IMPROVING THE PERFOMANCE PROPERTIES OF ABRASIVE TOOLS AT THE STAGE OF THEIR OPERATION.

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ABSTRACT:
Grinding performance largely depends on the durability of the abrasive tool. Developed and tested solid lubricant for impregnating the working surface of the grinding wheel, which increases its cutting ability and, as a result, reduces the number of edits. Reducing the need for frequent revisions of the abrasive tool reduces dust generation in the workshop and helps to prevent the occupational disease of the grinder - pneumoconiosis. It is established that the depth of cut when grinding according to an elastic scheme depends not only on the coefficient of grinding and the coefficient of friction, but on the magnitude of their difference.

Keywords: *higher fatty carboxylic acids, friction coefficient, grinding wheel, solid lubricant.*

1.INTRODUCTION

Intensification of the industry leads to severe environmental pollution. The point of abrasive dust generated during grinding wheel grinding affects the respiratory organs.

Lightweight possess a very important property. They are constantly cleared of dust using phagocytes (a special type of white blood cells). but with a high content of abrasive dust in the air, the protective effect of the body weakens [1].

Dust accumulating in the lungs affects them, leading to a dash of pneumoconiosis. This disease is characterized by a slow transformation of the lung tissue from elastic ones that can significantly stretch and increase the area of air exchange when inhaling into a tissue with many scars (fibrosis) [2].

There are many types of pneumoconiosis. The most common and dangerous is silicosis, which is the result of a large amount of dust containing free silica entering the lungs Al_2O_3) And carborundum (silicon carbide Sio) And contains a small amount of silica SiO_2Z- report content in a bunch of quartz (sand). Due to this content of silicon dioxide in abrasive dust, formed directly in the process of grinding, it is insignificant, but its content increases dramatically when editing the grinding wheel, used to restore its cutting properties. To prevent occupational disease of the grinder, caused by the impact on the bronchopulmonary apparatus of abrasive dust, it is necessary to reduce its content in the air of the working area. To do this, it is necessary to make technological decisions to reduce dust generation at the workplace of the grinder. One of such solutions is an increase in time of the cutting ability of grinding wheels, i.e. an increase in the time interval between two changes of the abrasive tool. The following methods are known for improving the performance properties of abrasive tools at the stage of technological preparation of production: creation of grinding wheels with a discontinuous working surface [4], Impregnation of wheels with special impregnating compounds [5-15]. For the same purpose at the stage of operation of abrasive tools use: special cutting fluids [19] and solid lubricants [20,21,22]. Of the above methods for improving the performance properties of an abrasive tool, the most easily accessible and economical way is to impregnate the working surface of the grinding wheel with a solid lubricant directly during its operation.

It is known that good lubricating properties with a sufficient long period of grinding are preserved in the case of using the binder binder component with high thermal stability. What are the components of higher fatty carboxylic acids and their esters with monatomic higher alcohols (waxes). at elevated temperatures, fatty acids react with metals to form salts (soaps). Thermal and lubricating properties of metallic soaps (for example, salts of higher fatty carboxylic acids and iron) are higher than those of the original derivatives of hydrocarbons.

$$2C_{17}H_{35} - COOH + Fe \rightarrow Fe\,(C_{17}H_{33}COO)_2$$

(stearic acid) (iron stearate)

In the case of grinding steel, such reactions take place when the grain contacts the metal being processed on the surface of the cutting grains. there is a decrease in the friction coefficient as a result of the formation of metallic soaps on the submicro-profile of the cutting grains. The consequence of this process is to reduce the abrasive ability of the grain. For grinding processes that are performed at small lengths of the contact arc of a circle and parts, such changes in the conditions of micro-cutting are beneficial as the number of cutting grains increases. Depth of penetration of active grains is reduced, which allows you to load previously overlapped screened grains.

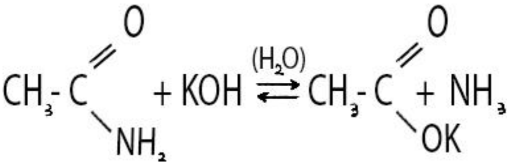
It was proposed to increase the heat capacity and lubricity of the binder component at the stage of manufacturing solid lubricants to carry out partial saponification of the used fatty acids with caustic alkalis (for example, potassium hydroxide KOH). The presence of alkali metal soap in a solid lubricant along with free higher fatty carboxylic acids makes it possible to increase the heat capacity of the lubricant and its anti-friction properties and also provides the possibility of chemical interaction with the material being processed. In this paper, to optimize the grinding process, we propose the following composition of solid lubricant (Table 1). In the last row of the table is the composition of solid lubricant does not contain potassium hydroxide [4.21].

Oleic acid is an unsaturated higher fatty acid, which, under severe conditions, is oxidized with breaking of carbon-carbon bonds with the formation of the corresponding acids according to the scheme:

$$CH_3 - (CH_2)_7 - CH = CH - (CH_2)_7 - COOH \xrightarrow{t^\circ} CH_3(CH_2)_7COOH + HOOC - (CH_2)_7 - COOH \quad (1)$$

With an increase in the number of carboxyl groups, reactivity in terms of interaction with the material being processed increases.

In an alkaline medium, acetamide is hydrolyzed to form the salt of carboxylic acid and ammonia.



(2)

(Acetamide)

In turn, when heated, ammonia decomposes into hydrogen and nitrogen, using iron as a catalyst of the process.:

$$2NH_3 \overset{Fe}{\rightleftarrows} 3H_3 + N_2 \;\; (1200 - 1300)^oC \quad (3)$$

Hydrogen with air oxygen at $t = 550^oc$ burns to form water vapor:

$2H_2 + O_2 = 2H_2O$ (4)

The formation of water vapor contributes to the chemical interaction of the lubricant with the treated surface.

Manufacturing techniques of pencils solid lubrication and testing.

Stearic acid is poured into the tank, heated to melt$(90 - 100)^oC$, oleic acid, potassium hydroxide and acetamide are added, stirred until complete dissolution in stearin and poured into a cylindrical shape. After hardening and cooling, the solid lubricant pencils are ready for use. Solid lubricant is applied to the surface of the abrasive wheel at a working speed of rotation. lubrication is considered complete when the working surface of the abrasive tool changes its color.

When the content of stearic acid is more than 67%, the pencils of solid lubricant become brittle and inconvenient to use. In terms of their technological properties, they approach the action of pure stearin, that is, the effectiveness of the lubricant decreases when the grinding mode becomes more stringent. When the amount of stearic acid is less than 60%, the consistency of the composition changes, the melt hardens worse when using solid lubricants in the form of pencils.

According to the technology described above, 5 lubricant compositions were prepared (Table 1): 4 within the limits of the proposed concentrations of stearic acid (60-67%), and 1 composition with extreme concentration (70%). The composition of the exorbitant concentration of stearic acid less than 60% was not prepared, since samples with such a component content are not well cured.

The compositions of solid lubricants 1-5 tested on surface grinding machine model 3Г71 wheel ПП 200x20x76 24A 40 C2 5 K6 on steel samples 65Г. This steel is viscous and when it is ground there is a rapid salinization of the working surface of the abrasive wheel. Grinding was carried out on the modes: the depth of grinding t=0.01;

0.02; 0.03; 0.04 $\frac{mm}{propulsion\ stem}$(the magnitude of the wheel on the limb, the speed of rotation of the circle $V_{кр} = 30$ м/с , table moving speed $V_{заг} = 10\ m/min$. Surface area $5 \times 150 mm^2$.
Before applying on the working surface of the Circle of solid lubricant was carried out editing. Experiments with masks having the compositions № = № = 1-5, Repeated 5 times. Moreover, the Circle was edited and its working surface was impregnated only before the first experiment. Grinding with the use of a prototype lubricant (composition No. 6 in Table 1) and grinding without using a lubricant. Repeated in the flesh before the Circle was used, a sign of which was a sharp increase in power and the appearance of burns on the surfaces to be treated. Table 2 shows the results of power measurements during grinding “dry” by using lubricants of different compositions, and Table 3 shows photographs of the chips formed as a result. From table 2 it can be seen that the appearance of burn-throughs on the surfaces being processed and the salting of the working surface of the abrasive circle occur during grinding using lubricants No. 1-5. After 5 experiments, using lubricant No. 6 (of the prototype) after four experiments, and when grinding dry ”- after the third experiment.
From this it follows that the proposed solid lubricants (compositions No. 1-5) Significantly increase the period of operation of the abrasive tool between revisions. The need for frequent revisions in connection with the salting of m Circle and, as a result, the appearance of burn-throughs on the treated surfaces when grinding “dry” is one of the significant reasons that reduces the productivity of abrasive machining.
Released during the decomposition of ammonia into hydrogen and the formation of water vapor during grinding with a solid lubricant (formulations nos. 1-6) Intensifies the oxidation process of iron shavings. Iron oxidation is accompanied by the release of a significant amount of heat, which leads to control chips. This is confirmed by the presence of spherical chips after grinding with an impregnated wheel (table 3). The formation of a fragile oxide film on chips facilitates removal from the surface of the Circle and improves the course of the grinding process.
Figure 1 shows the nature of the change in the grinding coefficient over time. $K_s = \frac{Fz}{Fy}$, Equal to the ratio of the tangential component of the cutting force to its normal component when machining steel$12 \times 2H4A$ normal and impregnated grinding wheels ПП $200 \times 20 \times 76\ 24A\ 40\ C2\ 5K6$. From the graph it can be seen that in the interval of the 12-minute processing period, a decrease in the grinding coefficient is observed both for the impregnated and for the usual circles. Moreover, the grinding coefficient for a conventional circle is greater than for an impregnated one. In the time interval$12min \le T \le 25min$ The grinding ratio for a conventional Circle continues to decline, while for the impregnated one it is increasing. Reduced grinding ratio in the time interval $1min \le T \le 25min$ when machining, the circle impregnated is explained by a decrease in the tangential component of the cutting force Fz due to the formation of lubricating films on cutting grains.
It is established that when grinding by an elastic scheme, the depth of cut T depends not only on the grinding coefficient K_s or coefficient of friction f but of the magnitude of the difference $(K_s - f)$:

$$t = \frac{1}{2} \cdot \left[\frac{(3-n)\cdot(6-n)\cdot k_s \cdot F_y}{1{,}32 \cdot AB} \right]^{\frac{6}{(6-n)}} \cdot \left[\frac{V_{kr}}{6{,}9 \cdot V_{zag} \cdot (1 + l_2/l_1)} \right]^{\frac{2\cdot(3-n)}{(6-n)}} \times \quad (5)$$

$$\times \left[\frac{29{,}369 \cdot \bar{x}^3 \cdot \sqrt{R} \cdot (k_s - f)^2}{tg\gamma \cdot m \cdot [0{,}37\cdot(k_s - f) + 1{,}49 - k_s \cdot 1{,}016] \cdot [0{,}37 \cdot (k_s - f) + 2{,}98 - k_s \cdot 2{,}032]} \right]^{\frac{2n}{(6-n)}}$$

where R is the radius of the grinding wheel, m; B - grinding width, m; F_y- grinding wheel rotation speed, m/s; V_{zag}- longitudinal moving speed, m/s; l_1, l_2- the length of the depression and the length of the cutting protrusion on the intermittent abrasive wheel, respectively, m; m - volume concentration of grains of a circle, %; $\underline{x}$- circle grain, m; A - parameter characterizing the strength properties of the material being processed; n - parameter determined experimentally.
For the usual abrasive wheel, which does not have cavities on its working surface, the parameter $(1+l_2/l_1) = 1$, becouse $l_2 = 0$.

Steel samples 12X2H4A width 3 mm and length 150 mm processed on the machine 3Г71М by wheel ПП200x20x76 24A40C25K6 mortise grinding mode: V_{kr} =30 m/s, V_{zag} =6 m/min with constant clamping force of the sample to the circle $F_y = 60H$, without coolant.

Constant force F_y It was provided with the help of a special device, which is a body inside which the slider freely moved with a fixed sample. The sample was pressed to the circle with a lever, one end of which was connected to the slider, and the load was suspended at the other end.

From formula (5) it is possible to isolate the parameter M, which characterizes the cutting ability of the grinding wheel during the time of grinding :

$$M = k_s^{\frac{6}{6-n}} \left[\frac{(k_s - f)^2}{[0{,}37(k_s - f) + 1{,}49 - k_s \cdot 1{,}016] \cdot [0{,}37 \cdot (k_s - f) - 2{,}98 - k_s \cdot 2{,}032]} \right]^{\frac{2n}{(6-n)}} \quad (6)$$

Raito $\frac{M_{pr}}{M_{sp}}$ shows how many times the cutting ability of a discontinuous circle is greater than the cutting ability of a continuous circle. From fig. 2, it can be seen that after the 14-minute periods, the periods of grinding using an elastic scheme began to cut a continuous circle 5 times worse than intermittent ones. In fig. 2 shows the dependence$(k_{s.pr} - fi)/(k_{s.sp} - f) = f(t)$, showing how the cutting ability of a continuous circle deteriorates over time compared to the cutting ability of a discontinuous impregnated circle of the same characteristic. From the graph it can be seen that after a 14-minute grinding period, the cutting ability of the solid wheel decreased by 9 times compared with the cutting properties of the intermittent impregnated wheel.

No Composition of impre-nator	Stearic acid $C_{17}H_{35}COOH$ %	Oleic acid $C_{17}H_{33}COOH$ %	Acetamide CH_3CONH_2 %	Potassium hydroxide KOH %
1.	70	15	14	1
2.	67	17	14	2
3.	65	19	13	3
4.	63	21	12	4
5.	60	23	12	5
6. (prototype)	63	23	14	-

Table 1. Chemical compositions of solid lubricants

Grease composition	Grinding depth, mm	The number of repetitions of experiments				
		1	2	3	4	5
		Grinding power, W				
1	0,01	120	140	140	140	150
	0,02	225	240	240	245	250
	0,03	345	345	345	350	360
	0,04	500	530	505	520	530
2	0,01	120	100	100	110	110
	0,02	210	210	220	220	220
	0,03	350	425	310	340	340
	0,04	530	460	440	460	470
3	0,01	140	145	145	150	150
	0,02	240	250	255	280	285
	0,03	340	345	370	410	410
	0,04	485	485	505	510	520
4	0,01	135	140	140	145	145
	0,02	235	240	245	260	265
	0,03	335	240	350	380	400
	0,04	470	480	490	500	510
5	0,01	130	135	135	140	140
	0,02	230	235	235	255	260
	0,03	330	335	345	375	395
	0,04	465	475	485	495	500
6 (prototype)	0,01	160	165	170	175	
	0,02	260	265	270	280	
	0,03	360	365	370	380	
	0,04	480	485	490	burned	
Dry	0,01	290	300	310		
	0,02	400	410	415		

grinding	0,03	500	510	burned		
	0,04	610	630			

Table 2. Grinding power measurement results

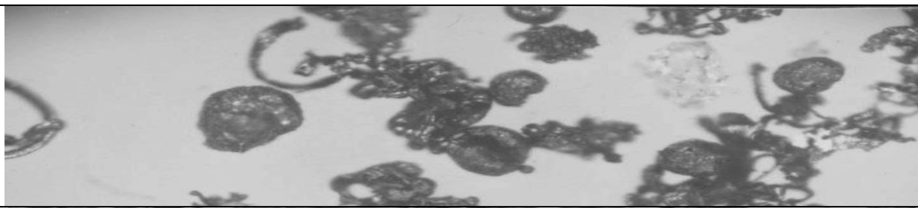
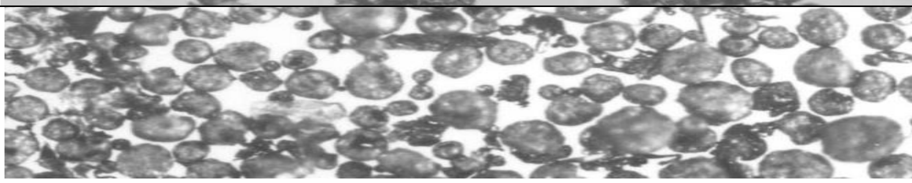
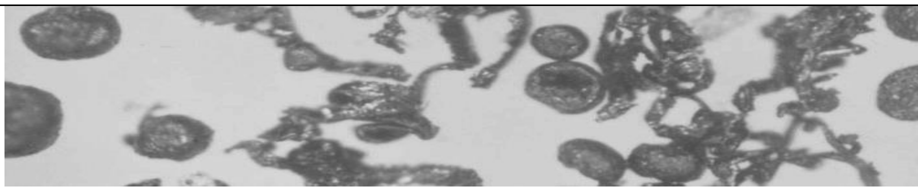
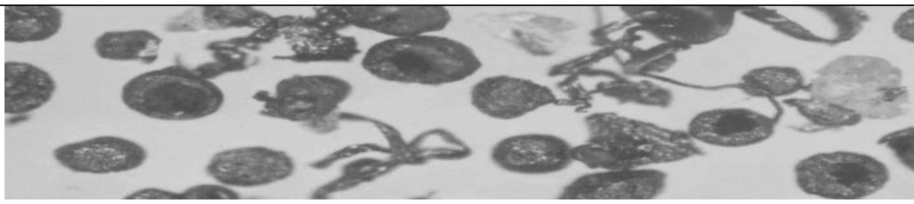
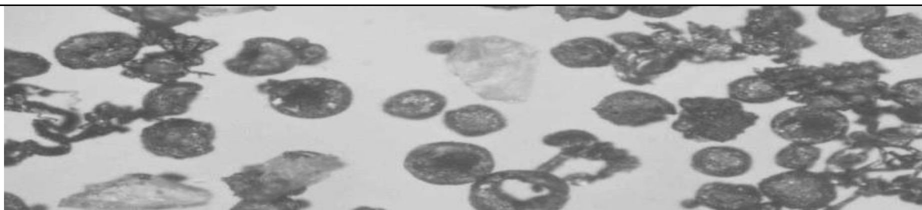
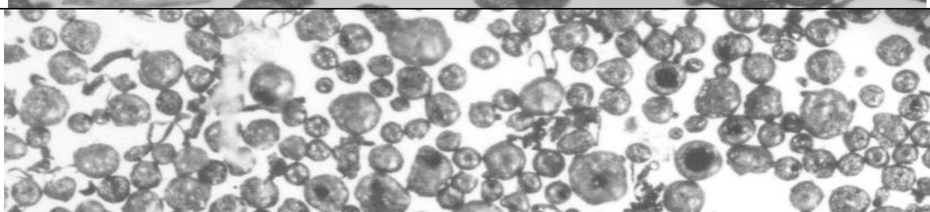
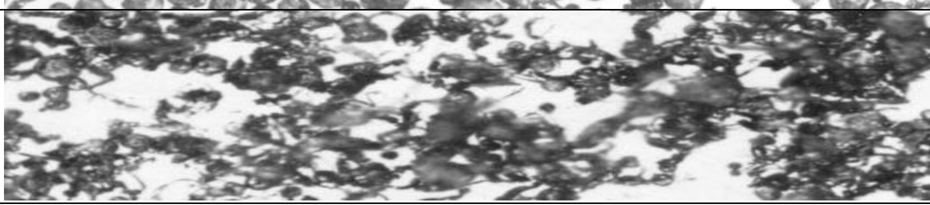
№ impregnator composition	Grinding chips
1	
2	
3	
4	
5	
6 prototype	
Dry grinding	

Table 3.

Chips formed during grinding with circles using lubricants having a different ratio of chemical elements

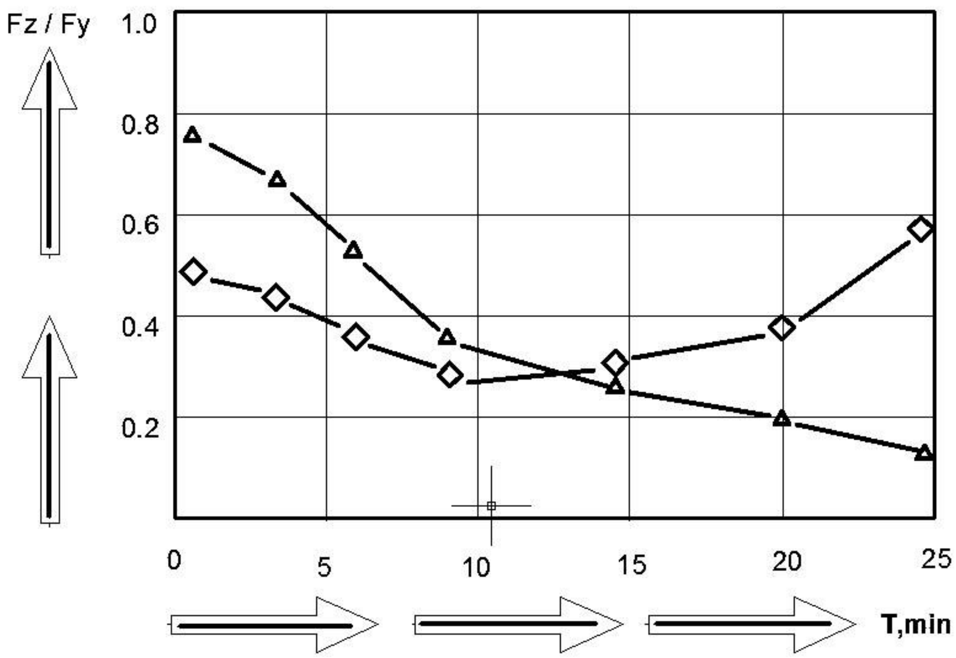


Fig. 1Changing the coefficient of grinding in time in the process of working with ordinary (curve with triangular points) and impregnated (curve with square points) circles.

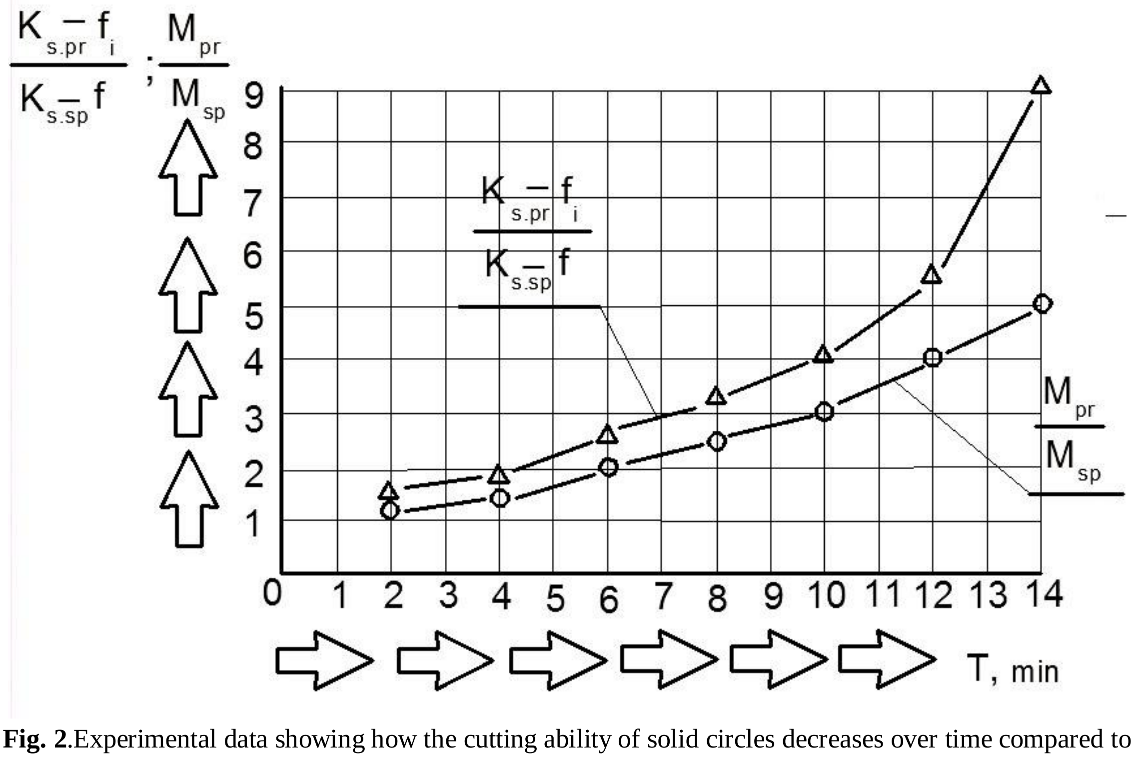


Fig. 2.Experimental data showing how the cutting ability of solid circles decreases over time compared to intermittent and intermittent impregnated circles.

CONCLUSION.

Created and tested solid lubricant for abrasive machining of steels 12x2 H4A and 65Г, in which acetamide and potassium hydroxide are introduced along with stearic and oleic acid. This provides improved lubricating and cooling properties of the lubricant, thereby increasing the time between grinding wheel changes, which increases productivity and reduces the release of abrasive dust in the workplace of the polisher, which reduces the likelihood of occupational lung disease.

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