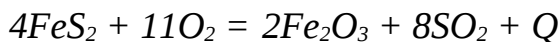


Before use, large pieces of pyrite are crushed in crushing machines. After grinding the pyrite, it is cleaned of impurities (gangue and earth) by flotation. For this, the crushed pyrite is lowered into huge tanks with water, mixed, the waste rock floats up, then it is removed.

The first stage is the burning of pyrite in a fluidized-bed kiln at $t = 800\text{ }^{\circ}\text{C}$ according to the reaction equation:



The crushed purified wet (after flotation) pyrite from above is poured into the kiln in a “boiling layer”. Oxygen-enriched air is passed from below (counterflow principle) for fuller pyrite firing. The temperature in the kiln reaches $800\text{ }^{\circ}\text{C}$. Pyrite is heated to red and is in a “suspended state” because of the air blown from below in the form of a boiling liquid. The temperature in the furnace is maintained by the heat generated by the reaction. Excess heat is removed using a heat exchange system.

The resulting iron oxide Fe_2O_3 (cinder) is not used in the production of sulfuric acid. But it is collected and sent to a metallurgical plant, where iron is obtained from iron oxide and its alloys with carbon - steel (2% carbon C in the alloy) and cast iron (4% carbon C in the alloy).

In this way, the principle of chemical production is fulfilled - waste-free production.

The furnace gas comes out of the furnace, the composition of which is: SO_2 , O_2 , water vapor (pyrite was wet!) and the smallest particles of cinder (iron oxide). Such a furnace gas must be cleaned of impurities of cinder solid particles and water vapor.

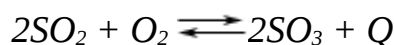
Cleaning the furnace gas from solid particles of the cinder is carried out in two stages:

- *in a cyclone* (centrifugal force is used, solid cinder particles hit the cyclone walls and crumble down);

- *in electrostatic precipitators* (using electrostatic attraction, cinder particles stick to the electrified plates of the electrostatic precipitator, with sufficient accumulation under their own weight they crumble down).

Concentrated sulfuric acid is used to remove water vapor in the furnace gas (drying the furnace gas), which is a very good desiccant because it absorbs water. The kiln gas is dried in a drying tower - kiln gas rises from bottom to top, and concentrated sulfuric acid flows from top to bottom. At the exit of the drying tower, the furnace gas does not contain any cinder particles or water vapor. The kiln gas is now a mixture of sulfur oxide SO_2 and oxygen O_2 .

The second stage is the oxidation of SO_2 to SO_3 with oxygen in the contact apparatus in accordance with the reaction equation:



The optimum temperature for a direct reaction with the maximum formation of SO_3 is a temperature of $400\text{-}500\text{ }^{\circ}\text{C}$. This is a fairly low temperature in chemical industries. In order to increase the reaction rate at such a low temperature, vanadium oxide (V_2O_5) is introduced into the reaction.

A direct reaction proceeds with a decrease in gas volumes, so the process is carried out at elevated pressure.

Before the mixture of SO_2 and O_2 enters the contact apparatus, it must be heated to a temperature of $400\text{-}500\text{ }^{\circ}\text{C}$. Heating of the mixture begins in the heat exchanger, which is installed in front of the contact apparatus. The mixture passes between the heat exchanger tubes and is heated. Inside the tubes, hot SO_3 passes from the contact apparatus. Once in the contact apparatus, the mixture of SO_2 and O_2 continues to heat up to the desired temperature, passing between the tubes in the contact apparatus. The temperature in the contact apparatus is maintained due to the released heat in the reaction of conversion of SO_2 to SO_3 . As soon as the mixture of sulfur oxide and oxygen reaches the catalyst layers, the oxidation of SO_2 to SO_3 begins.