

Power Transmitted by a Rotating Shaft

The work done by a force \mathbf{F} over a differential displacement vector $d\mathbf{r}$ is

$$dW = \vec{F} \cdot d\vec{r}$$

Equation 1

If a shaft is being driven by a motor or another shaft, then the motor or attached driving shaft is transmitting an applied torque T . One can think of this applied torque as being the result of a force \mathbf{F} located a distance r away from the axis of rotation. If the force is perpendicular to the radial vector \mathbf{r} , then a scalar equation can be written that, the effective force due to the torque is perpendicular to the displacement vector for the case of a rotating shaft, so the effective force in terms of the applied torque is

$$F = \frac{T}{r}$$

Equation 2

where r is the distance from the center of rotation. Again, since \mathbf{F} is perpendicular to $d\mathbf{r}$ dW may be written in scalar form as

$$dW = F dr$$

Equation 3

So substituting the formula for torque, T gives

$$dW = \frac{T}{r} dr$$

Equation 4

Finally, by dividing both sides of Eq. 4 by dt -

$$\frac{dW}{dt} = \dot{W} = T \frac{dr}{r} = T \frac{v}{r} = T \omega$$

Equation 5

Equation 5 represents the power transmitted by a shaft rotating with angular speed ω and applying a torque T to another shaft.