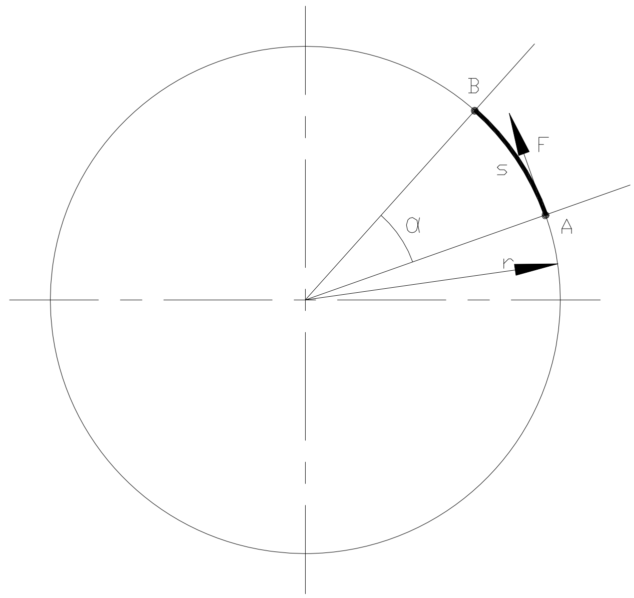
WOODWARD

Application Note 51214
(Revision NEW, 6/2003)
Original Instructions



Work versus Torque
(using correct terminology)

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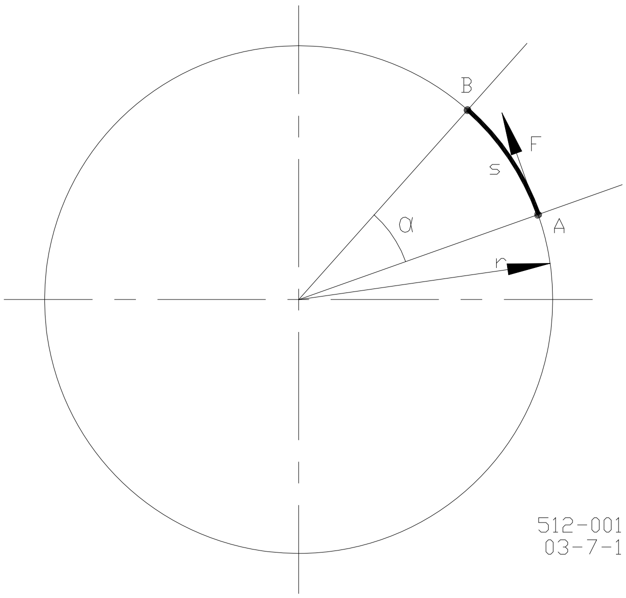
In general, work and torque are two much-confused items. People often use work when they mean torque and vice-versa. This document explains the difference between these two.

Consider a unitary circle, as depicted below.
We have a force F, going through a circular movement from point A to point B over an angle of α (alpha) degrees. The radius of the circle is r.



The first thing to do is to convert the angle α from degrees to radians:

$\alpha = \text{degrees} \times (\pi / 180)$

The distance traveled between points A and B is s:

$s = (\alpha / 2\pi) \times 2\pi r = \alpha \times r$

Now, torque is defined as force times moment arm or:

$M = F \times r$

Work is defined as force times distance traveled or:

$W = F \times s$

If we substitute s we get:

$W = F \times \alpha \times r$

This means that torque and work have a fixed relation which depends only on the travel in radians:

$W = M \times \alpha$

Conversion Table (Degrees to Radians)

Degrees	10	15	20	25	28	30	32	38	42	45	70	75
Radians	0.175	0.262	0.349	0.436	0.489	0.524	0.559	0.663	0.733	0.785	1.222	1.309

Observations

1. It is assumed that the force is always at a right angle to the radius. If this is not true, we have to correct the moment arm for this by multiplying by the sine of the included angle.

2. Since in general Woodward does not know how its customers are mounting their fuel linkage to the terminal shafts, we cannot verify whether the angle between the force and the moment arm is at 90°. This is the reason why Woodward cannot discuss torque with customers, but must discuss work.

3. The relation between work and torque does not depend on the units used. It will work just as well with feet and pounds as it does with meters and newtons. The only prerequisite is that the angle of travel be translated from degrees into radians as indicated.

4. Units for work and torque:

   Work is expressed in joules (J). 1 J = 1 kg·m²/s².
   The US equivalent is foot-pounds (ft-lb) or inch-pounds (in-lb).

   Torque is expressed in newton meters (N·m). 1 N·m = 1 kg·m²/s².
   The US-equivalent is pound-feet (lb-ft) or pound-inches (lb-in).

   It is clear that although work and torque have different units, they are actually identical.

   To convert between SI and US units:
   1 ft-lb = 1.356 J and 1 in-lb = 0.113 J
   1 lb-ft = 1.356 N·m and 1 lb-in = 0.113 N·m

   1 J = 0.737 ft-lb = 8.85 in-lb
   1 N·m = 0.737 lb-ft = 8.85 lb-in

5. This also shows why every work statement must be accompanied by the angle over which that work is determined. A smaller angle traveled results in less work (but not less force or less torque).

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 51214.

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