Power

In physics, Power is the rate of doing work or transferring heat, the amount of energy transferred or converted per unit time.

Having no direction, it is a scalar quantity. In the international system of units, the unit of power is (Joule/sec), Known as (watt). Another common and traditional measure is (horsepower)

$$Power = \frac{work}{time}$$

Equations for power

power, as a function of time, is the rate at which work is done, so can be expressed by this equation

$$P = \frac{dw}{dt}$$

Because work is a force F applied over distance r, $w = \vec{F} \cdot \vec{r}$ for a constant force, Power can be rewritten as:

$$P = \frac{dw}{dt} = \frac{d}{dt}(\vec{F} \cdot \vec{r}) = F \cdot \frac{dr}{dt} = \vec{F} \cdot \vec{V}$$

Averge power

As a simple example, burning one kilogram of Coal releases much more energy than does detonating a kilogram of TNT, but because the TNT reaction releases energy much more quickly, it delivers far more Power than the coal. The average the power over a period of time is given by

$P_{ave} = \frac{\Delta W}{\Delta t}$ It is the average amount (المحولة) of work done or energy converted per unit time.

The instantaneous power is then the limiting value of the average power

$$P = \lim_{\Delta t \to 0} P_{ave} = \lim_{\Delta t \to 0} \frac{\Delta W}{\Delta t} = \frac{dW}{dt}$$

In case of constant power P, the amount of work performed during a period of duration t

$$W = Pt.$$

Mechanical Power

Power in Mechanical systems is the combination of forces and movement. In particular, Power is the product of a force on an object and object's velocity, or the product of a torqure on a shaft and shaft's anguar velocity.

In mechanics, the work done by a force F on an object that travels along a curve C is given by the line integral:

$$W_C = \int_C \vec{F} \cdot \vec{V} \, dt = \int_C \vec{F} \cdot d\vec{x}$$

, where x defines the path C and v is the velocity along this path.

$W_C = U(B) - U(A)$, where A and B are the beginning and end of the path along which the work was done.

The power at any point along the curve C is the time drivative

$$P(t) = \frac{dW}{dt} = \vec{F} \cdot \vec{V} = -\frac{dU}{dt}$$

In one dimension, this can simplified to:

$$P(t) = \vec{F} \cdot \vec{v}$$

In rotational system, power is product of the torque τ and angular velocity.

$$P(t) = \vec{\tau} \cdot \vec{\omega}$$ where (ω) measured in (rad/s)

In fluid power system such as hydraulic actuators power is given by

$$P(t) = pQ$$, where p is pressure in pascal (N/m^2)
Q is volumetric flow rate (m^3/s)

Electrical power

The instantaneous (اللحظي - الفوري) electrical power delivered to a component is given by

$$P(t) = I(t) \cdot V(t)$$, $V(t)$ is the potential difference (volts) across the component, $I(t)$ is the current through it, measured in (Ampere)

$$P = IV = I^2R$$