Units and dimensions

Contents

Tables

Introduction

In the design and operation of any engineering process or system a question most commonly asked is how much? how big? In order to answer such questions it is important to have systems of measurement which are consistent and understood by all.

A dimension is a property that can be measured such as distance, time, temperature, speed.

A unit is a basic division of a measured quantity and it enables to say how much of the quantity we have - 10 miles, 2 hours etc.

Top

Base units and derived units

Base units are units that are defined by reference to some external standard. This external standard is arbitrary but is a matter of common agreement.

Derived units are units that are defined by reference to combinations of the base units.

Top

The SI system of units.

The SI system is an internationally agreed system of units based on seven base units. These are listed in table 1 below. Some of the more important derived units are listed in table 2.

Top

Table 1 Base units of the SI system of units

Quantity	Unit	Symbol
Mass	kilogram	kg
Length	metre	m
Time	second	s
Mole	mole	mol
Temperature	Kelvin	K
Electric current	ampere	A
Light intensity	candela	cd

Top

Table 2 Some derived units in the SI system

Quantity	Unit	Symbol
Area	square metre	m^2
Land area	Are (= 100 m^2)	a
Volume	cubic metre	m^3
Force	Newton = kg m s^{-2}	N
Pressure	Pascal = N m^{-2}	Pa
Work, Energy	Joule = N m	J
Power	Watt = J s^{-1}	W

Multiples of the basic units are used to avoid having to write very large or very small numbers. These are listed in table 3.

Top

Table 3 Multipliers for SI units

Prefix	Abbreviation	Multiplier	Prefix	Abbreviation	Multiplier
Exa	E	10^{18}	deci	d	10^{-1}
Peta	P	10^{15}	centi	c	10^{-2}
Tera	T	10^{12}	milli	m	10^{-3}
Giga	G	10^{9}	micro	m	10^{-6}
Mega	M	10^{6}	nano	n	10^{-9}
Kilo	k	10^{3}	pico	p	10^{-12}
hecta	h	10^{2}	femto	f	10^{-15}
deca	D	10^{1}	attia	a	10^{-18}

Note: 1 million = 10^{6}, 1 billion = 10^{9}

Top

Units of Energy and Power

The ***Joule*** is the basic SI unit of energy and is the energy expended when an object is moved through adistance of one metre as a result of a force of one Newton being applied to the object.

Power is the rate at which energy is expended and is Calculated from;

$$\text{Power} = \frac{\text{Energy used}}{\text{time}}$$

The SI unit of power is the ***Watt*** and is equal to one Joule per second (1.0 W = 1.0 J s^{-1})

One unit of energy which causes confusion is the kilowatt-hour. This is a unit of ***energy*** , not of power as it is derived by multiplying the Power in kilowatts by the time in hours. One kilowatt-hour is equal to 3600 kilojoules or

1.0 kWh = 3600 kJ = 3.6 MJ

It is important to be clear about the distinction between kilowatt-hours and kilowatts, as it can often lead to errors in calculations if you are not.

In Summary;

- The Joule is a unit of ***energy***
- The Watt is a unit of ***power***
- The kilowatt-hour is a unit of ***energy*** equal to 3600 kilojoules or 3.6 megajoules.

The table below gives conversions between kWh and Joules.

Table 4. Power/Energy conversions involving kilowatt-hours.

1. Energy Conversions	2. Power conversions	
kWh -> Joules	**kWh/day -> Watts**	**kWh/year -> Watts**
1 kWh = 3.6 MJ	1kWh/day = 42 W	1kWh/yr = 114 mW
1 MWh = 3.6 GJ	1MWh/day = 42 kW	1MWh/yr = 114 W
1 GWh = 3.6 TJ	1GWh/day = 42 MW	1GWh/yr = 114 kW
1 TWh = 3.6 PJ	1TWh/day = 42 GW	1TWh/yr = 114 MW
1 PWh = 3.6 EJ	1PWh/day = 42 TW	1PWh/yr = 114 GW

Top

Units of land area

Since renewable energy sources are often quite diffuse, land area plays a prominent role in some aspects of T265.

The formal metric unit of land area is the Are which is 100 m^2. However the most useful unit is the hectare (ha) ie. 100 Are or 10 000 m^2. This is the metric equivalent of the Acre and 1.0 ha is approximately 2.5 Acres. Also 100 ha = 1 km^2 (= 10^6 m^2)

Top

Back

Produced by Geoff Walker
Last Modified December 30, 2000