TOPIC I - Systems and Energy

Introduction (Lecture 1/3)

Thermodynamics – science of the relationship between heat and mechanical work (Pocket Oxford Dictionary)

Today:

- Discussion of Thermodynamics
- Course Contents
- Dimensions and Units

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1 Preamble

Types of Engine

Savery – Newcomen – Watt

Innovations – better machining + condenser

1/3 of Newcomen's steam demand

The Principles (Flanders & Swann Lyrics)

"The first law of thermodynamics

Heat is work and work is heat ….

The second law of thermodynamics

"Heat cannot of itself pass from one body to a hotter body "

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2 Course Contents

1) concepts
2) properties
3) first law – energy conserved
4) second law - not all heat converted to work - reversibility and entropy
5) engine and heat pump cycles

Book - Engineering Thermodynamics, Work and Heat Transfer (Rogers and Mayhew)

Laboratories (assessment during session)

Tests – www.ole.bris.ac.uk

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At the end of the course you should be able to:

1. calculate the performance of experimental rigs

2. balance energy inputs and outputs to heat engines and heat pumps

3. quantify the (non-ideal) “irreversibility” in systems

4. estimate the efficiencies of heat pump and engine cycles

5. understand the “vocabulary” of thermodynamics – open/closed system, equilibrium, irreversibility …

3 Problem Solving – a template

Calcs reviewed by colleagues, supervisors, clients, regulatory bodies….

1. Problem Statement (succinct)
2. Schematic (include important numbers)
3. Assumptions.
4. Physical laws (e.g. Ideal Gas, Charles, Boyle)
5. Properties (e.g. density of water)
6. Calculation
7. Discussion (how does estimate compare against other values – range of applicability)

4 Dimensions and Units

Dimensional homogeneity – LHS and RHS show identical units. E.g.

$$E_K = 0.5\, m\, v^2 \qquad [1]$$

[J] = [kg] [m^2 s^{-2}]

Unit conversion factor =1; converts measured quantity to a different unit of measure without changing the relative amount.

E.g. object weighs 2 lb and travels at 4 ft s^{-1}

$$E_k = \frac{1}{2} \times 2\,lb \times [\frac{1\,kg}{2.205\,lb}] \times 4^2\, \frac{ft^2}{s^2} \times [\frac{1\,m}{3.2808\,ft}]^2 = \ldots$$

$$0.674\,kg\,m^2\,s^{-2} = 0.674\,J$$

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Teaching Style

- Take notes – embellish with reading
- Additional lecture notes on Blackboard
- Occasional tests (electronic)
- Problems classes– assistance available
- Laboratory – importance of report writing
- Examination in January

Resources

- The textbook, Rogers and Mayhew, preferred
- Slides, topic notes and problems sheets on Blackboard
- Websites on note-taking (Berkeley, Wikihow…)

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Conclusions

1. Thermodynamics = work from heat
2. Five parts – concepts, properties, first law, second law, cycles
3. Guidelines to problem solving
4. Dimensional homogeneity