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METALLURGICAL FLUX AND METHOD OF PRODUCING IT

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This invention relates to the production of a synthetic flux for use in metallurgical processes in substantially any circumstances requiring a fluorspar-bearing flux having certain more or less specific physical and chemical characteristics, as in the production of steel in open hearth furnaces or the like.

Fluorspar fluxes are used in steel manufacture and other metallurgical operations principally to insure the desired fluidity in the slag and thereby assist in refining the bath of molten metal but without changing the basicity or acidity of the slag, and it has been customary to employ for this purpose fluorspar which occurs in nature in limited quantities in certain parts of the United States, since not all natural fluorspar ores possess the degree of purity and physical characteristics requisite for the purpose.

For attainment of the best results in commercial practice, a fluorspar flux usually should contain not less than 85% calcium fluoride (CaF_2) and not more than 5% silica (SiO_2) and also, even when conforming to or excelling these chemical standards, must be available in quantity and preferably in a physical form such that the largest pieces do not exceed in size a one inch cube and the portion of the material which can be passed through a twenty-mesh screen does not exceed 25% by weight of the total; of course, it is usually preferable that the pieces be more uniform in size than is the case when considerable numbers of them approximate these maximum and minimum dimensions.

Much of the fluorspar used for fluxing is derived from deposits of fluorspar ore in the Southern Illinois-Kentucky district, the ore being usually either in the form of loose to partly coherent coarse gravel associated with clay and lying near the surface or else in veins in association with shale, limestone and silica and lying at greater depth but in either case the ore can readily be concentrated to the requisite degree of purity. This concentration, however, is generally accomplished through log washing and/or jigging operations which are wasteful in that substantial losses occur in middling products and in the fine sizes so that it has usually been distinctly preferable, when possible, to obtain the ore for the production of metallurgical flux from a deposit in which it occurs naturally in a relatively pure state.

As a result, but a limited number of the known fluorspar deposits have been practically workable for flux production, as those in which the spar does not occur naturally in quantity with the requisite purity or with the essential physical characteristics are substantially valueless for the purpose.

To the end that industry may be freed from its present dependence for its requirements upon the limited output of those districts in which there occur natural deposits of fluorspar suitable for use as metallurgical fluxes, it is a principal object of the invention to provide a synthetic metallurgical flux of the required fluorspar content as well as physical form produced from fluorspar concentrate or other fluorspar-bearing materials which because of their finely divided condition cannot be used as metallurgical fluxes.

A further object of the invention is the production of a metallurgical flux from such materials in which the particles are agglomerated in lumps or pellets having adequate physical strength and resistance to abrasion and impact, which are readily susceptible of incorporation in the slag, and which are of sufficient mass individually to prevent their being carried out the stack of an open hearth furnace by the draft.

A still further object is to provide a novel method of producing from finely divided fluorspar flotation concentrate or similar substantially pulverized fluorspar-bearing material a practical synthetic metallurgical fluorspar flux of such character, physical condition and chemical purity that it may be satisfactorily employed in place of the best grade of the natural product.

As is well known by those familiar with the art, relatively finely divided fluorspar such as that resulting from flotation concentration of fluorspar ores and commonly known as fluorspar concentrate, in which the particles are usually of the order of 100 mesh, cannot be used as metallurgical flux for the reason that the spar particles are blown out through the furnace stack by the violent currents of air and gases in open hearth and other metallurgical furnaces before they can unite with or become incorporated in the slag layer floating on the bath of molten metal. To obviate this condition, it has been proposed to agglomerate spar concentrate with a tarry or other carbonaceous viscous binder and press the mixture in molds to form briquettes large enough to prevent their being blown out the stack when charged into the furnace. This expedient is unsatisfactory, however, for the reason that the intense heat of the furnace causes violent and rapid oxidation or combustion of the carbonaceous binder so that the briquettes virtually explode as soon as they are charged into it which is not only dangerous to the operatives

but causes wide dissipation of the spar particles contained in the briquettes, so that a large proportion of them are lost in the stack gases just as when loose concentrates are used while much of the remainder is quickly destroyed by chemical reaction without contributing materially to the quality of the product of the furnace or producing any other beneficial result.

Portland cement has also been suggested for use as a binder in the manufacture of fluorspar concentrate briquettes as it is cheap and non-combustible but such briquettes do not have adequate strength and hardness to withstand the abrasion to which they are subjected during handling and shipment unless so much cement is used that the fluorspar content is diluted to an excessive degree. Sodium silicate and similarly water soluble materials have also been utilized in briquettes but are so susceptible to the action of rain and atmospheric moisture that the briquettes cannot be economically stored and/or shipped and such binders are therefore generally considered unsuitable for practical use in this connection.

These and other objections to the artificial fluorspar fluxes hitherto proposed are entirely obviated by our invention by means of which we are able to produce from fluorspar flotation concentrate or other finely divided fluorspar a fluorspar-containing material in which the fluorspar particles are held together in fairly porous lumps of suitable size which can be handled and shipped without becoming pulverized or otherwise disintegrating, which do not readily dissolve in atmospheric moisture or in other ways lose their normal physical and chemical characteristics, and which, when charged into the furnace, do not burn with undue rapidity or pass up the stack and thereby nullify in whole or in material part the desired effect of the fluorspar.

As illustrative of the practice of our invention we shall initially refer to the production in accordance therewith of a fluorspar flux using as ingredients fluorspar flotation concentrate consisting principally, if not entirely, of particles of the order of one hundred mesh and finer, this being the size of the particles of the fluorspar flotation concentrates of relatively high purity now being produced in certain parts of the United States, particularly in the Rosiclare district in Illinois. Such concentrates usually contain about 8% to 12% moisture when delivered from the filter or comparable mechanism in the flotation circuit and in accordance with our invention may be used immediately in this condition without further drying. If they have already been dried, however, they are first preferably moistened and then, to a given quantity of the moist concentrate we add casein, preferably that commercially known as "B" brand marketed by the Borden Company although other caseins may be used, and bentonite clay in substantially equal amount, equivalent by weight to about 1% each of the dry weight of the spar concentrate, and up to about 0.3% of lime (CaO) on the same basis and then thoroughly mix together and work these several ingredients in any suitable mixing machine with just sufficient water to produce a relatively stiff plastic mass of substantially uniform consistency. During this operation chemical reactions may occur between the casein and the lime and/or the fluorspar and produce a small percentage of calcium caseinate which readily emulsifies and supplements the cohesiveness of the mass as a whole and of the flux ultimately made therefrom, while the bentonite clay facilitates the mixing of the ingredients and the subsequent passage of the mixture through a pelleting machine to which it is next transferred either continuously or in batches.

This machine may comprise, essentially, a plate or die perforated with a plurality of holes, which may be circular, square or of any other desired shape, and preferably about 3/8" in greatest transverse dimension, over one face of which heavy rollers are arranged to travel so as to force the plastic material through the holes as it is deposited on the plate and extrude it from its other face. A rotating blade cooperative with the latter may be provided to sever the materail into pellets of suitable length, desirably 1/2" to 5/8", as it is extruded through the holes by the pressure exerted by the rollers, or the extruded material may be allowed to simply break off by its own weight and thus form longer pieces usually some 3" in length which in the subsequent drying and handling tend to break up into shorter pieces. The pellets in either case are of sufficient strength to retain their shape until they are subjected to the succeeding drying operation.

The moist pellets are discharged from the pelleting machine preferbly directly onto a moving belt arranged to convey them into a drying and curing oven where they are heated to about 200–400° F., the exact temperature depending on the speed at which they are heated and the time allotted thereto. This treatment removes most of the retained excess moisture in the pellets and dries the casein and whatever calcium caseinate may have been formed through its reaction with the lime and/or calcium fluoride, with the result that the spar concentrate particles are held tightly together in the dried pellets which are therefore hard and contain substantially nothing but fluorspar concentrate, which, as noted, is preferably of greater purity than 85% CaF_2.

This flux material can be stored for long periods of time, if protected from direct action of the elements, and when charged into an open hearth furnace the pellets are of sufficient size and density to penetrate immediately into the slag floating on the charge without being blown from the furnace by the draft. As substantially the only combustible constituent of our flux is the casein, generally present as calcium caseinate, and its combustibility is of but a sluggish nature, disintegration of the pellets upon encountering the furnace heat is relatively slow and there is a total absence of the explosive effect which occurs when briquettes made of fluorspar and carbonaceous binders are charged.

Furthermore, as casein is composed of elements which are substantially completely driven off by the furnace heat, its use as a binder in pellets formed of spar concentrate does not result in introduction into the furnace charge of appreciable amounts of foreign material for which allowance must be made in the furnace operation. Thus when Portland cement, sodium silicate and other materials relatively high in silica, alkaline earths or other minerals are used as binders in fluorspar briquettes, it is usually requisite for the furnace operator to take into account the amount of foreign constituents imported in the flux in determining the amounts of other ingredients required for proper refining of the charge, but when using the flux of our invention this is entirely unnecessary.

While we have herein described with consider-

able particularity a preferred method of making our novel flux, we do not thereby desire or intend to restrict or confine ourselves specifically thereto as changes and modifications in the practice of the invention as well as in the materials utilized will readily occur to those skilled in the art and may be made if desired without departing from the spirit and scope of the invention as defined in the appended claims.

Having thus described our invention we claim and desire to protect by Letters Patent of the United States:

1. A metallurgical flux consisting of pellets of approximately uniform size and substantially devoid of uncombined water each pellet comprising particles of fluorspar agglomerated with casein, bentonite clay and calcium oxide.

2. A metallurgical flux comprising pellets of substantially uniform size each consisting of fluorspar flotation concentrate, casein, bentonite clay and calcium oxide, said pellets being substantially dehydrated and resistant to abrasion, impact and moisture.

3. A metallurgical flux comprising substantially dry pellets of approximately uniform size each consisting by weight of approximately 97.7% fluorspar flotation concentrate, 1% casein, 1% bentonite clay and 0.3% calcium oxide.

4. The method of producing a calcium-fluoride-containing metallurgical flux which comprises forming into pellets a relatively stiff wet mixture of finely dvided fluorspar particles, casein, bentonite clay and calcium oxide and then drying the pellets to thereby harden them and materially increase their strength and moisture resistance.

5. A method of producing a calcium-fluoride-containing metallurgical flux which comprises mixing fluorspar flotation concentrate with casein, bentonite clay and calcium oxide in the presence of moisture to thereby form a plastic mass, progressively pelleting the mass and then heating the resultant pellets to a temperature between 200 and 400° F. to thereby remove moisture from the pellets.

6. A method of producing a calcium-fluoride-containing metallurgical flux which comprises mixing with one hundred parts by weight of fluorspar flotation concentrates approximately one part casein, one part bentonite clay, 0.3 parts lime and water sufficient to form a relatively stiff plastic mass, then pelleting the mass and heating the resulting pellets to substantial dryness.

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