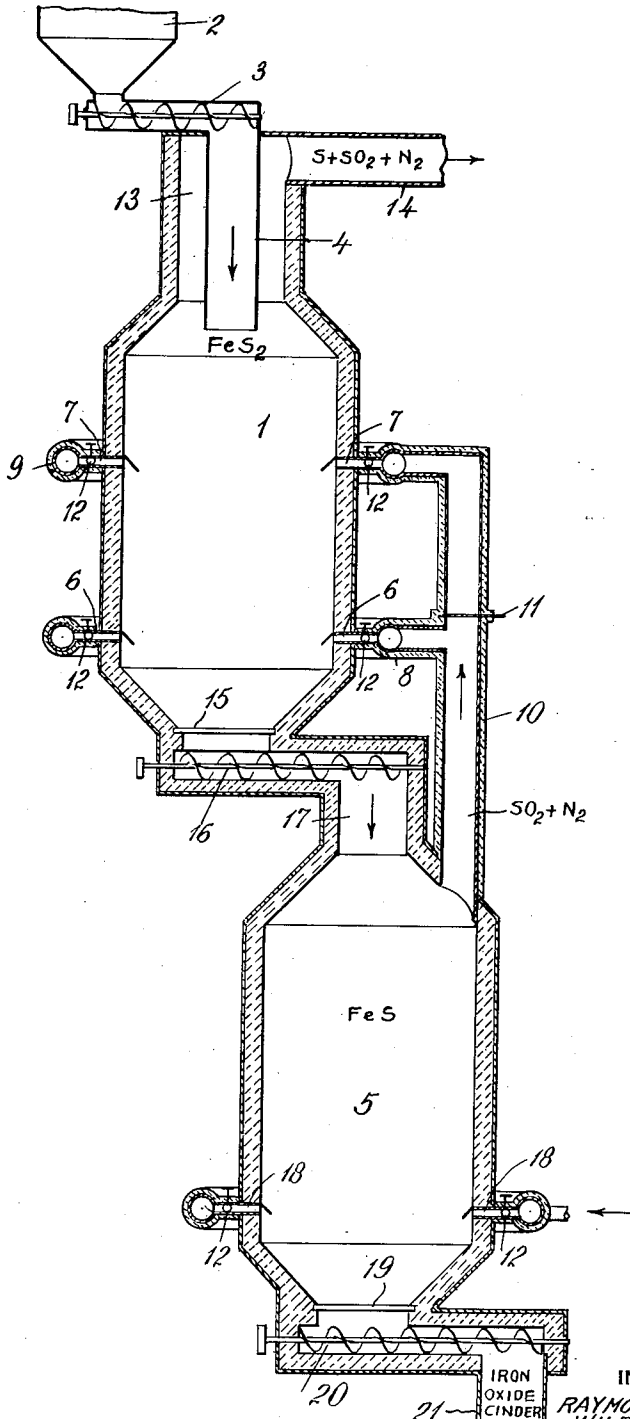


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ROASTING PYRITES FINES

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ROASTING PYRITES FINES

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This invention relates to the roasting of finely divided sulphide ores, flotation concentrates and the like, and more particularly to the suspension or "flash" roasting of pyrites fines or flotation concentrates in an oxidizing gas, as distinguished from the bed roasting operation of shelf or mechanical burners.

In the suspension or "flash" roasting of pyrites fines as ordinarily conducted, numerous operating difficulties have presented themselves which are distinctly detrimental to the effective conduct of the roasting operation. Principal among these are the formation of sintered accretions upon the walls of the roasting furnace, incomplete desulphurization of the pyrites, and the too rapid burning out of the furnace. The formation of accretions is of quite common occurrence and is particularly objectionable, for the accretions assume such substantial and obstructing proportions in a short time that the operation of the furnace must be suspended at all too frequent intervals to permit their being broken away from the furnace walls. This breaking away of the large masses of accretion, moreover, involves considerable wear and tear upon the furnace, and in addition results in the waste of material amounts of green or undesulphurized pyrites which is frequently enclosed in the accretions.

Our investigations of this problem indicate that the objectionable accretions resulting from sintering, the incomplete desulphurization attendant thereupon, the rapid burning out of the furnace, and in some cases slagging of the furnace lining with the oxidized pyrites, are in large part ascribable to the excessively high temperature which results in the usual flash roasting.

Pyrites is highly combustible even in lump form, and with the large surface area presented to the oxidizing gas in the suspension or flash roasting of fines, the oxidation, with its accompanying production of heat, proceeds with such intensity and rapidity that a very high local temperature results. As a consequence of this excessively high temperature, which because of the intensity and rapidity of the action cannot be controlled by ordinary means, there will be a natural tendency to burn out the furnace relatively quickly, and material quantities of the pyrites will be sintered and form accretions upon the walls before complete desulphurization has taken place.

In accordance with our invention, the aforementioned difficulties are overcome and a highly effective and economical process is provided by first heating the suspended fines in a relatively non-

oxidizing atmosphere to drive off the volatile sulphur atom, then roasting the residual sulphide, which for practical purposes can be designated as iron monosulphide, by suspension in an oxidizing gas, and utilizing the hot gases from the roasting of the monosulphide as a hot gaseous suspending medium to drive off the volatile sulphur from fresh portions of the pyrites.

In the accompanying drawing an illustrative arrangement of apparatus is shown more or less schematically by means of which the process of our invention may be carried out.

Reference numeral 1 designates the distillation chamber constructed of firebrick or the like, into which pyrites fines or flotation concentrates from the hopper 2 are introduced through the medium of the screw conveyor 3 leading to the inlet duct 4. The hot sulphur dioxide gases from the roasting chamber 5 to be hereinafter described, are introduced into the chamber 1 through tuyères 6 and 7 leading from feed pipes 8 and 9 respectively, which pipes are connected to the exit duct 10 from the roasting chamber 5. A damper or other valve 11 is disposed in the duct 10 to permit the cutting in or out of the upper tuyères 7, and suitable valves 12 may be disposed in the tuyères and other ducts as necessary or desirable. The discharge gases from the distillation chamber pass off through a housing or preheating chamber 13 surrounding the pyrites inlet duct 4 and thence through the exit duct 14. The iron monosulphide resulting from the distillation operation passes downwardly through a grate 15 into the screw conveyor 16 and is conveyed to the inlet duct 17 of the roasting chamber 5.

Air or oxygen, preheated or not as desired, is blown in at the bottom of the roasting chamber through the tuyères 18 and passes upwardly in countercurrent flow with the monosulphide showering down from the inlet duct 17. The discharge gases from the roasting chamber pass off through the exit duct 10 leading to the distillation chamber 1. The iron oxide produced in the roasting chamber passes through the grate 19 to the screw conveyor 20 leading to the cinder outlet 21. The roasting chamber, as is the distillation chamber, is constructed of firebrick or other suitable non-corrodible refractory material of suitable insulating thickness, and the various ducts, pipes, etc. are preferably provided with suitable insulation to retain the heat in the gases passing therethrough.

An illustrative method of operation is as follows: In one mode of initiating the opera-

tion, the roasting chamber 5 is strongly preheated, for example by means of oil burners inserted through suitable work-holes in the chamber, until its temperature is above the ignition point of pyrites, for example approximately 850° C. An adequate quantity of the fines is then admitted to the roasting chamber either by way of the distillation chamber 1 and the screw conveyor 16, or directly thereinto with suitable provision therefor, and air is blown at a suitable velocity through the tuyères 18. Contacting with the pyrites the air will serve to rapidly oxidize the same to iron oxide and sulphur dioxide with the liberation of a very substantial amount of heat. The hot gases resulting from this initial roasting, containing principally sulphur dioxide and nitrogen, pass off through the exit duct 10 and thence through the feed pipes 8, 9 and the tuyères 6, 7 respectively into the distillation chamber 1.

When the distillation chamber has been heated to a suitable degree by the passage of these hot gases, which heating may be supplemented or replaced by a preliminary preheating with oil burners as in the roasting chamber, and a fairly steady current of hot gas is passing through the chamber, the flow of pyrites is started from the hopper 2 by the screw conveyor 3. Showering downwardly through the inlet duct 4 the pyrites is preheated in its passage therethrough by heat-exchange with the hot gases passing off through the housing 13, and entering the distillation chamber, it is subjected to the further action of the hot gases therein to volatilize the feeble sulphur atom. To obtain satisfactory results in this respect, it is desirable that the pyrites be heated to a temperature not substantially less than 500° C., at and above which point the volatile sulphur will distill off in a satisfactory fashion. The temperature of the pyrites should not however, be elevated to a point (approximately 850° and above) where sintering might take place. A highly favorable distillation temperature is readily maintainable by the hot gases from the roasting chamber which can be supplied at temperatures of 800-1000° C. and above with little difficulty. The rate of flow of the pyrites and the hot gases, the length of the distillation chamber, etc., should be so regulated that the pyrites is maintained in contact with the hot gases for a sufficient period of time to result in substantially all of the feeble sulphur atom being driven off.

The partially desulphurized pyrites, which for convenience we will refer to as the monosulphide, passes through the grate 15 and is delivered by the screw conveyor 16 to the inlet duct 17 to the roasting chamber. The grate 15 will serve to retain any agglomerations too large for convenient handling by the conveyor which might have been formed in the distillation chamber, and these may be broken up by access through a suitable work-hole when and if they have accumulated to a sufficient extent to warrant such a procedure.

The hot monosulphide, which will be at a temperature in the approximate neighborhood of 500° or thereabove, showers down into the hot roasting chamber 5 where it comes in contact with the countercurrent of air flowing in through the tuyères 18. The flow of air with respect to the pyrites is preferably so regulated that substantially the theoretical amount of oxygen for complete desulphurization of the sulphide is supplied to the chamber and, if desired, the air may be

preheated. Such can be conveniently accomplished by heat-exchange with the hot exit gases from the distillation chamber.

An intense oxidation of the monosulphide will take place in the roasting chamber, and due to the condition to which the pyrites has been reduced, much less tendency towards sintering and the formation of accretions is exhibited. The conduct of the roasting operation and the resulting temperature in the roasting chamber should be so regulated however, that the temperature in the upper portion of the chamber wherein the sulphide is principally in the state of monosulphide, should not exceed the fusing temperature of the monosulphide (approximately 850-900° C.). This can be readily accomplished by providing a chamber of suitable length, regulating the rate of feed of the sulphide and air, etc., as will be apparent to one skilled in the art. As the lower zones in the roasting chamber are approached it appears to be possible to carry the temperature up to a much higher degree without producing sintering. This seems to be due to the fact that when a quantity of Fe_2O_3 is present the tendency toward sintering of the monosulphide, or whatever the particular composition of the sinterable sulphide may be, is considerably inhibited. As a consequence, in the lower portions of the roasting chamber the temperatures may be elevated as high as 1400° C. without sintering, and this is of advantage for it permits a very thorough desulphurization of the ore before discharge.

In its passage through the roasting chamber the monosulphide is converted to sulphur dioxide and iron oxide, either as Fe_2O_3 and/or Fe_3O_4 depending upon the conditions of the operation, and the roasting should be so controlled, by proper regulation of the length and design of the chamber, temperatures, rate of flow of the air and ore, and the like, that the sulphide will be suspended under favorable conditions for a sufficient period of time to assure the substantially complete oxidation of the sulphide by the oxygen in the air.

The particles of iron oxide cinder from the roasting chamber pass through the grate 19 into the screw conveyor 20 whence they are discharged through the cinder outlet 21. The hot roaster gases, containing principally sulphur dioxide and nitrogen, together with some slight amount of oxygen which is generally not present in sufficient quantity to exhibit any appreciable oxidation effect in the distillation chamber, pass upwardly through the exit duct 10 for introduction into the distillation chamber.

The temperature of these gases will generally be in the neighborhood of 800-1000° C. and above. Passing from the exit duct 10 into the feed pipe 8, which surrounds the distillation chamber 1, the hot gases are introduced into the chamber through the tuyères 6 which are provided around the chamber in any desired number. The rate of flow through, or operation of, each tuyère can be controlled by a suitable valve 12. It is desirable that the hot gases be introduced into the distillation chamber at points above the bottom tuyères 6 in order to provide a more or less uniform temperature throughout the chamber, with resultant facilitation of the distillation. To this end a second series of tuyères 7 leading from the feed pipe 9 are disposed in a higher zone of the distillation chamber and, if desired, supplementary sets of tuyères may be provided at additional points. The operation of these supplementary sets of tuyères may be controlled by the medium of

dampers such as 11, as supplemented or displaced by the individual tuyere valves 12.

The hot gases introduced through the tuyeres will pass upwardly through the chamber 1 in countercurrent flow to the pyrites being introduced through the duct 4, accomplishing the distillation of the volatile sulphur atom of the pyrites in passage, and pass off by way of the housing 13 through the exit duct 14. These gases will consist of sulphur dioxide, elemental sulphur, nitrogen, and some small amount of oxygen in relatively inactive concentration. The gases are quite hot, for example 400° or above, and as has been noted, they can if desired be utilized as a sole or partial source of heat for preheating the air being introduced into the roasting chamber.

Due to the fact that a fines roasting is involved, these exit gases will also carry entrained therein some amount of dust which it is preferable to remove prior to any subsequent treatment or use of the gases. This may be accomplished by passing the gases as necessary through one or a series of dust chambers of any suitable type, such for example as mechanical baffle chambers, electrostatic precipitation chambers, or a combination of both. After the removal of the dust the gases may then be treated or utilized as desired.

In view of the fact that these gases already contain a substantial quantity of elemental sulphur, are quite rich in sulphur dioxide, and are substantially free from oxygen, they are admirably adapted for treatment to recover elemental sulphur. This can be accomplished, for example, by reaction of the sulphur dioxide in the gases with carbonaceous reducing agents such as producer gas, water gas, natural gas, solid carbon, and the like, or with hydrogen sulphide, or in any other suitable manner. The elemental sulphur already present in the gases may be removed therefrom by condensation, as for example by means of a waste heat boiler, prior to any treatment of the sulphur dioxide if such preliminary removal is of advantage, or if the presence of the elemental sulphur is not particularly detrimental, it may be permitted to remain in the gases and the total sulphur subsequently collected in one operation.

Apart from the particular adaptability of these gases for elemental sulphur recovery, they may likewise be advantageously utilized for their sulphur dioxide, for example, in the manufacture of sulphuric acid. Despite the fact that they contain a substantial amount of the sulphur in elemental form, they are, nevertheless, as a result of the thorough desulphurization attainable by the roasting process of our invention, quite rich in sulphur dioxide. The latter is generally present in amounts ranging from 10-13%, a content when diluted with air quite suitable for sulphuric acid manufacture. Moreover, if it is desired to increase the sulphur dioxide concentration, the elemental sulphur present in the gases can be readily burned thereto to the extent desired, and any residual sulphur removed. By burning the entire sulphur content of the gases it is possible to produce a gas containing as high as 12-15% sulphur dioxide.

The foregoing description is intended merely to be illustrative and various changes may be made in the operation and apparatus as will be apparent to one skilled in the art. In the apparatus, for example, the distillation chamber and the roasting chamber may be disposed upon the same level instead of as shown. Such an arrangement will necessitate the provision of a

suitable elevator to convey the sulphide from the bottom of the distillation chamber to the top of the roasting chamber, and under some circumstances it may be found necessary to supplement the action of the blower at the tuyeres of the roasting chamber by the inclusion of a suction fan or a blower either at the exit end of the distillation chamber or between the roasting chamber and distillation chamber, or elsewhere in the system, to assist the downward flow of the exit gas from the top of the roasting chamber into the bottom of the distillation chamber. Such supplemental suction fans or blowers can of course be similarly included in the arrangement shown if their use is necessary or desirable to control the flow of the gases through that system.

Likewise, the screw conveyors shown for feeding solid material to the chambers may be replaced by other feeding means which will permit suitable control of the rate of feed of the solid. If it is desired, a suitably insulated storage hopper provided with a regulatable gate at the discharge end, may be inserted in advance of the roasting chamber to receive the hot sulphide from the distillation chamber and feed it at a controlled rate to the roasting chamber.

The mode of operation is also susceptible to various modifications. In initiating the operation, for example, instead of roasting the first part of the pyrites without a preliminary distillation of the feeble sulphur atom, the distillation chamber may be heated electrically, or in any other suitable fashion, to bring about the distillation of the feeble sulphur from the initial charge of pyrites before its introduction into the roasting chamber, and such auxiliary supply of heat may be maintained until the operation is functioning properly and the hot gases from the roasting chamber can be relied upon to provide the heat necessary for the distillation. In preheating the air or other oxygen-containing gas for the roasting operation, the hot cinder from the roasting chamber may be effectively utilized as an alternative or supplemental source of heat. This may be accomplished by simply introducing the air through the cinder outlet where it will pass in contact with the hot cinder, or it may be passed in heat-exchanging relationship with the hot cinder externally of the chamber and then introduced as shown.

While the foregoing detailed description is directed principally to iron pyrites fines, or flotation concentrates, the operation is of course likewise adapted for the treatment of finely divided marcasite, chalcopyrites, and other similar sulphide ores, all of which are intended to be included in the term "pyrites fines" used in the appended claims.

We claim:

1. In a process for treating pyrites-bearing material in which the material is heated to distill the volatile sulphur of the pyrites and produce a gaseous product containing elemental sulphur vapor and to convert the pyrites substantially to the monosulphide of iron, and the monosulphide of iron is roasted to produce a gaseous product containing sulphur dioxide, the improvement which comprises subjecting the pyrites-bearing material and the monosulphide of iron to the distillation and roasting treatments while in gaseous suspension.

2. In a process for treating pyrites-bearing material in which the material is heated to distill the volatile sulphur of the pyrites and produce a

<p>gaseous product containing elemental sulphur vapor and to convert the pyrites substantially to the monosulphide of iron, and the monosulphide of iron is roasted to produce a gaseous product</p> <p>5 containing sulphur dioxide, the improvement which comprises subjecting the monosulphide of iron to the roasting treatment while in gaseous suspension, and utilizing the heat generated in the roasting operation to distill the volatile sulphur of the pyrites.</p> <p>3. In a process for treating pyrites-bearing material in which the material is heated to distill the volatile sulphur of the pyrites and produce a gaseous product containing elemental sulphur vapor and to convert the pyrites substantially to the monosulphide of iron, and the monosulphide of iron is roasted to produce a gaseous product containing sulphur dioxide, the improvement which comprises subjecting the monosulphide of iron to the roasting treatment while in gaseous suspension, and passing the gaseous product of the roasting operation in contact with pyrites-bearing material in the distilling operation, thereby to utilize the heat generated in the roasting operation for the distillation of the volatile sulphur of the pyrites.</p> <p>4. In a process for treating pyrites-bearing material in which the material is heated to distill the volatile sulphur of the pyrites and produce a gaseous product containing elemental sulphur vapor and to convert the pyrites substantially to the monosulphide of iron, and the monosulphide of iron is roasted to produce a gaseous product containing sulphur dioxide, the improvement which comprises subjecting the pyrites-bearing material to the distillation treatment while in gaseous suspension, and utilizing the heat generated in the roasting operation to distill the volatile sulphur of the pyrites.</p> <p>5. In a process for treating pyrites-bearing material in which the material is heated to distill the volatile sulphur of the pyrites and produce a gaseous product containing elemental sulphur vapor and to convert the pyrites substantially to the monosulphide of iron, and the monosulphide of iron is roasted to produce a gaseous product containing sulphur dioxide, the improvement which comprises subjecting the pyrites-bearing material to the distillation treatment while in suspension in the gaseous product of the roasting operation.</p> <p>6. In a process for treating pyrites-bearing material in which the material is heated to distill the volatile sulphur of the pyrites and produce a gaseous product containing elemental sulphur vapor and to convert the pyrites substantially to the monosulphide of iron, and the monosulphide of iron is roasted to produce a gaseous product containing sulphur dioxide, the improvement which comprises subjecting the pyrites-bearing material and the monosulphide of iron to the distillation and roasting treatments while in gaseous suspension, and utilizing the heat generated in the roasting operation to distill the volatile sulphur of the pyrites.</p> <p>7. In a process for treating pyrites-bearing material in which the material is heated to distill the volatile sulphur of the pyrites and produce a gaseous product containing elemental sulphur vapor and to convert the pyrites substantially to the monosulphide of iron, and the monosulphide of iron is roasted to produce a gaseous product containing sulphur dioxide, the improvement which comprises subjecting the pyrites-bearing material and the monosulphide of iron to the distillation and roasting treatments while in gaseous suspension, and utilizing the gaseous product of the roasting operation to maintain the pyrites-bearing material in suspension and to provide heat for distilling the volatile sulphur of the pyrites.</p>	<p>80</p> <p>85</p> <p>90</p> <p>95</p> <p>100</p> <p>105</p> <p>110</p> <p>115</p> <p>120</p> <p>125</p> <p>130</p> <p>135</p> <p>140</p> <p>145</p> <p>150</p>
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