

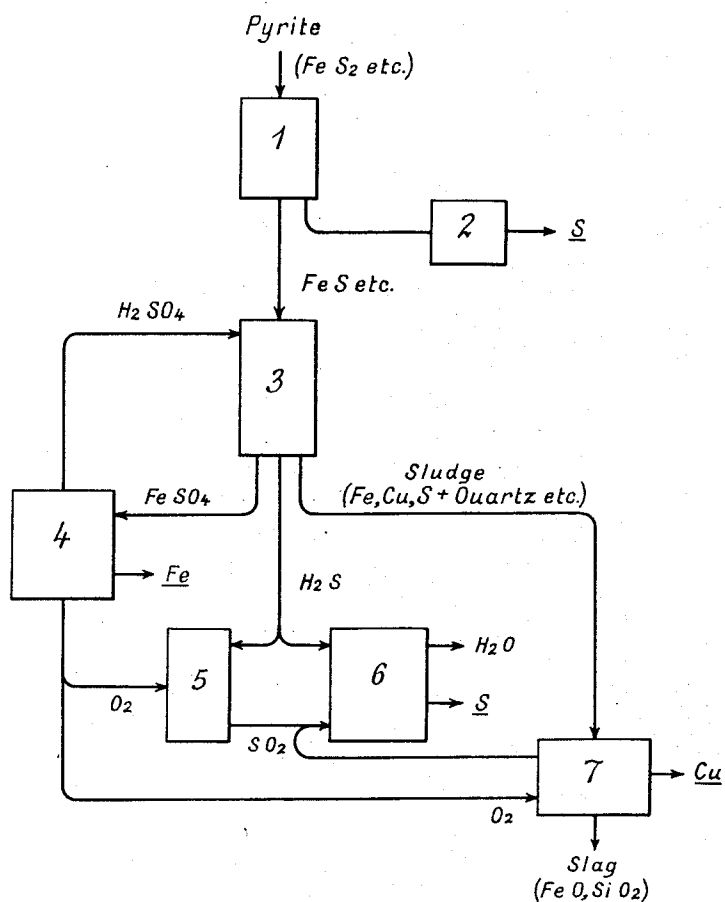
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PROCESS FOR TOTAL TREATMENT OF COPPER-CONTAINING IRON PYRITES

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PROCESS FOR TOTAL TREATMENT OF  
COPPER-CONTAINING IRON PYRITES

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According to several methods heretofore known of treating copper-containing iron pyrites, the sulphur content of the ore is recovered as elementary sulphur and the copper content in the form of copper or copper matte. To this end, the recovery of elementary sulphur is effected by the use of reducing agents such as coke or, if desired, carbon monoxide for the reduction of  $\text{SO}_2$  produced by total or partial roasting of the pyrites. Apart from the fact that thereby a large quantity of fuel is consumed, the iron content of the ore and other metals which in addition to the copper may be present in small quantities, are often not utilized. In addition, when roasting with air, the  $\text{SO}_2$  gas is not obtained in pure form, but mixed with the constituents of the air, for which reason an absorption of  $\text{SO}_2$  from the roast gases is often effected before the reduction process.

It is an object of the present invention to provide a process whereby the sulphur content of the ore may be recovered as elementary sulphur by the use of reactions known per se without requiring coke or other reducing agents for the main reaction. It is another object of this invention to provide a method as set forth in the preceding paragraph, which will make it possible to utilize substantially the whole mineral content of the ore to obtain pure sulphur-containing gases.

These and other objects and advantages of the invention will appear more clearly from the following description in connection with the accompanying drawing, which shows a flow sheet for the course of the process according to the invention.

The iron pyrites are first heated in preferably continuously charged, closed furnaces indicated by the reference numeral 1, to a temperature whereby one sulphur atom is driven off. The heating may take place in countercurrent to a suitable heating medium either indirectly by means of muffles or the like, or directly with an inert circulating gas. However, care is taken that the ore does not attain a temperature of about 1000 centigrades at which the sintering begins, and preferably the operation takes place with a maximum temperature up to 900 centigrades.

The escaping sulphur may be condensed in the usual manner by cooling in steam boilers (indicated at 2 in the drawing), thereby utilizing the condensation heat.

Owing to the driving off of the first sulphur atom without sintering, the ore thus treated, which now contains  $\text{FeS}$  and sulphides of copper and of other metals which may be present,

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and quartz, is now in an entirely porous, solid form, which makes it particularly suited for a treatment with chemicals. In this form it is supplied to containers 3 in which it is treated with sulphuric acid which may be used in a low concentration down to about 5%. By this treatment the major part of the iron is dissolved, while a corresponding proportion of sulphur is driven off as sulphurated hydrogen. This process can be carried out at usual temperature, but in order that it shall proceed more rapidly, it is convenient to keep a somewhat higher temperature of for example 90 centigrades, utilizing part of the heat content of the ore from the first step of treatment. It has been found that the dissolution can be carried on in a fractional manner, that is, that it is possible to dissolve most of the iron without dissolving the copper, which remains in the solid residue.

The iron sulphate formed is supplied to electrolyzers 4 equipped with a suitable diaphragm for the electrolytic separation of the iron, if desired with the application of heat. Hereby the recovery of a pure iron is achieved with simultaneous recovery of sulphuric acid which is returned to the container 3 for the treatment of fresh  $\text{FeS}$ , and at the same time oxygen is obtained at the anode, which oxygen can be used for the further recovery of sulphur.

The recovery of elementary sulphur from the sulphurated hydrogen gas formed by the acid treatment may for example take place by means of the Claus-process (catalytic combustion  $\text{H}_2\text{S} + \text{O} \rightarrow \text{H}_2\text{O} + \text{S}$ ), but a procedure is preferred in which a minor part of the sulphurated hydrogen gas is burnt so as to form  $\text{SO}_2$  (indicated by 5), using preferably oxygen from the electrolysis as indicated above (if the combustion is effected with air, the sulphur dioxide may in known manner be absorbed in a suitable absorbing agent and driven off again as 100-percentage) whereafter the remaining sulphurated hydrogen gas is mixed with the sulphur dioxide in the volume ratio 2:1 and passed over a suitable catalyser (at 6), whereby the following reaction is obtained at a suitable temperature



For this process it is possible for example to use porous alumina-containing catalyser mass in known manner. Since by this process it is possible to obtain the sulphur in liquid form and  $\text{H}_2\text{O}$  in the form of steam, the sulphur may without difficulty be collected separately. And as the process may take place together with a reduction of the gas volume, it may be accelerated by the application of pressure. Thus, additionally,

the  $H_2O$  formed is obtained in the form of pressure steam which can be utilized for example for driving pressure pumps for the gas to be introduced.

In the residue from the acid treatment the copper remains together with the silica and some iron and sulphur apart from valuable metals which may be contained in the ore, such as gold, silver and cobalt. This rich copper sludge may be treated by known methods for recovering the copper and other valuable constituents for example by direct melting and Bessemer treatment or roasting and extraction, if desired combined with a flotation. As shown in the drawing, in which this treatment is indicated by 7, it is possible also for this roasting to use pure oxygen from the electrolysis and to have the remainder of the sulphur recovered by mixing the sulphur dioxide formed by the roasting, with the gas from the combustion of  $H_2S$ , which is conveyed to the catalyzing step. The measuring of oxygen and sulphurated hydrogen to the various steps of the process will in that case be made by means of gasometres in such a manner that the correct mixing ratio 2:1 is obtained for the catalysis.

I claim:

1. A process of treating an iron ore comprising sulphur and containing valuable metal constituents including copper, which includes the steps of (a) heating the ore under non-oxidizing conditions to a temperature below sintering temperatures of the ore so as to decompose said ore and produce gaseous sulphur, leaving a porous calcined product with substantially all of the original  $FeS_2$  present reduced to  $FeS$ , (b) dissolving the major part of the iron content of said calcined product selectively by leaching fractional portions of said calcined product with dilute sulphuric acid solution, leaving undissolved the major part of the copper and other of said valuable metal constituents present forming a resultant mixture comprising ferrous sulphate solution, gaseous hydrogen sulphide, and a sludge containing undissolved solid matter, and (c) electrolyzing said ferrous sulphate solution in a diaphragm electrolytic cell to electrolytically recover metallic iron and sulphuric acid and gaseous oxygen, (d) subjecting said sludge to a roasting treatment with oxygen recovered by step (c) to produce gaseous sulphur dioxide and effect recovery of said valuable metal constituents, and (e) reacting said sulphur dioxide with gaseous hydrogen sulphide from said mixture in the presence of a catalyst for forming liquid sulphur and steam.

2. A process of treating an iron ore comprising sulphur and containing valuable metals including copper, which includes the steps of (a) heating the ore under non-oxidizing conditions to a temperature below that at which said ore sinters but high enough to decompose the ore and produce gaseous sulphur, leaving a porous calcined product with the original  $FeS_2$  substantially reduced to  $FeS$ , (b) dissolving the major part of the iron content of said calcined product selectively by leaching fractional portions of said calcined product with dilute sulphuric acid solution leaving undissolved the major part of the copper and other of said valuable metal components present forming a resultant mixture comprising ferrous sulphate solution, gaseous hydrogen sulphide, and a sludge containing undissolved solid matter, (c) electrolyzing said ferrous sulphate solution in a diaphragm electrolytic cell for electrolytically separating and ob-

taining sulphuric acid, metallic iron and gaseous oxygen, and (d) subjecting said sludge to a roasting treatment with the oxygen thus obtained to recover said valuable metal constituents from said roasted sludge.

3. A process of treating an iron ore comprising sulphur and containing valuable metals including copper, which comprises the steps of heating the ore under non-oxidizing conditions to a temperature below that at which said ore sinters but high enough to produce gaseous sulphur while leaving a porous calcined product with the original  $FeS_2$  substantially reduced to  $FeS$ ; dissolving the major part of the iron content of said calcined product selectively by leaching said product in fractional portions with dilute sulphuric acid solution, leaving undissolved the major part of the copper and other of said valuable metal components present producing ferrous sulphate solution, gaseous hydrogen sulphide, and a sludge containing undissolved solid matter; electrolyzing said ferrous sulphate solution in a diaphragm electrolytic cell for obtaining sulphuric acid, metallic iron and gaseous oxygen; reacting a part of said gaseous hydrogen sulphide with said oxygen thus recovered to produce sulphur dioxide; and reacting said sulphur dioxide with further amounts of said hydrogen sulphide in the presence of a catalyst for forming liquid sulphur and steam.

4. A process for treating an iron ore comprising sulphur and containing valuable metals including copper, which comprises the steps of heating the ore under non-oxidizing conditions to a temperature below that at which said ore sinters but high enough to decompose said ore and produce gaseous sulphur and leaving a porous calcined product containing the original  $FeS_2$  substantially all reduced to  $FeS$ ; dissolving the major part of the iron content of said calcine selectively by leaching fractional portions of said calcine with dilute sulphuric acid solution leaving undissolved the major part of the copper and other of said valuable components present to produce a resultant mixture comprising ferrous sulphate solution, gaseous hydrogen sulphide, and a sludge containing undissolved solid matter; electrolyzing said ferrous sulphate solution in a diaphragm electrolytic cell for recovering sulphuric acid, metallic iron and gaseous oxygen; burning a part of said gaseous hydrogen sulphide with a part of said oxygen; subjecting said sludge to a roasting treatment with a portion of said oxygen, for recovering said valuable metal constituents therefrom; and reacting sulphur dioxide, formed by said burning and by said roasting, with another portion of said gaseous hydrogen sulphide in the presence of a catalyst and in controlled proportions so as to produce liquid sulphur and steam.

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