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Gearing is a common way to reduce speed and boost torque. During this transformation, the gear “consumes” a certain percentage of power. This power is termed as a loss and is measured in watts.

Efficiency—*as it relates to enclosed gearing*—is simply the ratio of the output power (power transmitted through the gearbox as usable work) to the input power. Losses can be measured by subtracting the power out from the input power. As losses are reduced or minimized, efficiency improves.

Gearing losses are due to friction. Two gears in mesh generate losses and inefficiency from the sliding action of one gear tooth against the corresponding tooth of the mating gear. This action converts usable power to heat and reduces overall efficiency of the gear set. While it’s inaccurate to say that a specific gear type has a definite efficiency, some gear types typically operate at lower efficiencies than others.

How to calculate these losses

Keeping in mind various gearing types (right angle helical bevel; right angle worm/helical; parallel-helical; and right angle worm), it’s easy to determine gearing losses:

1. Measure losses by subtracting the power out from the input power:

Power losses (watts) =
input power (watts) - output power (watts)

2. Comparing two choices of gearing for an application, the power savings is the difference in

the power losses or the difference in the input power required:

Power saved (watts) =
input power choice 1 - input power choice 2

3. If data is available, converting from horsepower to watts yields the savings directly:

Power saved (watts) =
746 x HP in [1- eff lower / eff higher]

4. Calculate annual energy savings, cost of energy in $/kW and estimated hours of operation per year as follows:

Savings / year = power saved (watts) x cost of energy ($/kW) x hours of operation

5. In justifying the cost premium of an alternative gearing selection, you can calculate simple payback (i.e., number of years required to pay off the initial investment) as follows:

Simple payback =
initial cost difference / savings / year

Of course, common sense reduces the need to calculate losses. For example, avoid over-powering the application. The proper selection of gearing and motor to meet application requirements will save energy and keep equipment costs low. Gearing should be applied based on output capability—*not on the input power required*. During idle periods, consider turning off equipment. Finally, remember that proper installation and alignment are priceless, as is proper maintenance.

Conclusion

Since many factors affect gearbox efficiency, it can be worthwhile to perform a system study and replace inefficient, unreliable gearboxes with more reliable units. For example, the durability and longevity of helical bevel gears often makes it possible to replace a worm gearbox/motor combination with a smaller-horsepower input-HB and produce more torque at the driven shaft.

The bottom line is if you're using the right gearing type—*and following the above advice*—you can expect to save money while you boost reliability and efficiency.
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