OVERVIEW OF GEAR PRODUCTION TECHNOLOGY WITH DISC MILLS

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Abstract

In this paper the method of manufacture of tooth gears is considered by a disk hob. The paper also contains(keeps) an urgency of application of this method in is mining industry and on attritors of concentrating industrial complexes. Analytical formulas of calculation and the circuit(scheme) of handling of tooth gears are reduced. The information from GOST and also practical recommendations for choice a package of disk hobs is supplied. And in the end of a paper the output and the technical(engineering) offer of ground made assaying is concluded.

Relevance of the research topic

In the mining and processing industry, at the mills of the mining and processing plants of Uzbekistan, gear wheels with a diameter of 4-12 m, weighing 12-16 tons are used in the drives of mechanisms. As a rule, the wheels are modular and consist of two to four sectors. Most of the wheels are helical with a tooth tilt angle of 5.25 °, a module of 20 mm and a gear rim width of 800 mm. Gear wheels (crowns) are mechanically fixed on mill drums. During the operation of the crowns for 8-12 years, the wear of the teeth along the profile is 7-8 mm. After this period, the wheels are cut into pieces and sent for remelting.

Introduction

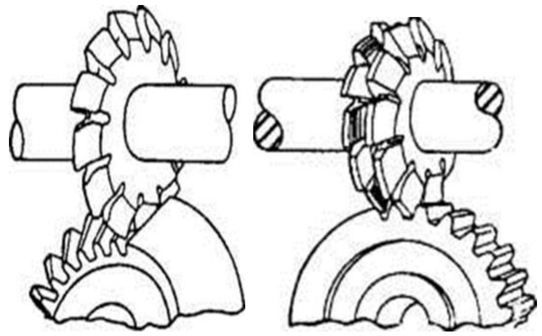
Gear drives are the most common types of mechanical transmissions. They are widely used in all branches of mechanical engineering, in particular in metal-cutting machines, automobiles, tractors, agricultural machines, etc., in instrument making, the watch industry, etc. They are used to transfer power from fractions to tens of thousands of kilowatts at peripheral speeds up to 150 m / s and gear ratios up to several hundred and even thousands, with wheel diameters from fractions of a millimeter to 6 m or more.

The object of research is a modular disk cutter for processing gear wheels using the copying method.

Processing of gear wheels with disc cutters

Disk modular cutters are used for roughing and finishing cutting of cylindrical wheels with straight (Fig. 1 b) and oblique teeth, splined shafts, sectors, racks, rough cutting of bevel gears with straight teeth (Fig. 1 a) and finishing cutting fine-modular gears. Cutting is carried out on special and universal milling machines using the copying method. Each tooth is cut separately with a unit division.

The method of cutting teeth with disk cutters is used in the manufacture of spare parts in the repair business or in the manufacture of small batches of gears, the accuracy of which does not impose high demands. Practically, the accuracy of manufacturing cylindrical wheels corresponds to the 10th degree of accuracy (GOST 1643). The limiting factor is usually the pitch error, which depends on the precision of the gearbox. The advantages of this method include the low cost of the tool and the ability to manufacture parts with different tooth shapes.



а) б)
Рис. 1. Схемы нарезания дисковыми фрезами конических *(а)* и цилиндрических *(б)* зубчатых колес

Disk modular cutters are most often used for rough cutting of cylindrical gear teeth. Rough disc cutters to improve cutting conditions are designed with a rake angle of 8 ... 10 °. [1]

Disk modular cutters are designed for processing straight, helical, bevel, and chevron wheels with a groove on the rim (for tool exit). In the presence of special devices, disk modular cutters can be used to cut on gear hobbing machines and wheels with internal gearing. [1]

When processing spur wheels, disk cutters work by the copying method, when processing helical and chevron wheels - by the centroid bending method (there are no centroids on the tool and parts during the cutting process), when the profile of the cutter at no time of the bending coincides with the profile of the final cut cavity. In accordance with OST 2 I41-14-87, modular disk cutters are manufactured in sets of 8 cutters and are designed for cutting wheels of the 10th degree of accuracy in accordance with GOST 1643-81 with modules m = 1 ... 16 mm. These cutters have outer diameters do = 50 ... 180 mm, diameters of bore holes d = 19 ... 50 mm, number of teeth z = 14 ... 10 and width b = 4 ... 53 mm. According to this standard, disc cutters are also manufactured with "half" numbers (1.1 ½, 2.2 ½, 3.3 ½,... 7 ½, 8), i.e. set of 15 tools. [3]

GOST 13838-68 regulates fine-module disk cutters for cutting cylindrical wheels of the 9th degree of accuracy and below modules m = 0.2 ... 0.9 mm in a set of 8 or 15 tools. Since, with equal diameters, the profiles of the teeth of wheels with an equal number of teeth are not the same, a separate milling cutter with its own profile is required for cutting by the copying method of a wheel with a certain number of teeth. To cut wheels from teeth, you need to have a theoretically infinite number of disc milling cutters. Practically they do the following. The profiles of the wheels are drawn and the resulting maximum difference is divided into 8 or 15 parts and it is determined to what number of teeth the profiles 1, 2, 3, ... 8 correspond (Fig. 2). For example, profile No. 4 exactly corresponds to the profile of the wheel with, and profile No. 5 -, therefore, the cutter No. 4 is intended for wheels with Z = 21 ... 25, and No. 8 - for wheels with the number of teeth Z = 135 and toothed racks[3].

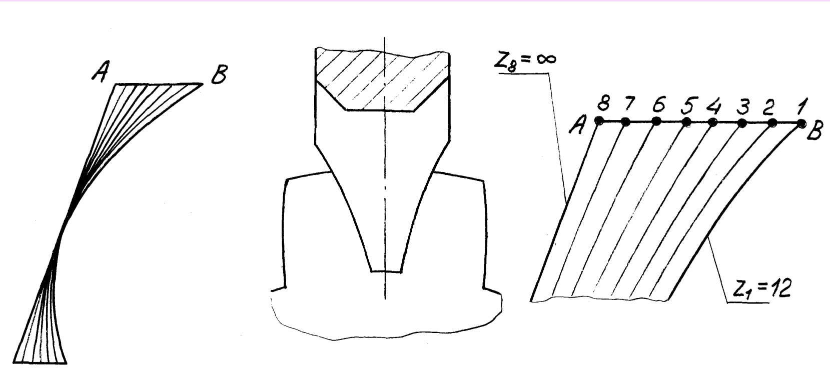


Fig. 2. Forms of the sides of the gear wheel with a different number of teeth

The construction of profiles of cutters of standard sets according to this scheme lays down the errors of the cut wheels, therefore, with disk modular cutters, wheels can be obtained not higher than the 9th degree of accuracy.

In addition, modular disk cutters have low durability and productivity due to γ = 0, small outer diameter, number of teeth and small clearance angles at the side edges (αb = 1020 '... 2030').

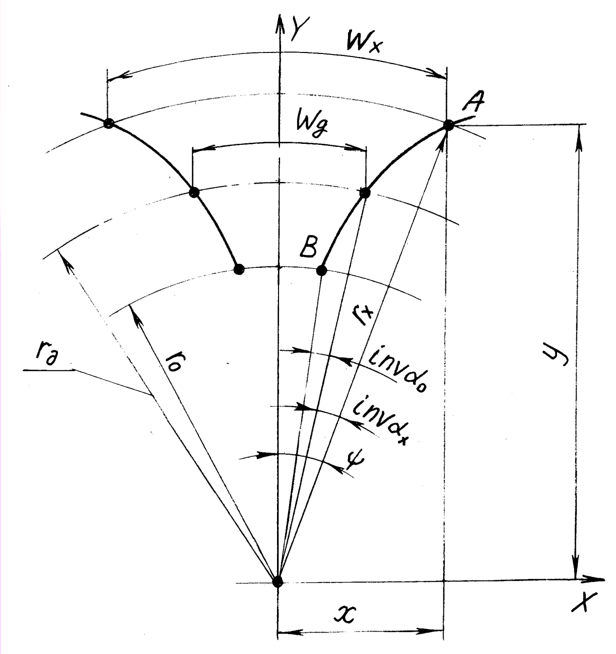


Fig. 3. Scheme for determining the profile of a modular cutter

Profiling modular cutters for spur gears. Since the profile of the cutter must be an exact copy of the cavity between the teeth when cutting by copying, it must ensure that the working participation of the profile in the form of an involute and non-working participation in the form of straight lines or curves. Let us determine the coordinates of the involute part of the profile. We place the origin of coordinates at the center of the wheel, and place the axis symmetrically with the depression (Fig. 3). [2]

The width of the cavity, by analogy with the thickness of the tooth for point A, is determined by the formula

$$W_x = r_x\left[\frac{W_\partial}{r_\partial} - 2(inv\alpha_x - inv\alpha_0)\right] = r_x\left[\frac{\pi m - S_\partial}{r_\partial} - 2(inv\alpha_x - inv\alpha_0)\right]. \quad (1)$$

Point A coordinates are:

$$X_A = r_x \sin\psi; \qquad Y_A = r_x \cos\psi. \qquad (2)$$

But from fig. 3 it follows that

$$W_x = r_x \cdot 2\psi. \qquad (3)$$

Equating the right-hand sides of (1) and (3), we obtain

$$\psi = \frac{r_x\left[\frac{\pi m - S_\partial}{r_\partial} - 2(inv\alpha_x - inv\alpha_0)\right]}{2r_x} = \left[\frac{\pi m - S_\partial}{2r_\partial} - (inv\alpha_x - inv\alpha_0)\right]. \quad (4)$$

But

$$S_\partial = \pi m/2 \pm 2\xi m\, tg\alpha_0 \text{ и } r_\partial = mz/2.$$

Then

$$\psi = \left[\frac{\pi m - \frac{\pi m}{2} \mp 2\xi m\, tg\alpha_0'}{mz} - (inv\alpha_x - inv\alpha_0)\right] =$$

$$= \frac{\pi \pm 4\xi\, tg\alpha_0'}{2z} - (inv\alpha_x - inv\alpha_0). \quad (5)$$

Here in the expression $4\xi\, tg\alpha_0'$ α_0' is the profile angle. In the formula for ψ the angle α_x is determined by the dependence

$$\cos\alpha_x = r_0/r_x = \frac{r_\partial \cos\alpha_0}{r_x} = \frac{mz\cos\alpha_0}{2r_x}, \qquad (6)$$

Where α_0 is the engagement angle determined from the relation $\cos\alpha_x = r_0/r_\partial$ and $r_0 = r_\partial \cos\alpha_0$.

Having determined in degrees with an accuracy of a second according to formula (6), we find $inv\alpha_x = tg\alpha_x - \alpha_x$ from tables of involute functions. The data of the tables of these functions should also be interpolated to the nearest second. [2]

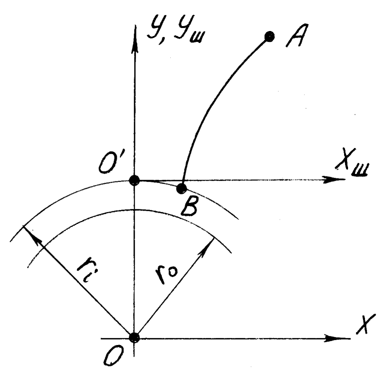


Fig. 4. Coordinate system to define a template profile

Now we will substitute the value in the formula (5) and find the angle ψ. When substituted ψ in formulas (2) for X_A and Y_A, it must be converted into a degree measurement, i.e. multiply by 206264.8 ”. [3]

Given a number of values r_x, determine α_x, ψ and X and Y.
A template is designed to check the profile of the cutter. To find the equation of its profile, the origin of coordinates should be moved to the lower point of the wheel tooth profile, determined by the radius r_i (Fig. 4), while:

$$Y_ш = Y - r_i; \quad X_ш = X. \qquad (7)$$

The value of *X* and *Y* in (7) should be taken from calculations based on dependencies (2).

Based on these data, the technology for the production of gear wheels with disk milling cutters will be improved.

References

1. Калашников А. С., Технология изготовления зубчатых колёс. Учебное пособие. М.: Машиностроение, 2004. 480 с ил.
2. Рыжкин А. А. и др. Режущий инструмент: Учеб. пособие/ Рыжкин А. А., Каганов В. С., Дмитриев В. С.; ДГТУ.- Электронное издание.- Ростов н/Д, 2000.
3. Калашников А. С., Моргунов Ю. А., Калашников П. А. Современные методы обработки зубчатых колес. Учебное пособие. Издательский дом «Спектр», 2012. 238 с.
4. Odilovich, U. E., & Ugli, M. U. T. (2020). Analyzing the effect of magnetic field on Lubricoolant in machining process. *IJAR*, *6*(5), 347-352.
5. Umarov, E. O., Mardonov, U. T., & Turonov, M. Z. (2021, January). MEASUREMENT OF DYNAMIC VISCOSITY COEFFICIENT OF FLUIDS. In *Euro-Asia Conferences* (Vol. 1, No. 1, pp. 37-40).
6. Ташбулатов, Ш. Б., Турсунбаев, С. А., & Чоршанбиев, Ш. М. (2018). Влияние различных примесей и добавок на свойства меди. In *ТЕХНИКА И ТЕХНОЛОГИИ МАШИНОСТРОЕНИЯ* (pp. 25-28).
7. Турсунбаев, С. А. (2019). Особенности обработки деталей из магнитотвердых материалов. In *ТЕХНИКА И ТЕХНОЛОГИИ МАШИНОСТРОЕНИЯ* (pp. 23-27).
8. Аликулов, Д. Е., & Бигбутаев, Ж. Н. (2019). Повышение точности установки заготовок на зуборезных операциях. *Academy*, (6 (45)).