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ABRASIVE ARTICLES

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This invention relates to abrasive articles and more particularly to grinding wheels in which the bond comprises a filler or active agent capable of improving the wheel quality.

One object of the invention is to provide a filler or active agent for abrasive articles which improves the quality thereof and makes the abrasive capable of removing metal from a work piece at an increased rate or with a reduced wheel wear in a given unit of time, and particularly to improve the efficiency or economy of a grinding wheel.

Another object of the invention is to provide a filler for grinding wheels which not only gives economical grinding results, but also is itself economical, i. e., of low cost, and furthermore is readily available in the United States. Other objects will be apparent in the following disclosure.

In accordance with my invention, I have found that the quality of an abrasive article and particularly a grinding wheel may be materially improved by incorporating therein a quantity of a sulfide of iron or a mineral composed primarily of the same. I may use ferrous sulfide, ferric sulfide, ferrosoferric sulfide or iron disulfide, or the minerals corresponding thereto, such as troilite (FeS) or pyrites and marcasite (FeS_2).

These substances may be employed as fillers in a solid, dry and preferably finely divided condition suitably interspersed throughout the bond. As a general rule, the larger the amount of filler, the higher is the quality of the wheel, up to that point at which the amount of bond is reduced to a detrimental extent. Ordinarily, the filler may constitute from 5 to 60% or more by volume of the bond in an abrasive article; I preferably use from 10 to 35% for most types of grinding wheels.

The value of these substances as fillers for grinding wheel bonds may be seen in the following data. Cryolite has been found to be an excellent filler for grinding wheels made of resinoid bonded or rubber bonded abrasive grains. In a comparative test involving grinding cast carbon steel with two wheels which were identical in grain, grade, structure and resinoid bond composition, except that one contained 25% by weight of pyrite (FeS_2) and the other 25% of cryolite, the wheel wear of the wheel containing the pyrite was found to be 78% of that of the cryolite wheel, while the quality number of the pyrite wheel was 138% of that of the cryolite wheel. The value of the quality number Q is expressed in the equation

$$Q=K\frac{M^2}{W}$$

in which K is a constant, M is the weight of the metal removed from the work in unit time and W is the loss in weight of the wheel in the same time. When grain, grade and structure are the same, the wheel with the higher quality number is the most economical. It will be seen that the formula gives more significance to the metal removed than to the wheel wear. This gives weight to the fact that the cost of grinding includes not only the cost of abrasive per pound of metal removed, but also the labor cost and overhead.

In another test, a grinding wheel having a grade of S on the Norton scale and a structure involving 58% by volume of abrasive and 16% of pores, and in which the bond was a phenol formaldehyde resinoid containing 21% by volume of cryolite and 4% of calcium oxide, the wheel wear was found to be 31.1 and the quality number of the wheel was 19. A similar wheel was tested in which a part of the cryolite was replaced by ferrous sulfide (FeS), this wheel having 10% of FeS, 11% of cryolite and 4% of CaO. The wheel wear of the iron sulfide wheel was found to be 25.7 and the quality number was also 19. Cryolite has been proved by thousands of tests to be a good filler. It has been found that for some operations, such as snagging, if the quality of two wheels is the same but the wheel wear different, the one having the lower wheel wear is the more economical wheel to use. Hence, in the above comparison of two wheels having the same quality, the one filled with iron sulfide is the better. Moreover, in cases where the various iron sulfides have been found to be in general the equivalent of cryolite, a particular advantage in the use of an iron sulfide lies in its low cost and availability. Iron sulfide, particularly iron pyrites, is found widely distributed in the United States, whereas cryolite has to be imported from Greenland, and, owing to the war there can be no certainty that it will be imported in sufficient quantities for all useful purposes. Furthermore, even under normal conditions iron sulfide is decidedly cheaper than cryolite.

One example of the manufacture of a grinding wheel according to the invention is as follows: I provide a quantity of abrasive grains, for example fused alumina abrasive or silicon carbide abrasive, and wet the grains with furfural in a mixing pan. A quantity of "A"-stage phenol-formaldehyde and a quantity of iron sulfide are then added, the phenol-formaldehyde including a suitable hardening agent, such as hexamethylene tetramine. Mixing is continued until a good dry granular mix is formed, and then a wheel is molded and is cured at around 175° C. either in the mold and in the press, or outside of the mold, or in the mold but outside of the press. Quantities of the various ingredients vary widely for different structures and grades of wheels and the technique thereof is known to those skilled in the art.

As another example, I may proceed as above substituting, however, aniline formaldehyde for the phenol-formaldehyde. As a still further example, I may press in a hot press a mixture of abrasive, aniline formaldehyde powder and iron sulfide and a good wheel results.

The invention may be embodied in a rubber bonded wheel which may be formed by passing raw rubber in sheet form back and forth between calendering rolls, sprinkling onto the sheet abrasive and dry powdered iron sulfide together with other ingredients, such as sulfur and an accelerator for promoting the step of vulcanization. After thus breaking down the rubber, it is sheeted and cut to the shape of a grinding wheel after which it is vulcanized in accordance with the accepted practice in the art.

A vitrified grinding wheel may have the filler incorporated therein by the following procedure. The vitrified bonded abrasive grinding wheel may be first made in accordance with standard practice to provide a given grade and percentage of open pores. The pores in the wheel form interconnected passages open at the surface of the wheel. These pores are thereafter impregnated with a mass comprising iron sulfide suspended in a supplemental fluid bond, such as a standard type of phenol-formaldehyde condensation product in the liquid stage. The suspension of iron sulfide in the fluid resinoid is forced into the wheel pores. For example, the wheel may be placed in a vessel containing the filler suspended in the liquid bond and a vacuum is applied to draw the air out of the pores and when atmospheric pressure is restored the filler and liquid enter the pores. Thereafter, the wheel may be subjected to a further heating operation to convert the liquid resin to its final infusible state. This forms a supplemental bond within the wheel pores which holds the filler interspersed substantially uniformly throughout the pores of the wheel structure. Rubber in a fluid condition, such as a solution of rubber or rubber latex containing the iron sulfide, may be used in place of the resin. Various other types of materials may be employed for carrying the filler and fixing it within the wheel pores.

Any one of the iron sulfides may be utilized as an active filler in accordance with this invention either alone or in combination with the other sulfides or with other active agents, such as cryolite, that are found to be suitable in this field. That is, these comparatively inexpensive iron sulfides may be employed with other, and often more expensive, active agents to decrease the cost of the grinding wheel and make it freer or cooler cutting or otherwise improve its grinding characteristics. The composition and structure of the abrasive article may be widely varied and the iron sulfide filler may be incorporated therein in any desired or feasible manner. Hence, the above disclosure is to be interpreted as illustrating the general principles of this invention and the preferred types and compositions of abrasive articles and not as limitations on the following claims.

I claim:

1. An abrasive article comprising abrasive grains, a bond uniting the grains as an integral body and iron sulfide interspersed throughout the bonded mass.

2. An abrasive article comprising abrasive grains, an organic bond uniting the grains as an integral body and a filler of finely divided solid iron sulfide interspersed throughout the bond.

3. An abrasive article comprising abrasive grains and a resinoid bond which unites the grains as an integral body, said bond having intimately associated therewith a filler comprising iron sulfide which constitutes from 5 to 60% by volume of the bond mass.

4. An abrasive article comprising abrasive grains, a vulcanized rubber bond uniting the grains integrally and a filler containing from 5 to 60% of iron sulfide interspersed therethrough.

5. An abrasive article comprising abrasive grains, a vitrified ceramic bond uniting the grains as an integral body and proportioned to form interspersed pore spaces between the grains, and a supplemental bond and a filler comprising iron sulfide in said pore spaces, said filler constituting from 5 to 60% by volume of the supplemental bond.

6. An abrasive article comprising abrasive grains, a bond uniting the grains as an integral body which has as its primary constituent a converted phenol formaldehyde condensation product, and a solid granular filler incorporated in the bond composed primarily of iron sulfide which constitutes from 5 to 60% of the bond mass.

7. A grinding wheel comprising abrasive grains, a bond uniting the grains as an integral body which has as its primary constituent a heat converted phenol formaldehyde condensation product, and iron sulfide dispersed through the bond as a filler constituting from 10 to 35% by volume thereof.

8. An abrasive article comprising abrasive grains, an organic bond uniting the grains as an integral body and a filler interspersed throughout the bond comprising cryolite and an iron sulfide which together constitute from 5 to 60% by volume of the bond mass.

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