New Single-Component Abrasive Tool

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Machined surfaces of very high quality are required in honing the most important and most precise machine parts (for example, cylinder linings in internal-combustion engines for cars, trucks, and tractors), whose operational reliability is a primary concern in competitive markets.

We know that the formation of even one deep scratch on the cylinder surface requires additional finishing (honing by bars with micropowder or lapping), with considerable loss of production time.

Such scratches are due to the considerable size variation of the cutting grains that is permitted by the standard regarding the manufacture of diamond and abrasive honing bars. As a rule, the time required for the elimination of such scratches is up to 30% of the total machining time. Therefore, there is a pressing need to reduce the likelihood that large cutting grains will form part of the abrasive tool.

The standard size distribution of diamond and abrasive grains in the tool does not permit the elimination of such defects in machining important parts (such as the linings of hydraulic cylinders in heavy-duty mechanisms within excavators, bulldozers, cranes, and other transport systems).

One promising approach is to use a new single-component abrasive tool based on white corundum [1]. In the manufacture of this tool, boron-carbide powder must be added to white-electrocorundum abrasive powder (10–20 wt % boron carbide). Then a compressive shock wave is passed through the powder mixture, with subsequent high-temperature sintering in an electrovacuum furnace.

When the shock wave passes through the powder mixture, the particles of each component are crushed.

The size distribution of the white-electrocorundum and boron-carbide grains will be different.

However, under the action of the impact force, the electrocorundum grains briefly move at enormous speed toward the boron-carbide grains (whose hardness is 37–43 GPa, as against 20–24 GPa for the electrocorundum) and are further crushed, which considerably changes their size distribution, since additional pores are formed in the high-temperature sintering of boron-carbide powder.

After honing the 40X steel parts (the cylinder linings of A-type motors and hydraulic cylinders) by the new abrasive tool, the following results are obtained: the number of surface scratches is reduced to 0.1% (in other words, practically to zero); and the stable mean surface roughness of the machined part is $Ra = 0.14\text{--}0.2\text{ }\mu\text{m}$, which is 2.4–3.2 times less than the value after machining with a diamond tool.

CONCLUSIONS

The action of a compressive shock wave on white-electrocorundum grains or on boron-carbide grains is insufficient to permit the use of these powders individually for abrasive tools in finishing. However, the application of a fast compressive shock wave to a mixture of white-electrocorundum and boron-carbide grains changes the size distribution of the grains at the working surface so that the machined surfaces obtained exhibit high performance.

REFERENCES

1. Russian Patent 2293013.