Załącznik nr 6 do ZW 121/2020

FACULTY OF MECHANICAL AND POWER ENGINEERING

SUBJECT CARD

Name of subject in Polish:	Chłodnictwo Sorpcyjne
Name of subject in English:	Sorption Refrigeration
Main field of study (if applicable):	POWER ENGINEERING
Specialization (if applicable):	Refrigeration and Cryogenics
Profile:	academic
Level and form of studies:	2nd level, full-time
Kind of subject:	optional
Subject code:	W09ENG-SM0081
Group of courses:	YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	15		15	
Number of hours of total student workload (CNPS)	90	60		60	
Form of crediting	Exam	crediting with grade		crediting with grade	
For group of courses mark final course with (X)					
Number of ECTS points	**3**	1		1	
including number of ECTS points for practical (P) classes	0	1		1	
including number of ECTS points for direct teacher-student contact (BK) classes	3	1		1	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Fundamental knowledge of thermodynamics, fluid mechanics and heat transfer.
2. Knowledge of technical drawing and construction rules
3. Ability to construct using graphic programs

SUBJECT OBJECTIVES

C1 Transfer of basic knowledge, including application aspects of absorption refrigeration
C2. Transfer of knowledge regarding heat exchanger calculations
C3. To develop skills in qualitative understanding, interpretation and quantitative analysis - based on relationships describing absorption chill cycles
C4. Developing the skill of designing absorption refrigeration equipment.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 - have ordered knowledge of thermodynamic foundations, construction and operation of sorption energy systems
PEK_W02 - have ordered knowledge in the field of energy balancing processes and thermal calculation of sorption devices for energy systems
PEK_W03 - have ordered knowledge in the field of constructing sorption devices for energy systems.

relating to skils:

PEK_U01 - know how to identify and balance processes of sorption circuits of energy systems.

PEK_U02 - know how to calculate and construct energy sorption devices

PROGRAM CONTENT		
Lectures		**Number of hours**
Lec 1	Lecture scope, credit conditions, literature. Characteristics of the basic concepts and definitions of the thermodynamics of solutions needed for modeling the absorption cycle. History and perspectives of absorption refrigeration.	2
Lec 2	Properties of working fluids (aqueous ammonia solution, aqueous lithium bromide solution) and their effect on the design of absorption systems. Construction of chart for aqueous ammonia solution lgP - h -ξ and its interpretation on 2D diagram h -ξ	2
Lec 3	Determining the basic operating temperatures of the absorption circuit. Application of thermodynamic balancing principles to modeling the sorption circuit. Heat balance of the ammonia sorption system on the h-ξ. chart. Substantive and thermal balances of partial processes.	2
Lec 4	Basics of design of shell and tube apparatus for industrial absorption chillers on the example of a condenser, construction details: orthogonal, hexagonal and concentric arrangement of pipes, selection of tube pates	2
Lec 5	Mathematical model of thermal and hydraulic calculations of condensers and evaporators of water-ammonia absorption systems, construction review: horizontal, vertical, coil and articulated apparatus.	2
Lec 6	Absorbers in absorption refrigeration installations - mathematical model, construction review,	2
Lec 7	Desorbers in absorption refrigeration installations - mathematical model, construction review, Bottom and upper part of the rectifier	2
Lec 8	Deflegmators in absorption refrigeration installations - mathematical model, constructions review. The role of recuperators in absorption cooling installations: construction, thermal and hydraulic calculations	2
Lec 9	Comparison of industrial sorption system and absorption-diffusion system. The way the absorption-diffusion system works, the selection of working factors, the impact of system geometry on the efficiency of its work.	2
Lec 10	Design variants of absorption and diffusion systems, development trends, performance characteristics of the thermosiphon pump. Absorption-diffusion devices - hydrogen circulation in the device, design principles of exchangers located in the hydrogen cycle.	2
Lec 11	Absorption devices working with H_2O-LiBr solution. Construction of the h-ξ and lgp-t graph for an aqueous lithium bromide solution, identification of status points and heat balance of a single-effect water cooler for air conditioning purposes, determination of the COP absorption chiller.	2
Lec 12	Review of H_2O-LiBr absorption constructions of water chillers, absorption water coolers in solar systems, exploitation problems (vacuum maintenance, solution recrystallization)	2
Lec 13	Adsorption and desorption processes. Classification (physical and chemical adsorption) and characteristics. Working pairs and their properties. Basic adsorption cycle. Adsorption cycle efficiency	2
Lec 14	Thermodynamic analysis of the adsorption cycle. Ways to increase the efficiency ratio. Multi-adsorber systems, with regeneration, with mass	2

	regeneration, with heat wave.	
Lec 15	The structure of the adsorbent layer. Diffusion processes and thermal phenomena. Intermolecular and intramolecular flows. Fundamentals of heat and mass flow modeling in the adsorbent structure.	2
	Total hours	30

Classes		**Number of hours**
Cl 1	Familiarization with the structure of the enthalpy-composition-pressure (h-ξ–logp) chart for aqueous ammonia. Determination of the liquid and vapor phase areas, calculation of the enthalpy of the solution for pure solution components, determination of the course of isotherms in the two phase area.	2
Cl 2	Identification of status points for total and partial condensation, identification of status points for the evaporation process. Computational tasks. Discussion of results	2
Cl 3	Identification of state points for the absorption process, determination of a simple mixing, application of analytical-descriptive balancing method, thermal and substantive balances of the absorption process.	2
Cl 4	Identification of status points for the desorption process, application of the analytical-descriptive balancing method, thermal and substantive balances of the desorption process. Computational tasks. Analysis of the results obtained	2
Cl 5	Thermal and substantive calculations of the water-ammonia sorption system rectifier. Thermal and substantive calculations of the rectifier, determination of the number of shelves of the rectification column.	2
Cl 6	Familiarization with the construction of enthalpy-composition-pressure (h-ξ–np) and pressure-temperature (lnp-t) diagrams for aqueous lithium bromide solution.	2
Cl 7	Mass and energy balance of a refrigerator working with an H2O-LiBr solution - calculating exercises	2
Cl 8	Final test	1
	Total hours	15

Project		**Number of hours**
Proj 1	Project scope, crediting conditions, literature. Assigning individual project topics to students.	2
Proj 2	Discussion and approximation of issues raised in projects. Individual work of students on projects. Determining the basic operating temperatures of the absorption circuit. Identification of status points for individual design data.	2
Proj 3	Individual work of students on projects. heat balance of the Carre's absorption machine for individual design data.	2
Proj 4	Individual work of students on projects. Thermal and hydraulic calculations of the selected apparatus. Calculation and determination of the heat transfer surface	2
Proj 5	Individual work of students on projects. Strength calculations of selected construction nodes. Preliminary sketches of the designed camera structure. Analysis and discussion on the selected concept and its implementation.	2
Proj 6	Individual work of students on projects. Drawing drawings for the designed	2

	heat exchangers.	
Proj 7	Individual work of students on projects. Drawing drawings for the designed heat exchanger. Preparation of the report. Preparation of project presentation.	2
Proj 8	Presentation and submission of ready projects by students.	1
	Total hours	15

TEACHING TOOLS USED
N1. Lecture with presentation N2. Tutorial – discussion of task solutions N3 Individual design presentation N4. Self-study – reading of supplementary materials. N5. Self-study – study and preparation for the final exam. N6. Office hours.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes number	Way of evaluating learning outcomes achievement
P1	PEK_W01 ÷ PEK_W03	Final exam containing questions based on the entire range of the lecture
P2	PEK_U01	Final test
P3	PEK_U02	Final presentation of the design

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Keith E.Herold, Reinhard Rademacher, Sanford A. Klein Absorption Chillers and Heat Pumps CRC Press LLC 1996
[2] Risto Ciconkov Refrigeration - Solved examples, "St Kiril & Metodij" Faculty of Mechanical Engineering. Po. Box 464. 1000 Skopie Macedonia
[3] Handbook: refrigeration, American Society of Heating, Refrigerating and Air-Conditioning ASHRAE 2006
[4] Wilbert F. Stoecker - Industrial refrigeration handbook McGraw-Hill 1998
[5] Georg Alefeld, Reinhard Rademacher: Heat Conversion Systems, CRC Press 1994

SECONDARY LITERATURE:

[1] Web Site: „3D Absorption ” http://fluid.itcmp.pwr.wroc.pl/~kasper/absorpcja3d/
International Journal of Refrigeration

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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