AMERICAN Journal of Engineering,
Mechanics and Architecture
Volume 01, Issue 06, 2023 ISSN (E): 2993-2637

Sulfur Mines Are Mined by Underground Smelting

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Abstract: The article deals with the extraction of sulfur minerals from underground by non-traditional (geotechnological) methods. In particular, this method is effective due to its uniqueness and simple technology. This method is widely used in the extraction of small or deep sulfur bodies from sulfur mining. Low melting temperature of sulfur mineral, i.e., ease of movement is the basis for this method. Sulfur minerals brought to a state of motion are brought to the surface with the help of wells.

Keywords: sulfur, underground melting, well, geotechnological method, autoclave, hydrothermal waters.

Sulfur (S) is a chemical element belonging to group VI of Mendeleev's periodic system, atomic number 16, atomic mass 32, and making up 2% of the Earth's crust by mass. In nature, sulfur is found free (purely native) and in the form of compounds. The most important natural compounds of the sulfur element are metal sulfides, such as MaS, FeS_2 - iron colchaden (pyrite), ZnS - zinc cheater, PbS - glenite, Cu_2S - copper glitter, etc. In the case of sulfur sulfates, anhydrite $CaSO_4$, gypsum $CaSO_4$-$2H_2O$, heavy spar $BaSO_4$, Glauber's salt, etc. also occurs. In addition, element Sulfur is present in the form of organic and inorganic compounds in coal, shale, oil, natural gases, animal and plant organisms. Pure native sulfur is found in several allotropic forms in Mexico, USA, Italy, Japan, CIS countries. Rhombic lattice Sulfur is yellow, density 2.07 g/cm^3 (at 20°), melting point 112.8° C, boiling point 445° C. Monoclinic Sulfur consists of prismatic clear crystals, density 1.96 g/cm^3, melting point 118.9° C. If we conclude from this, if the element of sulfur is heated, that is, if heat is sent to the body of sulfur at 120° C, it will melt and turn into a mobile liquid of yellow color. At 160°C, it turns brown and becomes viscous. Sulfur combines with almost all elements except inert gases, nitrogen, iodine, platinum, gold. It ignites at 250° in oxygen and 360° in air.

After the invention of coal, industrial production of sulfur increased significantly. One of the main reasons for this is that sulfur became an integral part of the industry along with coal and saltpeter. Today, sulfur is an important raw material in many branches of the chemical industry. The annual consumption of sulfur in the world is about 20-24 million tons. Its industrial consumers are sulfuric acid, paper, rubber, matches, pyrotechnics, means and preparations for combating pests in the national economy, partly medicine, etc. Sulfur is one of the most abundant elements in the earth's crust, its share is 0.03%. However, Sulfur in pure form is not common, it is often found in mixtures. Its pure state is a rock composed of pure sulfur (S).

Sulfur ores are mined in different ways depending on the conditions of formation. But in any case, a lot of attention is paid to safety, because sulfur mines are almost always accompanied by the release of toxic gases and sulfur compounds. In addition, sulfur is highly prone to spontaneous combustion. Until the end of the 19th century, sulfur was mined in the open pit like other mineral deposits. As usual, the cover rocks were opened with the help of excavators and other equipment, and the ore was extracted from the massif, mined, loaded and transported.

Extraction of sulfur by smelting underground wells. The United States and Mexico are the world's largest suppliers of sulfur, and the reason for this, of course, was the new methods of sulfur mining. At the same time (at the end of the 19th century), geologists discovered deposits rich in sulfur ore in the southern parts of the United States. But the sulfur layer was not easy to reach in this period and was not economically efficient. Because the sulfur layers were much deeper than the surface of the earth.

Chemist Hermann Frasch found a way to melt sulfur underground under the influence of heat in a geotechnological method and extract it to the surface like oil through wells. The fact that sulfur melts at a relatively low temperature of less than 120°C proved Frasch's idea to be true. In principle, the implementation of the Frasch technology was very simple, since it consisted only of drilling wells into the sulfur body and abscising. Superheated water is piped into the sulfur body and the sulfur is dissolved. In most cases, hydrothermal waters were used, because in order to bring the sulfur to 120 ° C, even higher temperature water or steam had to be sent through the wells. Bringing the water to this temperature would have caused a lot of trouble on the surface, so the use of hydrothermal waters found underground was the only option. Dissolved sulfur rises through pipes heated on all sides. Water pipes that can withstand the above temperatures are used when laying pipes along the well. The third modern version of the Flash technology is the installation of narrow tubes through which compressed air is sent down. As a result, dissolved sulfur rises to the surface. The main advantages of this method created by Frash:

- Getting relatively pure sulfur at the first stage of extraction;
- Ore mining is technically and economically cheap;
- High efficiency in ore mining.

In the past, only the "salt domes" of the Pacific coast of the United States and Mexico were thought to be able to extract sulfur by underground smelting, because the special characteristics of the land itself allowed this method to be used. However, the experiments conducted in Poland and the USSR rejected this idea. During this period, people in Poland were already extracting sulfur in this way. In 1968, the first Sulfur wells were commissioned in the USSR. Sulfur ores mined in quarries and mines had to be processed. In this method, the cost of processing was very low or almost non-existent. Later, steam water, filtration, thermal, centrifugal and extraction methods of non-conventional sulfur extraction were added to the extraction methods.

The thermal method of underground sulfur extraction is considered ancient. In the 18th century, in the kingdom of Neopalus, sulfur heaps were melted with "solfatars". Until now, in Italy, sulfur is melted in primitive "calcarone" furnaces. Here, the heat needed to melt the sulfur from the ore body is obtained by burning some of the sulfur being mined. This process is inefficient, with losses as high as 45%. Because burning coal to heat water at the temperature necessary to melt sulfur is not effective because the price of coal is higher than sulfur. Italy became the home of steam methods for extracting sulfur from ores. In 1859, Giuseppe Gill received a patent for his apparatus. It is the ancestor of autoclaves. The autoclave method is still used in many countries and has been greatly improved. During the autoclave process, the sulfur ore concentrate enriched with up to 80% of sulfur is poured into the aktoclav after being made into a liquid slurry with reagents. Water vapor is supplied there under strong pressure, the pulp heats up to 130°C, the sulfur contained in the concentrate dissolves and is separated from the ore. After a short period of cooling, the dissolved sulfur separates. Then the waste is removed from the autoclave (aqueous suspension) and, since the waste still contains a lot of Sulfur, it is processed again. In Russia, the autoclave method was first used by engineer K. G. Patkanov in 1896. Today, a modern autoclave is as large as a four-story building, and such autoclaves are installed, in particular, at the Sulfur Smelting Plant of the Rozdolsk Mining and Chemical Combine in the Carpathian region.

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