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ABRASIVE ARTICLES

John C. Cohen, Knutsford, and Edward Roy B. Jackson, Mobberley, England, assignors, by mesne assignments, to The Carborundum Company, Niagara Falls, N.Y., a corporation of Delaware

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This invention relates to bonded abrasive articles and, more particularly, to bonded grinding wheels including novel fluorine-containing fillers for better cutting action and improved abrasive efficiency.

It has been known heretofore that the addition of certain fluorine-containing fillers such as potassium fluoborate and cryolite (sodium aluminum fluoride) to organic bonded grinding wheels provides improved abrasive efficiency over wheels using fillers such as flint or kaolin. At the temperatures and pressures encountered at the grinding interface, the fluorine atom is apparently released and, by some chemical reaction, provides the better cutting action. However, the search for increasingly better grinding wheels continues, indicating the desirability of providing still more highly improved fillers.

It is accordingly an important object of this invention to provide improved bonded abrasive articles such as grinding wheels.

Another object is to provide novel fluorine-containing fillers which impart improved cutting action and abrasive efficiency to bonded abrasive articles such as grinding wheels.

A further object is to provide improved bonded grinding wheels wherein novel fluorine-containing fillers are employed in conjunction with an organic bond.

A still further object is to provide improved bonded grinding wheels containing novel fluorine-containing additives in a resinoid bond.

In accordance with the present invention, bonded abrasive articles such as organic bonded grinding wheels containing an abrasive such as silicon carbide, are provided with improved abrading and cutting characteristics by incorporating therein during the process of their manufacture, selected amounts of novel fluorine-containing additives. The additives of this invention are potassium zirconium fluorides. This term encompasses potassium zirconium hexafluoride, K_2ZrF_6, and potassium zirconium pentafluoride, $KZrF_5$.

The novel additives of this invention are high-melting chemical compounds and, accordingly, are stable at high temperatures. For example, potassium zirconium hexafluoride has a melting point of 840° C. and is particularly adapted for improving the cutting characteristics of heavy duty grinding wheels wherein grinding operations encounter both high pressures and high temperatures generated at the grinding interface. In such applications, potassium zirconium hexafluoride has been found to give freer cutting action and a higher quality factor. The term "quality factor" is well known in the abrasives industry and is obtained from the formula

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

where Q is the quality factor, M is the weight of metal removed, and W is the abrasive wheel wear in a given time interval.

Potassium zirconium pentafluoride has a melting point

of about 470° C. and provides a highly beneficial effect as a filler material in a wide range of resin-bonded grinding wheels. Since this compound has a lower melting point than potassium zirconium hexafluoride, it becomes chemically active at the grinding interface under lower temperature and pressure conditions. Accordingly, it finds application for light and medium duty grinding, where grinding pressures and temperatures are less than those encountered in stainless steel billet snagging and other heavy duty snagging operations.

In preparing improved bonded abrasive articles by this invention, the potassium zirconium fluoride is added to a forming mixture to be used for the production of such articles, including grinding wheels, in an amount in the range from about 0.5 weight percent to about 20.0 weight percent of the mixture. Preferred amounts of the additives will be in the range from about 1.0 weight percent to about 10.0 weight percent. The optimum additions of the additive in any particular case will depend upon conditions of use, such as the nature of the work being ground or cut, the amount of stock to be removed and whether grinding or cutting is to be carried out wet or dry, among other factors. Also, it is to be included within the scope of the invention to use the additives either singly or in admixture, depending upon the grinding effect to be provided.

In the practice of this invention the additive has been employed in particulate form to facilitate its admixture with the other ingredients going into the composition. The particle size employed can vary, and particle sizes in the range of 30 mesh and finer are suitable.

The potassium zirconium fluoride fillers of this invention can be utilized with other fluorine-containing fillers such as potassium fluoborate and cryolite of the prior art, if desired, to improve the efficiency thereof. Also, the additives are compatible with bonds employed for the production of many different kinds of bonded abrasive articles, being particularly adapted for use in organic bonded articles. As utilized in this disclosure, the term "organic bond" encompasses the synthetic and natural resins, including the phenol-formaldehydes, urea-formaldehydes, melamine-formaldehydes, epoxies, alkyds, polyesters, modified phenolics, natural and synthetic rubbers, shellac and the like. The additives are particularly adapted for use with the synthetic resin bonded abrasive wheels such as those wherein the bond consists of a phenolic resin, such wheels being used mainly for heavy duty grinding operations such as snagging wheels for stainless steel billets and the like, and it is in this field in particular that the benefits of the potassium zirconium fluoride fillers have become apparent.

The present invention is adapted to the production of bonded abrasive articles wherein the abrasives include silicon carbide, aluminum oxide, bauxite, zirconia, flint, garnet, and the like, either singly or in admixture.

The following examples illustrate the principles of the invention; the manner in which bonded grinding wheels are made, and the results of grinding tests employing wheels made by the invention.

Example 1

Bonded abrasive grinding wheels were made for grinding tests employing potassium zironium hexafluoride and potassium zirconium pentafluoride as fillers and comparison was provided by wheels of the same composition except that they contained potassium fluoborate filler of the prior art. The wheels were resinoid bonded stainless steel billet snagging wheels. The ingredients in the composition of the batches from which the wheels were made were as follows:

	Percent by Weight		
	Wheel A	Wheel B	Control
Aluminum oxide grain, fused, 16 grit	51.5	51.5	51.5
Phenolic resin	26.0	26.0	26.0
Powdered filler without the fluoride component	14.5	14.5	14.5
KBF_4	--------	--------	8.0
$KZrF_5$	8.0	--------	--------
K_2ZrF_6	--------	8.0	--------

The ingredients were admixed and molded into wheels under identical conditions. Grinding tests were then run on the wheels under controlled grinding laboratory conditions using 9-inch diameter wheels on an automatic snagging machine for grinding stainless steel slabs. The following results were provided.

	Wheel A	Wheel B	Control
Wheel wear (cu. in./hr.)	1.98	2.07	1.43
Metal removal rate (lb./hr.)	5.11	4.88	3.51
Quality factor (M^2/W)	13.21	11.5	8.62

The above results indicate that wheels made by the invention show substantial improvement over wheels made by the prior art. Thus, though the wheel wear is slightly increased, the metal removal rate is substantially increased and the quality factor is also substantially improved.

Example 2

Field tests were run utilizing wheels made in accordance with the procedure of Example 1 to provide the following results:

	Wheel B	Control
Quality factor (M^2/W)	12.0	7.9

The results show a substantial improvement in quality factor, indicating greater grinding efficiency, analogous to the laboratory results of Example 1.

Example 3

Field tests were also run utilizing Wheel A made in accordance with the process of Example 1 and results of such field tests are as follows:

	Wheel A	Control
Wheel wear, lb.	60.8304	59.288
Total metal removed, lb.	469.452	385.70
Time, hrs.	3.9	3.43
Stock removal rate, lb./hr.	121.22	112.404

The foregoing results show that a marked improvement is provided in field operations utilizing grinding wheels containing additives of this invention over the prior art materials.

While the present invention has been described in connection with preferred embodiments thereof, it is subject to reasonable modifications as will become apparent to those skilled in the art, and such modifications are to be included within the scope of the invention as defined by the appended claims.

We claim:

1. A raw batch mixture for the manufacture of a bonded abrasive article which comprises abrasive grains, an organic bonding agent for said abrasive grains, and a filler, said filler including a useful amount of a potassium zirconium fluoride selected from the group consisting of K_2ZrF_6 and $KZrF_5$.

2. A raw batch mixture as set forth in claim 1 in which said fluoride is present in an amount ranging from about 0.5 weight percent to about 20 weight percent of said mixture.

3. A raw batch mixture as set forth in claim 1 in which said fluoride is present in an amount ranging from about 1 weight percent to about 10 weight percent of said mixture.

4. A raw batch mixture as set forth in claim 1 in which said organic bonding agent is a phenolic resin.

5. An abrasive article comprising abrasive grains bonded with an organic bond and having distributed uniformly throughout said bond a reactive filler including a useful amount of a potassium zirconium fluoride selected from the group consisting of K_2ZrF_6 and $KZrF_5$.

6. An abrasive article as set forth in claim 5 in which said fluoride is present in an amount ranging from about 0.5 weight percent to about 20 weight percent of said article.

7. An abrasive article as set forth in claim 5 in which said fluoride is present in an amount ranging from about 1 weight percent to about 10 weight percent of said article.

8. An abrasive article as set forth in claim 5 in which said organic bond is a phenolic resin.

9. An abrasive article consisting essentially of abrasive grains, a resin bond and a filler comprising a compound selected from the group consisting of potassium zirconium pentafluoride ($KZrF_5$) and potassium zirconium hexafluoride (K_2ZrF_6).

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