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Worm vs. Helical?

A Cost-Efficiency Analysis Helps You Make the Right Choice

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Boston Gear

An Altra Industrial Motion Company

Worm vs. Helical?

A Cost-Efficiency Analysis Helps You Make the Right Choice

By Greg Cober, Boston Gear Sales and Product Training Manager

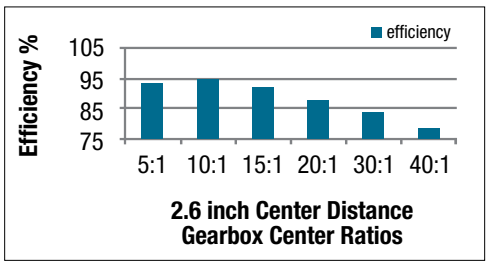

Figure 1

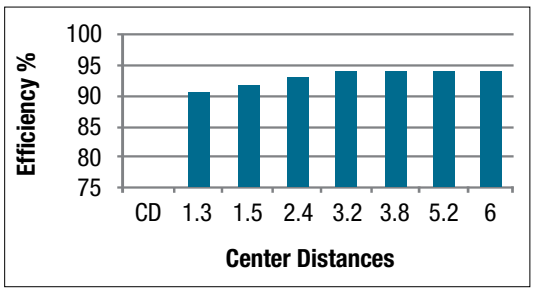

Figure 2

Change, as they say, is the only certainty. When comparing efficiency of gearboxes in industrial drivetrains, this is more true than ever. It may be conventional wisdom that using a helical gearbox design will lead to more system efficiency than using a worm gear design. At one time that was quite true, but advances in worm gearbox designs as well as improvements in lubrication are closing the efficiency gap to the point where the cost-effectiveness of worm gearboxes is more than competitive with helical designs.

In evaluating the efficiency of worm gearboxes from as little as 10 years ago, it can be seen that efficiency has increased. Right-angle worm gearboxes that were shown as having efficiency of 82 or 83% previously are now showing ratings in the upper 80% ranges, while units that were in the upper 80% range now are rated in the ranges of 93 to 94%. It should be noted that some manufacturers have made greater strides in these efficiency improvements than others and designers would do well to evaluate their suppliers' progress.

Generally speaking, right-angle worm gear reducers begin to see drops in efficiency as they cross into higher ratios. It is also true that larger center distance worm gearboxes are generally more efficient than smaller center distances.

For example, a standard unit with a 2.6 inch center distance sees efficiency decrease slowly as ratio increases (Figure 1).

Similarly, as center distance grows, efficiency improves. Figure 2 shows the rise in efficiency for seven center distances at a 10:1 ratio.

The challenge designers and engineers have is similar to the one homeowners have when selecting a new furnace or appliance. What is the trade-off between purchase price and cost savings through efficiency? Is it more economical to pay extra for higher efficiency or is the cost of that efficiency too high to recapture through lower operating costs?

When comparing the energy savings for a helical gearbox compared to a worm gearbox in the same application, we can find that there are many situations where the dollars saved are minimal. As a general statement, the multiple stages required within a helical gearbox add complexity and cost. Helical gearboxes are generally more expensive than worm gearboxes for the same HP and gear ratios. When the energy dollars saved are compared to gearbox purchase costs, there are strong reasons to consider right-angle worm gearboxes in many lower HP applications.

To compare the savings in some common lower HP applications, we have calculated the dollar cost to operate a motor at full-load current for an eight hour shift using a standard AC motor (Figure 3). Motor costs are calculated using a US Department of Energy website which identifies a national average industrial power rate of 6.3 cents per kilowatt hour as of March 2012.

Motor HP	Cost per hour to operate motor at full load at 100% efficiency
1 HP	$0.08
2 HP	$0.17
5 HP	$0.35
10 HP	$0.73

Figure 3

Based upon market prices and catalog stated efficiencies, the payback time for low HP applications can be extremely long. For example, in a simple application for a 1 HP unit with a 10:1 reduction, the cost of a worm gearbox is $840 less than the equivalent helical unit. The efficiency of the worm gearbox would be 92% compared to a best of 97% for a helical gearbox.

For example, in an application for a 1 HP unit with a 10:1 reduction, you can conservatively expect to pay a $300 or more premium when using a helical right angle gearbox instead of a worm right angle gearbox. Even the most efficient helical reducer will not exceed 97% (more typically it is in the low to mid 90% range). So, you can use an efficiency of 97% as the best scenario for the helical right angle reducer, as compared with 92% for worm reducers that are manufactured using current technology. That converts to less than a penny per hour of operation. At that rate it would take more than 200,000 hours of operation to recover the difference in costs between the two (or a bit more than 7-1/2 years at continuous-duty 24/7/365 usage).

As noted, the higher the ratio, the lower the efficiency of the gearbox. For the same 1 HP application, a 30:1 ratio would see a worm gearbox efficiency drop to 81%.

Even in this instance, the purchase price differential between a helical and a worm gearbox is high enough that the time to make up the cost difference would be 48,000 hours (or more than 2-1/2 years at continuous-duty 24/7/365 usage).

The crossover point, where it becomes more efficient to use helical rather than worm gearboxes, is at the 10 HP range with ratios above 20:1. With low ratios, the worm gearbox still has a lower purchase cost compared to the helical and still has a high efficiency of 94%. But, as ratios rise, the relative efficiency decreases and, in higher ratios, the purchase cost and efficiency ratings both show that the helical gearboxes may be a more cost-efficient design at both purchase and cost of use.

The purpose of these examples is not to imply that worm gearboxes are more suitable than helical gearboxes in all applications. To this point, you will find that in applications requiring higher torque (for example 10HP at a 30:1 ratio), a helical reducer generally provides a better solution. In this example, the difference in efficiency plays a larger role in the TCO calculation and allows for the capability to downsize. The overall takeaway is that it is very important to compare published efficiency ratings of both helical and worm gearboxes for the applicable HP and ratio during the specification process.

As with many industrial components, the efficiencies of worm gearboxes have increased as materials and manufacturing methods have improved. For applications with a 5HP motor or less and where speed reductions are 50:1 or less, it would be wise to consider worm gearing since it may provide the lowest total cost of ownership. The conventional wisdom that helical gearboxes are widely more efficient than worm gearboxes may have been true once, but should no longer be taken as a given. For many lower HP applications, the long-term efficiency advantages (and cost savings) of a helical gearbox may never be realized.

About Altra Industrial Motion

Altra Industrial Motion (NASDAQ:AIMC) is a leading multi-national designer, producer and marketer of a wide range of electromechanical power transmission products. The company brings together strong brands covering over 40 product lines with production facilities in nine countries.

Altra's leading brands include Boston Gear, Warner Electric, TB Wood's, Formsprag Clutch, Wichita Clutch, Industrial Clutch, Ameridrives Couplings, Kilian Manufacturing, Marland Clutch, Nuttall Gear, Bauer Gear Motor, Stieber Clutch, Twiflex Limited, Bibby Turboflex, Matrix International, Inertia Dynamics, Huco Dynatork, Lamiflex Couplings, Ameridrives Power Transmission, Delroyd Worm Gear and Warner Linear. For information on any of these technology leaders, visit www.AltraMotion.com or call 815-389-3771.

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