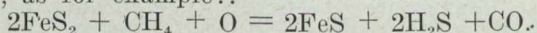


Another possibility is that the methane and metallic sulphide in the presence of only enough oxygen to burn the carbon in the methane, may give results directly, as for example::

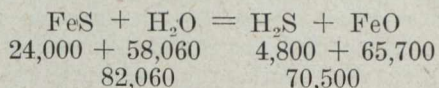


But the reaction most desired was the formation of hydrogen sulphide by the action of steam upon the pyrite and this was the point investigated in the next series of experiments.

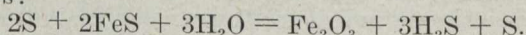
A combustion chamber similar to that described above, about one-half filled with crushed pyrite was connected as before to the condenser, and steam under three pounds pressure was led in through an eight-inch pipe.

The temperature was raised to an incipient red and held there for half an hour. A very notable volume of hydrogen sulphide was given off and some sulphur was precipitated, but no sulphur dioxide could be detected. These results apparently contradict those obtained by the Bureau of Mines in somewhat similar experiments, for here it is claimed sulphur dioxide was an end product. Differences in temperature and amount of steam used may account for the discrepancy noted. Upon examination of the remaining mineral it was evident that most of it which had been exposed to direct contact with the steam had been changed to the hydrous oxide of iron, $2\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$, indicated by a yellow stain. The remainder was left untouched or as a black sulphide, probably FeS.

A second run on pyrite at a dull red heat gave a much larger volume of hydrogen sulphide and considerably more sulphur, due no doubt to the distillation of the first atom. Very satisfactory results were obtained with commercial ferrous sulphide, FeS, although a simple equation, denoting the reaction, shows a consumption of heat on comparing the heats of formation, thus:



An equation showing the reaction with pyrite from which the free sulphur has been distilled might be as follows:



This also is a heat consuming reaction, but, because of the large excess of steam used the rapid removal of hydrogen sulphide and the plentiful supply of heat, the reaction went forward at a rapid rate.

All the possibilities considered and the results obtained from the foregoing experiments indicated that an experimental furnace was a necessity for further study. To obviate the necessity for two compartments, it was decided to build only one and to use it intermittently for roasting and smelting.

The furnace shell consisted of a six foot section of 36 in. water pipe and this was cut for flue, tuyeres, tap-notch and pyrometer pipes and lined with seven inches of fire brick, which left a twenty-two inch opening for the ore.

The vacuum chamber was designed to draw 150 cu. ft. of air through the furnace per minute and to create this draft a 6 inch Byron Jackson centrifugal pump, rated at 1,125 gallons per minute, was directly connected to a 30 h.p. Wagner motor. This pump required, theoretically, only 19 h.p., but to allow for all possible contingencies, 30 h.p. was considered to be none too much.

The flue from the furnace to the vacuum chamber was of 5 inch pipe, in which a gate valve was placed to control the amount of air passing through the

charge. This was water-cooled by a sprinkler above, and the waste water was carried through the vacuum chamber to the tank. Below the gate a vacuum gauge was placed. This registered from zero centimeters, when the gate was open and no ore was in the furnace, to 76 centimeters, when the gate was closed.

The water tank was cylindrical and fitted with a partition between the openings to and from the pump. This partition came to within 2 inches of the water surface and served to prevent the return of water carrying gas bubbles to the pumps. A cover, tightly caulked, was put on the tank and bored to admit a 6 inch flue leading out of the building. Gas samples were taken from the top of the tank through small holes.

Furnace adjustments.—Preliminary runs were made as soon as the plant was complete, to determine the grade and amount of oil required, volume of steam to be admitted, temperature most desired and the possible range of temperatures.

These runs showed that a light grade of fuel oil was necessary because of the small burners used and about 15 gallons was consumed per hour. Two three-quarter inch pipes carrying steam under 4 lb. pressure gave very good results, but it was found necessary to keep the ore about 2 feet above the tuyeres and to use only one burner to keep the temperature below the melting point of the ore. The ore was held up by filling the furnace to this level with crushed limestone or magnesite. Between 900 and 950 degrees centigrade proved to be the most desirable temperature, and this was maintained during the latter part of our later runs.

Method of obtaining data.—It is obvious that if the results were to be of value, fairly accurate observations were essential and the nature of these is as follows:

The per cent. of sulphur in the ore was known and an analysis for sulphur was run on several samples taken after the run. The gas escaping from the tank was frequently sampled and tested for sulphur dioxide by measuring the amount of gas required to discolor an iodine solution of known strength. This is the usual method and is given in full in Dennis' "Gas Analysis," but is only accurate where hydrogen sulphide is lacking, for this gas will also discolor the solution.

When both these gases were allowed to pass through the solution, although the odor of hydrogen sulphide was noticeable, and the percentage of sulphur dioxide was calculated on the basis of the volume of gas passed through, this percentage was so low as to make a distinction between the two gases superfluous.

To return to the observations recorded:

During any of the runs, other notes made apply to the following; time of observations, temperature of furnace as recorded by a chrome-nickel pyrometer reading to 1,300 deg. C., vacuum on the furnace nozzle water pressure, steam used, etc.

The following data applies to the first trial giving good results.

April 22, 1915.

Charge—250 lb. sulphide ore averaging 46 per cent. sulphur.

Air pressure—41 lb.; steam pressure 4 lb.

Temperature readings obtained at a point 2 ft. above the bottom of the ore. Ore column 14 ft. high, bottom 2 in. above the tuyeres.

Start furnace 9.27 a.m. T equals 20 deg. C.

The temperature was below 700 deg. about a third