

# PATENT SPECIFICATION

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## (54) PROCESS FOR THE RECOVERY OF SULPHUR FROM HYDROGEN SULPHIDE AND SULPHUR DIOXIDE

(71) We, SHELL INTERNATIONALE  
RESEARCH MAATSCHAPPIJ N.V., a  
company organised under the laws of the  
Netherlands, of 30, Carel van Bylandtlaan,  
The Hague, the Netherlands, do hereby  
declare the invention, for which we pray  
that a patent may be granted to us, and  
the method by which it is to be performed,  
to be particularly described in and by the  
following statement:—

The present invention relates to a process  
for the recovery of sulphur from hydrogen  
sulphide and sulphur dioxide.

The recovery of elemental sulphur from  
hydrogen sulphide-containing gases by the  
Claus reaction is well known and various  
processes using this reaction are in com-  
mercial use. One such process involves carry-  
ing out the Claus reaction in a thermic re-  
action zone and one or more catalytic re-  
action zones, sulphur being recovered after  
each zone by cooling the gases and condens-  
ing the sulphur vapour formed. In the thermic  
reaction zone hydrogen sulphide is partially  
combusted in order to produce gases contain-  
ing hydrogen sulphide and sulphur dioxide  
in substantially stoichiometric proportions for  
the recovery of sulphur by the Claus reaction  
and a substantial amount of sulphur vapour  
is formed. On leaving the thermic reaction  
zone the gases are cooled and the majority  
of the sulphur vapour is condensed and re-  
covered. The gases are then reheated and  
passed to one or more catalytic reaction  
zones in which additional sulphur vapour is  
formed and subsequently recovered by con-  
densation.

In this type of Claus process the stoichi-  
ometric amount of sulphur dioxide, which is  
required for the Claus reaction has in the  
past either been completely or substantially  
completely provided by the partial com-  
bustion of hydrogen sulphide. In cases where  
a small amount of sulphur dioxide is provided  
from another source the amount of sulphur  
dioxide so provided has not been enough to

significantly reduce the yield of sulphur  
vapour formed in the thermic reaction zone.

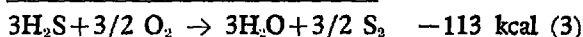
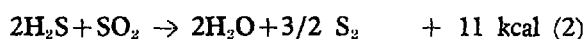
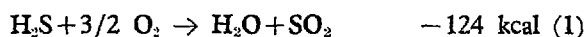
Processes for the desulphurization of indus-  
trial flue gases have recently been proposed  
in which large quantities of sulphur dioxide-  
containing gases are produced; the disposal  
of such gases presents certain problems. If  
large quantities of sulphuric acid are re-  
quired the sulphur content of such gases may  
advantageously be converted into sulphuric  
acid but usually such large quantities are not  
required and it is then more advantageous  
to recover the sulphur content of the gases as  
elemental sulphur. In the case where a plant  
operating a Claus process as hereinbefore  
described exists it would be highly desirable  
to convert the sulphur dioxide-containing  
gases in such plant recovering the sulphur  
content thereof as elemental sulphur. In this  
way the need to build additional sulphur  
recovery plant would be obviated. In prac-  
tice this involves certain difficulties relating  
to the efficiency of sulphur recovery and the  
stability of operation.

It is therefore an object of the present  
invention to provide a process of the Claus  
type in which efficient recovery of elemental  
sulphur from large amounts of sulphur di-  
oxide-containing gases may be effected.  
Another object is to allow stable operation of  
a process of the Claus-type in which a sub-  
stantial proportion of the sulphur dioxide re-  
quired for the Claus reaction is introduced  
into the thermic reaction zone from an  
external source.

The present invention comprises a process  
for the recovery of sulphur from hydrogen  
sulphide and sulphur dioxide in which pro-  
cess a hydrogen sulphide-containing gas is  
partially combusted with a free oxygen-con-  
taining gas in a thermic reaction zone in the  
presence of a sulphur dioxide-containing gas,  
sulphur being formed in the said thermic  
reaction zone and being withdrawn from the  
gas mixture leaving the thermic reaction zone  
which gas mixture is then passed to at least

one catalytic reaction zone in which additional sulphur is formed and subsequently withdrawn, the sulphur dioxide-containing gas being introduced into the thermic zone from an external source in an amount such that the mole percentage of sulphur dioxide so introduced to sulphur dioxide formed by partial combustion is at least 25% and additional heat being supplied to the thermic reaction zone to maintain a high temperature therein.

As used herein thermic reaction zone means a zone in which a hydrogen sulphide-containing gas is partially combusted to form a gaseous mixture of hydrogen sulphide and sulphur dioxide, the residence time of such mixture in such zone being sufficient for substantial amounts of sulphur to be formed according to the Claus reaction. The main reactions which take place in the thermic reaction zone of a Claus plant can be represented by the following equations:



The equilibrium state is finally determined by reaction (2) which is endothermic at high temperatures.

In order to obtain high yields of sulphur it is necessary to maintain a high temperature in the thermic reaction zone and at the same time allow the hydrogen sulphide and sulphur dioxide sufficient time to reach equilibrium according to equation (2). If these conditions are fulfilled then sulphur yields in the order of 70% of the sulphur present in the feed to the thermic reaction zone can be achieved.

If non-combustible material is introduced to the thermic reaction zone the proportion of hydrogen sulphide in the gases which requires to be combusted decreases and as a consequence the temperature of the gases in the thermic reaction zone decreases. If the non-combustible material is sulphur dioxide the temperature of the gases in the thermic reaction zone is even further reduced because less hydrogen sulphide is required to be combusted in order to provide sulphur dioxide for sulphur formation and therefore less heat is supplied by the highly exothermic equation (1).

According to the present invention sulphur dioxide-containing gas is introduced into the thermic reaction zone from an external source in an amount such that the mole percentage of sulphur dioxide so introduced to sulphur dioxide formed by the partial combustion of hydrogen sulphide is at least 25%. Since the introduction of large amounts of sulphur dioxide-containing gas has the effect of reducing the temperature of the gases to such a low level that substantially no sulphur formation according to equation (2) takes place during the limited time in which the gases remain in the thermic reaction zone the present invention entails the supply of additional heat to the thermic reaction zone to maintain a high temperature therein. In this way high yields of sulphur are achieved even though large amounts of sulphur dioxide are introduced into the thermic reaction zone.

In order to achieve high yields of sulphur in the thermic reaction zone the amount of additional heat supplied is preferably such that a temperature of at least 700°C is maintained in the thermic reaction zone. More preferably, sufficient additional heat is supplied such that the temperature in the thermic reaction zone lies between 900°C and 1400°C.

The supply of heat to the thermic reaction zone can be achieved in a number of different ways. One method is to heat up the sulphur-dioxide-containing gas to a high temperature before passing it to the thermic reaction zone. Alternatively, the hydrogen sulphide-containing gas or the free oxygen-containing gas may be heated before passing to the thermic reaction zone. Variations on this theme in which two of the three gases or all of the three gases are pre-heated before passing to the thermic reaction zone may be employed. The main disadvantage of these methods of supplying heat is that heating equipment is required for heating the gas supply lines and this can be rather expensive. Another method of supplying heat is to inject a fuel via a line burner in the sulphur dioxide-containing gas supply line and to fully combust it in the line burner so that the gases are hot when introduced to the thermic reaction zone. This however has the disadvantage that the line burner is a large and expensive item of equipment.

The method for supplying heat to the thermic reaction zone which is preferred according to the present invention entails combusting a fuel within the said zone. This has the advantage of requiring no additional heating equipment and is therefore more economic. In this case the amount of free oxygen-containing gas which is introduced to the thermic reaction zone should be regulated such that it is sufficient for the complete combustion of the fuel and for the combustion of the required amount of hydrogen sulphide.

The complete combustion of all the fuel which is introduced to the thermic reaction zone is required in order to prevent the formation of soot which would lead to the undesirable formation and recovery of black sulphur and the fouling of the catalyst in the catalytic reaction zone(s).

The amount of hydrogen sulphide which requires to be combusted in the thermic reaction zone, and therefore the amount of free oxygen required to be introduced, depends on the type of fuel used and the amount of sulphur dioxide which is introduced from an external source. Advantageously the aggregate amount of sulphur dioxide formed by combustion of hydrogen sulphide and that introduced from an external source should be such that the mole ratio of hydrogen sulphide to sulphur dioxide in the gases in the thermic reaction zone is substantially 2:1 (i.e. the stoichiometric amounts for the reaction according to equation (2)). In this way high yields of sulphur can be achieved in the thermic reaction zone.

Although the supply of free oxygen-containing gas into the thermic reaction zone is usually regulated such that the mole ratio of hydrogen sulphide to sulphur dioxide in the gases in the thermic reaction zone is substantially 2:1 this is not essential. If, for example, it is decided that either part of the hydrogen sulphide-containing gas or part of the sulphur dioxide-containing gas or both should by-pass the thermic reaction zone and pass directly to the catalytic reaction zone the mole ratio of hydrogen sulphide to sulphur dioxide in the gases leaving the thermic reaction zone may vary substantially from 2:1 in order that the mole ratio of hydrogen sulphide to sulphur dioxide in the gases passing to the catalytic reaction zone (i.e. the gases from the thermic reaction zone plus the by-pass gases) should be substantially 2:1. The yield of sulphur formed in the thermic reaction zone is reduced if such a by-pass is employed but if the amount of by-pass is small the effect on the overall sulphur recovery in the process is not significant.

The fuel may be introduced into the thermic reaction zone separately from the other gases. In this case it is advantageous to introduce the fuel directly behind or in the immediate vicinity of the flame formed by the partial combustion of the hydrogen sulphide-containing gas. This is not essential however and introduction of the fuel may be made in any part or parts of the thermic reaction zone. The fuel may also be introduced into the thermic reaction zone as a mixture with one or more of the other gases. Accordingly it may be mixed with the sulphur dioxide-containing gas or even with the free oxygen-containing gas before passing to the thermic reaction zone. It is particu-

larly preferred however to introduce the fuel into the thermic reaction zone as a mixture with the hydrogen sulphide-containing gas. This has the advantage that the flame formed by combustion of the gaseous mixture is very hot and remains stable even in the presence of large amounts of sulphur dioxide.

The amount of fuel which is introduced to the thermic reaction zone depends, inter alia, on the amount of sulphur dioxide-containing gas which is introduced thereto, the temperature at which it is desired to operate and the type of fuel used. In general however it is not greater than 25 mole % of the hydrogen sulphide content of the hydrogen sulphide-containing gas introduced to the thermic reaction zone. Preferably the amount of fuel introduced to the thermic reaction zone lies between 1 mole % and 10 mole % of the hydrogen sulphide content of the hydrogen sulphide-containing gas introduced to the thermic reaction zone.

Any suitable fuel may be combusted in the thermic reaction zone. The fuel may be a gas, a liquid or a solid. A liquid fuel should be combusted in an atomizer and a solid fuel should be finely pulverized before combustion in order to ensure that complete combustion occurs. A gaseous fuel is preferred however in view of each of handling and the fact that special burner equipment is not required. A particularly preferred fuel is a hydrocarbon gas having a substantially constant composition since the control of the temperature within the thermic reaction zone is then facilitated. The reason for this is that if a gas is used whose composition continually varies during operation of the process, the heating value of the gases also varies and renders control of the temperature more difficult. Accordingly, methane, ethane, propane, butane, pentane or a mixture of two or more of such gases in fixed proportions may be advantageously employed.

The sulphur dioxide-containing gas may be introduced to the thermic reaction zone separately or as a mixture with the hydrogen sulphide-containing gas or the free oxygen-containing gas. Whichever method is used however the important considerations to bear in mind are that the flame formed by the partial combustion of the hydrogen sulphide-containing gas should not become unstable and the temperature of the flame should not become too low. The latter point is of added importance when the fuel is introduced to the thermic reaction zone as a mixture with the hydrogen sulphide-containing gas because if the flame temperature is too low the fuel is not completely combusted and soot formation occurs.

According to a preferred embodiment of the present invention the introduction of the sulphur dioxide-containing gas into the

thermic zone is effected by distributing it around the gas flame formed by the partial combustion of the hydrogen sulphide-containing gas. This is advantageous because the flame remains stable and the temperature of the flame does not decrease to low levels. The distribution of the sulphur dioxide-containing gas around the gas flame may be effected by any suitable means. Preferably however a ring distributor with nozzles is used for this purpose.

The present invention is particularly suitable for the recovery of sulphur from sulphur dioxide - containing gas obtained in the desulphurization of flue gases. In the abatement of pollution of the atmosphere by industrial flue gases an increasingly important objective is the removal of sulphur dioxide from the flue gases. One of the processes proposed to achieve this recovers sulphur dioxide as a sulphur dioxide rich gas comprising about 90% by volume of sulphur dioxide the remainder being water. The present process is well suited to treat such a gas.

In practice the amount of sulphur dioxide-containing gas which is introduced into the thermic reaction zone in relation to the amount of hydrogen sulphide-containing gas so introduced is limited. Accordingly the relative amount of sulphur dioxide-containing gas should not be so small that the temperature within the thermic reaction zone is not significantly reduced because in such a case the supply of additional heat to the thermic reaction zone would not then be necessary. On the other hand it is not normally so high that no partial combustion of hydrogen sulphide is necessary in order to provide sulphur dioxide for sulphur recovery. In general therefore the mole ratio of hydrogen sulphide to sulphur dioxide in the gases introduced into the thermic reaction zone lies between 10:1 and 2:1. Preferably it lies between 5:1 and 3:1.

In the case where the mole ratio of hydrogen sulphide to sulphur dioxide in the gases introduced into the thermic reaction zone is lower than 2:1 then the fuel is partially combusted in order to provide hydrogen for reducing a certain amount of the sulphur dioxide and to achieve stoichiometric proportions of hydrogen sulphide to sulphur dioxide for sulphur recovery. In such case the fuel not only acts to provide heat but also to provide hydrogen for reducing sulphur dioxide.

The invention also includes apparatus for the recovery of sulphur from hydrogen sulphide and sulphur dioxide, which comprises:

- (a) a reactor containing means for combusting hydrogen sulphide and fuel, said reactor having one or more inlets

for hydrogen sulphide - containing gas, free oxygen-containing gas and fuel and an inlet for sulphur dioxide-containing gas comprising a ring distributor with nozzles positioned round the means for combusting hydrogen sulphide and fuel,

- (b) a sulphur condenser connected to said reactor (a) downstream thereof, and

- (c) a catalytic reactor followed by a sulphur condenser, said catalytic reactor being connected to said sulphur condenser (b) downstream thereof.

The sulphur condenser (b) can be connected to a plurality of catalytic reactors (c) disposed in series, each of said plurality of catalytic reactors being followed by a sulphur condenser.

In said apparatus the inlet for the sulphur dioxide-containing gas is so positioned that the gas is distributed around the flame formed by the partial combustion of the hydrogen sulphide-containing gas.

As means for combusting hydrogen sulphide and fuel any suitable burner may be used. In particular, a high-intensity whirl chamber burner is very suitable.

A method in which the process and apparatus according to the present invention are suitably used for the recovery of sulphur from hydrogen sulphide and sulphur dioxide is described below with reference to the accompanying drawings. Accessories such as valves, pumps and control instruments are not shown in the drawings.

Figure 1 is a diagrammatic representation of a process for the recovery of sulphur from hydrogen sulphide and sulphur dioxide.

Figures 2, 3 and 4 are diagrammatic representations of 3 possible types of reactor which may be used in the process according to the present invention.

With regard to Figure 1 a mixture of a hydrogen sulphide - containing gas and a gaseous fuel is passed via a line 1 to a reactor 2 in which the mixture is combusted. Free oxygen-containing gas is passed to the reactor 2 via a line 3 and sulphur dioxide-containing gas is introduced into the reactor 2 via a line 4 and a ring distributor 5. The ring distributor 5 serves to evenly distribute the sulphur dioxide-containing gas around the flame formed by combustion of the hydrogen sulphide-containing gas and the gaseous fuel. The hot gases are passed out of the reactor 2 via line 6 and into a heat exchanger 7. Coolant is passed into the heat exchanger 7 via a line 8 and out via a line 9. Sulphur is condensed out of the gases in the heat exchanger 7 and is recovered via a line 10. The cooled gases are then heated and passed via line 11 through two catalytic reactors 12 in series. After passing through the first catalytic reactor the gases are cooled in a cooler (not shown) in

order to condense out the sulphur formed and then reheated before passing to the second reactor. After passing out of the second reactor the gases are again cooled in a condenser (not shown) in order to condense out sulphur. Sulphur is recovered via a line 13. The effluent gases from the catalytic reactors are passed via a line 14 to an incinerator (not shown) before being discharged to the atmosphere.

With regard to Figures 2, 3 and 4 equivalent parts of the three reactors depicted are numbered with the same reference numerals. Hence the number 21 refers to the hydrogen sulphide and fuel inlet to the reactor, 22 to the refractory lining of the reactor, 23 to the free oxygen-containing gas inlet to the reactor, 24 to the sulphur dioxide-containing gas inlet to the reactor, 25 to the distribution means used for distribution of the sulphur dioxide-containing gas within the reactor, 25a and 25b to the nozzles of the distribution means and 26 to the reactor exit.

Figure 2 depicts a conventional burner in which the distribution means for sulphur dioxide-containing gas is a ring distributor housed within the free oxygen-containing gas inlet compartment. The sulphur dioxide-containing gas is introduced by the nozzles around the flame formed by the burning hydrogen sulphide and fuel.

In Figure 3 the sulphur dioxide-containing gas is introduced into the reactor via nozzles situated towards the middle of the reactor. These nozzles may be perpendicular to the reactor walls as in nozzle 25a or at an angle to them as in nozzle 25b.

Figure 4 depicts a reactor incorporating a high intensity burner. The sulphur dioxide-containing gas is introduced via a simple distribution chamber 25 through nozzles which may either be perpendicular to the reactor walls as in nozzle 25a or at an angle to them as in nozzle 25b.

The following Example will further elucidate the invention.

#### EXAMPLE

A mixture of a hydrogen sulphide-containing gas and butane/pentane was combusted at atmospheric pressure in a main reactor. The hydrogen sulphide-containing gas had a hydrogen sulphide content of 88.0 mole % and the amount of butane/pentane which was mixed with the hydrogen sulphide-containing gas was 4.6 mole %. The feed rate of the mixture to the main reactor was 27.2 cubic metres per minute.

Air was introduced into the main reactor at a rate of 69.5 cubic metres per minute and a sulphur dioxide-containing gas having a sulphur dioxide content of 91.5 mole % was introduced into the main reactor via a ring distributor at a rate, in accordance

with the present invention, of 0.8 cubic metres per minute. 65

The average temperature of the gases within the main reactor was 1255°C and the residence time of the gases within the main reactor was 0.5 second. The amount of sulphur dioxide introduced into the main reactor and the amount of sulphur dioxide formed therein by combustion of hydrogen sulphide was such that the mole ratio of hydrogen sulphide to total sulphur dioxide in the gases therein was substantially 2:1. 70 75

The gases were passed from the main reactor to a heat exchanger in which they were cooled to a temperature of 205°C. Sulphur was condensed out of the gases at the rate of 24.5 kilograms per minute. The percentage of sulphur recovered to total sulphur content of the feed streams to the main reactor was 63.0%. 80

The gases were then passed to two catalytic reactors disposed in series, each catalytic reactor being followed by a sulphur condenser. Before passing to the first catalytic reactor the gases were heated to 250°C and the gases leaving that catalytic reactor were cooled to 150°C in its associated sulphur condenser in order to condense sulphur out. The gases leaving that condenser were heated to 220°C before being passed to the second catalytic reactor, and the gases leaving the latter were cooled to 140°C in the sulphur condenser which followed the second catalytic reactor. The catalyst in each of the catalytic reactors was activated natural bauxite. 85 90 95 100

The total sulphur condensed out of the gases from the two catalytic reactors in the two sulphur condensers which followed those reactors was 12.0 kilograms per minute. The percentage of sulphur recovered in the catalytic reactors to total sulphur content of the feed streams to the main reactor was 30.9%. 105

The effluent gases from the last catalytic reactor contained 0.8 mole % of hydrogen sulphide and 0.4 mole % of sulphur dioxide. These gases were incinerated to give a gas having a hydrogen sulphide content of less than 20 ppm which was discharged to the atmosphere. 110 115

It can be seen from this Example that the total amount of sulphur recovered was 93.9% of the sulphur present in the feed streams to the main reactor, 63.0% of the sulphur being recovered in the heat exchanger i.e. the sulphur condenser connected to the main reactor downstream thereof and 30.9% being recovered from the gases leaving the catalytic reactors in the sulphur condensers following those reactors. 120 125

#### WHAT WE CLAIM IS:—

1. A process for the recovery of sulphur from hydrogen sulphide and sulphur dioxide



order to condense out the sulphur formed and then reheated before passing to the second reactor. After passing out of the second reactor the gases are again cooled in a condenser (not shown) in order to condense out sulphur. Sulphur is recovered via a line 13. The effluent gases from the catalytic reactors are passed via a line 14 to an incinerator (not shown) before being discharged to the atmosphere.

With regard to Figures 2, 3 and 4 equivalent parts of the three reactors depicted are numbered with the same reference numerals. Hence the number 21 refers to the hydrogen sulphide and fuel inlet to the reactor, 22 to the refractory lining of the reactor, 23 to the free oxygen-containing gas inlet to the reactor, 24 to the sulphur dioxide-containing gas inlet to the reactor, 25 to the distribution means used for distribution of the sulphur dioxide-containing gas within the reactor, 25a and 25b to the nozzles of the distribution means and 26 to the reactor exit.

Figure 2 depicts a conventional burner in which the distribution means for sulphur dioxide-containing gas is a ring distributor housed within the free oxygen-containing gas inlet compartment. The sulphur dioxide-containing gas is introduced by the nozzles around the flame formed by the burning hydrogen sulphide and fuel.

In Figure 3 the sulphur dioxide-containing gas is introduced into the reactor via nozzles situated towards the middle of the reactor. These nozzles may be perpendicular to the reactor walls as in nozzle 25a or at an angle to them as in nozzle 25b.

Figure 4 depicts a reactor incorporating a high intensity burner. The sulphur dioxide-containing gas is introduced via a simple distribution chamber 25 through nozzles which may either be perpendicular to the reactor walls as in nozzle 25a or at an angle to them as in nozzle 25b.

The following Example will further elucidate the invention.

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A mixture of a hydrogen sulphide-containing gas and butane/pentane was combusted at atmospheric pressure in a main reactor. The hydrogen sulphide-containing gas had a hydrogen sulphide content of 88.0 mole % and the amount of butane/pentane which was mixed with the hydrogen sulphide-containing gas was 4.6 mole %. The feed rate of the mixture to the main reactor was 27.2 cubic metres per minute.

Air was introduced into the main reactor at a rate of 69.5 cubic metres per minute and a sulphur dioxide-containing gas having a sulphur dioxide content of 91.5 mole % was introduced into the main reactor via a ring distributor at a rate, in accordance

with the present invention, of 0.8 cubic metres per minute.

The average temperature of the gases within the main reactor was 1255°C and the residence time of the gases within the main reactor was 0.5 second. The amount of sulphur dioxide introduced into the main reactor and the amount of sulphur dioxide formed therein by combustion of hydrogen sulphide was such that the mole ratio of hydrogen sulphide to total sulphur dioxide in the gases therein was substantially 2:1.

The gases were passed from the main reactor to a heat exchanger in which they were cooled to a temperature of 205°C. Sulphur was condensed out of the gases at the rate of 24.5 kilograms per minute. The percentage of sulphur recovered to total sulphur content of the feed streams to the main reactor was 63.0%.

The gases were then passed to two catalytic reactors disposed in series, each catalytic reactor being followed by a sulphur condenser. Before passing to the first catalytic reactor the gases were heated to 250°C and the gases leaving that catalytic reactor were cooled to 150°C in its associated sulphur condenser in order to condense sulphur out. The gases leaving that condenser were heated to 220°C before being passed to the second catalytic reactor, and the gases leaving the latter were cooled to 140°C in the sulphur condenser which followed the second catalytic reactor. The catalyst in each of the catalytic reactors was activated natural bauxite.

The total sulphur condensed out of the gases from the two catalytic reactors in the two sulphur condensers which followed those reactors was 12.0 kilograms per minute. The percentage of sulphur recovered in the catalytic reactors to total sulphur content of the feed streams to the main reactor was 30.9%.

The effluent gases from the last catalytic reactor contained 0.8 mole % of hydrogen sulphide and 0.4 mole % of sulphur dioxide. These gases were incinerated to give a gas having a hydrogen sulphide content of less than 20 ppm which was discharged to the atmosphere.

It can be seen from this Example that the total amount of sulphur recovered was 93.9% of the sulphur present in the feed streams to the main reactor, 63.0% of the sulphur being recovered in the heat exchanger i.e. the sulphur condenser connected to the main reactor downstream thereof and 30.9% being recovered from the gases leaving the catalytic reactors in the sulphur condensers following those reactors.

#### WHAT WE CLAIM IS:—

1. A process for the recovery of sulphur from hydrogen sulphide and sulphur dioxide



- in which process a hydrogen sulphide-containing gas is partially combusted with a free oxygen-containing gas in a thermic reaction zone in the presence of a sulphur dioxide-containing gas, sulphur being formed in the said thermic reaction zone and being withdrawn from the gas mixture leaving the thermic reaction zone which gas mixture is then passed to at least one catalytic reaction zone in which additional sulphur is formed and subsequently withdrawn, the sulphur dioxide-containing gas being introduced into the thermic zone from an external source in an amount such that the mole percentage of sulphur dioxide introduced from the external source to sulphur dioxide formed by partial combustion is at least 25% and additional heat being supplied to the thermic reaction zone to maintain a high temperature therein.
2. A process as claimed in claim 1, in which a temperature of at least 700°C is maintained in the thermic reaction zone.
3. A process as claimed in claim 2, in which a temperature between 900°C and 1400°C is maintained in the thermic reaction zone.
4. A process as claimed in any one of claims 1 to 3, in which heat is supplied to the thermic reaction zone by combusting a fuel therein, the amount of free oxygen-containing gas which is introduced to the said zone being regulated such that it is sufficient for the complete combustion of the fuel and for the combustion of the required amount of hydrogen sulphide.
5. A process as claimed in any one of claim 4, in which the fuel is introduced to the thermic reaction zone as a mixture with the hydrogen sulphide-containing gas.
6. A process as claimed in claim 4 or 5, in which the amount of fuel introduced to the thermic reaction zone is not greater than 25 mole % of the hydrogen sulphide content of the hydrogen sulphide-containing gas introduced to the thermic reaction zone.
7. A process as claimed in claim 4 or 5, in which the amount of fuel introduced to the thermic reaction zone lies between 1 mole % and 10 mole % of the hydrogen sulphide content of the hydrogen sulphide-containing gas introduced to the thermic reaction zone.
8. A process as claimed in any one of claims 4 to 7, in which the fuel is a hydrocarbon gas having a substantially constant composition.
9. A process as claimed in claim 8, in which the fuel is methane, ethane, propane, butane, pentane or a mixture of two or more of such gases.
10. A process as claimed in any one of claims 1 to 9, in which the introduction of the sulphur dioxide-containing gas into the thermic zone is effected by distributing it around the gas flame formed by the partial combustion of the hydrogen sulphide-containing gas.
11. A process as claimed in claim 10, in which the sulphur dioxide-containing gas is distributed around the gas flame by means of a ring distributor with nozzles.
12. A process as claimed in any one of claims 1 to 11, in which the sulphur dioxide-containing gas is obtained from the desulphurization of flue gases.
13. A process as claimed in any one of claims 1 to 12, in which the mole ratio of hydrogen sulphide to sulphur dioxide in the gases introduced to the thermic reaction zone lies between 10:1 to 2:1.
14. A process as claimed in any one of claims 1 to 12, in which the mole ratio of hydrogen sulphide to sulphur dioxide in the gases introduced to the thermic reaction zone lies between 5:1 and 3:1.
15. An apparatus for the recovery of sulphur from hydrogen sulphide and sulphur dioxide, which comprises:
- (a) a reactor containing means for combusting hydrogen sulphide and fuel, said reactor having one or more inlets for hydrogen sulphide-containing gas, free oxygen-containing gas and fuel and an inlet for sulphur dioxide-containing gas comprising a ring distributor with nozzles positioned round the means for combusting hydrogen sulphide and fuel,
  - (b) a sulphur condenser connected to said reactor (a) downstream thereof, and
  - (c) a catalytic reactor, followed by a sulphur condenser, said catalytic reactor being connected to said sulphur condenser (b) downstream thereof.
16. An apparatus as claimed in claim 15, in which the sulphur condenser (b) is connected to a plurality of catalytic reactors (c) disposed in series, each of said plurality of catalytic reactors being followed by a sulphur condenser.
17. An apparatus as claimed in any one of claims 15 or 16, in which the means for combusting hydrogen sulphide and fuel is a high-intensity whirl chamber burner.
18. A process for the recovery of sulphur from a hydrogen sulphide-containing gas as claimed in any one of claims 1 to 14, substantially as hereinbefore described and with specific reference to the accompanying drawings or to the Example.
19. An apparatus for the recovery of



\* C L M S \*

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7

5 sulphur from a hydrogen sulphide-containing gas as claimed in any one of claims 15 to 17, substantially as hereinbefore described and with specific reference to the accompanying drawings.

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