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SULPHUR-WATER-AIR SEPARATOR

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This invention relates to a new method and apparatus for improving the production of sulphur from mines and more particularly to a method and apparatus for continuously separating sulphur from the discharge of a Frasch process sulphur mine containing molten sulphur and gas (air), and also on occasions varying proportions of water.

In the Frasch process of mining sulphur, a well is drilled into the sulphur bearing formation, and four concentric pipes are placed in the hole. The outer pipe is a ten-inch-wide protective casing. The next pipe, an eight-inch, extends into a caprock to the bottom of the sulphur deposit therein, the lower end of which is perforated with small holes. A four-inch pipe extends to within a short distance of the bottom. A one and one quarter-inch pipe carrying compressed air and reaching to within 200 feet of the bottom is in the center.

Superheated water, raised to about 330 degrees Fahrenheit under pressure, is forced down the space between the eight-inch and four-inch pipes and flows out the holes into the sulphur deposit. The sulphur melts and sinks to the bottom of the well. It is then forced several hundred feet up the four-inch pipe by the pressure of the water above in the rock formation. Compressed air forced down the smallest pipe lifts the sulphur to the surface, where it is discharged into steam-heated vats at central points called relay stations.

The rate of withdrawal of sulphur must be closely regulated so that the bottom of the well is "sealed" with molten sulphur, for if the rate is too high, the level of the pool falls and water enters the sulphur withdrawal line. Since this water is at a temperature of about 300° F., reduction of the pressure on the mixture of water and sulphur in the discharge line causes the water to flash to steam, thereby extracting heat from the sulphur and forming a mixture of air, water, steam, solid sulphur and liquid sulphur. This is known as "blowing."

The variations in mine formations and difficulties in operation of the sulphur wells make it impossible to avoid the presence on occasions of varying amounts of water in the fluid stream. Heretofore, only a low grade of sulphur could be recovered from such water-containing streams, and the recovery of this sulphur involved diversion of the stream into a cooling and settling basin known as a "blow box." The expense of recovery in this way has been very high.

Accordingly, it is an object of this invention to provide a method, together with apparatus for practicing it, capable of efficiently separating molten sulphur from the air used in lifting the same and from any water which may unavoidably be present due to blowing or due to leakage of water through the sulphur-conducting pipe in the well.

It is another object of the invention to provide a method and apparatus which not only effects the efficient recovery of sulphur from the fluid streams flowing from the wells, but also permits the adoption of improved techniques in mining and handling the separated sulphur.

A further object of the invention is to provide a method and apparatus for separating sulphur of high grade from water-containing, molten sulphur-air streams flowing from sulphur wells.

Still another object of the invention is to provide a method and apparatus by which the rate of production from a mine may be increased without adding to the cost of sulphur.

Yet another object of the invention is to provide a method and apparatus in which the efficient recovery of sulphur from fluid streams cannot be seriously interfered with by fire.

It has now been found that it is possible to bring about a highly advantageous separation of sulphur from a fluid stream flowing from a sulphur mine and containing sulphur and gas, and also varying proportions of water either intermittently or continuously, by passing such a stream into a columnar separation zone in which it will undergo at least a partial gravimetric separation of its constituents and simultaneously discharging separated gas upwardly from the separation zone, settling sulphur from the same zone and, when present, collecting separated water in a liquid body separate from the settled sulphur. By performing these operations in an enclosed space in which separated constituents are collected in supernatant layers, it is possible to raise the separation of sulphur to a high degree of perfection.

It has also been found that a separation of the nature described can be maintained continuously with high efficiency by carrying out the operations in a pressure vessel under conditions of high temperature at which the sulphur content of the incoming fluid stream is kept molten, and under a suitable superatmospheric pressure. Indeed, the constituents of the inflowing fluid stream can be separated conveniently at a temperature approximating the temperature at which the stream flows from the well. Under these conditions, the separated water and sulphur in the pressure vessel can be excluded from objectionable contact with air, the formation of water-sulphur emulsions and solid sulphur froth particles can be largely or entirely avoided, and the freezing of sulphur in the separator as well as other obstruction of it by the sulphur content can be prevented.

Another important feature of the invention resides in conducting the water separated in the columnar separation zone away from that zone at a location above the layer of settled sulphur that collects in the bottom of the separator or pressure vessel so that the actively flowing water and settled sulphur do not intermix in such a manner as would promote the formation of objectionable sulphur-water emulsions.

By providing apertures in the side walls of an upright hollow member forming the columnar zone, the water separated from the fluid in the zone may be passed laterally outward into the supernatant water layer. It is also possible to adjust the height of the hollow member so that the separated water in whole or in part flows over the top end thereof.

Still another important feature of the invention resides in extending the lower end of the columnar zone into the settled sulphur layer collected at the bottom of the pressure vessel, so that sulphur being settled from the fluid in the columnar zone may pass directly into the sulphur layer, thus preventing the formation of water-sulphur emulsions that would arise from the agitation induced by passage through a portion of the supernatant layer.

A further important feature of the invention resides in conducting water separated in the columnar zone into a considerable body or layer of water maintained within the enclosed space or pressure vessel over a layer of settled sulphur maintained therein, so that sulphur particles suspended or otherwise carried by the separated water can settle from the water layer into the sulphur layer before the water is discharged from the separator.