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METHOD OF PREPARING CHROMITE BRIQUETTES

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This invention relates to a method of briquetting.

One of the objects of my invention is the method of briquetting chromite for use in processes where it is undesirable or impossible to use it in a powdered or finely divided state.

Another object of my invention is a method for briquetting finely divided chromite employing a plastic clay-like material such as bentonite as a bonding agent; and in which method, the particles or the compound are seemingly welded together.

Still another object of my invention is a method for briquetting finely divided chromite so that it behaves much in the manner of lump ore when used at relatively high temperatures.

A further object of my invention is a method of briquetting chromite utilizing bentonite which, alone, has a relatively low melting point; but which, when heated in some manner reacts with the chromite ore, forming some compound having a high melting point and which produces a briquette that can be used without excessive losses.

A still further object is a method of producing a briquette from chromite by the use of a plastic clay-like material, which will allow excessive handling without pulverizing.

Yet another object of my invention is a method of briquetting which guarantees that the particles of the chromite briquetted will be so consolidated that they cannot segregate even at high temperatures and thus become susceptible to being blown from the furnace.

An even further object of my invention is a briquette of chromite, the particles of which are bonded together by a small amount of bentonite or other plastic clay-like material, and in which the bonding agent and the chromite melt as a unit at substantially the same time and temperature, when subjected to relatively high temperatures.

In the past, the metal industry has often encountered considerable difficulty in the manufacture of alloys where it is necessary to add various compounds, ores or minerals, such as chromite which has a relatively high melting point. Many of these compounds either contain or are mixed with substances which contain carbon or some other element, which, when subjected to high temperatures, combine with the oxygen of the ore to form carbon monoxide, carbon dioxide, or some other gas. Such gas may be given off from the furnace very quickly, even at a near explosion rate, and naturally has a great tendency to carry some of the particles of chromite with it. It is obvious, therefore, that if the cromite, being subjected to these temperatures, is in a finely divided state, the small particles will be blown before they have been reduced. There is a great advantage to be gained if the chromite can be added in a manner that will allow it to melt and be properly reduced without being blown out by the undesirable action of the gases. The idea of accomplishing this result by adding chromite, sometimes added in a finely divided state, in briquette form is old; but it has been found that it is very difficult to briquette in a form which still retains its desirable original characteristics.

Heretofore, attempts have been made to briquette various substances with high melting points for use at high temperatures by adding to them substantial quantities of bentonite, a clay composed of various metallic oxides, including chiefly SiO_2 and Al_2O_3; and which, when mixed with water, forms a voluminous jelly; or with boric acid or other clays. Hitherto it has been the practice to add from 5 to 10% of bentonite or some other clay-like body to the ore and to heat this mixture to a temperature such that the bentonite or clay-like body would melt, forming a glue-like mass between the particles of the ore. When this mass was cooled, the bentonite or clay would solidify and thus bind the ore particles together in the same manner as would glue. In other words, the bentonite or clay would act purely as an agglutinating agent. However, when this mass was again heated and the temperature carried up to a high point, the bentonite or clay would again melt into a very thin liquid and this liquid would run out from the mass of ore particles, leaving them in segregated condition, susceptible to being blown out from the furnace in the manner and from the causes above stated.

I have found, however, that the difficulties just described may be overcome by the use of, not more, but less of the plastic clay-like material, such as bentonite. In other words, if I take a certain quantity of chromite which I wish to briquette, in its finely divided state, and add to it a very small amount of bentonite, a briquette will be produced which will operate successfully.

To describe my process or method, I shall take, as an example, chromite ore which is to be used in the production of ferro-chrome. A chromite ore which is proper for this purpose, should contain about 50% chromic oxide and have a

chromium-iron ratio (metallic) of not less than 3:1. A natural chromite having this composition is rarely found, and none exists in the United States. Therefore, it may be necessary, before briquetting, to add some concentrated chromite, having a high chromic oxide content, to a quantity of lower grade chromite, in order to have the proper over-all percentage of chromic oxide as well as a proper chromium-iron ratio.

The ore is in a finely divided state and if mixed with carbon and added to the electric furnace, the carbon which is present combines with the oxygen in the metals to form carbon monoxide at a very fast rate. This gas passes off so quickly and with such force as to carry most of the desired chromite with it.

To illustrate, the action in a smelter of any sort, outside of perhaps electrolytic, takes place above and out of direct contact with the metal produced. The metal in all cases is reduced above the hearth and runs down through the mass and gathers at the bottom in the hearth. The reducing action in the case of the electric furnace, wherein carbon is used as the reducing agent, is brought about by the carbon combining, at a very high temperature, with the oxygen of the chromite, forming carbon monoxide or carbon dioxide, as the case may be, and this gas tremendously expands at the high temperature. This creates a heavy draft of these gases which will, in escaping from the furnace, blow out any finely divided particles that may be loose, thus causing heavy loss of material, sometimes more than 25%.

I have found, however, that if I add to chromite from 1.5 to 3.5%, by weight, of a plastic clay-like material such as bentonite, montmorillonite, or Wyomingite, this result can be avoided. It should be noted that all of the above plastic clay-like materials will work, but I have found that bentonite is preferable.

The bentonite may be added to the chromite in either of two ways. It may first be mixed with water to form a voluminous jelly and then added to the chromite, or may be added directly thereto in its dry state. In the latter case, sufficient water should be added so that the mixture is slightly damp.

After the bentonite, which is the material I shall use in my discussion here, has been added to the chromite, the mixture is moulded into briquettes which are subjected to pressure, then heated until it is brought to good red heat, and again cooled. The amount of pressure used in producing the briquette depends on various circumstances. For instance, if the briquette is to be used where produced very little pressure is necessary to make it sufficiently hard and adherent for use in an electric furnace. However, if the briquettes are to be shipped or subjected to extensive handling, it is desirable that they be made extremely hard and tough, and the moistened mixture must be subjected to a high pressure, sometimes as high as 15 to 20 tons per square inch.

When the briquettes are completed, they may be fed to an electric furnace, just as is natural lump ore. It will be found that under the temperature at which the furnace operates, the briquettes which are produced by my method, melt as units, substantially at the temperature of the lump ore. Thus, the chromite melts at relatively the same time and temperature as does the bonding agent, and there is no chance for the carbon monoxide, which is formed, to blow out the particles of the chromite.

It is to be noted that the amount of bentonite or plastic clay-like material used is very important. If less than 1.5% bentonite is added, no sufficient bonding action is produced. Above 1.5% the bonding or welding action increases with the addition of bentonite up to about 2.5% as a maximum. The addition of further bentonite tends to cause the welding or bonding action to decrease and the bentonite then seems to act as no more than an agglutinating agent. Thus, if the actual bonding action at high temperatures is plotted against the percentage of bentonite added to the chromite, the curve would clearly show the maximum bonding strength at about 2.5% bentonite.

I am not aware of the exact reason for the effect which these quantities of bentonite produce, in contradistinction to relatively higher quantities. But in any case, when the smaller quantities of bentonite are added, the resulting briquette is extremely hard and appears relatively homogenous. Two possible explanations may be made for this unexpected result deriving from the use of such small amounts of bentonite. The first is that since bentonite has a relatively low melting point, it actually reacts with the faces of the mineral particles when the red heat temperature is reached; and consequently welds the particles together and forms a small amount of a new compound with a relatively higher melting point. The other possible explanation is that since bentonite contains many of the same elements as did the original gangue matter of the chromite, the chromite may actually again go into solution in the bentonite.

In any case, the whole briquette melts at substantially the same temperature, not at all like a briquette containing 5% bentonite, for instance. In that case, the bentonite melts out at a temperature much below the melting point of the chromite, leaving it free in the form of small crystalline particles which will be lost when blown out.

In other words, my method involves more than a change in the amount of bentonite used, as a new kind of bonding is produced. If 5% or so bentonite is used, it then simply acts as an agglutinating agent to stick the particles of the ore together and which melts out before the ore or mineral has reached its melting temperature. But, by the use of the smaller amounts in accordance with my invention, a peculiar effect is produced upon the particles, so that they and the bentonite seem to combine to weld the particles of the ore together; and the whole briquette melts at substantially the same time and temperature. Thus an entirely new method of bonding, based on a new principle is produced. The new proportions of bentonite accomplish a new result which allows the briquettes to be used in ways which proved impossible when greater quantities of the same material were used; and such combination has overcome a problem which has for many years remained unsolved.

Thus, my invention makes available properly proportioned chromite for direct addition to the electric furnace where heretofore it has been either impossible or undesirable to add it in a finely divided state. The briquettes produced by my process or method behave just as though lumps of natural chromite were being added. Consequently their use is important in those cases where low-grade ores are of no value until

they have been pulverized and concentrated, or where it is desirable to blend different ores or different grades of ore into solid masses having any particular desired composition, such as is illustrated in my co-pending application, Serial No. 399,425, filed June 23, 1941, wherein the material briquetted is composed of blends of different grades of chromite and deironized chromite, to properly establish the chromium-iron ratio.

Having described my invention, I claim:

1. A method of briquetting chromite ore, comprising heating a quantity of finely divided chromite ore, mixed with from 1.5 to 3.5%, by weight, of clay.

2. A method of briquetting chromite ore, comprising heating to a red heat a quantity of finely divided chromite ore, mixed with from 1.5 to 3.5%, by weight, of clay.

3. A method of briquetting chromite ore, comprising heating a quantity of finely divided chromite mixed with a small amount of water and from 1.5 to 3.5%, by weight, of clay.

4. A method of briquetting chromite ore, comprising the steps of mixing a quantity of finely divided chromite ore with from 1.5 to 3.5%, by weight, of clay; molding the mixture under pressure; and heating it.

5. A method of briquetting chromite ore, comprising heating a quantity of finely divided chromite ore, mixed with from 1.5 to 3.5%, by weight, of one or more materials selected from the group consisting of bentonite, montmorillonite, and Wyomingite.

6. A method of briquetting chromite ore, comprising heating to a red heat a quantity of finely divided chromite ore, mixed with from 1.5 to 3.5%, by weight, of one or more materials selected from the group consisting of bentonite, montmorillonite, and Wyomingite.

7. A method of briquetting chromite ore, comprising heating a quantity of finely divided chromite mixed with a small amount of water and from 1.5 to 3.5%, by weight, of one or more materials selected from the group consisting of bentonite, montmorillonite, and Wyomingite.

8. A method of briquetting chromite ore, comprising the steps of mixing a quantity of finely divided chromite ore with from 1.5 to 3.5%, by weight, of one or more materials selected from the group consisting of bentonite, montmorillonite, and Wyomingite; molding the mixture under pressure; and heating it.

9. A method of briquetting chromite ore, comprising heating a quantity of finely divided chromite ore, mixed with from 1.5 to 3.5% by weight, of bentonite.

10. A method of briquetting chromite ore, comprising heating a quantity of finely divided chromite ore, mixed with from 1.5 to 3.5%, by weight, of montmorillonite.

11. A method of briquetting chromite ore, comprising heating a quantity of finely divided chromite ore, mixed with from 1.5 to 3.5%, by weight, of Wyomingite.

12. A method of briquetting chromite ore comprising heating a mixture of finely divided chromite and from 1.5 to 3.5%, by weight, of clay to a temperature such that the clay combines with the particles of the chromite to strongly bond the said particles of chromite together.

13. A briquette composed of finely divided chromite ore and from 1.5 to 3.5%, by weight, of clay, which melts as a unit at substantially the temperature of the original chromite.

14. A briquette of finely divided chromite ore, bonded together with from 1.5 to 3.5%, by weight, of clay.

15. A briquette of finely divided chromite ore, bonded together with from 1.5 to 3.5%, by weight, of one or more materials selected from the group consisting of bentonite, montmorillonite, and Wyomingite.

16. A briquette composed of finely divided chromite mixed with from 1.5 to 3.5%, by weight, of clay, and in which the particles of the chromite are bonded together by their combination with the adjacent clay.

17. A method of briquetting chromite ore, comprising: heating a quantity of finely divided chromite ore; mixed with from 1.5 to 3.5%, by weight, of a clay capable of forming a voluminous gell, when mixed with water.

18. A method of briquetting chromite ore, comprising: heating to a red heat a quantity of finely divided chromite ore; mixed with from 1.5 to 3.5%, by weight, of a clay capable of forming a voluminous gell, when mixed with water.

19. A method of briquetting chromite ore, comprising: heating a quantity of finely divided chromite ore; mixed with a small amount of water and from 1.5 to 3.5%, by weight, of a clay capable of forming a voluminous gell, when mixed with water.

20. A briquette of finely divided chromite ore, bonded together with from 1.5 to 3.5%, by weight, of a clay which is capable of forming a voluminous gell, when mixed with water.

21. A briquette composed of finely divided chromite; mixed with from 1.5 to 3.5%, by weight, of a clay capable of forming a voluminous gell, when mixed with water; and in which the particles of the chromite are bonded together by their combination with the adjacent clay.

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