# Selection of Hobbing Data

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### Introduction

The art of gear hobbing has advanced dramatically since the development and introduction of unique machine and tool features such a no backlash, super rigidity, automatic loading of cutting tools, CNC controls, additional machine power and improved cutter materials and coatings. It is essential to utilize all these features to run the machine economically.

The following guideline is an attempt to systemize the modern knowledge of hobbing and to assist gear process engineers in selection and determination of various unknowns for cutting gears most efficiently. Obviously, it is an impossible task to take into consideration all the variables influencing machine, cutter, speed and feed selection. There are also differences of opinion regarding the best ways to hob gears. Nevertheless, this guideline can serve as a starting point for a large variety of applications and sizes. The recommendations are based on the assumption of using adequate hobbing machines, rigid fixtures and TiN coated hobs made of M35 or similar material.

### Cutter Selection

*Selection of number of starts.* The number of starts of the hob depends on pitch, number of teeth, stage of manufacturing, gear quality and divisibility with number of teeth of the gear. Generally, the productivity increases when hobs with greater number of starts are employed.

Table 1 shows multi-start hobbing limitations depending on pitch and number of teeth.

Additional limitations can be set for finish hobbing in reference to AGMA quality.

In the case of non-hunting ratio combinations between the number of teeth of the gear and number of starts of the hob, the maximum number of starts should not exceed two.

Additional limitations for pre-shave hobbing:

The number of starts should be tested for hunting ratio combination, and in case of a non-hunting ratio, the number of starts should be reduced until a hunting condition is reached.

For AGMA quality less than 11, the number of starts can equal 2, even in the case of non-hunting ratio combinations.

For AGMA quality greater than 10, the number of starts should not exceed 3. (See Table 2.)

*Selection of number of hob gashes.* The more numbers of gashes, the more cutting edges are engaged, resulting in less cutter load and wear. Greater numbers of gashes also increase the number of enveloping cuts, which make the involute smoother. This is especially important when cutting gears with small numbers of teeth. Table 3 shows minimum recommended number of gashes depending on number of hob starts.

*Selection of hob diameter.* Smaller hob diameter usually results in less cutting time since greater hob RPM can be achieved. Limiting factors for reducing further hob diameter are usually minimum number of gashes and lead angle. Maximum lead angle for hobs with straight gashes is usually within 6 to 8 degrees. Sometimes for high production, hob diameter has to be increased to enable utilization of a longer hob, since very high length over diameter ratio may undermine the system rigidity.

*Hob accuracy class selection.* Hob accuracy selection is based on AGMA gear quality, stage of manufacturing and number of starts. Class accuracy should be equal or better than the accuracies shown in Tables 4 and 5.

### Selection of the Machining Data

The selection of the number of cuts is influenced by pitch, number of gear teeth, stage of manufacturing, surface finish and gear quality. A two-cut cycle can be selected for gears with a module greater than 4.5. For small numbers of teeth (less than 12) and a module greater than 4, a two-cut cycle should also be selected. The number of cuts for finish hobbing can be selected from Fig. 1.

Hob speed is usually selected based on cutter material and coating as well as workpiece material, hardness and pitch. Fig. 2 can be used to determine machinability in reference to workpiece material and Brinell hardness, assuming the cutting tool is made of M35 or the equivalent.

Based on machinability and module, one can determine hob surface speed from Fig. 3.

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Table 1—Multi-start hobbing limitations.

| | LIMITATIONS | |
|---|---|---|
| No. of Hob Starts | Max. Module (NDP) | Min. No. of Teeth |
| 2 | 5.5 (4.61) | 13 |
| 3 | 4.5 (5.64) | 17 |
| 4 | 3.0 (8.46) | 20 |
| 5 | 2.5 (10.16) | 25 |

Table 2—Number of starts in relation to AGMA quality level.

| AGMA Quality Level | 12 | 11 | 10 | 9 | 8 | 7 | 6 |
|---|---|---|---|---|---|---|---|
| Max. No. of Starts | 1 | 1 | 1 | 2 | 2 | 3 | 3 |

Table 3—Minimum gashes in relation to hob starts.

| Number of Starts | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Min. No. of Gashes | 9–12 | 12–13 | 13–17 | 17–19 | 17–21 |

Table 4-5—AGMA class accuracy vs. hob starts.

| Selection for 1 or 2 Start Hob | | | Selection for 3 to 5 Start Hob | | |
|---|---|---|---|---|---|
| | Finish | Pre-Shave | | Finish | Pre-Shave |
| Class C | 3 | 4 | Class C | 3 | 4 |
| | 4 | 5 | | 4 | 5 |
| | 5 | 6 | | 5 | 6 |
| Class B | 6 | 7 | Class B | 6 | 7 |
| | 7 | 8 | | | |
| Class A | 8 | 9 | Class A | 7 | 8 |
| | 9 | 10 | | 8 | 9 |
| | 10 | 11 | | | 10 |
| | | | | | 11 |
| Class AA | 11 | 12 | | | |
| | 12 | | | | |

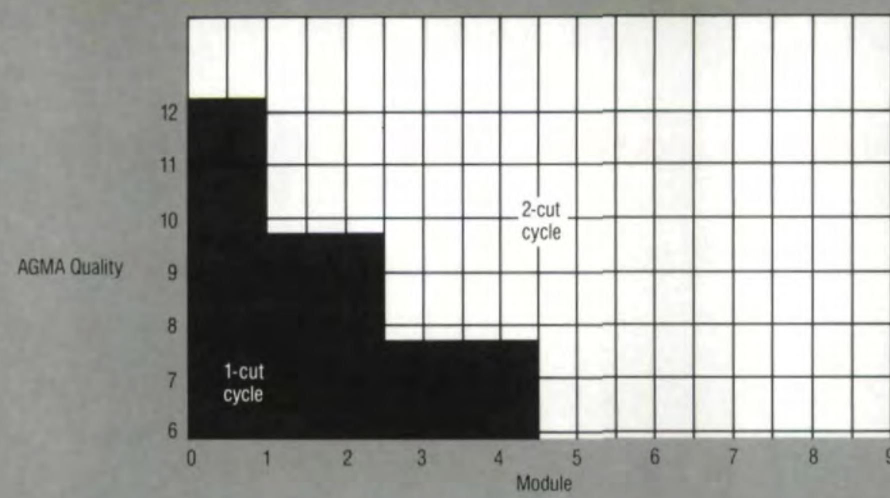


Fig. 1—Finish hob cut selection chart.

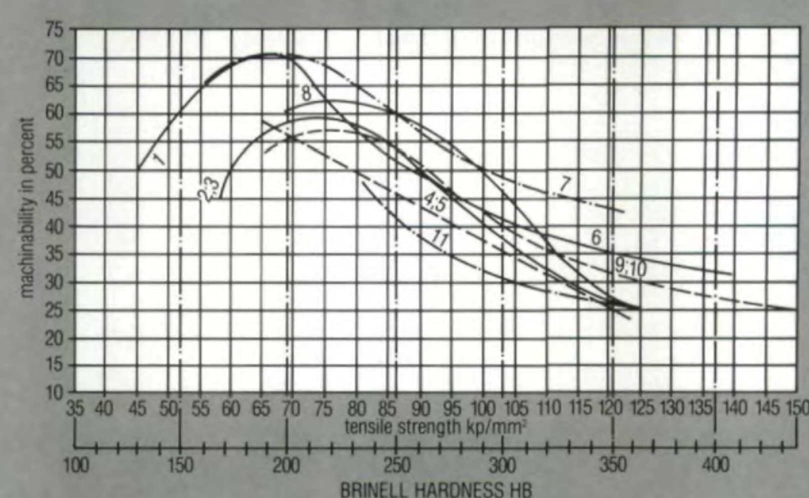


**Table of Machinability of Material**

(AISI Designations)

1. Carbon steels 10xx, 11xx, 12xx, 15xx
2. Low alloy chrome-nickel steels.
3. Nickel steels 23xx, 25xx.
4. Chrome-nickel steels.
5. High alloy chrome-nickel steels, 31xx, 33xx, 303xx stainless steel.
6. Chrome-nickel-molybdenum steels 43xx, 47xx, 86xx, 87xx, 93xx, 98xx.
7. Nickel-molybdenum steels 46xx, 48xx.
8. Chrome-molybdenum steels 41xx.
9. Chrome steels 50xx, 51xx, 511xx, 521xx, 514xx, 515xx.
10. Chrome-vanadium steels 61xx.
11. Silicon-manganese steels 92xx.
12. Ductile iron.

Fig. 2—Machinability in reference to workpiece material.

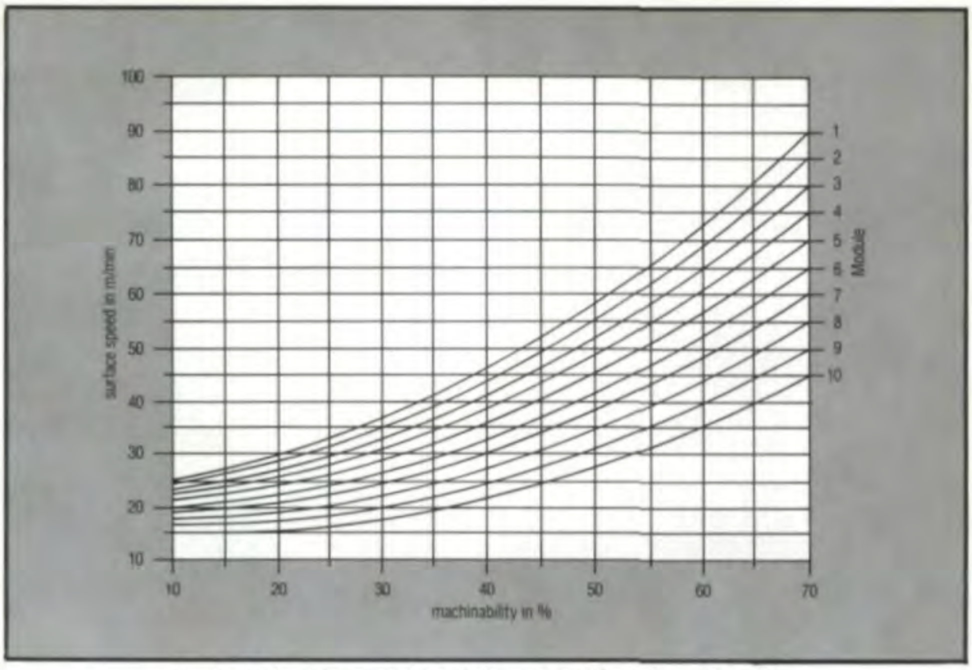


Fig. 3—Hob surface speed in relation to module and machinability.

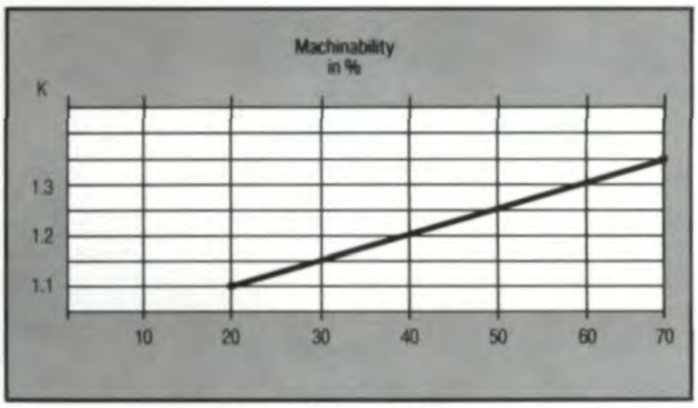


Fig. 4—Multiplier K chart.

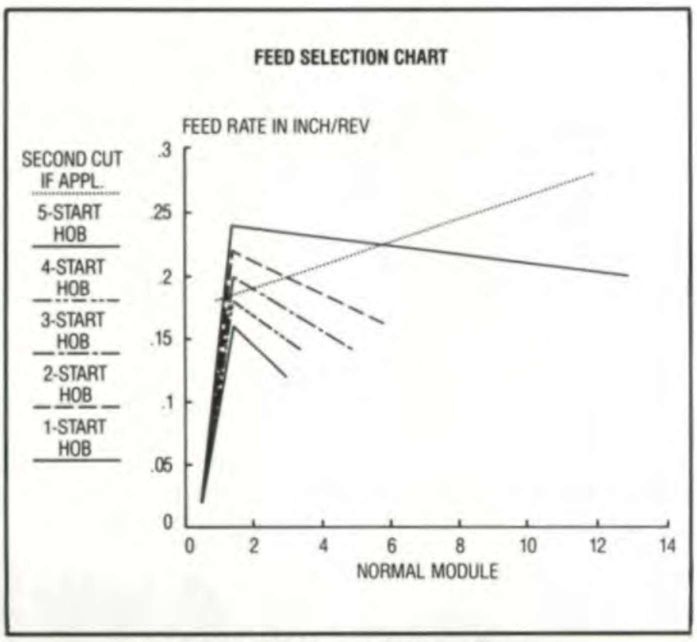


Fig. 5—Roughing cut feed rate chart.

For TiN coated hobs, the speed can be increased depending on the machinability for all materials (except ductile iron) according to the multiplier K selected from Fig. 4 (*K-multiplier*).

### Feed Selection

Feed rate for roughing cut can be selected according to Fig. 5. The selected rate should be multiplied by the machinability factor C1 and the factor C2 for small number of gear teeth.

$$C1 = \left(\frac{\text{Machinability}}{70}\right)^{.4}$$

Gear teeth factor should apply only if number of teeth is less than 25.

Gear teeth factor

$$C2 = \left(\frac{\text{Number of teeth}}{25}\right)^{.3}$$

Feed rate for finish cut should be limited by allowed feed scallop depth. Maximum allowed feed rate for finish cut can be calculated with formula:

$$\text{Feed rate} = \cos\beta \bullet \sqrt{\frac{\delta \bullet 4 \bullet \text{DAO}}{\text{SIN } \lambda}}$$

Where

$\beta$ = helix angle
$\delta$ = allowed feed scallop depth
DAO = hob diameter
$\lambda$ = pressure angle.

For pre-shave cut, the feed scallop depth should not exceed .0008". If approach feed control rate is available, it can be set to roughing feed rate.