

UNITED STATES PATENT OFFICE

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PREPARING PHOSPHATE CHARGING STOCK

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amended April 30, 1928; 370 O. G. 757)

This application is made under the act of April 30, 1928, and the invention herein described, if patented, may be manufactured and used by or for the Government for governmental purposes without the payment to us of any royalty thereon.

This invention relates to the process of preparing fine, solid chemical materials for incorporation in the charging stock of metallurgical furnaces and particularly the treatment of fine phosphate rock for incorporation in phosphorus reduction furnace charging stock.

One of the objects of this invention is to provide a means for the combining of fine, solid chemical materials, including ores and other metallurgical furnace charging stock constituents, in order that they may be in suitable physical condition to include in such charging stocks.

Another object of this invention is the provision for a continuous process for the agglomeration of fine phosphate rock to make particles of sufficient size for incorporation in phosphorus reduction furnace charging stock.

Another object of this invention is the provision for a means of modifying the coking properties of coking coal in order that the coke so produced may be suitable for metallurgical furnace operations.

Other objects of this invention include the provision for a means for the carbonization of coking coal at low temperatures.

We have found that, by heating fine, solid chemical material, such as sand, coke breeze, phosphate rock and other metallurgical furnace charging stock constituents, which are not volatilized at the temperature of heating, to a temperature of 750° to 1000° C., by adding fine coking coal to the heated fine material, and by mixing the fine coal and heated fine material through the plastic stage of the coal, a partial carbonization of the coal to semi-coke takes place. The resulting material while still in a heated state may be densified by compression, such as by a passing between rolls, and the carbonization of the densified mixture may be completed by utilizing the residual coking properties of the semi-coke. The resulting material has been found to be of sufficient size and hardness to use as a constituent of a metallurgical furnace charging stock or to constitute the charging stock itself, provided proper proportions of original ingredients were used to result in the correct proportions in the final mixture.

One example of the operation of our process is given for the agglomeration of fine phosphate

rock so that the resulting mixture may be used as a constituent of a phosphorus reduction furnace charging stock. Fine Tennessee brown phosphate rock of less than twenty mesh may be heated at 850° C. while being agitated continuously and conveyed to a mixer. A fine coking coal of less than twenty mesh may be heated at 170° C. while being agitated continuously and conveyed to the same mixer. The hot fine coal may be conveyed into the hot fine phosphate rock in the ratio of 1 part to 3.7 parts by weight and the resulting mixture at approximately 620° C. may be conveyed and agitated continuously until the mixture is uniformly black and plastic. In this condition, the hot mixture may be subjected to compression by passing between heated rolls in order to densify the mixture and preserve the residual coking properties of the agglomerated mass. The densified material may be carbonized further to establish the possibility of utilizing its residual coking power by heating at 650° to 800° C.

Another example of the operation of our process is given for the agglomeration of a mixture of fine phosphate rock and fine silica so that the resulting product may be used as a phosphorus reduction charging stock. Fine Tennessee phosphate rock may be mixed with fine silica in the ratio of 88.3 parts to 11.7 parts by weight and the mixture may be heated to 850° C. and agitated continuously and conveyed to the mixer. A fine coking coal may be heated to 170° C. while being agitated continuously and conveyed to the same mixer. The hot, fine coal may be added continuously to the hot mixture of fine phosphate rock and fine silica in the ratio of 1 part to 4.5 parts and the resulting mixture further processed as in the foregoing example.

It is evident that there are numerous factors which will influence the conditions for the most satisfactory operation of our process, the actual limits of which cannot be established except by detailed study of each set of raw materials and finished products involved.

The fine, solid chemical material, which may be agglomerated, includes any fine material, which may not be appreciably volatilized at the temperature of heating, even if it is required in certain instances to maintain an inert atmosphere during the heating period. The fine material should preferably be less than ten mesh, with more effective heat transfer being obtained with much finer material. The temperature of heating for the fine, solid chemical material may vary but for all materials so far investigated we

have found that it should be at least 750° C. with the preferred temperature range of 850° to 1000° C.

The coal used should be a highly coking coal, that is, one which becomes very fluid on heating. The fineness of this coking coal should, in general, be at least that of the fine, solid chemical material which is being agglomerated. The ratio of the weights of coal to the weights of materials being agglomerated may vary from 1 to 2 to 1 to 10 but the preferred ratio is approximately 1 to 4 for the materials which have so far been investigated. The coal which has been freshly mined is preferred, in order that there has been no appreciable oxidation during the period of storage. The fine coal may be used without a preliminary heating or may be heated to a reasonable degree, so long as the heating conditions are such that no appreciable oxidation of the coal takes place.

When it is desired to pre-heat the coal, it has been found that temperatures between 125° and 170° C. are effective, both as a means of reducing the moisture content of the coal somewhat and as a means of supplying some heat to the subsequent mixture by having the coal above atmospheric temperatures and still below any possible coking temperatures of the coal. It is necessary in every instance to add the fine coal or the fine pre-heated coal to the relatively highly heated solid chemical material which is to be agglomerated.

The fine, solid chemical material to be agglomerated may most conveniently be heated during continuous conveying and stirring to obtain good heat transfer. When the proper temperature of this heated material has been reached, the fine coal, either with or without pre-heating, may be added to the heated material and the mixing continued until the resulting mixture contains an appreciable quantity of semi-coke.

In certain instances the heated material to be agglomerated may be cooled below the maximum heating temperature before the fine coal is added to obtain the maximum benefit of the coal during its period of plasticity. In other instances, a small amount of additional heat may have to be added to maintain the temperature of the mixture at the optimum for the proper carbonization of the coal in the mixture. Rates of feed may be suitably varied so that the temperature of the resulting mixture will be from 600° to 750° C.

Ordinarily, it is preferred to utilize only a portion of the coking properties of the coal up to this point, in view of the fact that, in certain instances, it is desirable to treat the semi-plastic mass under pressure, such as between rolls, to densify the porous mixture. The resulting densified mixture may be used as such or may be further carbonized by conventional means. The gaseous and liquid products resulting from the low temperature carbonization of the fine coal, after its contact with the heated material which is being agglomerated, may be recovered and utilized as desired.

Certain terms used throughout the description and claims are understood to have the following meaning: Solid chemical materials refer to crude materials, such as minerals and materials of high, as well as intermediate states of purity, limited in this application to those materials which are not appreciably volatilized at the temperature of heating in the respective steps of the process involved, with or without being maintained in an

inert atmosphere. The solid chemical materials include metallic and non-metallic ores, acidic and basic materials used as fluxes and carbonaceous materials which may be agglomerated separately or in mixtures for use as constituents of the charge or constitute the charge for metallurgical furnaces.

We claim:

1. Process of preparing phosphorus reduction furnace charging stock which comprises mixing fine phosphate rock and fine silica, heating the mixture of fine phosphate rock and fine silica to a temperature below the sintering point of the mixture, heating fine coking coal, adding the hot fine coking coal to the hot unsintered mixture of fine phosphate rock and fine silica, mixing the coal, phosphate rock and silica until the mixture contains semi-coke, passing the mixture containing semi-coke between rolls to increase its apparent density and completing the carbonization of densified mixture.

2. Process of preparing phosphorus reduction furnace charging stock which comprises heating a mixture of fine phosphate rock and fine silica to a temperature below the sintering point of the mixture, adding hot fine coking coal to the hot unsintered mixture of fine phosphate rock and fine silica, mixing the coal, phosphate rock and silica until the mixture contains semi-coke, subjecting the mixture containing semi-coke to compression to increase its apparent density and completing the carbonization of densified mixture.

3. Process of preparing phosphorus reduction furnace charging stock which comprises heating a mixture of fine phosphate rock and fine silica to a temperature below the sintering point of the mixture, adding hot fine coking coal to the hot unsintered mixture of fine phosphate rock and fine silica, mixing the coal, phosphate rock and silica until the mixture contains semi-coke and subjecting the mixture containing semi-coke to compression to increase its apparent density.

4. Process of preparing phosphorus reduction furnace charging stock which comprises heating a mixture of fine phosphate rock and fine silica to a temperature below the sintering point of the mixture, adding fine coking coal to the hot unsintered mixture of fine phosphate rock and fine silica, mixing the coal, phosphate rock and silica until the mixture contains semi-coke and subjecting the mixture containing semi-coke to compression to increase its apparent density.

5. Steps in process of preparing phosphorus reduction furnace charging stock which comprise adding hot fine coking coal to a hot unsintered mixture of fine phosphate rock and fine silica and mixing the coal, phosphate rock and silica until the mixture contains semi-coke.

6. Steps in process of preparing phosphorus reduction furnace charging stock which comprise adding fine coking coal to a hot unsintered mixture of fine phosphate rock and fine silica and mixing the coal, phosphate rock and silica until the mixture contains semi-coke.

7. Process of agglomerating fine phosphate rock which comprises heating the fine phosphate rock to 850 to 1000° C., heating fine coking coal to 125 to 170° C., adding the hot fine coking coal to the hot fine phosphate rock, mixing the coal and phosphate rock until the mixture contains semi-coke, passing the mixture containing semi-coke between rolls to increase its apparent density and completing the carbonization of densified mixture.

8. Process of agglomerating fine phosphate rock which comprises heating the fine phosphate rock to a temperature below the sintering point of the rock, heating fine coking coal, adding the hot fine coking coal to the hot unsintered fine phosphate rock, mixing the coal and phosphate rock until the mixture contains semi-coke, subjecting the mixture containing semi-coke to compression to increase its apparent density and completing the carbonization of densified mixture.

9. Process of agglomerating fine phosphate rock which comprises heating the fine phosphate rock to a temperature below the sintering point of the rock, heating fine coking coal, adding the hot fine coking coal to the hot unsintered fine phosphate rock, mixing the coal and phosphate rock until the mixture contains semi-coke and subjecting the mixture containing semi-coke to compression to increase its apparent density.

10. Process of agglomerating fine phosphate rock which comprises heating the fine phosphate rock to a temperature below the sintering point of the rock, adding hot fine coking coal to the hot, unsintered fine phosphate rock, mixing the coal

and phosphate rock until the mixture contains semi-coke and subjecting the mixture containing semi-coke to compression to increase its apparent density.

11. Process of agglomerating fine phosphate rock which comprises heating the fine phosphate rock to a temperature below the sintering point of the rock, adding fine coking coal to the hot, unsintered fine phosphate rock, mixing the coal and phosphate rock until the mixture contains semi-coke and subjecting the mixture containing semi-coke to compression to increase its apparent density.

12. Steps in process of agglomerating fine phosphate rock which comprise adding hot fine coking coal to the hot, unsintered fine phosphate rock and mixing the coal and phosphate rock until the mixture contains semi-coke.

13. Steps in process of agglomerating fine phosphate rock which comprise adding fine coking coal to the hot, unsintered fine phosphate rock and mixing the coal and phosphate rock until the mixture contains semi-coke.

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