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Economic efficiency and effectiveness of ways of separating materials electro diamond processing

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Abstract.

Purveying operations on the division of all types of materials include a hand and machine scission on the equipment of the different setting. In an engineer there is reliable information about the mastered methods, their maximum possibilities and defects. With the increase of stake of expenses there was a problem of research of new types of division of materials on materials, especially it touched scarce and expensive alloys.

Introduction

Harvesting and separation operation of all types of materials include hand and machine cutting equipment for various purposes. For this purpose, traditional methods (press, metal-cutting equipment with metal and abrasive tools, etc.) and new types of processing (laser cutting, EDM division, ultrasonic processes). In engineering there is reliable information about mastered the methods, their limits and shortcomings. With the increase in the share of material costs was an issue of finding new types of separation of materials, especially of scarce and expensive alloys of the precious metals, tungsten, magnetic alloys, fragile semiconductors, where the yield details after processing was less than half of the initial mass, and the defects introduced into the surface layer when cutting, is preserved in the product and reduced its performance. In accordance with the definitions of the national standard GOST R ISO 9001-2015 performance refers to the degree of implementation of planned activities and achieving planned results and effectiveness - the link between the reached result and used resources. As the object of study selected two groups of dielectric materials: ductile and brittle, have high cost and very scarce. In world practice, the separation of such materials are reinforced disks, EDM, ultrasonic method, a laser. However, such methods are not capable of providing the required high requirements on precision, surface layer quality, performance, lower wastage of material. In addition, most methods causing environmental pollution (dust when using abrasive, etc.)

The combination of different effects on object processing allows to design a combined methods, in particular electroablation (electrolysis). These methods are applied for cutting in the production of billets with subsequent treatment, which in some cases (the manufacture of parts of instruments, radio, controls) undesirable, because it leads to undue loss of material, secondary errors and defects, and dramatically increases the cost of products. The establishment of unequivocal relationships between the properties of the processed materials, the combination of the impacts of the combined process allows you to create modern automated equipment with the office of mechanical, chemical, erosive component in a single process, providing after separation of materials finished parts with an accuracy of above 30 μm and a roughness not higher than 0.32 μm . This eliminates the negative impact on the environment and is accelerated to 2 times the cycle of manufacturing parts.

The use of these processes accelerates the creation of new competitive products, expanding the technological capabilities of production, helping to reduce the deficit and the cost of materials. It is important for modern engineering and to meet global requirements for new products.



1. The theoretical part

There are some circuits of low-waste separation of materials with the imposition of an electric field.

1. Electrochemical machining with stationary electrode. Under this scheme share of thin sheet material, applies information (serial numbers, product codes, etc.), remove burrs, sharp edges scroogled. Electrode-the tool does not move to the treated surface — electrode gap as the removal of metal from the workpiece increases, and the rate of flow of the electrolyte decreases. The process will be transient with non-stationary on the time-Meaney mode of processing. This greatly complicates the calculations of technological parameters regulation and control of the process.

In addition, the separation process does not allow to cut parts of a thickness exceeding 0.5 mm (single cutting). While processing errors increase with increasing thickness of the workpiece and make the cut with this method of round billets not promising.

2. Known method of separation of materials by ink jet method. Electrode-the tool consists of a busbar, washed by the flow of electrolyte.

Current lead is located inside the housing of insulating material. The electrolyte creates a conductive channel between the current supply and the workpiece. At the site of contact of the liquid with the processing surface of the workpiece material is dissolved and forms a recess. As it took inclusion the hole depth casing together with the workpiece. The process is fast enough only at high voltages (several hundred volts). So cut out the contours of complex-shaped parts. This method is not suitable for the separation of materials with thickness more than 0.3 mm.

1. The cutting profile or tool apropiirovannye involves separating the billet into pieces - cutting and getting the non-rectilinear contour - cut, which runs only apropiirovannye electrode-tool. Profile of the electrode-tool when cutting of parts may be made in the form of a disc or plate. His move to the workpiece at a speed and in the plane of rotation along the part. Processing is performed in a bath of dielectric fluid. If the cutting plate is performed with a single translational movement to the workpiece, it will be flashing.

In the case of apropiirovannye electrode tool perform in the form of a round wire with a diameter of 0.02 to 0.3 mm or a rod that can move in different directions at a speed and in any part of the workpiece. To eliminate the effect of wear of the electrode tool on the accuracy of the slots cut by a wire or rod is moved (usually by peremanivanie) along the axis with speed. Perform cutting in a bath of dielectric fluid[1]. Combined methods of treatment are aimed at intensification of the process of anodic dissolution. The rate of metal removal and accuracy of shaping in electrochemical processing depends on how quickly the reaction of the transition of the workpiece material in the sludge. The rate of anodic dissolution is limited by the presence of the film, passivating the surface, and the thickness of the diffusion layer, which overcome the removed treatment products.

When electroerosive grinding of solid particles (abrasive grain or filler) remove the tape, activating the process of electrochemical machining. The size of abrasive grains determining the spacing between the electrodes, as a rule, does not exceed tenths of a millimeter. At such small gaps, the current density will be substantially more than in the case of dimensional electrochemical machining. Dramatically increases the speed of metal removal in the area of the abrasive grains of the tool. In addition, some allowance of prowess is mechanical grinding. Unlike normal grinding, when the anode-abrasive processing on the surface of the workpiece is not formed stronger work-hardened layer, and manufacturer of grinding increases. Consequently, the removal rate of the metal during anodic dissolution increases due to the mechanical removal of passivating film and accelerate the process of removal of products of processing from the gap, and electrochemical dissolution of metal parts, in turn, can increase the speed of the mechanical grinding. In addition to these components of a pickup at small gaps can take place EDM process. At small sizes of the gap portion of the metal billet is removed by electrical erosion[2]. When electro-abrasive polishing allowance is removed by anodic dissolution of the metal and removing the abrasive grain or dissolution. In the first case, the tool contains a linked or free abrasive powder in the second — as a tool use a wooden or plastic bars that are located between the metal electrodes-tools. Comparing the performance of different methods, you can determine the most effective use in engineering.

Electrical discharge machining in electric mode, occurs at relatively low energy pulses. The volume of metal removed for each pulse is small, and the depth of the hole is negligible. This mode allows to obtain surfaces with high precision and small roughness at low productivity. In addition, the process is very energy intensive. Estimate the intensity ratio of electric power consumption to the mass removed from the workpiece metal. The energy intensity in the processing in spark mode much higher compared to machining PA similar operations. Great wear profile of the tool. With that said processing in spark mode effective for the manufacture of precision parts with small dimensions. Efficiency is further enhanced if the material of the part is difficult the traditional governmental methods of mechanical treatment or if the treated surface has a complex shape. Such details are characteristic for instrument making, exact mechanical engineering, tool Production of.

Processing in electric-pulse mode is characterized by greater energy level - the height of the irregularities. But due to the increase of the discharge energy, a high productivity process, which in 15 ... 20 times higher than in spark mode and is for steel of up to 250 mm³/s, for hard alloys is 3 ... 5 mm³/s. Given the small wear of the electrode tool and satisfactory energy not exceeding the same indicator for milling, treatment on electric-pulse mode can be recommended for replacing the milling of large cavities of complex shapes, recesses, channels where machining is unable to achieve high performance or where access to the tool in the cutting zone. These products are used in many industries, particularly in energy and transport machine-building, engine building, electronic industry.

Electrocontact cutting in the liquid allows to obtain process performance up to 400 ... 450 mm³/s, which is considerably higher than during the mechanical cutting of preforms. However, surface finish and machining accuracy are low. The method is economical - the consumption of electricity in 6 ... 10 times lower than in the processing in spark mode. Significant wear of the electrode tool and inconvenient in operation, the working fluid that is sprayed. This causes pollution of the machines, parts, clothes working, and requires special structures miscellaneous baths.

Electrocontact cutting in the liquid is used as a blanking operation upon receipt of the blanks from hard conductive materials.

The cutting profile of the tool electrode in spark mode allows you to perform:

- the grooves and cracks of small width, for example in the collets;
- profile electrodes-tools for flashing;
- cutting workpieces made of tungsten and other materials.

Appropriately cutting electrode-tool get:

- narrow through or blind slit;
- punches with small dimensions made of hard alloys and hardened steels;
- the working part of cutters and other tools;
- slits in the collets for work pieces of small diameter (less than 2 ... 3 mm);
- tablets of the magnetic tungsten alloys, the processing of which is required to achieve a minimum consumption of material;
- labels, signs, prints.

Electrocontact cutting of the disk or tape used in the liquid:

- to receive workpieces of hard materials (stainless, HRSA, titanium, magnetic, and other alloy-WWII);
- for cutting pipes made of construction materials;
- for cutting narrow slots and holes in parts.

Cutting in air is widely used in metallurgical industry for:

- separation of part of the rental;
- cutting the sprues with large castings.

2. Systematization of modes separation of materials with electrical fields
For more complete advantage of electrochemical machining is necessary to design parts with consideration of the peculiarities of the process of anodic dissolution of alloys. It should be considered that when electrochemical machining there is no division into roughing and finishing operations - any mode electrochemical machining height of the irregularities corresponds to finish machining operations, and with increasing the metal removal rate the surface roughness decreases. Unlike machining technological parameters of electrochemical processing even increased with increasing hardness of the workpiece material. In addition, when the electrochemical processing tool or do not wear, or wear not-significantly (for the combined method of treatment).

Dimensional electrochemical machining significantly expands the technological capabilities of manufacturing parts. It is possible to obtain the surface shape that other methods or impossible, or unprofitable.

According to the scheme of cutting can be obtained with high precision delicate parts without deformation and Burr. The electrode-tool made in the form of a thin disk. The anodic dissolution takes place without significant efforts on the workpiece so it does not deform the workpiece can have a rotary motion that accelerates the process of cutting. The rate of deepening of the tool can reach 0.2..0.3 mm/s, the error processing is within 0.1 mm. When it reached the edge fillet with a radius of 0.5 mm. When using appropriate electrode wire is possible to obtain grooves of complex shape; the straight sections are paired as the radii R1, R2, R3, R4, and practically radius ($R=0$). The cutting speed can reach 0.2 mm/s, the width of the groove is 0.5 .. 5 mm, depth of 0.1 to 20 mm, the error of width up to 0.1 mm.

3. Analysis of the methods of separation of materials

Apply methods of separation of metals let, mainly to perform blanking operations, which do not require high accuracy and quality surface layer, which are provided on subsequent stages of processing that require significant allowances a process with high complexity and energy consumption. Electrical discharge machining appropriate electrode provides the accuracy of the process, but requires subsequent operations to achieve the required purity. In addition it is much more time-consuming compared with the reinforced cutting disc, which makes it not efficient for mass production. The division reinforced disc increases on the order of and higher loss of material and ensures stable performance on the accuracy of the cut, which causes the need for finishing operations. The known design of disk tool to give a greater separation width of a groove or not provide the required accuracy of the process, the quality of the surface layer.

The equipment available for the separation of materials is not equipped with the necessary means of automation of the process, including elements of adaptive management with the adjustment modes according to specified patterns[3].

4. Economic efficiency and effectiveness

Analysis of the known processes and equipment shows that it is possible to achieve a high precision when dividing by establishing regularities of the process under variable processing conditions, the creation of automated systems of process control with adaptation of the parameters, in particular the feed of the tool – disk management state during cutting, the control and adjustment of the position of the cutting in the groove.

The second effective direction of research to reduce the loss of scarce materials is the use of snap-in retention of details until the end of the calibration side surfaces of the groove.

Reveals the prospective use of the results of work in other industries that use precious and scarce materials (medical equipment, dentistry, controls, devices, electrical connectors, etc.), where savings from the elimination of losses of metals can constitute a significant amount.

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