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PYRITES ROASTING

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FOREWORD.

The shortage of elemental sulphur in the world market renders the subject of producing sulphurous gases by roasting Pyrites one of interest, even in countries which normally find it more convenient to use Sulphur.

Furthermore, the same sulphur shortage and the improvements in the methods of selective flotation have induced Pyrites producers to exploit low grade deposits and deposits of complex minerals, so that the quantity of flotation pyrites concentrates available in the world market has increased, such concentrates being extremely fine in size af particle(90 to 95% passing through 100 mesh).

We believe it of interest to review the apparatus at present in use for the production of sulphurous gases from Pyrites with some observations justified by our experience as producers in a country, Italy, where the cost of crude sulphur has always been too high as compared with the sulphur content in Pyrites for the production of sulphurous gases in full-scale plants.

The furnaces now in use for roasting Pyrites are of four types: mechanical multiple hearth furnaces; rotary furnaces; flash roasters; fluo-solid furnaces.

Whilst mechanical multiple hearth furnaces were introduced in the industry some 70 years ago, rotary furnaces some 25 years ago, and flash roasters some 20 years ago, fluo-solid furnaces are only just coming into use in the last few years, and must therefore be considered as a novelty, particularly for use in the production of sulphurous gases destined for the manufacture of sulphuric acid.

MECHANICAL MULTIPLE HEARTH FURNACES are those most in use to-day. They are constructed by many firms (Nichols-Herreshoff; Lurgi; Moritz; Nouvelle Induschimie; Montecatini etc.) and to-day the larger capacity type of furnace, as generally preferred; up to 30 to 40 tons per day of Pyrites with a 50% sulphur content, as compared with 5/10 tons per day in the past. This development has been brought about by the need to avoid multiplying the number of furnaces in plants with a large production of sulphuric acid, and has been made possible by some detailed improvements which have eliminated the major difficulties which in the past made the use of large dimensional furnaces inadvisable.

Among these improvements should be mentioned the following:
(a) The increase in the quantity of Pyrites which it is possible to burn per unit of surface of the roasting hearth and per unit of time. (up to 150 kilos per sq.m. per day, as compared with 90 to 100 kilos per sq. m. per day) by controlling the maximum temperature which is usually reached in the second or third hearth of the furnaces. With this object in view, our company has, by sub-dividing into two circuits, separated Pyrites and gas in the first phase of combustion, as already mentioned at the preceding congress, and as described in the Italian patent No. 353,401, which process has already been patented in many other countries.

(b) The adoption of rabble arms and teeth in chrome nickel steel in the place of less resistant and heavier rabble arms in cast iron, which with the action of time and high temperatures become progressively sulphurised, with consequent deterioration, particularly of the teeth, and reduction of resistance. Rabble arms in alloy steel are generally produced by fusion. Our Company has successfully experimented and now adopted the use of rabble arms constructed in laminated welded steel 18/8, and also even in ordinary heat-treated laminated steel. Thus rabble arms of a lighter type are obtained which can be readily repaired (straightened, teeth renewed etc.) in the works where they are employed.

(c) The construction of the casing in prefabricated slabs, cast in wooden or iron moulds, made of a mixture of aluminous cement and refractory material, and pouring on the spot the same mixture for the hearths, which in this way are made in one piece.

With these improvements, which evidently can also be realised in existing furnaces, the production can be considerably increased, and the working of this type of furnace, made considerably easier which should be considered as having now reached the limit of its technical evolution.

ROTARY FURNACES.

The application of the rotary type of furnace to the roasting of pyrites was realised by Lurgi, and has been particularly welcome in large capacity plants. These are furnaces which in the most suitable types have a roasting capacity of 60 to 80 tons per day of pyrites containing 45 to 50% S.

Since it is not generally advisable to base the production of a sulphuric acid works upon the sulphurous gases produced by only one furnace, it can be seen that the capacity of a plant of this type should be 150 to 200 tons per day.

This type of furnace is sufficiently well-known for it not to be necessary for us to describe it here. We would simply draw attention to the fact that in this type of furnace, in which the pyrites in combustion are continually lifted and allowed to fall back in the interior of the cylinder through which the gas passes, there is already a process which foreshadows the use of furnaces for pulverised pyrites. In other words, a rotary furnace can be considered as an intermediate apparatus between the multiple hearth furnace, where the roasting takes place principally upon the hearths, and the flash roasting furnace, where the roasting takes place entirely while the particles are falling into the combustion chamber.

Naturally it follows that all the characteristics involved by this more or less intimate contact between the material in combustion and the gas producing the combustion assume in the rotary furnace an intermediate value between that usually obtained in mechanical hearth furnaces and those obtained in flash roasters, as can be seen from the following table:

Type of furnace	Hearth	Rotary	Flash Roasting
Furnace exit gas SO_2%	6/8	8/10	12/14
Cinders removed by the gas % of total	2/3	12/15	20/25
Maximum temperature in the furnace °C.	750/800	850/900	1000/1200

Also in this type of furnace the use of nickel chrome steel has been adopted for the spoon-shaped flights situated in the interior of the furnace, particularly in the first zone where the first atom of sulphur of the pyrites distils and burns with the characteristic long violet-coloured flame, and where the flights deteriorate most rapidly. Other detailed improvements have made it possible to operate these furnaces practically continuously for periods of up to 3/4 years. After that time it is necessary to shut down the furnace and repair the worn parts, which involves a shut-down of 3/4 months.

One of the constructional principles of a rotary furnace is that is makes use of the considerable external surface of the furnace to disperse heat, and thus the thickness of the refractory material is adjusted, so as to regulate by such heat dispersion the temperature of the material to be roasted, in order to avoid it becoming sintered.

It is evident that where the recovery of waste-heat from the sulphurous gases for the production of steam is desirable, this characteristic becomes a disadvantage.

With rotary furnaces it is possible to use granular pyrites of a size similar to those used in hearth furnaces, but to ensure a satisfactory de-sulphurisation, it is desirable that the maximum size of the particles should not exceed 5 mm.

FLASH ROASTERS

The most widely-known furnace of this type is constructed by Nichols-Freeman. This furnace has a wide application, both to take advantage of the availability of flotation pyrites and on account of the considerable amount of steam which can be produced (3 kilos per 1 kilo of S contained in the pyrites).

Other advantages are the facility and rapidity with which the furnace can be started or stopped and the high SO_2 concentration of the gas obtained (up to 14%).

As is known, in this type of furnace, the temperature can be regulated so as to avoid sintering the cinder and incrustation of the walls by circulating the sulphurous gas taken by a suitable fan at the bottom of the boiler or better at the bottom of the electrostatic dust-precipitator and re-introduced into the combustion chamber.

In one Italian works a flash roaster is now being installed designed by Ing. Garbato, in which instead of reducing the temperature of the combustion chamber, it is being increased so as to reach maximum temperatures exceeding 1200°C by pre-heating the combustion air to about 300°C. The advantages which the designer expects to obtain are:

(1) Elimination of the recycling of the sulphurous gases;
(2) Improved heat recovery;
(3) Agglomeration of the cinders, making them easier to handle, and reducing the quantity of dust removed with the gases leaving the furnace;
(4) Larger quantity of pyrites roasted per unit of volume of the combustion chamber per unit of time.

In order to avoid incrustation, the designer proposes to cool the walls of the furnace by protecting them with the tubes constituting the boiler.

The danger of insufficient de-sulphurisation due to reduction of the contact surface between the gas and raw materials, if the latter by melting should agglomerate in masses of a certain thickness, seems to be avoided, since the cinders are mostly composed of minute hollow porous spheres with very thin surfaces.

Flash roasters require to be supplied with pyrites which pass practically entirely through a 100 mesh screen. If this fineness has not been obtained for example by the requisites of the flotation processes, the necessity for grinding and drying the pyrites reduces considerably the advantages of this type of furnace.

FLUO-SOLID FURNACES.

This type of furnace was introduced originally some five years ago for the de-sulphurisation of auriferous pyrites by the American Dorr Company in a Canadian plant, but without utilising the sulphurous gases.

A furnace based on similar principles has been working regularly for some six to seven months at the Ludwigshafen sulphuric acid plant owned by the Badische Anilin and Soda Fabrik.

This type of furnace is composed of a cylindrical combustion chamber with refractory walls with a laminated steel casing, the bottom of which consists of a grating through which a current of air is blown in and which maintains in suspension, fluidifying it, a stratum of pyrites in combustion about 50 cm thick.

Suitable apparatus prevents the material in combustion from falling through the grating, even when for some reason or other the supply of blown air from under the grating should prove insufficient.

The pyrites to be roasted are introduced into the furnace at the level of the fluidified strata by ordinary hopper or rotating table type feeders, and some 50 to 60% leaves the furnace after combustion by an overflow provided on the lateral walls of the furnace, whilst the remaining 40 to 50% is removed with the gas, which can, if desired, pass through a waste heat boiler for the recovery of the considerable heat developed, which gas is then rendered dust-free either in air separators or an electrostatic dust-precipitator.

The stratum of material in combustion is rendered fluid to such a point by the air blown in from under the grating as to be perfectly homogeneous in temperature and in granulometrical composition etc. so that it behaves exactly as if it were a liquid.

Suitable arrangements are made to moderate the temperature of the strata of material in combustion and to avoid its becoming sintered. Among such means Dorr sometimes introduce the pyrites to be burnt into the furnace in the form of a sludge containing up to 20% of water which is suitably prepared by saturating the flotation pyrites with water, and pumped into the interior of the furnace.

These furnaces can burn pyrites with particles considerably larger than those used in flash roasters (up to 1.4 mm in the Dorr furnace; up to 6 mm in the Ludwigshafen furnace of the B.A.S.F. as compared with a maximum of 0.16 mm. for flash roasters).

The capacity of these furnaces in terms of surface of the grating is extremely high, for example in the Ludwigshafen furnace it is possible to burn up to 25 tons per sq. m. per day whilst with the Dorr furnace the capacity would be only 4 tons per sq. m. per day.

The consumption of electric current of the Ludwigshafen furnace runs about 10 to 12 kwh. per ton of pyrites roasted.

The sulphurous gas leaving the furnace has an SO_2 content of between 12 and 14%, 2.5 to 3% of O_2, 0.08% of SO_3 and a temperature of about 800° C.

This high concentration of SO_2 with a minimum of SO_3 assist the operation of dust removal and washing of the gas, and allow a recovery of steam at the rate of 2.3 to 2.5 Kg of steam per Kg. of sulphur burnt.

With these types of furnace, the production of sulphurous gas from pyrites can be considered as not being very much more expensive than that obtained from crude sulphur, which must now be considered as becoming increasingly too valuable a raw material to be used in the production of sulphurous gas.

This short summary of types of furnace now available for roasting pyrites has simply the object of giving rise to a discussion on this subject by the technicians taking part in the Congress, which subject we consider to be of particular interest at a time when many plants are being forced to replace their sulphur burners with pyrites furnaces.

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