VISUAL SUMMARY

Chapter Introduction provides a background to the concepts discussed in the chapter

CHAPTER **10**

Ocean Energy

10.1 INTRODUCTION

Oceans cover about 71% of earth's surface. They receive, store and dissipate energy through various physical processes. As per present technological status, recoverable energy in oceans exists mainly in the form of waves, tides and temperature difference (between surface and deep layers). Tides and waves produce mechanical energy whereas temperature difference produces thermal energy. Tidal energy technology is relatively more developed compared to other two, which are still undergoing evaluation and initial development stages. Main disadvantages common to all of them are: (i) low energy density, and (ii) in general the potential occurs remote from the consumption center. Because of the diversity in physical processes involved, exploitation techniques and state of development, these are discussed in three different sections.

CHAPTER **4**

Solar Energy—Basics

4.1 INTRODUCTION

The sun radiates energy uniformly in all directions in the form of electromagnetic waves. When absorbed by a body, it increases its temperature. It provides the energy needed to sustain life in our solar system. It is a clean, inexhaustible, abundantly and universally available renewable energy. A major drawback of solar energy is: it is a dilute form of energy, which is available intermittently, uncertainly and not steadily and continuously. However, it is more predictable than wind energy. Also peak solar insolation (incident solar radiation) often coincides with peak daytime demand, it can be well matched to commercial power needs.

Solar energy can be utilized directly in two ways: (i) by collecting the radiant heat and using it in a thermal system or (ii) by collecting and converting it directly to electrical energy using Photovoltaic system. The former is referred

CHAPTER **3**

Energy Storage

3.1 INTRODUCTION

In contrast to fossil fuel and nuclear fuel based energy, the initial input power in case of renewable energy source is outside our control. The use of renewable energy supplies constitutes a diversion of a continuing natural flow of energy; there are problems in matching supply and demand in time domain, i.e. matching the rate at which energy is used. The mismatch varies with time, on scales of months (e.g. house heating in temperate climate), days (e.g. artificial lighting) and even seconds (e.g. starting motors).

VISUAL SUMMARY

Figures are used exhaustively in the text to illustrate the concepts and methods described

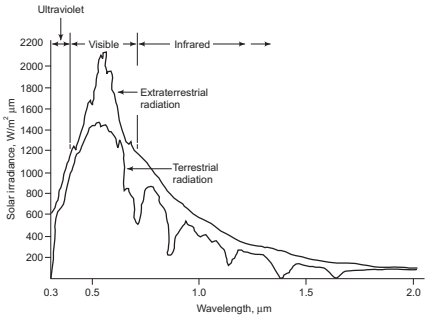

FIG. 4.4 Spectral solar irradiation, extraterrestrial and terrestrial

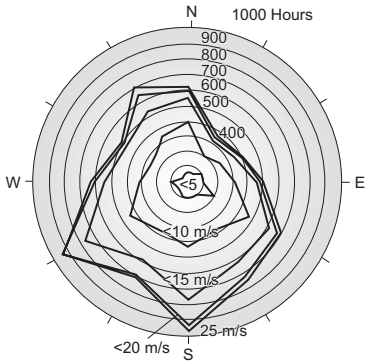

FIG. 7.4 Alternative presentation of wind rose

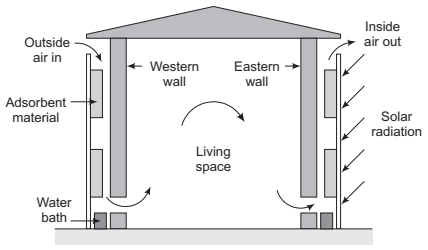

FIG. 5.17 Solar passive cooling through dehumidification

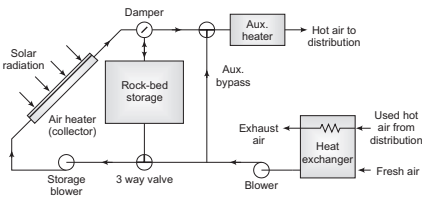

FIG. 5.18 Hot air industrial process heat system

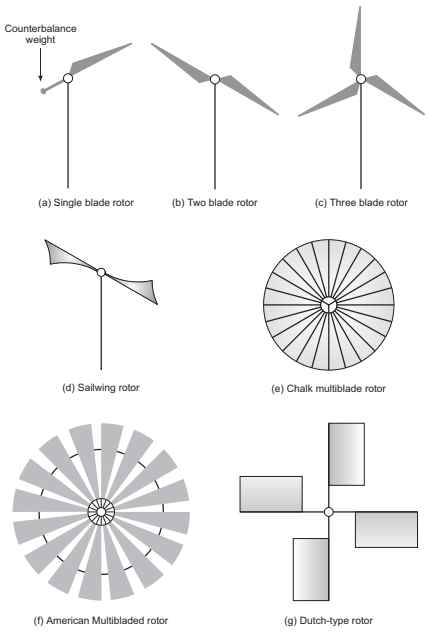

FIG. 7.14 Various types of rotors for HAWT

VISUAL SUMMARY

Several chapters contain worked out examples which will help the student in understanding the concepts and working out the exercise problems

Example 4.2

Calculate the number of daylight hours (sunshine hours) in Srinagar on January 1 and July 1. The latitude of Srinagar is 34° 05′ N.

Solution From given data:

n = 1 and 182 respectively for January 1 and July 1.

From Eqn (4.5), $\delta = -23.01°$ and $23.12°$ respectively for January 1 and July 1.

From Eqn (4.11), on January 1,

$$t_d = (2/15)\cos^{-1}[-\tan(34.083°)\tan(-23.01°)]$$
$$= 9.77 \text{ Hrs}$$

on July 1,

$$t_d = (2/15)\cos^{-1}[-\tan(34.083°)\tan(23.12°)]$$
$$= 14.24 \text{ Hrs}$$

Example 7.1

A propeller type wind turbine has following data:

Speed of free wind at a height of the 10 m = 12 m/s

Air density = 1.226 kg/m^3

α = 0.14°

Height of tower = 100 m

Diameter of rotor = 80 m

Wind velocity at the turbine reduces by 20%

Generator efficiency = 85%

Find:

(i) Total power available in wind

(ii) Power extracted by the turbine

(iii) Electrical power generated

(iv) Axial thrust on the turbine

Solution From given data:

$u_H = 12$ m/s, $H = 10$ m, $z = 100$ m

$\rho = 1.226$ kg/m^3, $\alpha = 0.14°$

$D = 80$ m $A_1 = 5026.55$ m^2

$u_1 = 0.8\, u_0$, $\eta_{Gen} = 0.85$

From Eqn (7.2), $u_z = 16.565$ m/s $= u_0$, and $u_1 = 0.8 \times 16.565 = 13.252$ m/s

From Eqn (7.4), $P_0 = 14$ MW

From Eqn (7.10), the interference factor, 'a' = 0.2

From Eqn (7.14), the power coefficient $C_P = 0.512$

VISUAL SUMMARY

Review questions will help the readers test their understanding of the concepts discussed in the text. Practice problems are also given in a few chapters for the students to work out.

REVIEW QUESTIONS

3.1. What do you understand by energy storage?
3.2. Under what circumstances storage of energy becomes necessary?
3.3. On what basis energy storage systems are classified? Can energy available in one form be stored in another form?
3.4. Which types of energy storage systems are suitable for peak shaving in electrical utility?
3.5. State the main applications of flywheel energy storage.
3.6. Which type of energy storage method is employed in hybrid vehicles?
3.7. Which type of energy storage method is suitable to improve the transient stability of an electric power grid?
3.8. What are the main advantages and limitations of a battery storage system?

REVIEW QUESTIONS

4.1. What are the limitations of solar energy?
4.2. What are the indirect forms of solar energy?
4.3. How is the energy continuously being produced in the sun?
4.4. What do you understand by earth's albedo?
4.5. At what wavelengths the radiation emitted from the sun and that reflected from the earth are centered?

PROBLEMS

4.1. Calculate the number of daylight hours (sunshine hours) at Bangalore on 21 June and 21 December in a leap year. The latitude of Bangalore is 12° 58′ N.

(**Ans.** 12.056 hrs, 11.944 hrs)

4.2. Calculate the angle made by beam radiation with normal to a flat plate collector, tilted by 30° from horizontal, pointing due south, located at Delhi, at 11:00 Hrs (IST), on June 1. The latitude and longitude of Delhi are 28° 35′ N and 77° 12′ E respectively. The standard IST longitude is 81° 44′ E.
(**Ans.** 29.88°)

VISUAL SUMMARY

Detailed Bibliography gives a list of related books to guide the interested readers in their further study. It also has a list of URLs which will lead them to the related sites on the Internet.

REFERENCE BOOKS

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8. Begamudre R.D., *Energy Conversion Systems,* New Age International Publishers, 2000.

INTERNET SITES FOR SUPPLEMENTARY READING MATERIAL

1. http://mnes.nic.in/
2. http://www.hitzeindia.com/hitze/NCES.html
3. http://mapsofindia.com/maps/nonconventional/
4. http://www.retscreen.net
5. http://www.rimstar.org/sdenergy/
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7. http://www.em-er.org/
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