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## RECOVERING ELEMENTAL SULFUR FROM WATERS CONTAINING HYDROGEN SULFIDE

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11 Claims

### ABSTRACT OF THE DISCLOSURE

Water, containing hydrogen sulfide, is stripped of hydrogen sulfide with nitrogen gas, without the introduction of external heat, a portion, about one-third, of the hydrogen sulfide removed from the water is oxidized to sulfur dioxide and the resulting sulfur dioxide reacted with the remainder of the hydrogen sulfide to produce elemental sulfur. The elemental sulfur is cooled, collected and removed from the system. The remaining uncondensed inert gases, consisting primarily of nitrogen, are recycled to strip hydrogen sulfide from additional amounts of water containing it.

This application is a continuation-in-part of my copending application, Ser. No. 652,853, filed July 12, 1967, now abandoned.

The present invention relates to a process for removing hydrogen sulfide from water. More particularly, the invention is concerned with a novel integrated process for treating water, having a high content of hydrogen sulfide, to remove the hydrogen sulfide and recover the sulfur values in the form of elemental sulfur.

Natural well waters and waters from other sources frequently have a high content of hydrogen sulfide. It is generally not desirable to discharge such waters to waste in natural bodies of water, or even man-made ponds, because the hydrogen sulfide is both toxic and volatile. The hydrogen sulfide escapes into the air causing air pollution and an obnoxious odor in the surrounding atmosphere. When discharged into natural bodies of water the hydrogen sulfide can poison valuable fish and by contaminating the water make it unpalatable for human consumption.

So far as is known, no commercial process has ever been developed which will recover the hydrogen sulfide from waters containing it and convert the sulfur values to elemental sulfur. Yet, waters high in hydrogen sulfide content are potentially valuable because of the sulfur content and if an economical method of recovering the hydrogen sulfide from the water and converting it to elemental sulfur could be found, a source of nuisance could be converted into a source of value.

Up to the present, the art has been concerned almost solely with the treatment of waters containing large amounts of hydrogen sulfide to make the water safe for disposal. This has involved treatment of the water or the hydrogen sulfide so that it could be disposed of without causing injury to aquatic life or create a public nuisance. In some cases, the prior art methods have involved con-

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verting the toxic hydrogen sulfide into some less objectionable compound which can then be released into natural waters or sewers. But no effort has been made to capitalize on the presence of the hydrogen sulfide and convert it to a usable form. These prior art methods have served only to increase the cost of disposing of the hydrogen sulfide in the water without obtaining any commercial compensation for the cost of the treatment.

In spite of the absence of activity to recover the hydrogen sulfide present in waters and convert it into elemental sulfur, there are known methods for transforming hydrogen sulfide, in gaseous form, into elemental sulfur. One prominent process for this purpose is the Claus process, in which about one-third of the hydrogen sulfide is burned with air to form sulfur dioxide, and the resulting mixture of hydrogen sulfide, sulfur dioxide, water vapor and the nitrogen which remains after the oxygen in the air has been utilized to oxidize the hydrogen sulfide to sulfur dioxide, is then passed through a catalyst bed at elevated temperature. In the catalyst bed the hydrogen sulfide and sulfur dioxide react with one another to form elemental sulfur vapor and water vapor. Upon cooling of the reaction gases, the sulfur vapor condenses to liquid sulfur and is easily recovered as a valuable product, while the water vapor, nitrogen, and any small amounts of unreacted gases are discharged to the atmosphere as waste without causing significant pollution problems.

Extraction of the hydrogen sulfide from the water, prior to processing the former in the Claus process, can be dealt with in various ways. It is generally necessary to allow the water to trickle downward through packing in a packed tower while a current of inert gas or vapor passes upward in contact with it. The inert gas or vapor volatilizes the hydrogen sulfide so that it is removed from the water and recovered mixed with the inert gas. The use of gas which contains oxygen, such as ordinary air, is objectionable for removing the hydrogen sulfide from the water because the oxygen reacts with hydrogen sulfide, causing some loss of the latter as well as causing plugging of the tower packing with the elemental sulfur which deposits in the packing as a result of oxidation of the hydrogen sulfide. Steam is frequently used as the vapor to sweep the tower and, in this case, the steam condenses into the water so that the effluent gas is nearly pure hydrogen sulfide. Instead of a sweeping gas the tower may be subjected to a vacuum, causing the hydrogen sulfide to volatilize to the lower overlying pressure.

The use of inert gases is expensive because inert gases have heretofore been inherently expensive to produce. The use of steam is expensive because of the large amount of heat required to produce it, which heat cannot be recovered. The use of a vacuum is expensive because of the high pressure differential against which the vacuum pump must operate, and because of the necessity of constructing the vacuum pump of materials that are resistant to the corrosive action of wet hydrogen sulfide. Furthermore, the water leaving the packed tower in any of these methods always contains enough residual hydrogen sulfide to require further treatment before it can be discharged to waste.