ENGINEERING PRACTICAL BOOK VOL-1

THERMAL

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Thermal

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By

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&
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PREFACE

The importance of practical training in engineering education, as emphasized by the AICTE, has motivated the authors to compile the work of various engineering laboratories into a systematic Practical laboratory book. The manual is written in a simple language and lucid style. It is hoped that students will understand the manual without any difficulty and perform the experiments.

The manual incorporates latest experiment used to demonstrate the basic principles of Refrigeration, Air-conditioning (RAC), Heat and Mass Transfer(HMT). Different components of each experimental rig have been described in detail. Brief theory and basic fundamentals have been incorporated to understand the experiments and for the preparation of lab report independently. Sample calculations have been provided to help the students in tabulating the experimental and theoretical results, comparing and interpreting them within technical frame. The book also covers the general aspects for the preparation of a technical report and precautions to be taken in the laboratories for accurate and save performance of experiments . In end of each experiment questions related to each experiment have been provided to test the depth of knowledge gained by students.

The manual has been prepared as per the general requirements of an RAC and HMT laboratories in any graduate and Diploma level classes syllabus .Refrigeration Air-Conditioning and Heat Mass Transfer is an important area and its knowledge is applied in almost all industries. We hope that manual would be useful for establishing a new laboratory and for the students of all branches. Any suggestions for further improvement of the manual will be welcome and incorporated in the next edition.

Farrukh Hafeez

Mohd Arif

ABOUT THE AUTHOR

Dr Farrukh Hafeez is PhD from Jamia Millia Islamia. He has been in teaching profession for the last 17 years and has experience of serving some of the prestigious institutions of India and abroad. In the 17 years he has taught graduate and post graduate courses of mechanical engineering in universities of India such as; Aligarh Muslim University (a central Government University), Institute of Technology and Management Gurgaon, IIT Delhi, Jamia Millia Islamia New Delhi , International University of Shaqra in Saudi . Presently he is serving as an Associate Professor in Aligarh Muslim University. His experience in writing this book will be helpful for engineering graduate classes and for establishing thermal Engineering laboratories.

Mohd Arif is M.Tech in thermal Engineering and has an industrial experience of about 20 years in handling latest refrigeration and air-conditioning equipments within and outside India. For the last ten years he is working as an Assistant Professor in Aligarh Muslim University and has been engage in various teaching and practical laboratories of thermal engineering.

HEAT AND MASS TRANSFER

S.No	Experiments
1	To determine the convective heat transfer coefficient in vertical cylinder and
	surrounding air experimentally and empirically. Also to plot the temperature profile along the length of the cylinder for one set of readings.
2	To determine the temperature profile along the axis of a given circular fin experimentally and theoretically f under free convection and to compare the two profiles. Also determine the efficiency of the fin.
3	(i)To study the construction of a parallel flow heat exchanger
	(ii) To find overall heat transfer coefficient as a function of mass flow rate of water and to measure the effectiveness of the heat exchanger
4	To determine the coefficient of thermal conductivity of a given asbestos sheet by Guarded hot plate method at different temperatures and to draw a plot between conductivity and temperature.
5	To determine the temperature profile along the axis of a given circular fin (pin fin) experimentally and empirically under forced convection and to compare the experimental and theoretical values . Also determine the efficiency of the fin.
6	To determine the emissivity of a test plate surface and plot a graph between temperature and emissivity.

7	(i) To study the construction of a counter flow heat exchanger
	(ii) To find overall heat transfer coefficient as a function of mass flow rate of water and To measure the effectiveness of heat exchanger
8	To determine the convective heat transfer coefficient between hot air and inner surface of a tube in forced convection and compare these experimental values of convective heat transfer coefficient with the predicted values.
9	To determine the value of Stefan Boltzmann Constant, σ used in radiation heat transfer. Draw a graph also between temperature of disc and time.

REFRIGRATION AND AIR-CONDITIONING

S.No	Experiments
1.	To study the cut-sectional model of reciprocating refrigerant compressor.
2	(i) To study the vapor compression refrigerating system and to draw temperature -enthalpy (T-S) and pressure-enthalpy (P-H) diagrams for the cycle. (ii) Find power consumed in running the unit from energy meter readings and finding the disc revolutions of the energy meter. (ii) Calculate multiplying factor.
3.	To find Carnot COP, theoretical COP and actual COP of a vapor compression refrigeration system and efficiency of the cycle.
4.	To study a room conditioner. Also draw flow sheet diagrams of the unit, air circuit and refrigerant circuit
5.	To study and label the air-conditioning test rig.
	To determine its coefficient of performance COP
	i) Theoretically ii) By rotameter readings
	iii From mass flow rate of air actually cooled.
6.	(i) To study the psychometric process, heating, cooling, humidification, dehumidification and plot them on a psychometric chart
	(ii)To determine sensible heat factor of air in winter air conditioning.
7.	To study the ice plant and its working cycle and
	2. To determine coefficient of performance (COP) and capacity of the ice plant.

8.	To study the mechanical heat pump and to compute its actual coefficient of performance, COP.
9.	Study the effect of sub-cooling and superheating in a vapor compression refrigeration cycle system
10.	Introduction to Cryogenics system by visiting Cryogenics lab

PROPERTY TABLES AND CHARTS (SI UNITS)

TABLE A–1	Molar mass, gas constant, and ideal-gas specific heats of some substances
TABLE A–2	Boiling and freezing point properties
TABLE A–3	Properties of solid metals
TABLE A–4	Properties of solid nonmetals
TABLE A–5	Properties of building materials
TABLE A–6	Properties of insulating materials
TABLE A–7	Properties of saturated water
TABLE A–8	Properties of saturated water
TABLE A–9	Properties of saturated ammonia
TABLE A–10	Properties of liquid metals
TABLE A–11	Properties of air at 1 atm pressure
TABLE A–12	Properties of gases at 1 atm pressure
TABLE A–13	Properties of gases at 1 atm pressure
TABLE A–14	Emissivity of surfaces
FIGURE A–15	Solar radiactive properties of materials

GENERAL INSTRUCTIONS

To make laboratory experiments safe and effective, each student is expected to follow the given instructions.

SAFETY INSTRUCTIONS

1. High voltage source in the laboratory should be handled properly under the guidance of lab assistant, as it may cause a serious accident.
2. All students shall wear aprons /avoid loose clothes, shirts should be properly tucked, skirts with extra flares should be avoided, slippers are not allowed, shoes with rubber soles are recommended for mechanical work laboratories.
3. There should be no over-crowding and only trained person should operate the machine
4. Make sure that all power sources are off during set-up of machines.
5. Keep safe distance from moving parts of machines.
6. Follow the instruction given by the instructor
7. In case of operating furnace, don't touch the inside parts of furnace.
8. Failure to obey instructions may result in being expelled from the lab
9. Be careful not to damage any machine or instrument. Care must be taken in handling all instrument
10. Do not start any machine or operate it without the permission from instructor.
11. Lubrication and water-cooling should be checked before starting an engine.
12. All the valves must be opened and close slowly.
13. The application or removal of the load should be gradual.
14. Any unusual behavior or noise of the machine must be reported immediately reported to the instructor and investigated

PREPARATION OF LAB REPORT

1. Before coming to the laboratory, each student must read and review appropriate experiment to be conducted on the subsequent turn.
2. Record your experiment observations and sample calculations carefully.
3. Each student is required to write a neat and clean report for the experiment conducted.
4. Every student should bring his own set of drawing instruments logbooks, slide rule etc

5. Student should get the necessary apparatus issued against their names before starting the experiment should carefully inspect the apparatus and returned it well to the lab in charge after finishing the work
6. Reports are due one week after the completion of the experiment.
7. Each report shall be submitted with all necessary instructions, sample calculations, graphs, and discussion over data and graph.
8. Observations should be recorded in tabular form and in a proper order
9. Sample calculations should be done on a set of most important data. The calculations should be complete, leading from observed quantities to final results.
10. Results within the scope of the object should be given, with graphical representation wherever possible.
11. Sources of error should be reported properly. It provides a limit for admissible inaccuracy in the results.
12. Discussion over results should be analyzed properly and compared with the manufacture's rating.
13. A brief criticism of the test procedure and apparatus used with concrete suggestions, if any, for improvement should be explained. Any unusual occurrence observed during the test should be reported.
    - ✓ Discussion should reflect the opinion of the writer. It should not be a collection of merely the self-evident facts.
    - ✓ Questions give at the end of each experiment have to be answered appropriately with in the space provided in the manual.
    - ✓ tudents should remain prepare for the viva-voce on any turn.

HOW TO PLOT A GRAPH

1. Before drawing a graph between two observed variables it is necessary to know the nature of expected theoretical graph.
2. Decide which parameter to be considered on X axis and which one on the Y-axis.(parameter which is under the control of the student is generally kept over X axis)
3. Selection of appropriate scales for the two variables should be chosen such that it appears as square graph.
4. The following procedure should be observed in drawing the graphs.

(i) A curve should first be drawn freehand in pencil. It should then be faired, preferably in black ink, with proper instruments.

(ii) Unless otherwise specified, the independent variables should be plotted on the abscissa.

(iii) The axes should be well defined and bold.

(iv) The scales should be chosen for easy reading with due regard to the accuracy of the observed quantities so that variations are neither concealed nor exaggerated. Too large a scale should not be chosen simply to fill a curve sheet. Some times the scale of abscissa may be taken larger than ordinate to make the curves clear.

(v) The scale for the axes may or may not start from zero; but scale for the curves of efficiency, economy rate, capacity, etc should always start from zero.

(vi) When several curve are drawn over the same abscissa, care must be taken in choosing the ordinates of the scales such that the curves do not overlap confusingly.

5. Different indent points should identify each curve separately.
Points plotted should be joined such that it appears smooth and near to the theoretical nature of the curve. It is not necessary to join all points on the graph. Average graph is always advisable, instead of point to point plotting. Students shall be encouraged to use professional software's for plotting the curves.

GRADING POLICY:

1. The following is the grading policy shall be adopted for the lab report ;

GRADES.

A^{+} = 10.0	A = 9.5	A = 9.0
B^{+} = 8.5	B = 8.0	B = 7.5
C^{+} = 7.5	C = 7.0	C = 6.5

2. Make up Lab: Make up lab is only allowed in the case of valid excuse
3. The distribution is as follows.

Lab reports: 80%
Lab quiz: 10%
Attendance: 10%

About Author

Dr Farrukh Hafeez is PhD from Jamia Millia Islamia. He has been in teaching profession for the last 17 years and has experience of serving some of the prestigious institutions of India and abroad. In the 17 years he has taught graduate and post graduate courses of mechanical engineering in universities of India such as; Aligarh Muslim University (a central Government University), Institute of Technology and Management Gurgaon, IIT Delhi, Jamia Millia Islamia New Delhi, International University of Shaqra in Saudi. Presently he is serving as an Associate Professor in Aligarh Muslim University. His experience in writing this book will be helpful for engineering graduate classes and for establishing thermal Engineering laboratories.

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