understand the basic process of design; Simple operation analysis, evaluation and optimization of the equipment after preliminary design can be carried out, so as to establish students' engineering consciousness; Improve the ability to solve practical production problems with the learned chemical principle knowledge and tools, and lay a good foundation for learning professional knowledge and engaging in on-site technical work and scientific research in the future.

The teaching content includes four chapters. The first chapter is process calculation, which focuses on the design task requirements and the determination of the conditions such as pressure P, temperature T, reflux ratio R, number of trays N, the tower diameter D as well as the calculation of material balance and heat balance of the whole tower. The second chapter is the tray design and hydraulic calculation, focusing on the preliminary design of tray, hydraulic calibration, analysis of single plate load performance diagram and discussion of design results; The third chapter is the mechanical design of the tower and the selection of auxiliary equipment. This chapter focuses on the nozzle design and mechanical design of the tower such as cylinder, head, manhole, tower height and skirt, and selection of the auxiliary equipment such as heat exchanger and pump; The fourth chapter is the drawing of tower equipment drawing. The fifth chapter is the defense.

III. Course Objective

Objective 1: master the basic operation principles of distillation, heat transfer and flow units, be familiar with the process requirements of design tasks, be able to complete process calculations

such as material balance, heat balance and hydraulics calculation in distillation process, and complete the accounting and type selection of auxiliary equipment such as condenser and pump; Be able to master the significance of mechanical structure, size and main design parameters of tray and other internals, and understand the influence of tower internals design parameters on tray operation performance

Objective 2: master the basic operation principles of distillation, heat transfer and flow units, be familiar with the process requirements of design tasks, be able to carry out simple operation analysis and optimization analysis of design results for the designed tower equipment, find suitable operating conditions to meet the production requirements, and comment on the ways of strengthening process and problems existing in the design process;

Objective 3: be able to independently complete the drawing of distillation column equipment drawing and tray assembly drawing, and strengthen students' understanding of equipment and operation process;

Objective 4: be able to write design assignment independently and draw charts as required;

Objective 5: have strong oral communication skills (discussion, presentation, answering questions, etc.), be able to introduce and comment on the design content in the form of defense, and put forward improvement methods

IV. Contents and Requirements

Chapter/Unit		Contents and Key Points	hrs	Requirements
Chapter 1 Process calculation	1、Introduction to course design 2、Material balance of the whole tower 3、Determine operating conditions P, t 4、Determine operating conditions R, N 5、Heat balance of the whole tower 6、Determination D	Teaching content: determine the conditions such as pressure P, temperature T, reflux ratio R and number of trays n, carry out material balance and heat balance of the whole tower, and determine the tower diameter D; Key points: Calculation of reflux ratio R and number of theoretical editions; Difficulty: heat balance calculation of the whole tower	1 week	☐Memory ☐Comprehension ☑Application ☐Comprehensive Analysis
Chapter 2 Tray design and hydraulic	1 、 Preliminary design of tray 2 、 Tray hydraulic school nuclear 3 、 Discussion on	Teaching contents: (1) design of overflow internals (fixings) and tower plate (detachable parts) (2) Matching of operation point and suitable operation area,	1 week	☐Memory ☐Comprehension ☑Application ☐Comprehensive Analysis

Chapter/Unit		Contents and Key Points	hrs	Requirements
design	load performance diagram and design results of veneer	bubbling area and downcomer area, matching of tower diameter and load, and operation flexibility Key points: single board load performance diagram Difficulty: tray hydraulic test		
Chapter 3 Tower design and auxiliary equipment selection	1、Mechanical design of tower 2、Nozzle design 3、Selection of auxiliary equipment	Teaching contents: (1) design of cylinder, head, manhole, tower height and skirt (2) Condenser, cooler, reboiler, pump Key points: Design of condenser and Reboiler Difficulties: Design of condenser and Reboiler	1 week	☐Memory ☐Comprehension ☑Application ☐Comprehensive Analysis
Chapter 4	Drawing of tower equipment	Teaching contents: (1) tray layout (2) Float valve arrangement sketch (3) Assembly drawing of the whole tower Key points: tray layout and assembly drawing of the whole tower Difficulty: tray layout	6 days	☐Memory ☐Comprehension ☐Application ☑Comprehensive Analysis
Chapter 5	Design defense	-	1 day	☐Memory ☐Comprehension ☐Application ☑Comprehensive Analysis

V. Teaching Method

This course adopts the mode that teachers focus on teaching, students check data, design calculation, draw drawings and finally reply by themselves, and implements the teaching method of combining classroom teaching, DIY design and reply.

VI. Evaluation

Assessment contents and methods		Grade	Support for index points			
			3-2	3-3	5-2	10-1
check work attendance		5 points				√
Design specification	Process Design	20 points	√	√		
	Tower design	20 points	√			
	auxiliary equipment	10 points	√		√	

	design					
	The written expression is standard and serious	5 points		√		
	Design review (conclusion)	5 points	√			
Accurate specification of equipment drawing		25 points			√	
Design defense		10 points				√

VII. Textbook and Reference

(1) Textbook

Curriculum design of chemical engineering principles, edited by Liu xuenuan and Tang Jingning, China University of Petroleum Press, 2008；ISBN：9787116064911。

(2) Reference

1) Principles of petroleum processing unit process, edited by Li Yangchu and Liu Xuenuan, China Petrochemical Press, 2008, Second Edition；ISBN：9787802295261.

2) Atlas of petroleum refining and petrochemical calculation methods, Department of refining, University of petroleum, China University of Petroleum Press, 1990; ISBN：9787511434715.

3) Mechanical drawing, Zou Yihou, Dou Molin, pan Haidong, Tsinghua University Press, 2012, Sixth Edition; ISBN ：9787302292975.

4) Fundamentals of chemical equipment and machinery, Yu Jianliang, Dalian University of Technology Press, 2014, Second Edition; ISBN：9787561146255.

5) Modern tower technology, Lanzhou Petroleum Machinery Research Institute, Sinopec press, 2007, Second Edition; ISBN: 9787801644299.