Basic Mechanical Terms used in Drives Applications

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Basic Mechanical Terms used in Drives Applications (on photo: Rotor bandaging machine for DC drives)

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Terms below are the basic mechanical terms associated with the mechanics of DC drive operation. Many of these terms are familiar to us in some other context.

Force

In simple terms, a force is a ***push*** or a ***pull***. Force may be caused by electromagnetism, gravity, or a combination of physical means. The English unit of measurement for force is ***pounds (lb)***.

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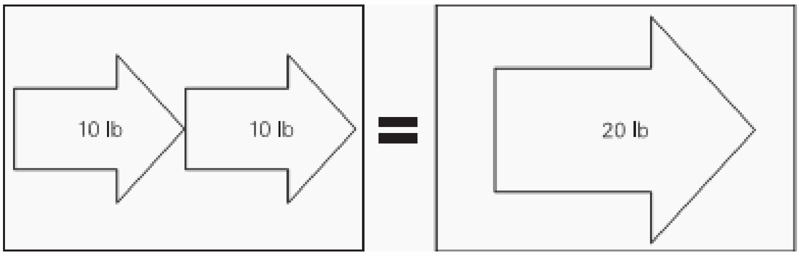
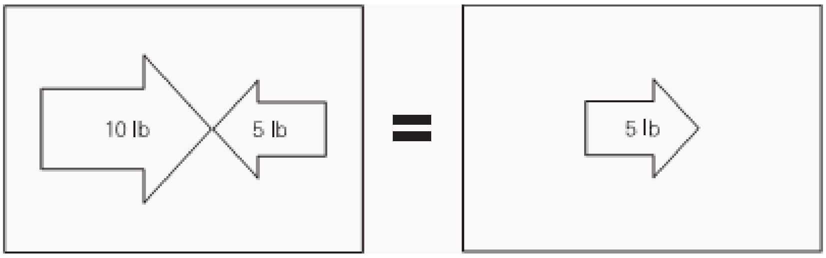
Net Force

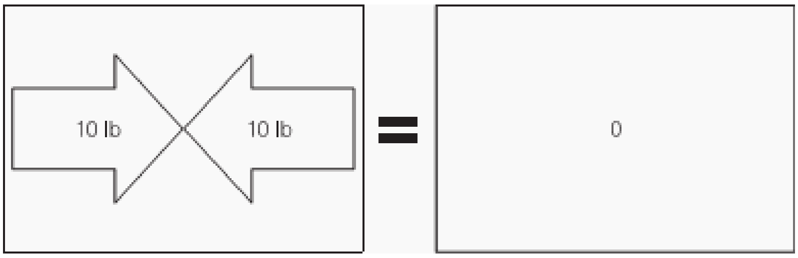
Net force is the ***vector sum of all forces*** that act on an object, including friction and gravity. When forces are applied in the same direction they are added. For example, if two 10 lb forces were applied in the same direction the net force would be 20 lb.



If 10 lb of force were applied in one direction and 5 lb of force applied in the opposite direction, the net force would be 5 lb and the object would move in the direction of the greater force.



If 10 lb of force were applied equally in both directions, the net force would be zero and the object would not move.



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Torque

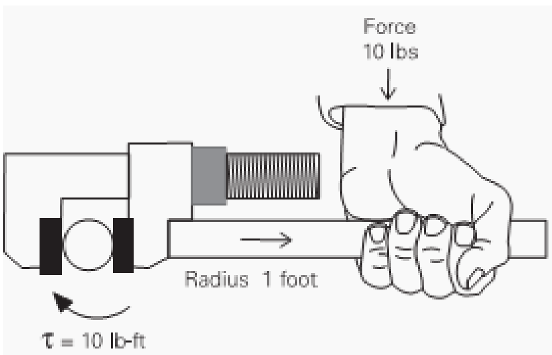
Torque is a ***twisting*** or ***turning force*** that tends to cause an object to ***rotate***. A force applied to the end of a lever, for example, causes a turning effect or torque at the pivot point.

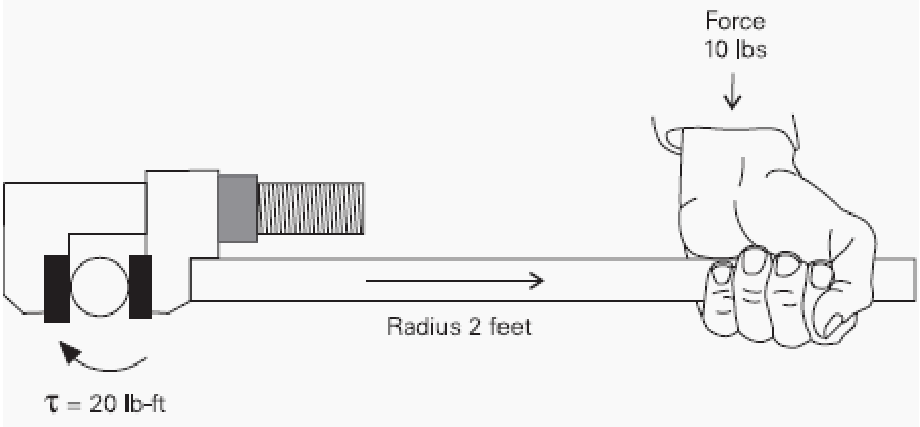
Torque (tau) is the product of force and radius (lever distance).

Torque (tau) = Force x Radius

In the English system torque is measured in ***pound-feet (lb-ft)*** or ***pound-inches (lb-in)***. If 10 lbs of force were applied to a lever 1 foot long, for example, there would be 10 lb-ft of torque.

An increase in force or radius would result in a corresponding increase in torque. Increasing the radius to 2 feet, for example, results in 20 lb-ft of torque.





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Speed

An object in motion travels a given distance in a given time. Speed is the ratio of the distance traveled to the time it takes to travel the distance.

Speed = Distance / Time

Linear Speed

The linear speed of an object is a measure of how long it takes the object to get from point A to point B. Linear speed is usually given in a form such as ***feet per second (f/s)***.

For example, if the distance between point A and point B were 10 feet, and it took 2 seconds to travel the distance, the speed would be 5 f/s.

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Angular (Rotational) Speed

The angular speed of a rotating object is a measurement of how long it takes a given point on the object to make one complete revolution from its starting point. Angular speed is generally given in revolutions per minute (RPM).

An object that makes ten complete revolutions in one minute, for example, has a speed of 10 RPM.

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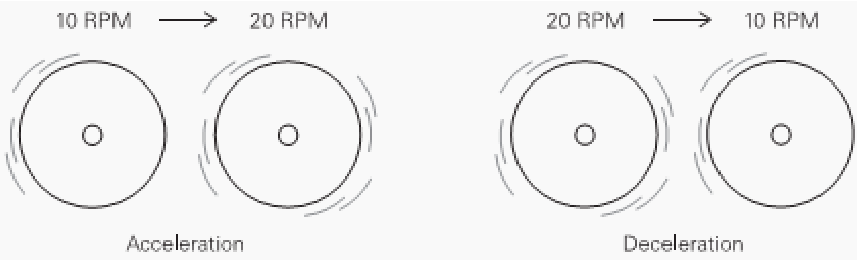
Acceleration

An object can change speed. An increase in speed is called ***acceleration***. Acceleration occurs when there is a change in the force acting upon the object. An object can also change from a higher to a lower speed.

This is known as ***deceleration*** (*negative acceleration*).

A rotating object, for example, can accelerate from 10 RPM to 20 RPM, or decelerate from 20 RPM to 10 RPM.



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Law of Inertia

Mechanical systems are subject to the law of inertia. The law of inertia states that an object will tend to remain in its current state of rest or motion unless acted upon by an external force. This property of resistance to acceleration /deceleration is referred to as the moment of inertia.

The English system of measurement is pound-feet squared (lb-ft^2).

If we look at a continuous roll of paper, as it unwinds, we know that when the roll is stopped, it would take a certair amount of force to overcome the inertia of the roll to get it rolling. The force required to overcome this inertia can come from a source of energy such as a motor.

Once rolling, the paper will continue unwinding until another force acts on it to bring it to a stop.

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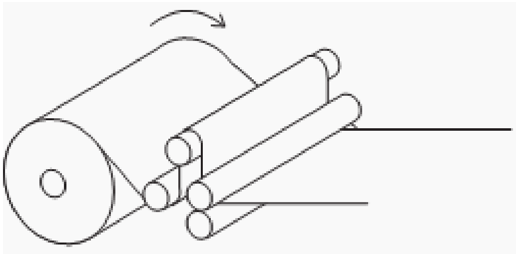

Friction

A large amount of force is applied to overcome the inertia of the system at rest to start it moving. Because friction removes energy from a mechanical system, a continual force must be applied to keep an object in motion. The law of inertia is still valid, however, since the force applied is needed only to compensate for the energy lost.

Once the system is in motion, only the energy required to compensate for various losses need be applied to keep it in motion.

In the previous illustration, for example: these losses include:

- Friction within motor and driven equipment bearings
- Windage losses in the motor and driven equipment
- Friction between material on winder and rollers

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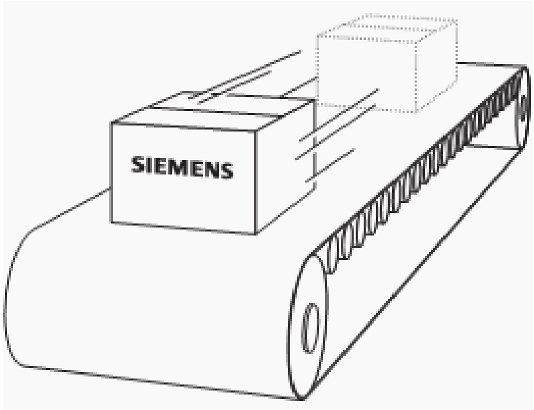
Work

Whenever a force of any kind causes motion, work is accomplished. For example, work is accomplished when an object on a conveyor is moved from one point to another.

Work is defined by the product of the ***net force (F)*** applied and the ***distance (d)*** moved. If twice the force is applied, twice the work is done. If an object moves twice the distance, twice the work is done.



W = F x d

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Power

Power is the rate of doing work, or work divided by time.

Power = (Force x Distance) / Time

Power = Work / Time

In other words, power is the amount of work it takes to move the package from one point to another point, divided by the time.

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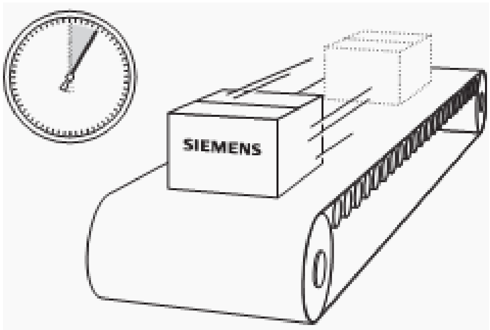


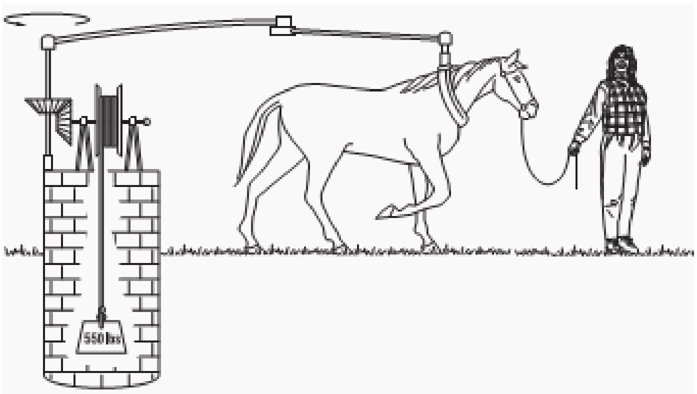
Horsepower

Power can be expressed in foot-pounds per second, but is often expressed in ***horsepower (HP)***. This unit was defined in the 18th century by ***James Watt***. Watt sold steam engines and was asked how many horses one steam engine would replace.

He had horses walk around a wheel that would lift a weight. He found that each horse would average about 550 foot-pounds of work per second.

One horsepower is equivalent to 500 foot-pounds per second or 33,000 foot-pounds per minute.

The following formula can be used to calculate horsepower when torque (lb-ft) and speed (RPM) are known.



It can be seen from the formula that an increase of torque, speed, or both will cause a corresponding increase in horsepower.

HP = (Torque x RPM) / 5250

Power in an electrical circuit is measured in ***watts (W)*** or ***kilowatts (kW)***.

Variable speed drives and motors manufactured in the United States are generally rated in ***horsepower (HP)***; however, it is becoming common practice to rate equipment using the ***International System of Units (SI units)*** of watts and kilowatts.

Resource: *Basics of DC Drives – SIEMENS*

Source: http://electrical-engineering-portal.com/basic-mechanical-terms-drives-applications