



- (51) **International Patent Classification:**  
*C07C 45/82* (2006.01) *B01J 29/40* (2006.01)  
*C07C 49/08* (2006.01)
- (21) **International Application Number:**  
PCT/US2013/039039
- (22) **International Filing Date:**  
1 May 2013 (01.05.2013)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**  
13/464,726 4 May 2012 (04.05.2012) US
- (71) **Applicant (for all designated States except US):** **LY-ONDELL CHEMICAL TECHNOLOGY, L.P.** [US/US]; 1221 McKinney, Suite 700, Lyondellbasell Tower, Houston, TX 77010 (US).
- (72) **Inventors; and**
- (71) **Applicants (for US only):** **POURREAU, Daniel, B.** [US/US]; 81 Devon Drive, Exton, PA 19341 (US). **GREY, Roger, A.** [US/US]; 111 Piedmont Road, West Chester, PA 19382 (US). **KAHN, Andrew, P.** [US/US]; 5109 Brandywine Drive, Eagleville, PA 19403 (US).
- (74) **Agents:** **STREETER, Leslie** et al.; Lyondellbasell Industries, 1221 McKinney, Suite 700, Houston, TX 77010 (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, BN, 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, PA, 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.
- (84) **Designated States (unless otherwise indicated, for every kind of regional protection available):** ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Published:**

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(54) **Title:** METHOD OF PURIFYING CRUDE ACETONE STREAM

(57) **Abstract:** The present invention relates to a method of treating a crude acetone stream. The method generally includes treating a crude acetone stream which has acetone and at least one low-boiling impurity with a catalyst to form a treated acetone stream that has acetone and at least one higher-boiling impurity and then distilling the treated acetone stream to remove at least a portion of the higher-boiling impurity to produce a purified acetone stream. This is particularly helpful in processes where a more pure acetone is desired, including a process for making purified isopropanol.



## METHOD OF PURIFYING CRUDE ACETONE STREAM

### BACKGROUND

5

**[0001]** The present invention relates to a method of treating a crude acetone stream. The invention relates to a method of purifying a crude acetone stream so as to convert low boiling impurities to higher boiling impurities that can be more easily separated from the acetone. This is particularly helpful in processes where a more pure acetone is desired, including a process for making highly purified isopropanol.

### SUMMARY OF THE INVENTION

**[0002]** The present invention relates to a method of treating a crude acetone stream. This invention relates to a method of purifying a crude acetone stream so as to convert low boiling impurities to higher boiling impurities that can be more easily separated from acetone. This is particularly helpful in processes where a more pure acetone is desired, including a process for making purified isopropanol.

**[0003]** In some embodiments, the present invention provides a method of purifying a crude acetone stream which comprises treating a crude acetone stream which comprises acetone and at least one low-boiling impurity with a solid acid catalyst to form a treated acetone stream that comprises acetone and at least one higher-boiling impurity and then distilling the treated acetone stream to remove at least a portion of the higher-boiling impurity to produce a purified acetone stream.

**[0004]** In other embodiments, the present invention provides a method for preparing a purified isopropanol comprising the steps of feeding an acetone stream which comprises acetone and at least one lower boiling impurity to a solid inorganic acid bed which comprises a catalyst to form a treated acetone stream that comprises acetone and at least one higher boiling impurity; distilling the treated acetone stream to remove at least a portion of the higher boiling impurity from the treated acetone stream to produce a purified acetone stream; and feeding the purified acetone stream to a hydrogenation reactor in a process for making isopropanol to produce purified isopropanol.

**[0005]** In other embodiments, the present invention provides a method for preparing a purified isopropanol comprising the steps of feeding an acetone stream which comprises acetone and at least one lower boiling impurity to a solid inorganic

acid bed which comprises a zeolite catalyst to form a treated acetone stream that comprises acetone and at least one higher boiling impurity; distilling the treated acetone stream to remove at least a portion of the higher boiling impurity from the treated acetone stream to produce a purified acetone stream having a purity of at least 80%; feeding the purified acetone stream to a hydrogenation reactor in a process for making isopropanol to produce a crude isopropanol; distilling the crude isopropanol to produce a purified isopropanol wherein the purified isopropanol has a purity of at least 99.5%.

**[0006]** The features and advantages of the present invention will be readily apparent to those skilled in the art upon a reading of the description of the preferred embodiments that follows.

### DETAILED DESCRIPTION

**[0007]** The present invention relates to a method of treating a crude acetone stream. This invention relates to a method of purifying a crude acetone stream so as to convert low boiling impurities to higher boiling impurities that can be more easily separated from acetone. This is particularly helpful in processes where a more pure acetone is desired, including a process for making purified isopropanol.

**[0008]** The present invention provides methods of treating crude acetone streams so that some of the lower boiling impurities are converted to higher boiling impurities. This facilitates the removal of impurities from the acetone stream, as separation of higher boiling impurities is easier, less costly, and more effective than removal of lower boiling impurities from acetone.

**[0009]** In some embodiments, the present invention provides a method of purifying a crude acetone stream which comprises treating a crude acetone stream which comprises acetone and at least one low-boiling impurity with a solid acid catalyst to form a treated acetone stream that comprises acetone and at least one higher-boiling impurity and then distilling the treated acetone stream to remove at least a portion of the higher-boiling impurity to produce a purified acetone stream.

**[0010]** In other embodiments, the present invention provides a method for preparing a purified isopropanol comprising the steps of feeding an acetone stream which comprises acetone and at least one impurity to a solid inorganic acid bed which comprises a catalyst to form a treated acetone stream that comprises acetone and at least one higher boiling impurity then distilling the treated acetone stream to remove at least a portion of the higher boiling impurity from the treated acetone stream to produce

a purified acetone stream, and then feeding the purified acetone stream to a hydrogenation reactor in a process for making isopropanol to produce a purified isopropanol.

**[0011]** In other embodiments, the present invention provides a method for preparing a purified isopropanol comprising the steps of feeding an acetone feed stream which comprises acetone and at least one lower boiling impurity to a solid inorganic acid bed which comprises a zeolite catalyst to form a treated acetone stream that comprises acetone and at least one higher boiling impurity; distilling the treated acetone stream to remove at least a portion of the higher boiling impurity from the treated acetone stream to produce a purified acetone stream having a purity of at least 80%; feeding the purified acetone stream to a hydrogenation reactor in a process for making isopropanol to produce a purified isopropanol; wherein the purified isopropanol has a purity of at least 99.5%. A further embodiment provides the use of a dual resin bed and dryer configuration.

**[0012]** Lower boiling impurities that can be found in crude acetone streams generally include: alcohols, esters, ethers, epoxides, aldehydes, water, and olefins. In some embodiments, the lower boiling impurities can include isobutylene, acetaldehyde, methanol, methyl formate, isopropanol, propionaldehyde, tert-butyl alcohol, isobutanol, methyl tert-butyl ether ("MTBE"), isobutyraldehyde, methyl ethyl ketone, t-butyl formate, propylene and isobutylene oxides, and diisobutylene. Generally any impurity which has a boiling point similar to acetone or form azeotropes with acetone, such that it is difficult to separate from acetone via distillation, would be considered a lower boiling impurity.

**[0013]** Higher boiling impurities that can be formed from the lower boiling impurities in crude acetone streams generally include ethers, alkyl acetals, alcohols, glycol ethers, dioxolanes, glycols, and ketones. In some embodiments, the higher boiling impurities can include 1,1-dimethoxypropane, 2,2-dimethoxypropane, 1-methoxy-2-methyl-2-propanol, 2,4,4-trimethoxydioxolane, 1,1-dimethoxyisobutane, 2,2,4,4-tetramethyldioxolane, 2-methoxy-2-methyl-1-propanol, 2-isobutyl-4,4-dimethyldioxolane, mesityl oxide, hydroxymesityl oxide, methoxymesityl oxide, propylene glycol ethers, propylene glycol and isobutylene glycol. Generally any impurity which has a higher boiling point than acetone, and thus are more easily separated from acetone via distillation, would be considered a higher boiling impurity.

**[0014]** Catalysts that can be used to treat the crude acetone stream include: zeolites, including delaminated zeolites, mesoporous silicas, acid clays, mixed

inorganic oxides, acidic inorganic oxides, crosslinked acidic polymer resins, or mixtures thereof.

**[0015]** Examples of zeolites include silicate-based zeolites and amorphous compounds such as faujasite, mordenite, chabazite, offretite, clinoptilolite, erionite, sihealite, and the like. Other suitable zeolite materials include zeolite A, zeolite L, zeolite beta, zeolite X, zeolite Y, zeolite HY, ZSM-5, MCM-22, MCM-41, UCB-1, and ITQ-2. A preferred zeolite catalyst is an HY zeolite that has a silica to alumina ratio between 2 and 10. The zeolite can be of any formed shape including extrudates, tablets, formed particles or beads. The use of binders to provide strength to the formed shape can be used. A particularly preferred zeolite catalyst is an 80/20 composition of Zeolite HY and alumina binder in extrudate form. It has been found that this particular composition gives the catalyst mechanical integrity in fixed bed operation and minimizes reactor pressure drop and plugging.

**[0016]** Zeolites are commonly altered through a variety of methods to adjust characteristics such as pore size, structure, activity, acidity, and silica/alumina molar ratio. The silica/alumina ratio of the zeolite can be altered, via a variety of methods, such as dealumination by steaming or acid washing to increase the silica/alumina ratio. Increasing the amount of silica relative to alumina can have the effect of increasing the catalyst hydrophobicity. The silica/alumina ratio can range from less than 0.5 to 500 or greater.

**[0017]** Examples of acidic inorganic oxides include, but are not limited to, acid treated clays, aluminas, silica-aluminas, silica containing mixed oxides, natural and synthetic pillared clays, and natural and synthetic zeolites. Examples of silica containing mixed oxides include silica-titania, silica-zirconia, silica-alumina-titania and silica-alumina-zirconia.

**[0018]** Examples of acid treated clays include montmorillonite clays, and smectite clays.

**[0019]** Examples of crosslinked acidic polymer resins include, but are not limited to divinylbenzene-crosslinked sulfonated polystyrene resins, sulfonated tetrafluoroethylene based fluoropolymer-copolymers, and the like. A particularly preferred crosslinked acidic polymer resin is a divinylbenzene-crosslinked sulfonated polystyrene resin. It should be noted that swelling can occur with at least some organic solid acids, such as Amberlyst 15. Preferred organic solid acids would not be subject to swelling.

**[0020]** The described methods are particularly helpful in processes where a more pure acetone is desired. Examples of such processes include a process for making solvent-grade isopropanol, solvent grade acetone, acetone cyanohydrin/methyl methacrylate, bisphenol A, methyl isobutyl ketone, methyl isobutyl carbinol, and isophorone.

**[0021]** The crude acetone streams of the present invention can vary. In some embodiments, the crude acetone stream may be at least 50% acetone, at least 60% acetone, at least 70% acetone, or at least 80%.

**[0022]** The purified acetone streams of the present invention will vary based on the crude acetone stream, the catalyst selected, and other variables. In some embodiments, the purified acetone stream will be at least 80% acetone. In preferred embodiments, the purified acetone stream will be at least 90% acetone.

**[0023]** In some embodiments, once a purified acetone stream is obtained, the purified acetone stream is hydrogenated to produce a crude isopropanol stream. In such embodiments, the yield of isopropanol is increased when compared to methods that do not use the process of purifying the acetone stream. In preferred embodiments, the yield of isopropanol is increased by at least 10% when compared to a process of producing isopropanol with an acetone fed stream that has not been fed to a solid inorganic acid bed.

**[0024]** Additionally, in some embodiments, the crude isopropanol stream is further purified to produce purified isopropanol. The crude isopropanol stream can be further purified using methods well known in the art, such as distillation, extractive distillation, or reactive distillation. In preferred embodiments the purified isopropanol stream has a purity of at least 99.0%. In other preferred embodiments, the purified isopropanol stream has a purity of at least 99.5%. In the most preferred embodiment, the purified isopropanol stream has a purity of at least 99.8%.

**[0025]** One exemplary embodiment involves the production of isopropanol. In the production of isopropanol, crude acetone is then converted to isopropanol by hydrogenation. Both the crude acetone stream and the isopropanol are purified by distillation. In this particular embodiment, a fixed bed containing acid catalyst is positioned between the crude acetone source and the first distillation column. The acid bed causes the lower boiling impurities in the crude acetone to react with alcohols or and water or to isomerize to the corresponding aldehydes that further react with contained alcohols to produce higher boiling impurities, such as glycols, glycol ethers, acetals, diacetals, and dioxolanes that are removed from the bottoms of the first

distillation column. In preferred embodiments, about twenty percent of the methanol and substantially all of the epoxides and aldehydes are removed from the acetone stream that enters the hydrogenation reactor in the process for production of isopropanol. This reduces the amount of t-butyl alcohol, sec-butanol, ethanol, and methanol by-products that exit the reactor. Because the contaminants are reduced, the isopropanol is more easily purified via distillation. The production rates are increased and higher product purity is also achieved. In preferred embodiments, the resulting product is 99.0% pure isopropanol. In other embodiments, the resulting isopropanol is up to or greater than 99.8% pure.

**[0026]** In further preferred embodiment involving the production of isopropanol, a drying medium is added before the organic acid resin bed to remove water from the crude acetone. The acid resin catalyst can be purchased in its dry form or the wet form pre-dried by known means, such as by passing hot nitrogen over the resin bed. A particularly preferred drying medium is 3A zeolite beads, which are microporous aluminosilicates with average pore diameter of 3 Angstrom. Using such 3A Zeolite beads can reduce the water content of the crude acetone stream by up to 96%. By reducing the water content, it is expected that the amount of t-butyl alcohol formed on the acid resin bed will be reduced and thus result in a higher yield of high purity isopropanol product. In addition, it is expected that more isobutylene will be converted to di-isobutylene and MTBE instead of t-butyl alcohol. Di-isobutylene can be efficiently removed with the bottoms of the first acetone distillation column and MTBE can be removed with the lights in the first isopropanol distillation column.

**[0027]** In an embodiment, a dual resin bed and dryer configuration can be used. The dual resin bed and dryer configuration can be used in processes which require purification of an acetone crude stream, including processes such as processes for making solvent-grade isopropanol, solvent grade acetone, acetone cyanohydrin/methyl methacrylate, bisphenol A, methyl isobutyl ketone, methyl isobutyl carbinol, and isophorone. Use of a dual resin bed and dryer configuration would allow a zeolite and resin bed to be taken out of service or reactivated in-situ using known methods, such as with hot air or nitrogen while the crude acetone processing continues. This would also allow the used Zeolite and/or resin bed to be replaced, reactivated, or maintenance to be conducted without interrupting the production of isopropanol. Waste water stream from drying of the catalyst and zeolite beds could be sent to waste fuel tanks or a waste water treatment facility, or disposed of or recycled in other known manners.

**[0028]** Various parameters will be understood by one of skill in the art as affecting the method of treating a crude acetone stream. Such parameters will include temperature of the reaction, WHSV, and catalyst bed length to reactor diameter L/D ratio. In some embodiments, the temperature will range from about 30°C about 70°C. In other embodiments, it will range from about 40°C to about 60°C. In most preferred embodiments it will be about 50°C. In some embodiments, the weight hourly space velocity ("WHSV") will range from about 0.3 to about 2.5 hr<sup>-1</sup>. In other embodiments, it will range from about 0.5 to about 2.0 hr<sup>-1</sup>. In most preferred embodiments it will be about 1.0 hr<sup>-1</sup>. In some embodiments, the catalyst bed length to reactor diameter L/D ratio will range from about 1 to about 30. In other embodiments, it will range from about 2 to about 8. In some embodiments it will be about 6. In other embodiments, it will be about 2. The various parameters can be manipulated by a person of skill in the art so as to produce optimal working conditions.

**[0029]** To facilitate a better understanding of the present invention, the following examples of preferred embodiments are given. In no way should the following examples be read to limit, or to define, the scope of the invention.

### EXAMPLES

**[0030]** For Examples 1-11, a 1 inch ID jacketed tube was charged with solid acid catalyst. The tube was heated to 50 °C and the crude acetone (75 wt% acetone, 8 wt% methanol (MeOH), 3.5 wt% isobutylene oxide (IBO), 1.2 wt% propylene oxide (PO), 0.2 wt% acetaldehyde (AcH), 0.2% propionaldehyde (PA), 0.6 wt% isobutyraldehyde (IBA), balance = other organic compounds) was fed to the column at 50 g/h (WHSV = 1/h). Samples were collected and analyzed by gas chromatography.

**[0031]** For Examples 12-16, a ¾ inch OD stainless steel tube was charged with catalyst. The tube was heated to 50 °C by placing it in a heated bath and the crude acetone (76.2 wt% acetone, 6.8 wt% methanol (MeOH), 3.7 wt% isobutylene oxide (IBO), 1.6 wt% propylene oxide (PO), 0.2 wt% acetaldehyde (AcH), 0.3% propionaldehyde (PA), 0.7 wt% isobutyraldehyde (IBA), balance = other organic compounds) was fed to the reactor. For Amberlyst 15 (Rohm & Haas), WHSV is expressed on a dry resin basis assuming 50% by weight water. In the cases where a pre-bed was used, 50 g of 3A sieves (Aldrich, 8/12 mesh) were packed into a ¾" OD stainless steel tube placed in series before the main reactor. Samples were collected and analyzed by gas chromatography. A summary of the results are shown in the table below:



**TABLE 1:**

%Conversion to Heavier Compounds				
	Ex 1 HY Zeolyst CBV600 SiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub> = 5.2	Ex 2 HBeta Zeolyst CP 7148 SiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub> = 65	Ex 3 HBeta Zeolyst CP 611E-300 SiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub> = 300	Ex 4 Montmorillonite Clay BASF F24
g cat	50	50	50	50
WHSV (h <sup>-1</sup> )	1	1	1	1
Temp (°C)	50	50	50	50
Acetaldehyde	53	58	58	58
Propionaldehyde	75	28	70	33
Isobutyraldehyde	60	62	68	72
Propylene Oxide	98	99	99	100
Isobutylene Oxide	100	100	100	100
MeOH	20	20	20	17
Acetone	2	4	4	2
	Ex 5 TSM6 Tocat SiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub> = 5.1	Ex 6 HY Zeolyst CBV400 SiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub> = 5.1	Ex 7 HY Zeolyst CBV600 SiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub> = 5.2	Ex 8 HY Zeolyst CBV600 SiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub> = 5.2
g cat	50	50	15	48
WHSV (h <sup>-1</sup> )	1	1	1	0.5
Temp (°C)	50	50	70	50
Acetaldehyde	82	75	47	85
Propionaldehyde	55	35	46	75
Isobutyraldehyde	10	45	21	58
Propylene Oxide	97	90	75	87
Isobutylene Oxide	97	100	94	100
MeOH	17	20	13	19
Acetone	1	2	1	3
	Ex 9 HY Zeolyst CBV600 SiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub> = 5.2	Ex 10 HY Zeolyst CBV600 SiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub> = 5.2	Ex 11 HY Zeolyst CBV600 SiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub> = 5.2	Ex 12 Amberlyst 15
g cat	48	16	16	36
WHSV (h <sup>-1</sup> )	0.5	3	2	3.6
Temp (°C)	30	50	30	50
Acetaldehyde	51	72	49	55
Propionaldehyde	70	57	41	68
Isobutyraldehyde	48	29	5	42
Propylene Oxide	75	75	74	89
Isobutylene Oxide	100	96	100	100
MeOH	22	15	14	19
Acetone	3	2	2	1
	Ex 13 Prebed 3A sieve + Amberlyst 15	Ex 14 Prebed 3A sieve + Amberlyst 15	Ex 15 Prebed 3A sieve + HY Zeolyst CBV600 SiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub> = 5.2	Ex 16 Prebed 3A sieve + Montmorillonite Clay BASF F24
g cat	36	36	22	31
WHSV (h <sup>-1</sup> )	2.8	5.6	2.3	1.5
Temp (°C)	50	50	50	50
Acetaldehyde	53	51	51	54
Propionaldehyde	69	72	75	88
Isobutyraldehyde	24	32	45	77
Propylene Oxide	99	98	92	98
Isobutylene Oxide	100	100	97	100
MeOH	32	29	25	27
Acetone	1	1	2	4

5            **[0032]** As shown in the above Table 1, the low-boiling impurities are converted to higher-boiling impurities. For instance, the acetaldehyde content is

reduced 47-88%, propionaldehyde is reduced by 75-99%, isobutyraldehyde is reduced by 28-75%, and isobutylene oxide is reduced by 94-100%.

**[0033]** The data shows that temperature can be manipulated to lead to more efficient removal of low-boiling impurities, with 50 °C being the preferred temperature. Additionally, a higher WHSV can lead to less acetone loss. One of skill in the art will understand that these factors can be manipulated to reduce acetone loss and increase the efficiency of removal of low-boiling impurities.

**[0034]** Therefore, the present invention is well adapted to attain the ends and advantages mentioned as well as those that are inherent therein. The particular embodiments disclosed above are illustrative only, as the present invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular illustrative embodiments disclosed above may be altered, combined, or modified and all such variations are considered within the scope and spirit of the present invention. The invention illustratively disclosed herein suitably may be practiced in the absence of any element that is not specifically disclosed herein and/or any optional element disclosed herein. While compositions and methods are described in terms of "comprising," "containing," or "including" various components or steps, the compositions and methods can also "consist essentially of" or "consist of" the various components and steps. All numbers and ranges disclosed above may vary by some amount. Whenever a numerical range with a lower limit and an upper limit is disclosed, any number and any included range falling within the range is specifically disclosed. In particular, every range of values (of the form, "from about a to about b," or, equivalently, "from approximately a to b," or, equivalently, "from approximately a-b") disclosed herein is to be understood to set forth every number and range encompassed within the broader range of values. Also, the terms in the claims have their plain, ordinary meaning unless otherwise explicitly and clearly defined by the patentee. Moreover, the indefinite articles "a" or "an," as used in the claims, are defined herein to mean one or more than one of the element that it introduces. If there is any conflict in the usages of a word or term in this specification and one or more patent or other documents that may be incorporated herein by reference, the definitions that are consistent with this specification should be adopted.

**CLAIMS**

The invention claimed is:

1. A method of purifying a crude acetone stream which comprises
  - a. treating a crude acetone stream which comprises acetone and at least one low-boiling impurity with a solid acid catalyst to form a treated acetone stream that comprises acetone and at least one higher-boiling impurity than in the crude acetone stream;
  - b. distilling the treated acetone stream to remove at least a portion of the higher-boiling impurity to produce a purified acetone stream.
2. The method of claim 1 wherein the catalyst is selected from the group consisting of zeolites, acid clays, acidic inorganic oxides, crosslinked acidic polymer resins, or mixtures thereof.
3. The method of claim 2 wherein the zeolite is a ZSM-5 zeolite.
4. The method of claim 2 wherein the zeolite is an HY zeolite.
5. The method of claim 4 wherein the HY zeolite has a silica to alumina ratio between 2 and 10.
6. The method of claim 2 wherein the crosslinked acidic polymer resin is a divinylbenzene-crosslinked sulfonated polystyrene resin.
7. The method of claim 1 wherein the crude acetone stream is 50 wt% or greater acetone.
8. The method of claim 1 wherein the impurity comprises alcohol, epoxide, aldehyde, water, isobutylene, or some combination thereof.
9. The method of claim 1 wherein the purified acetone stream is at least 70%wt acetone.

10. The method of claim 1 wherein the crude acetone stream comprises about 70-80% acetone, at least 4% methanol, at least 0.2% aldehydes, at least 3% isobutylene oxide, and at least 1% isopropanol.
- 5 11. The method of claim 9 wherein the purified acetone stream is at least 80% acetone and less than 0.7% aldehydes, less than 3.5% isobutylene oxide and less than 1.5% isopropanol.
- 10 12. The method of claim 1 wherein the purified acetone stream is hydrogenated to produce a crude isopropanol stream.
13. The method of claim 12 wherein the crude isopropanol stream is further purified to produce a purified isopropanol with a purity of at least 99.5%
- 15 14. A method for preparing a purified isopropanol comprising the steps of
- a. feeding a crude acetone stream which comprises acetone and at least one lower boiling impurity to a bed of comprising a solid acid catalyst to form a treated acetone feed stream that comprises acetone and at least one higher boiling impurity ;
  - 20 b. distilling the treated acetone stream to remove at least a portion of the higher boiling impurity from the treated acetone stream to produce a purified acetone stream; and
  - c. feeding the purified acetone stream to a hydrogenation reactor in a process for making isopropanol to produce a crude isopropanol.
  - 25 d. distilling the crude isopropanol stream to remove at least a portion of the remaining impurities to produce a purified isopropanol stream;
15. The method of claim 14 wherein the catalyst is selected from the group consisting of zeolites, acid clays, acidic inorganic oxides, crosslinked acidic polymer resins, or mixtures thereof.
- 30 16. The method of claim 14 wherein the purified acetone stream is at least 90%wt acetone.

17. The method of claim 14 wherein the acetone feed stream comprises about 80% acetone, at least 6.5% methanol, at least 0.7% aldehydes, at least 3.5% isobutylene oxide, and at least 1.5% isopropanol, and further wherein the purified acetone stream is about 90% acetone and less than 6.5% methanol, less than 0.7% aldehydes, less than 3.5% isobutylene oxide and less than 1.5% isopropanol, and further wherein the purified isopropanol is at least 99.8%wt isopropanol.
18. The method of claim 14 wherein the yield of isopropanol is increased by at least 5% when compared to a process of producing isopropanol with an acetone feed stream that has not been fed to a solid acid bed.
19. A method for preparing a purified isopropanol comprising the steps of
- feeding an acetone feed stream which comprises acetone and at least one lower boiling impurity to a solid inorganic acid bed which comprises a zeolite catalyst to form a treated acetone feed stream that comprises acetone and at least one higher boiling impurity ;
  - distilling the treated acetone stream to remove at least a portion of the higher boiling impurity from the treated acetone stream to produce a purified acetone stream having a purity of at least 80%;
  - feeding the purified acetone stream to a hydrogenation reactor in a process for making isopropanol to produce a crude isopropanol.
  - distilling the crude isopropanol stream to remove at least a portion of the remaining impurities to produce a purified isopropanol stream.
  - wherein the purified isopropanol has a purity of at least 99.5%;

**A. CLASSIFICATION OF SUBJECT MATTER****C07C 45/82(2006.01)i, C07C 49/08(2006.01)i, B01J 29/40(2006.01)i**

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)

C07C 45/82; C07C 49/08; C07C 29/145; B01D 3/34; C07C 29/136; C07C 45/80; C07C 45/78; C07C 45/90; B01D 3/40; B01J 29/40

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) &amp; Keywords: acetone, isopropanol, impurity, zeolite, clay, acidic polymer resin

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6303826 B1 (BHINDE, M.V. et al.) 16 October 2001 See abstract; examples 8, 9; claims 1-11.	1,2,7-11
Y		12-19
A		3-6
Y	US 7041857 B1 (HAYES, K.S. et al.) 09 May 2006 See abstract; examples 1-5; claims 1-11.	12-19
A	US 6340777 B1 (ARISTOVICH, V.J. et al.) 22 January 2002 See abstract; tables 1, 2; claims 1-10.	1-19
A	US 05399776 A (FRAINI, E.A. et al.) 21 March 1995 See abstract; claims 1-13.	1-19
A	US 05788818 A (LORENZONI, L. et al.) 04 August 1998 See abstract; claims 1-8.	1-19
A	US 05762764 A (CHANG, T. et al.) 09 June 1998 See abstract; claims 1-4.	1-19



Further documents are listed in the continuation of Box C.



See patent family annex.

\* 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 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

25 September 2013 (25.09.2013)

Date of mailing of the international search report

**25 September 2013 (25.09.2013)**

Name and mailing address of the ISA/KR

Korean Intellectual Property Office  
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City,  
302-701, Republic of Korea

Facsimile No. +82-42-472-7140

Authorized officer

KANG Tai Hyun

Telephone No. +82-42-481-8408



**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2013/039039**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6303826 B1	16/10/2001	AU 2001-27697 A1 WO 01-53242 A1	31/07/2001 26/07/2001
US 7041857 B1	09/05/2006	None	
US 6340777 B1	22/01/2002	AU 2000-78762 A1 EP 1226102 A1 EP 1226102 B1 JP 04-653920 B2 JP 2003-512447 A KR 10-0738718 B1 WO 01-30735 A1	08/05/2001 31/07/2002 25/10/2006 16/03/2011 02/04/2003 12/07/2007 03/05/2001
US 05399776 A	21/03/1995	None	
US 05788818 A	04/08/1998	EP 0767160 A1 EP 0767160 B1 JP 03-916702 B2 JP 09-124539 A KR 10-0283301 B1	09/04/1997 07/04/1999 23/05/2007 13/05/1997 02/04/2001
US 05762764 A	09/06/1998	None	