CENTRAL ASIAN JOURNAL OF THEORETICAL AND APPLIED SCIENCES

Volume: 03 Issue: 12 | Dec 2022 ISSN: 2660-5317
https://cajotas.centralasianstudies.org

Effect of Using Rolling Material in the Manufacture of Machine Parts

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Received 18th Oct 2022, Accepted 17th Nov 2022, Online 21st Dec 2022

Abstract: *The article discusses the definition of the rate of consumption of material per unit of production and the main prerequisites for the designation of the type of workpiece, obtaining a workpiece from rolled products.*

Keywords: *rolled products, mass of technological waste, mass of blank waste, billets.*

Determination of the material consumption rate per unit of production and the main prerequisites for the appointment of the type of workpiece.

The amount of metal or material consumed for the manufacture of machine parts is determined by the mass of usable parts and the amount of material that was used in the process of their manufacture. Waste from the production of machine parts consists of technological and procurement waste. Therefore, the rate of consumption of raw materials set per unit of production, taking into account certain specific production conditions, can be expressed by the formula:

$$fi=Q_r + Q_T + Q_S$$

Where fi is the material consumption rate, kg; QR is the mass of the usable part, kg; Q_T is the mass of technological waste, kg; Qs is the mass of the procurement waste, kg.

The mass of a suitable Qr part can be calculated using formulas based on drawing data or direct measurement, and in the case of a particularly complex configuration of the part – by control weighing of the sample.

The mass of technological waste Q_T represents the inevitable losses of material for this production in the form of allowances for machining, carbon monoxide, casting and stamping slopes, obloy, profits, etc. The magnitude of this waste is directly dependent on the conditions of the technological process and the characteristics of the equipment used for processing. The mass of technological waste is the difference between the mass of the work piece and the mass of the finished part, which will decrease as technological processes improve and progressive processing methods are applied.

The mass of the billet waste Q is not directly related to the manufacturing process of the part. It is caused by the conditions of delivery of metal or material (for example, the waste of a bar due to the non-multiplicity of its length) and is also reduced by improving the organization of production.

To choose a work piece means to establish the method of its production, to outline allowances for processing each surface, to calculate its dimensions and to indicate tolerances for inaccuracy of manufacture. For the correct choice of the work piece, it is always necessary to take into account the following main factors: the specified material of the part and its properties, i.e. its technological characteristics; the dimensions of the part and its geometric shape; the planned number of parts produced; the availability of equipment at the factory to produce the work piece; the required accuracy of the work piece and surface quality; special technological conditions imposed on the work of the part or the machine as a whole (explosion safety, corrosion resistance, wear resistance); the time required for production preparation (production of stamps, models, molds, etc.).

For the manufacture of machine parts, the following types of blanks are used: blanks made of rolled steel or non-ferrous metal alloys; forgings and stampings made of steel and some non-ferrous metals; castings made of steel, cast iron and non-ferrous metal alloys, blanks made by a combined method; blanks made of cermet's, plastics and other non-metallic materials.

The blanks for cast iron and bronze parts are castings. For the manufacture of copper, aluminum and brass parts, both appropriate castings and rolled products can be used as a blank. Steel parts are made from rolled products, stampings, forgings and castings.

Currently, rolled products of various shapes and sizes are used in mechanical engineering. The most common forms are: round cross-section with a diameter of 5-250 mm; square cross-section with a side of a square of 5-250 mm; hexagonal cross-section with a distance between opposite faces of 8-100 mm; rolled strip steel with a width of 12 mm with a thickness of 4-8 mm and a width of 220 mm with a thickness of 4-60 mm; rolled broadband universal steel with a width of 100-300 mm with a thickness of 4 mm and 160-1050 mm wide with a thickness of 4-60 mm; seamless steel pipes 25-820 mm; special thick-walled pipes; thin-sheet steel; wire; rolling of special shapes in the form of corners, channels, etc.

Steel with a diameter of up to 8 mm inclusive is supplied in coils, over 8 mm – usually in bars 2-10 m long.

Round rolled products, both hot-rolled and cold-drawn, are used for the manufacture of smooth and stepped shafts, axles, screws, studs, bolts, etc.

Stepped shafts from rolled products are recommended to be manufactured with a difference in diameters in steps $d_{max} - d_{min} \leq$: 30 ÷ 40 mm. When the diameter difference in the steps is more than 40 mm, the shafts are usually made of forgings. If the shaft has large diameter collars, then rolling material is taken as a blank, and separately turned collars are mounted on the shaft by hot fit and welded to it. To obtain shaped machine parts, the production of profile material is provided by hot periodic rolling, as well as pressing, stamping, drawing, etc. The use of profile rolling provides not only small allowances, but also a favorable arrangement of fibers. The accuracy of profile rolling depends on: the accuracy of the construction and manufacture of the copier, the setting and rigidity of the machine, the rolling speed, temperature fluctuations, the wear of the rollers, which should not exceed ± 0.1% in diameter and ± 0.5% in length from the nominal size.

A special allowance is installed on the incision. Metal cutting can be carried out on lathes of the turning group using one or two cutting cutters. In addition, it can be carried out with disk, drive, belt and friction saws, abrasive discs, on milling machines, drive shears with the use of cold breaking on presses, anodically mechanically, gas and electric cutting. As a rule, cutting cutters are used for cutting blanks from rolled products on lathes of the turning group (Fig. 1).

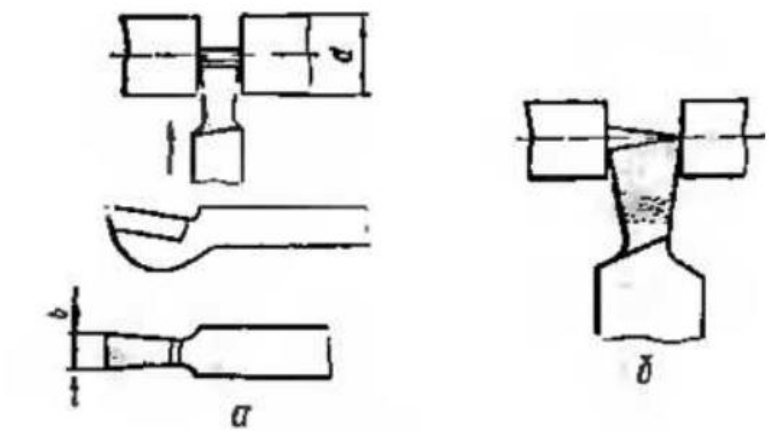

Fig. 1. Cutting cutters: a – with a straight cutting edge, b – with a beveled cutting edge.

To choose the width of the cutter, it is necessary to be guided by the ratio

$$b = 0,6\sqrt{d}$$

where d is the diameter of the metal being cut, mm.

The choice of feed depends on the material used and the quality of the cutting plates, as well as on the material of the work piece. With sufficient accuracy for practice, it is possible to recommend the feed rate for rolled steel

$$S=\frac{b}{15}\dots\frac{b}{20}$$

for cast iron blanks

$$S=\frac{b}{10}\dots\frac{b}{15}$$

In the event that it is necessary to obtain a smooth surface, blanks of small mass, a cutting cutter with a beveled cutting edge should be used (Fig. 1, b).

In the procurement workshops of large factories, special lathes are used for cutting blanks with two cutters. Their peculiarity is that the spindle rotation speed varies. It increases with the movement of the cutters from the periphery to the center of the work piece so that the cutting speed remains constant. Calculation and analysis of bearing systems of metal-cutting machines is described in the sources.

The advantage of such machines is to reduce machine time by increasing the feed per revolution and the absence of bending of the material being cut. The disadvantage is the ability to cut only the round profile of the work pieces.

Comparison of machine cutting time at constant speed (i=const) and constant cutting speed (V=const) gives the following results: in the first case (n=const) machine time t_m is determined by the formula

$$t_m=\frac{d}{2nS}$$

Where n is the rotation speed, rpm; 2 is the number of cutters; S is the feed, mm/rpm; d is the diameter of the workpiece, mm.

Since

$$n = \frac{1000}{\pi d}$$

then, substituting into the formula, we get:

$$t_m=\frac{2\pi d^2}{1000VS}$$

where V is the cutting speed on the outer diameter, m/min.

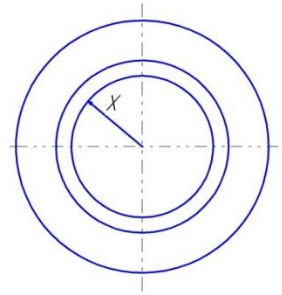

Fig. 2. The scheme for calculating the rolled time.

In the second case, the infinitesimal increment of machine time dt_x corresponding to the radial movement of the cutter d_x (Fig. 2) is determined by the formula:

Since

$$n_x=\frac{1000V}{2\pi X}, \text{ that } dt_x=\frac{2\pi x}{1000VS}$$

where n_x is the instantaneous value of the variable rotational speed corresponding to the radius x.

Integrating within the range of

$$x=\frac{d}{2} \text{ before } x=0$$

$$t_m=\frac{2\pi}{1000VS}\int_{\frac{d}{2}}^{0} x dx = \frac{2\pi}{1000VS} \left| \frac{x^2}{2} \right|_{\frac{d}{2}}^{0}$$

we get

$$t_m=\frac{\pi d^2}{1000VS}$$

Thus, the machine time at V=const is two times less than at n=const. But in fact, it decreases not by 50%, but by 30-35%, since the cutting speed decreases slightly when approaching the axis of the work piece.

Circular saws have proven themselves well for cutting profiles of any cross-section. They are manufactured in one piece with a diameter of up to 300 mm and with plug-in segments made of high-speed steel with a diameter of 300 to 2000 mm. Each segment can be replaced with another one in case of its breakdown. The use of cutting teeth made of carbide materials inserted on solder in pre-prepared places on a steel disc increases the durability and productivity of the process several times by increasing the feed to the tooth and the cutting speed. The cutting width of the circular saws is in the range of 4-14 mm, the pitch of the teeth is from 15 to 45 mm. The durability of circular saws, the quality of the cut surface and the working conditions are provided in the best way with the ratio of the height of the cut and the pitch of the teeth l = 0.15 h. When using circular saws, the cut material should be positioned symmetrically relative to the saw axis.

Cutting metal with drive saws ensures a good cut quality and a small cut width. Drive saws are cheaper in cost, easy to maintain and allow one worker to service 4-6 working saws at the same time.

Band saws are used to cut off gateways and profits in blanks made of non-ferrous metal alloys, as well as when cutting parts with a complex contour from a sheet.

A very productive way of cutting blanks from special and round profiles (from rolled products of small diameters) is cutting with friction saws.

Friction saws are a steel uncoated disc with a width of 2-3 mm and a diameter of 1-1.8 m, on the cylindrical part of which small teeth are rolled.

The operation of friction saws is based on the principle of metal melting at the point of instantaneous contact of the tooth of the disk with the work piece. To do this, a circumferential velocity of about 120-150 m / s is reported to the disk, which ensures the development of temperature at the contact point up to 1200 ° C. The cutting speed is almost independent of the hardness of the steel.

The disadvantage is large power consumption, the inability due to the jamming of the saw to cut a round metal of large diameter and a poor–quality cut surface. These disadvantages constrain the use of friction saws for cutting work pieces, and especially in cases where the work pieces are used for further machining.

To obtain small work pieces with clean and parallel cutting surfaces from rods up to 700 mm long, it is recommended to cut with disc cutters on milling machines.

The method of cutting with abrasive discs has been widely used in mechanical engineering to produce blanks from pipes of very hard and hardened materials of small cross sections. The thickness of such discs is 1-4 mm and the diameter is 200-400 mm.

For cutting sheet steel, shaped and round profiles of small sections, various types of drive shears are used. The thickness of the sheets cut on scissors can be from 6 to 25 mm and a width of up to 3,000 mm.

Metal cutting by anodic-mechanical method according to the principle of operation is not much different from friction saws and consists in the following. The positive pole of the DC source (anode) is connected to the work piece to be cut, and the negative pole (cathode) is connected to the tool. A metal disk made of mild steel is usually used as a tool. DC voltage 20-26 V. The electrolyte is an aqueous solution of liquid glass with a density of 1.2–1.3 g / cm2. At the point of contact of the disk with the metal, micro electrodes are formed that melt metal particles. The molten particles are ejected by the disk into the electrolyte solution. In terms of performance, this method is equivalent to cutting on circular saws.

Cold metal breaking under pressure is very productive, provided that the steel has an increased content of carbon, silicon, phosphorus and sulfur. To carry out the breaking of a metal bar of round, square or hexagonal cross-section, it is necessary to make an incision beforehand. The depth of the incision should be from 15 to 30% of the diameter of the rod. The incision is carried out mechanically or electrically. The quality of the surface during cold breaking depends on the depth of the incision, the chemical composition of the metal and the equipment. The size of the unevenness and the depth of the damaged layer is 1-3 mm.

Gas and electric cutting methods are in most cases used for cutting work pieces in metalwork workshops and foundries for cutting profits and gateways. The use of this method for metal cutting is limited due to the poor quality of the cut surface.

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