Universal Hobs

Email your question — along with your name, job title and company name (if you wish to remain anonymous, no problem) to: *jmcguinn@geartechnology.com*; or submit your question by visiting *geartechnology.com*.

QUESTION

I make all the double helical gears that go into a gearbox. Four different gears in all that go into this unit. If the gear module for the bull gear and the intermediate gear are the same (these are the two individual gears that mate), and the gear module for the high-speed pinion and high-speed gears are the same (these are the other two individual gears that mate in the gear box as well), is it then possible to just use two hobs in this setup to make all four gears, since they mate together with each other? We are currently using a different gear hob for each gear.

Editor's Note: While this question was asked and answered in the 2016 Sept/Oct issue of *Gear Technology*, what follows is a more detailed response to the question.

Expert Response: Provided by Dr. Hermann J. Stadtfeld:

The short answer to the reader's question is YES!

However, the reader who asked the question — and many other readers — might like to get some more information as to why and how?

Double helical gears consist of a left hand and a right hand helical gear with opposite helix angles that are grouped together on one shaft. The two-toothed sides of double helical gears commonly have the same module (or diametral pitch) and the same helix angle, where the sign of the helix angle is opposite between the two sides (Fig. 1). The manufacturing problem of double helicals is the width of the space between the two-toothed section. This space has to provide sufficient over travel clearance for a hob cutter. If the groove is too small the two helicals can be manufactured separately and then assembled back-to-back on a shaft. If separate manufacturing is not an option, then a shaping process can be employed that will accommodate very small, over travel grooves between the toothed sections. Shaping is slow and the cutters used are non-standard tools that are expensive compared to standard hobs.

Figure 1 Double helical gear.

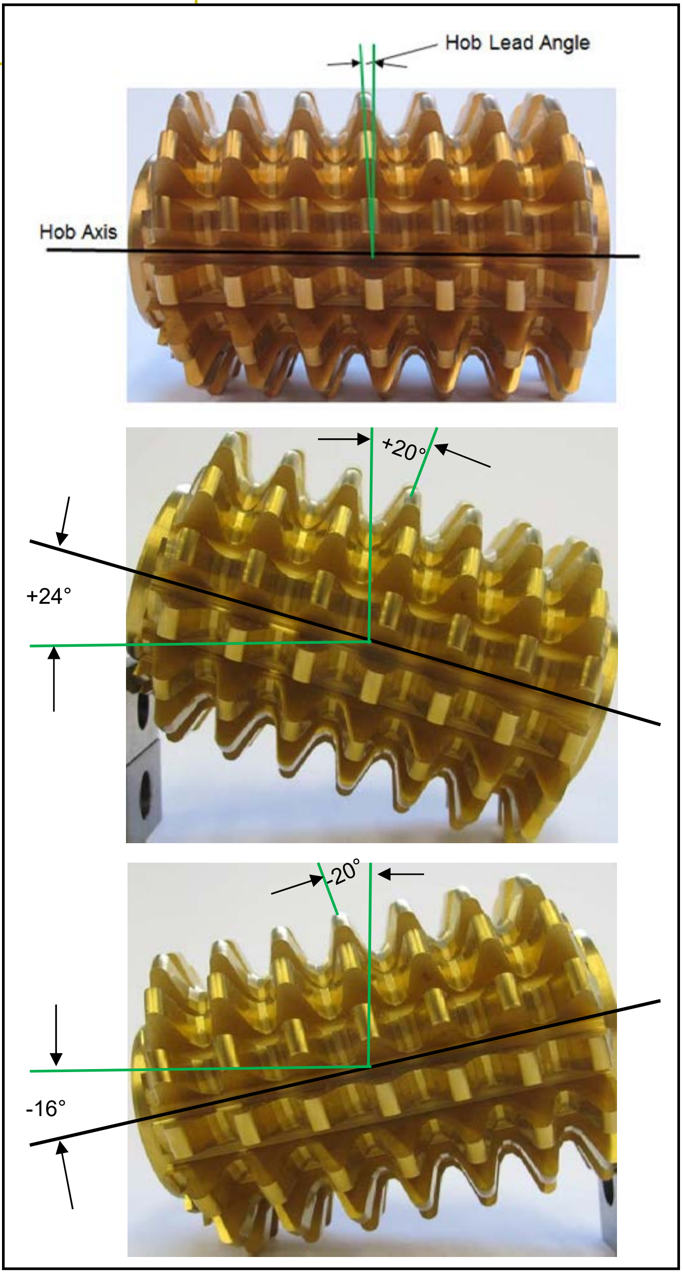

Figure 2 Module 4.75mm single start right hand protuberance hob with tip relief.

This leads to the advantages and the universal application of hob cutters. Standard hobs are available for a preferred range of modules (metric hobs) and diametral pitches (English system hobs). Standard hobs are also available with protuberance for root relief and with a tip relief section. Figure 2 (top) shows a module 4.75 hob with protuberance and tip relief. A hob with a certain module represents a section of a generating rack (Fig. 3). While the hob rotates with rotation *F*, the generating rack is shifted in direction *G*. The shift *G* requires a rotation *C* of the work gear. If the hob has one start, then one rotation of the hob requires the work to rotate by one pitch. The generating rack principle in Figure 3 makes clear that the hob could also be positioned in front of the rack (where the work is), and the work gear could in turn be positioned where the hob is located (Fig. 3). This principle explains the answer to the reader's question but there are some details to be considered. The hob teeth wind around the hob body like threads with a lead angle. If a spur gear is manufactured the hob axis will have to be swiveled out of its initial, horizontal position by the thread lead angle.

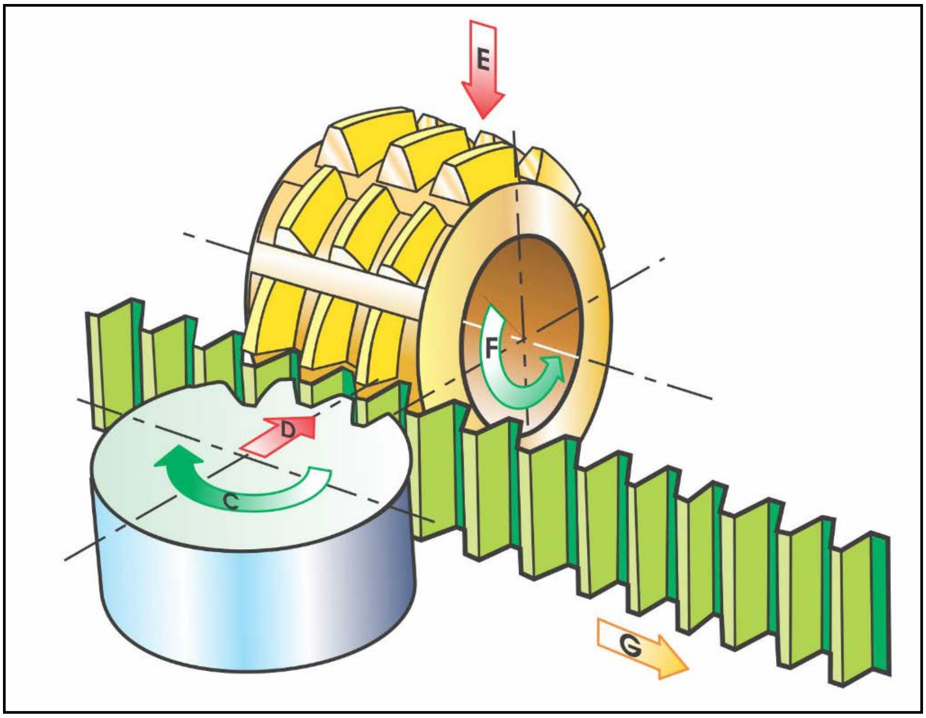

Figure 3 Hob and generating rack principle.

The double helical gear in Figure 1 has a helix angle of +20° on its bottom part and +20° on its top part. The hob in Figure 3 has right hand threads with a lead angle of 4°. In order to cut the top gear, the hob has to swivel 20° + 4° = +24° in clockwise direction, as shown in Figure 2 (center), if it is positioned in front of the gear in Figure 1. When the same hob cuts the bottom part the required swivel angle is –20° + 4° = 16°, as shown in the lower graphic in Figure 2.

The right hand top gear in Figure 1 meshes with a left hand mate and vice versa for the top gear. This fact already indicates that the same right hand hob cannot only cut the two members of the double helical we see in Figure 1, but also the two members of the mating double helical.

In order for helical and other gears to mesh correctly, the same module and pressure angle are required, which are both given when using the same hob. If the two mating gear pairs use the same root fillet radius and also have the same root and tip relief, then it is possible to use the same hob for both mating gears, which amounts in case of double helicals to four gears being cut with one hob. In our example the hob swivel angle will always have to change between bottom and top gear between –16° and +24°. Hobbing experts point out that the cutting conditions are better and that the influence of the surface scallops to the involute profile is lower if the hob is swiveled in the direction of the lead angle rather than against it. The influence of the hob lead angle to the cutting conditions is more significant in case of multiple start hobs, and can be neglected in case of single start hobs. If multiple start hobs are used it is recommended to use a left hand hob to cut a right hand part, and vice versa.

Using the same hob for pinion and gear is also possible if the two meshing members require different amounts of profile shift. The profile shift will not change the pitch diameters of the cut gears, but will alter the outside and root diameter. Profile shift is simply accomplished by turning the gear blanks with the correct outside diameter required for the particular profile shift and then, depending on the sign of the profile shift, advancing or retracting the hob versus the work in direction *D* (Fig. 2) in the hobbing machine.

Dr. Hermann J. Stadtfeld is vice president—bevel gear technology/R&D—The Gleason Corp., and valued contributor to Gear Technology magazine.