Selecting Correct Size of Hob/Gashing Cutter

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

How does one select the correct size of hob/gashing cutter like hob OD, length and number of flutes for teeth cutting process based on tip circle diameter and face width of job?

Expert response provided by Jin Zhou, gear tools engineer Nachi America. Solid hobs can cut a wide variety of cylindrical workpieces, including involute gears or splines, straight-sided splines, roller chain sprockets, worm gears, other special forms, etc., and non-cylindrical workpieces like racks. The detailed optimal features of the hob for each job should be evaluated individually, and often, it's even debatable what the optimal set of selection is.

However, there are some generic criteria for reference, focusing on hob OD, length and number of flutes.

Machine and fixture limitations (from tool layout drawings and machine manuals, arbor and keyway sizes for shell-type hobs), combined with the process (climb or conventional hobbing, etc.), will decide the boundary conditions such as maximum and minimum OD and length (OAL, or overall length for shell-type hobs and teeth length for shank-type hobs). Careful check is needed for a retrofitted or converted machine.

Within this narrowed range, a user can choose hob OD and length first. By and large, they are in proportion to the part teeth size (e.g., module or diametral pitch for involute parts, circular pitch for straight-sided splines and sprockets). With a larger OD, more cutting teeth with larger land widths are available to achieve better tool life, and more material between hob flute/gash bottom and keyway corners/bore to enhance hob strength for shell type

Module m	Diametral Pitch LW	Outside Dia. D	Overall Length L	Bore diameter (d) Type A	Bore diameter (d) Type B	No. of Flutes N
	26	50	50			
1	24	50	50			
	22	50	50			
1.25	20	50	50			12
	18	55	55			
1.5	16	55	55	22	22.225	
1.75	14	55	55			
2	12	60	60			
2.25	11	60	60			
2.5	10	65	65			
2.75	9	65	65			
3	8	70	70			
3,25		70	70			10
3.5		75	75			
3.75	7	80	75	22	26.988	
4	6	85	80			
4.5	5½	90	85			
5	5	95	90			
5.5	4½	100	95			
6		105	100			
6.5	4	110	110			
7	3½	115	115	32	31.75	
8	3	120	130			9
9	2¾	125	145			
10	2½	130	160			
11	2¼	140	175			
12		150	190			
	2	170	200			
14		170	210	40	38.1	
	1¾	190	220			
16	1½	190	230			8
18		210	250			
20	1¼	220	220	50	50.8	
22		230	300			
25	1	250	320			

hobs; this also results in less production efficiency. The recommended cutting speed is decided by the part material, with hardness, hob material and coating, and cutting condition (dry or wet) to avoid excessive wear rate. The hob rpm can then be calculated from the cutting speed and hob OD. For a hob with a larger OD but other features the same, usually a lower rpm is used to maintain the same cutting speed, which increases the cycle time. In addition, a larger hob OD may increase the torque on the hob spindle. In a similar manner, the larger hob length achieves a longer tool life, but also with more manufacturing errors related to flute lead and higher hob deflection during cut to potentially cause accuracy issues. Depending on the production volume, the trend of the industry is to maximize the tool life.

For a given OD, a user can pick the number of threads and flutes based on part in-process quality and process cycle time requirements. If the same machining parameters are used, the hob with a greater number of threads will generate the part faster, yet with lower accuracy. The hob with a greater number of flutes will give higher tooth form accuracy, but the hob tooth land width must be reduced for chip evacuation, thus resulting in a smaller number of sharpenings. The chip thickness can be estimated to prove the selection will not cause excessive cutting forces.

There is a small optimal range for each hob feature for a certain application. Most hob manufacturers established standard selections for commonly used part ranges through years of experience — and this is a good starting point for most users.

Other factors not directly on the hobbing operation could be considered as well, i.e. — can the larger hob's longer tool life translate into a lower piece cost from the quoted price? Can the weight of a larger hob (with or without arbor) satisfy safety/ergonomic standards or does it requires some lift assist equipment? Is there any process before or after hobbing on the same production line that the user needs to coordinate tool change to reduce the line downtime? Each application may have some unique situations.

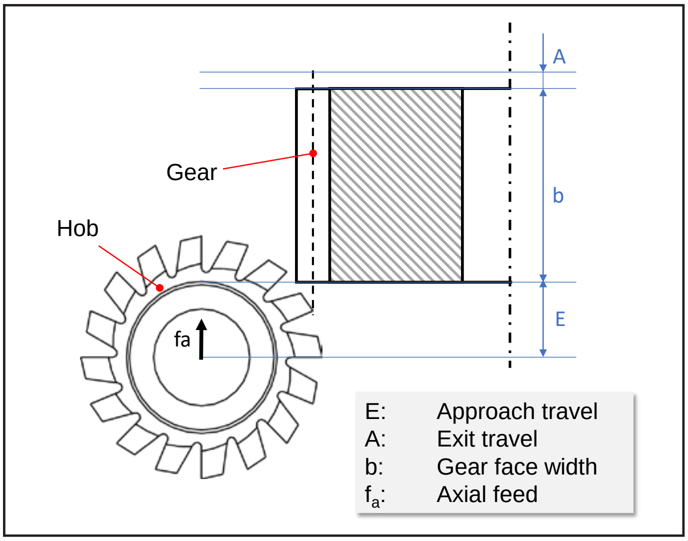
If a user has a special part material — especially non-ferrous based, or a job with very tight tolerance, or a very high production volume, or any other exceptional conditions — a thorough planning with hob manufacturer (also with hob machine OEM, fixture manufacturer, and process/product engineers as necessary) would ensure the best selections made and regrettable mistakes avoided.

To sum up, one should select the hob features based on several critical elements: machine and fixture limitation; part teeth size; part material machinability; hob material and coating; hob process condition; part in-process quality; cycle time; etc. And if the user has a common job, the hob manufacturer's standard hob size selection can be used as a starting point. But if the user has a unique application, a detailed discussion with the hob manufacturer should be conducted. The goal is to minimize tool costs and cycle time while meeting all quality specs, with the understanding that the end user's preference might eventually be the dominant deciding factor.

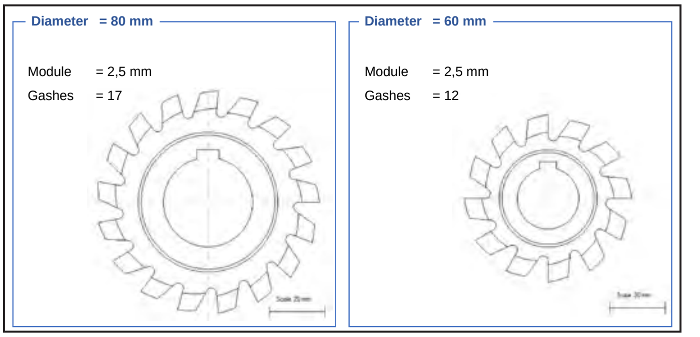
For More Information

Jin Zhou
Gear Tools Engineer
Nachi America, Inc.
46200 Twelve Mile Road, Novi, MI 48377
Cell: (248) 875-1858
www.nachiamerica.com

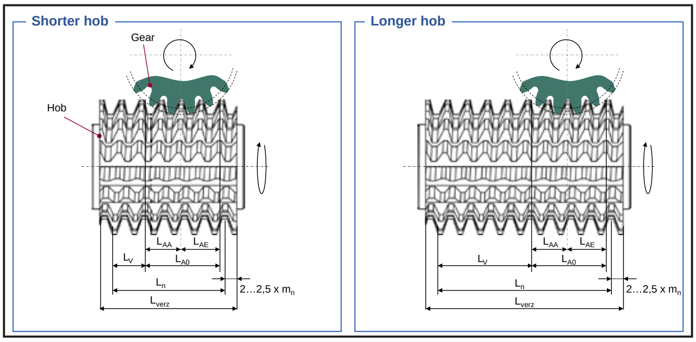
Second Expert Response provided by Dr.-Ing. Deniz Sari Star-Su. A question about the chosen size of a hob does not have just one single answer. It depends on several boundary conditions for the particular application. Starting with the choice of the hob's diameter, the diameter has to be chosen to provide required space and stability for the teeth and taking into account being a bore-type or a shank-type hob. Furthermore, the hob's diameter does have a direct impact on the productivity of the process. The picture below shows the different travel path sections a hob has to go through during gear cutting. Besides gear's face width b, the hob has to travel through the approach length E and the exit travel length A. Especially, the approach length is impacted by the hob`s diameter. To increase the productivity, the relation between A+B should be as small as possible. This explains the pursuit to keep the diameter smaller.



At the same time, a decreasing diameter of the hob leads to the fact of decreasing space for our gashes. Our example in the next picture shows two different hobs for the same application for a module 2.5 mm gear. The hob with a diameter of 80 mm does have 17 gashes. To ensure the same amount of *usable life* on the 60 mm hob, the number of gashes has to be reduced to 12. In case the hobbing application is set up to generate the same maximum chip thickness, the tool with a smaller number of gashes needs to run with a lower axial feed, which also could impact productivity. Furthermore, less gashes means a smaller number of teeth in contact, which reduces the possible numbers of gears to be cut until the hobs need to be reconditioned.



If the diameter has been chosen, the hob`s length is next to be defined. First, it is important to be able to cover the full generation length between hob and gear L_{A0}. Additionally, on the left and right side of the hob, a certain security value needs to be added which is in the range of 2 to 2.5 x module. With such a hob, now it is possible to cut the gear. But to increase tool life, a shifting length L_v is needed, which allows cutting the following gears on different hob positions and levels the tool wear along the tool's length. Simply said, with a longer hob, more teeth can be realized that can be used to cut the parts. How long the complete hob length will be depends on the customer's needs. If the customer is looking to produce a low number of gears, or just prototypes, the hob can be smaller. But if a large batch or a repeated production shall be realized, the hob length needs to be increased to be able to cut as many gears as possible before the tools need to be reconditioned.



Both questions — regarding hob diameter and length — do have an impact on a tool's investment as well. Therefore our goal for our customers is to get a tool dedicated to their needs, offering the best tool life for the application but keeping the investment as low as possible.

Finally, further boundary conditions for a hob's dimensions can be the hobbing machine, the clamping or the gear itself. If one of these gives a limitation for tool size, this must be respected and the best compromise needs to be found. To find the best compromise, a tool supplier needs to stay in close contact with the customer and to analyze the particular application in detail. Our experience in being the interface between the part, the machine and the hob itself gives us a huge opportunity to offer the best fit hob dimensions for our customers to have the highest productivity and tool life for their needs.

For More Information

Dr.-Ing. Deniz Sari
Star SU Group Technology Manager
5200 Prairie Stone Parkway, Suite 100
Hoffman Estates, IL 60192 USA
Phone: (847) 649-1450
Web: www.star-su.com

For Related Articles Search
hobs
at www.geartechnology.com

Do YOU have a technical question for our panel of experts? Whether it's design, manufacturing or inspection related, our experts are prepared to handle whatever is stumping you. You can submit your questions online at **www.geartechnology.com/asktheexpert.php**

NO QUESTIONS too Basic or Technical. We're here to help!