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METHOD OF PRODUCING FLUORSPAR-BEARING METALLURGICAL FLUX

Fred A. Jordan, Youngstown, Ohio, assignor to
Mahoning Mining Company, Youngstown, Ohio,
a corporation of Delaware

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1 Claim. (Cl. 75—53)

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.

To attain 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.

Consequently, most fluorspar used for fluxing is derived from the western Kentucky deposits of fluorspar ore, as this ore, probably largely as a result of weathering, is in the form of loose to partly coherent coarse gravel which is, in general, a satisfactory physical form for use as flux. In some places in the region mentioned, the deposits consist of substantially pure fluorspar while in others the fluorspar is more or less contaminated with clay, but can, if necessary, readily be concentrated to the requisite degree of purity. This purification, however, is usually accomplished through jigging or log washing, with attendant losses in middling products and in the fine sizes so that it has usually been distinctly preferable, when possible, to obtain the ore or flux from a deposit in which it occurs naturally in a sufficiently pure state.

As a result, but a limited number of the known fluorspar deposits have been practicably 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 are 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 concentrates 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 by initially agglomerating a mass thereof and subsequently treating the agglomerated mass to produce relatively large lumps of a hard, water resistant fluorspar-bearing material having physical and chemical properties adapting it for use for substantially all the purposes hitherto served by the natural flux above described.

It is a still further object of the invention to provide a novel method of producing from finely divided fluorspar concentrates or like materials heretofore considered substantially useless for fluxing, a synthetic metallurgical fluorspar flux in physical condition such that it can readily be handled and charged and which conforms to or even excels the usual chemical and physical trade specifications for natural flux.

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 in this physical condition as metallurgical flux for the reason that the spar particles decompose as a result of the intense heat or 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. It has therefore been proposed to agglomerate spar concentrates 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 such binders so that the briquettes virtually explode as soon as they are charged; this creates a condition 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 what remains is quickly destroyed by chemical reaction or decomposition in the intense heat 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. Sodium silicate and other water soluble materials have also been utilized but briquettes made with these binders are susceptible to the action of rain and atmospheric moisture and cannot be economically stored and/or shipped, since they require protection to prevent their softening from exposure to the elements.

These and other objections to the artificial fluorspar fluxes hitherto proposed are entirely obviated by my invention by means of which I am 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 dissolve or in other ways lose their normal physical and chemical characteristics when subjected to dampness or the action of the elements, 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 my invention I 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 petroleum coke or other generally comparable combustible fuel, preferably one having low silica content, since the presence of silica in the subsequent mixture of fluorspar and fuel renders difficult the satisfactory completion of the manufacturing operations without loss of part of the fluorine content of the fluorspar through formation of silicon tetrafluoride (SiF_4). I first thoroughly mix together in a dry state appropriate proportions of these two ingredients, the coke or other fuel preferably being obtained in, or first reduced to fairly finely divided form somewhat comparable to that of the spar, and I then dampen the mixture with a fine spray of water while continuing the mixing to thereby pelletize the material, that is, cause it to hold together in small lumps or pellets, and thereby produce an agglomerated and more or less loose porous mass.

I next subject this mass to a sintering operation with the aid of sintering apparatus of any convenient type, of which many are readily available in the open market, the pelletized condition of the material facilitating its introduction to the apparatus and resisting the natural tendency of the bed of material which it forms therein to settle and lose its porosity.

The sintering temperature is preferably controlled to bring about incipient fusion of the mass during retarded combustion of the fuel, which burns less readily than normally due to

being mingled with the concentrate, the temperature being kept low enough, however, to prevent material decomposition of the fluorspar and/or impairment of the cohesive quality of the product after the sintering is completed, a condition which is best realized when the temperature of incipient fusion is not materially exceeded, that is, when the temperature is kept at about 1650°F . to 1800°F .; particularly if silica is present in the fuel, excessive temperatures should be avoided as they enhance reaction between it and the fluorspar with the resultant loss of the fluorine content of the latter through formation of silicon tetrafluoride (SiF_4).

The sintering of the mass is continued for a sufficient period of time to remove therefrom the maximum possible amount of the combustible constituents of the fuel so that a minimum thereof will remain in the final product which, after cooling, is a substantially homogeneous, relatively hard, and practically non-combustible material which, as a result of the initial treatment of the ingredients and the subsequent combustion of the fuel, is quite porous and resembles somewhat, in appearance, the ash or clinker produced by normal combustion of a high residue coal.

Depending to some extent on the composition of the mass before sintering and the manner and type of apparatus in which the sintering is performed, the sintered material may be in relatively large frangible masses or in smaller heterogeneously shaped incongruous lumps of varying sizes when removed from the apparatus and may then, if necessary, be subjected to any suitable operations to bring it to a condition in which it may be most effectively utilized as a flux. I have already referred to the usual trade specifications for natural fluorspar flux, namely that it shall contain no lumps which exceed the size of a one inch cube and not over 25% by weight of material which will pass a 20-mesh screen, and these specifications can be readily met with my synthetic flux by breaking up any of the pieces resulting from the sintering operation which are too large. The incipient fusion induced during the sintering tends to coalesce instead of to separate the mass, so the proportion of very fine material such, for example, as will pass through a 20-mesh screen after the sintering, is relatively low and if proper care is exercised the total amount thereof resulting from the treatment of a given quantity of the initial mixture of fluorspar and fuel is relatively small. The fines after separation from the larger lumps by screening or in any other suitable way may be mixed with fresh fluorspar concentrate and fuel and resintered; in fact I have found this practice a desirable one in that it not only conserves and renders useful the fluorspar contained in the fines but increases the production of the sintering machine by enhancing the porosity of the sinter bed.

Thus the synthetic product when finally conditioned is in irregularly shaped fairly porous lumps of suitable sizes for effective use as a flux and can be charged into open hearth furnaces or the like without producing the violent and substantially explosive oxidation reactions attending the use of briquettes containing a material proportion of combustible fuel. Moreover, it cannot be blown out through the furnace stack after charging instead of becoming properly incorporated in the slag blanket covering the bath, while the lumps are hard enough to

withstand shipment and handling without material damage and do not dissolve or disintegrate when subjected to dampness or other action of the elements.

- 5 While I have herein described with considerable particularity a preferred method of making my novel flux from certain materials, it will be understood that I do not thereby desire or intend to restrict or confine myself thereto as the
10 manner of practising the method of my invention and the materials used in the production of the flux may be varied from those to which I have referred without departing from the spirit and scope of the invention as defined in the
15 appended claim.

Having thus described my invention, I claim

and desire to protect by Letters Patent of the United States:

The method of making fluorspar-bearing metallurgical flux which comprises preparing a dry mixture of fluorspar concentrate and petroleum coke, then spraying the mixture with water while continuing the mixing to form damp pellets of the mixed solids, subjecting the pelletized material to a sintering operation to effect substantially complete combustion of the coke and then cooling the residual solid while maintaining in the resultant irregularly shaped lumps thereof the voids produced by the combustion of the coke.

FRED A. JORDAN. 15