

GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICAL (CRYOGENIC ENGINEERING) (10)

CRYOGENIC PLANTS AND EQUIPMENTS

SUBJECT CODE: 2721002

SEMESTER: II

Type of course: Core Subject IV

Prerequisite: Knowledge of physics, thermodynamics , pressure vessel design and heat and mass transfer

Rationale: NA

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks		Practical Marks				
				ESE (E)	PA (M)	ESE (V)		PA (I)		
		ESE	OEP			PA	RP			
4	0	2#	5	70	30	20	10	10	10	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Gas separation and gas purification system : Thermodynamically Ideal separation system, general characteristics of mixtures , temperature composition diagram for cryogenic gas mixtures , fugacity , enthalpy composition diagrams, Simple condensation and evaporation, principles of rectification, theoretical plate calculations for columns, Mecabe – Thiele method for theoretical plate calculation , types of rectification columns	8	15
2	Air separation and purification systems: Linde single column, double column, Linde-Frankl and Heylandt systems, argon, xenon and krypton. 'L' Air liquefied systems for hydrogen, hydrogen – deuterium in separation systems, helium separation system, separation of helium isotopes, purification of helium.	8	15
3	Modern air liquefaction, liquid nitrogen and oxygen plants.	3	15
4	Dewars, classification of Dewars, static and chassis mounted cryogenic liquid storage and transport tanks LNG storage tanks, construction Liquid and vapour shielded vessels, cryogenic liquid transfer pumps, liquid transfer lines their design, vacuum insulated line joints, and cryogenic valves liquid transfer systems.	4	15
5	Fabrications and jointing techniques, flanged and bolted joints , joining of dissimilar metals , welding of stainless steel and alloy steels	4	10
6	Design of regenerative type heat exchanger for single and multi stage, Philips, Gifford single volume, double volume, cryo refrigerators. Finned tube and plate type heat exchangers, different configuration heat transfer coefficients and friction coefficient for various configuration	5	5
7	Single tube Linde exchanger, double tube type, three channel heat exchanger. Linde multiple tube type , Giauque Hampson, Collin's, Plate fin heat exchanger, different fin configuration, heat transfer coefficients, and friction	5	5

	factors for various configurations.		
8	Testing of heat exchangers as per standards.	2	5

Reference Books:

1. Cryogenic Systems, Barron, McGraw Hill Book Co.
2. Theory and design of cryogenic systems : A.Arkherov
3. Cryogenic process engineering Timmerchand & Flynn

Course Outcome:

After learning the course the students should be able to:

Gas Separation and purification for different gases, design of storage vessels and tanks, design cryo heat exchanger

List of Experiments:

1. Study of cryogenic storage vessels.
2. Study of separation system for O₂ and N₂
 - a) Linde single column system
 - b) Linde double column system
 - c) Linde Frankle system
 - d) Heylandt system
3. Study and design of rectification column.
4. Study of cryogenic fluid transfer line vacuum insulated line joints.
5. Cryogenic valves & design of transfer line.
6. Study of the various fabrication techniques applied to cryogenic plant & equipments.
7. To study of Philips LN₂ plant.
8. To study the salient design feature of a cryostat & its construction & equipments.
9. Study of separation system for H₂ & He.

Design based Problems (DP)/Open Ended Problem:

Every student or group of student should critically study two research papers on any one topic ,ingrate the details and make presentation.

Major Equipment:

LN₂ dewar ,Cryostats for specific applications

List of Open Source Software/learning website:

NPTEL lectures of Prof. M. D. Atrey , IIT Bombay, software for plate calculations for rectification column

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be

generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website