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- (71) Applicant (for all designated States except US):  
THIOSOLV, L.L.C. [US/US]; ThioSolv, LLC, 410 Grand Oaks Blvd., Spring Branch, Texas 78070 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): ANDERSON, Mark [US/US]; 8911 Kennett Valley, Spring, Texas 77379 (US). RAY, Michael [US/US]; 410 Grand Oaks Blvd., Spring Branch, Texas 78070 (US).
- (74) Agent: MENON, Usha; D'Ambrosio & Menon, PLLC, 2825 Wilcrest Drive, Suite 486, Houston, Texas 77042 (US).

- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
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**Declarations under Rule 4.17:**

— as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))

[Continued on next page]

(54) Title: ELIMINATION OF HYDROGEN SULFIDE IN AQUEOUS AMMONIA

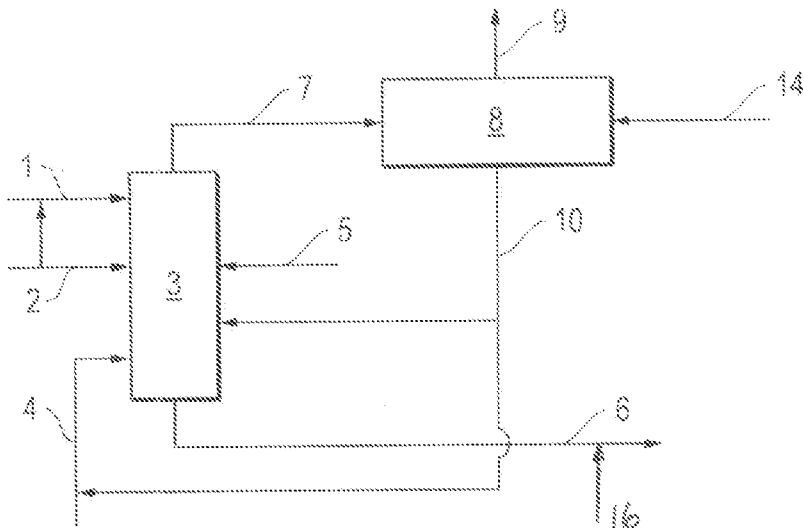


FIG. 1

(57) Abstract: Processes for selectively eliminating hydrogen sulfide from liquid ammonia, either anhydrous or aqueous, are described herein. The processes generally include contacting a first liquid stream, anhydrous or aqueous, comprising ammonia and hydrogen sulfide, with a solution comprising sulfur dioxide to convert the hydrogen sulfide to thiosulfate.





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— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))* (88) **Date of publication of the international search report:**  
1 May 2014

**Published:**

— *with international search report (Art. 21(3))*

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/28936

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - C01B 17/64; B01D 53/48 (2012.01)

USPC - 423/514; 423/243.06; 208/208R

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - C01B 17/64; B01D 53/48 (2012.01)

USPC - 423/514; 423/243.06; 208/208R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
Patents, Non-Patent Literature. Search term limited.

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

USPTO PubWEST; Google. Search terms: "hydrogen sulfide", "sulfur dioxide", ammonia, ammonium, thiosulfate

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2008/0050302 A1 (Anderson et al.) 28 February 2008 (28.02.2008) para [0002], [0004], [0010], [0012], [0018]-[0021], [0028], [0032], [0042], [0051]	1-12
Y	US 2003/0072707 A1 (Ray et al.) 17 April 2003 (17.04.2003) para [0027], [0051]	1-12
Y	US 3,431,070 A (Keller) 4 March 1969 (04.03.1969) entire document	1-12
Y	US 2007/0269357 A1 (Anderson et al.) 22 November 2007 (22.11.2007) entire document	1-12
Y	US 2003/0223930 A1 (Schoubye et al.) 4 December 2003 (04.12.2003) entire document	1-12
Y	US 2002/0131927 A1 (Anderson et al.) 19 September 2002 (19.09.2002) entire document	1-12

 Further documents are listed in the continuation of Box C.


\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

21 August 2012 (12.08.2012)

Date of mailing of the international search report

31 AUG 2012

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents  
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-3201

Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/28936

**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

- 1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
- 2.  Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
- 3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

Group I: claims 1-12

Group II: claim 13

see extra sheet for details

- 1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
- 2.  As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
- 3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
- 4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:  
1-12

**Remark on Protest**

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

## Box III continued

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1.

Group I: claims 1-12 directed to a process for selectively eliminating hydrogen sulfide from a liquid comprising: contacting, in a first contact zone, a first liquid stream comprising ammonia and hydrogen sulfide with a second stream comprising sulfur dioxide, the first contact zone producing a first contact zone liquid effluent comprising ammonia and ammonium thiosulfate.

Group II: claim 13 directed to a process for removing hydrogen sulfide from anhydrous ammonia by passing a first liquid stream comprising ammonia and hydrogen sulfide through a porous bed selected from the group consisting of metal sulfites, bisulfites and combinations thereof, wherein the hydrogen sulfide is converted to ammonium thiosulfate.

The inventions listed as Groups I and II do not relate to a single general inventive concept under PCT Rule 13.1 because under PCT Rule 13.2 they lack the same or corresponding technical features for the following reasons:

Group II does not include the sulfur dioxide of group I.

Group I does not include the anhydrous ammonia nor the porous bed selected from the group consisting of metal sulfites, bisulfites and combinations thereof of group II.

The common feature of groups I and II of reacting a mixture comprising ammonia and hydrogen sulfide to produce ammonium thiosulfate is taught by US 3,431,070 A to Keller et al. (04 March 1969) (col 3, ln 10-15); therefore the common feature is not an improvement over the prior art.

Groups I and II therefore lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.