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(54) Title: PROCESS FOR SELECTIVE REMOVAL OF MERCAPTAN FROM AVIATION TURBINE FUEL (ATF)

(57) Abstract: The present invention relates to a process for selective removal of mercaptan from aviation turbine fuel (ATF) feed comprising: mixing aviation turbine fuel feed with hydrogen, at a pressure in range of 3 bar to 20 bar to obtain a reaction mixture, heating the reaction mixture at a temperature range of 150 °C to 350 °C to obtain a heated mixture, reacting the heated mixture with a hydrotreating catalyst in a reactor to obtain a reactor effluent, stripping H₂S gas from the reactor effluent to obtain a stripper bottom product, and removing moisture from the stripper bottom product to obtain aviation turbine fuel product having less than 10 ppm mercaptan. The process of present invention also improves properties such as colour, acidity etc of other products. The present invention further relates to an aviation turbine fuel product having less than 10 ppm mercaptan prepared by a process of the present invention. The process of present invention is flexible and can be employed for a grass root unit or retrofitting-existing unit.



WO 2011/114352 A2

Process for selective removal of mercaptan from aviation turbine fuel (atf).**FIELD OF THE INVENTION**

[01] The present invention relates to a process for selective removal of mercaptan from aviation turbine fuel (ATF) feed. The present process provides aviation turbine fuel product having negligible mercaptan, good colour, moderate sulfur and low acidity. The process is for selective mercaptan removal with minimum removal of other sulfur compounds.

BACKGROUND

[02] Aviation Turbine Fuel (ATF) demand is expected to increase rapidly in the wake of robust economic growth and major developments in aviation industry. Air travel is projected to grow in popularity in the years to come and the refinery that produces jet fuel at competitive cost and environmentally friendly manner will be in the best position to compete in this market. The refiners need to respond promptly to the challenge of producing ATF meeting stringent specifications. A refiner that produces high quality jet fuels can find attractive markets for ATF product throughout the world.

[03] ATF / Kerosene can be produced through distillation of crude followed by some post-treatment by processes like Merox or through hydroprocessing route. The former type of processes can produce ATF from specific type of crude oils only and requires handling of chemicals like caustic. Further, the product properties such as color and acidity are inferior as compared to the present invention. In conventional hydroprocessing process, severe operating conditions are used leading to high equipment and operating costs. In addition, high severity of operation reduces sulfur content affecting the product's lubricity.

[04] Mercaptan is the generic name for a family of organic compounds where sulfur and a hydrogen atom (SH) are bonded to one of the carbon atoms in the molecule. The hydrogen atom in the SH radical can ionize and produce a mildly acidic environment, which may lead to corrosion. The most noticeable characteristic of mercaptan is their strong, unpleasant odor even when their concentration is only a few parts per million. Mercaptan need to be removed from

ATF due to corrosion and odour problems. Other specifications of ATF include acidity, aromatics, olefins, smoke point, mercaptan, freeze point, color, and water separation index, etc.

[05] US6,231,752 discloses a process for removal of mercaptan and diolefins from naphtha range feed using reactor system in hydrogen atmosphere but the process lacks capability for dealing with higher boiling feed (kerosene / diesel) and no claim for colour or acidity improvement has been cited.

[06] US6,334,948 discloses a process for producing gasoline with low sulfur content, the process does not suggest that the same process can be used for aviation turbine fuel. Also the process disclosed is not for selective removal of mercaptan from the feed.

[07] The art relating to the treatment of mercaptan containing sour hydrocarbon distillate and the regeneration of spent caustic solutions is well developed and the processes and the apparatus therefore are subject of many patents e.g. US Patent Nos. 2,988,500; 3,371,031; 3,413,215; 3,445,380; 3,515,677; 3,574,093; 3,923,645; 3,931,054; 3,972,829; 4,003,827; 4,009,120; 4,018,705; 4,033,860; 4,070,271; 4,087,378; 4,090,954; 4,098,681; 4,107,078; 4,113,604; 4,121,998; 4,121,999; 4,124,531; 4,141,819; 4,206,043; 4,248,694; 4,298,502; 4,364,843; 4,481,106; 4,481,107; 4,490,246; 4,498,977; 4,498,978 and 4,579,121 are representative of catalytic oxidation processes and catalyst for treating mercaptan containing sour hydrocarbon distillate. US Patent Nos. 2,425,414; 2,606,099; 2,740,749; 2,853,432; 2,921,021; 2,937,986; 3,107,213; 4,040,947; 4,081,354; 4,104,155; 4,199,440 and 4,362,614 are representative of extraction and regeneration processes for removal of mercaptan.

[08] Certain polar compounds can be removed from jet fuel by clay treating. In this relatively simple process, the fuel is allowed to pass through a bed of clay. Certain classes of polar compounds, especially those that act as surfactants, adsorb onto the surface of the clay and thus are removed from the fuel. Removal of surfactants from hydrocarbon distillate using post treatment methods employing clay is well known in the art.

[09] In order to meet the growing demand of high quality ATF, the current invention uses a selective hydroprocessing technology for production of ATF. The present invention provides all the advantages of conventional hydroprocessing at low severity and selectively removes mercaptan thereby not affecting the product's lubricity. The process has the capability of selectively removing mercaptan from ATF at low severity. It has been found that the process can reduce mercaptan to less than 10 ppm from ATF feed having not more than 350 ppm

mercaptan level. Acidity and colour are also improved in the process. All other critical product properties are also excellent. The process is flexible and can be employed for a grass root unit or retrofitting existing unit. For grass root unit, the process utilizes mixing of hydrotreated product with feed composition and negligible hydrogen for meeting chemical hydrogen consumption and losses. The process can also be operated with excess hydrogen gas for retrofitting in existing units having recycle gas compressor.

SUMMARY

[10] The present invention relates to a process for the selective removal of mercaptan from aviation turbine fuel (ATF) feed comprising: mixing aviation turbine fuel feed with hydrogen, at a pressure in range of 3 bar to 20 bar to obtain a reaction mixture, heating the reaction mixture at a temperature range of 150°C to 350°C to obtain a heated mixture, reacting the heated mixture with a hydrotreating catalyst in a reactor to obtain a reactor effluent, stripping H₂S gas from the reactor effluent to obtain a stripper bottom product, and removing moisture from the stripper bottom product to obtain aviation turbine fuel product having less than 10 ppm mercaptan.

[11] The present invention relates to a process for selective removal of mercaptan from aviation turbine fuel (ATF) feed as claimed in claim 1, comprising: mixing aviation turbine fuel feed with hydrogen gas at a hydrogen gas to aviation turbine fuel feed ratio in the range of 20:1 to 50:1, and at a pressure in range of 3 bar to 20 bar to obtain a reaction mixture, heating the reaction mixture at a temperature range of 150°C to 350°C to obtain heated mixture, reacting the heated mixture with a hydrotreating catalyst in a reactor to obtain reactor effluent, stripping H₂S gas from the reactor effluent to obtain stripper bottom product, and removing moisture from the stripper bottom product to obtain aviation turbine fuel product having less than 10 ppm mercaptan.

[12] The present invention also relates a process for selective removal of mercaptan from aviation turbine fuel (ATF) feed as claimed in claim 1, comprising: (a) mixing aviation turbine fuel with hydrogen, at the hydrogen to aviation turbine fuel feed ratio in the range of 0.0003:1 to 0.0007:1, and at a pressure in range of 3 bar to 20 bar to obtain a first reaction mixture, (b) heating the first reaction mixture at a temperature range of 150°C to 350°C to obtain a heated mixture, (c) reacting the heated mixture with a hydrotreating catalyst in a reactor to

obtain a reactor effluent, (d) stripping H₂S gas from the reactor effluent in an stripper to obtain a stripper bottom product, (e) mixing the stripper product with the heated mixture obtained in step (b), at the stripper product to heated mixture ratio in the range of 1: 1 to 10:1 to obtain a second reaction mixture, (f) reacting the second reaction mixture with a hydrotreating catalyst in a reactor to obtain a reactor effluent, (g) stripping H₂S gas from the reactor effluent in a stripper to obtain a stripper bottom product, (h) repeating steps (e) to (g), and (i) removing moisture from the stripper bottom product to obtain aviation turbine fuel product having less than 10 ppm mercaptan.

[13] The present invention further relates to an aviation turbine fuel product having less than 10 ppm mercaptan prepared by a process of the present invention.

[14] The process selectively reduces mercaptan to less than 10 ppm while retaining other sulfur compounds from aviation turbine fuel feed having not more than 350 ppm mercaptan and 2500 ppm Sulfur level. Acidity and colour are also improved.

[15] These and other features, aspects, and advantages of the present subject matter will become better understood with reference to the following description and appended claims. This summary is provided to introduce a selection of concepts in a simplified form. This summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

BRIEF DESCRIPTION OF DRAWINGS:

[16] The above and other features, aspects, and advantages of the subject matter will become better understood with regard to the following description, appended claims, and accompanying drawings where:

[17] **Figure 1** is a schematic illustration of the process of present invention for new grass root unit. In this figure the reference numerals represents: exchanger **3**, control valve **5**, reactor **7**, furnace **8**, stripper **9**, sand filter **12** and salt dryer **14**.

[18] **Figure 2** is a schematic illustration of the process of present invention for retrofitting in existing unit. In this figure the reference numerals represents: exchanger **2**, recycle gas compressor **4**, furnace **7**, reactor **9**, separator **11**, stripper **14**, sand filter **17** and salt dryer **19**.

DETAILED DESCRIPTION OF THE INVENTION

[19] The present invention relates to a process for the selective removal of mercaptan from aviation turbine fuel (ATF) feed comprising: mixing aviation turbine fuel feed with hydrogen at a pressure in range of 3 bar to 20 bar to obtain a reaction mixture, heating the reaction mixture at a temperature range of 150°C to 350°C to obtain a heated mixture, reacting the heated mixture with a hydrotreating catalyst in a reactor to obtain a reactor effluent, stripping H₂S gas from the reactor effluent to obtain a stripper bottom product, and removing moisture from the stripper bottom product to obtain aviation turbine fuel product having less than 10 ppm mercaptan.

[20] Another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed wherein the aviation turbine fuel feed has boiling range of about 120°C to about 330°C.

[21] Further embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the aviation turbine fuel feed has boiling range of about 140°C to about 280°C.

[22] Yet, another embodiment of the present invention provides a process for selective removal of mercaptan from a aviation turbine fuel feed, wherein the aviation turbine fuel feed has mercaptan content not more than about 350 ppm and sulfur content not more than about 2500 ppm.

[23] Still, another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the aviation turbine fuel feed is straight run hydrocarbon stream from crude distillation unit.

[24] Further an embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein aviation turbine fuel feed is a petroleum fraction.

[25] Still another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein said process is performed at a Liquid Hourly Space Velocity in the range of 4.0 hr⁻¹ to 6.0 hr⁻¹ with respect to the fresh feed.

[26] Further an embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the catalyst is cobalt molybdenum catalyst or nickel molybdenum catalyst.

[27] Another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the catalyst is supported on a support material such as alumina.

[28] Still another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the catalyst is sulfided prior to use.

[29] Another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the physical surface area of the support material is between 150-200 m²/g, the pore volume of the catalyst is between 0.3-0.6 cc/gm. The average pore diameter is between 60-100 °A. The metal content in the cobalt molybdenum catalyst is 2.5-3.5 wt % cobalt oxide and 13-15 wt % of molybdenum oxide.

[30] Further an embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the partial pressure is in the range of about 5 bar to about 15 bar.

[31] Yet another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the partial pressure is in the range of about 8 bar to about 12 bar.

[32] Still another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the temperature is in the range of 225°C-300°C.

[33] An embodiment of the present invention relates to a process for selective removal of mercaptan from aviation turbine fuel (ATF) feed comprising: mixing aviation turbine fuel feed with hydrogen gas at a hydrogen gas to aviation turbine fuel feed ratio in the range of 20:1 to 50:1, and at a partial pressure in range of 3 bar to 20 bar to obtain a reaction mixture, heating the reaction mixture at a temperature range of 150°C to 350°C to obtain heated mixture, reacting the heated mixture with a hydrotreating catalyst in a reactor to obtain reactor effluent, stripping H₂S gas from the reactor effluent to obtain stripper bottom product, and removing moisture from the

stripper bottom product to obtain aviation turbine fuel product having less than 10 ppm mercaptan.

[34] Another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed wherein the aviation turbine fuel feed has boiling range of about 120°C to about 330°C.

[35] Further embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the aviation turbine fuel feed has boiling range of about 140°C to about 280°C.

[36] Yet, another embodiment of the present invention provides a process for selective removal of mercaptan from a aviation turbine fuel feed, wherein the aviation turbine fuel feed has mercaptan content not more than about 350 ppm and sulfur content not more than about 2500 ppm.

[37] Still, another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the aviation turbine fuel feed is straight run hydrocarbon stream from crude distillation unit.

[38] Further an embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein aviation turbine fuel feed is a petroleum fraction.

[39] Still another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein said process is performed at a Liquid Hourly Space Velocity in the range of 4.0 hr⁻¹ to 6.0 hr⁻¹ with respect to the fresh feed.

[40] Another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the catalyst is cobalt molybdenum catalyst or nickel molybdenum catalyst.

[41] Yet, another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the catalyst is supported on a support material such as alumina.

[42] Still another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the catalyst is sulfided prior to use.

[43] Another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the physical surface area of the support material is between 150-200 m²/g, the pore volume of the catalyst is between 0.3-0.6 cc/gm. The average pore diameter is between 60-100 °A. The metal content in the cobalt molybdenum catalyst is 2.5-3.5 wt % cobalt oxide and 13-15 wt % of molybdenum oxide.

[44] Further an embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the partial pressure is in the range of about 5 bar to about 15 bar.

[45] Yet another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the partial pressure is in the range of about 8 bar to about 12 bar.

[46] Still another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the temperature is in the range of 225°C-300°C.

[47] Further an embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the hydrogen gas is a reformer off- gas or recycled gas from other hydroprocessing units such as diesel hydrotreating (DHDT) unit or diesel hydrodesulfurisation (DHDS) unit.

[48] An embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel (ATF) feed, comprising: (a) mixing aviation turbine fuel with hydrogen, at the hydrogen to aviation turbine fuel feed ratio in the range of 0.0003:1 to 0.0007:1, and at a pressure in range of 3 bar to 20 bar to obtain a first reaction mixture, (b) heating the first reaction mixture at a temperature range of 150°C to 350°C to obtain a heated mixture, (c) reacting the heated mixture with a hydrotreating catalyst in a reactor to obtain a reactor effluent, (d) stripping H₂S gas from the reactor effluent in a stripper to obtain a stripper bottom product, (e) mixing the stripper product with the heated mixture obtained in step (b), at the stripper product to heated mixture ratio in the range of 1: 1 to 10:1 to obtain a second reaction mixture, (f) reacting the second reaction mixture with a hydrotreating catalyst in a reactor to obtain a reactor effluent, (g) stripping H₂S gas from the reactor effluent in a stripper to obtain a stripper bottom product, (h) repeating steps (e) to (g), and (i) removing moisture from the

stripper bottom product to obtain aviation turbine fuel product having less than 10 ppm mercaptan.

[49] Another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed wherein the aviation turbine fuel feed has boiling range of about 120°C to about 330°C.

[50] Further embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the aviation turbine fuel feed has boiling range of about 140°C to about 280°C.

[51] Yet, another embodiment of the present invention provides a process for selective removal of mercaptan from a aviation turbine fuel feed, wherein the aviation turbine fuel feed has mercaptan content not more than about 350 ppm and sulfur content not more than about 2500 ppm.

[52] Still, another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the aviation turbine fuel feed is straight run hydrocarbon stream from crude distillation unit.

[53] Further an embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein aviation turbine fuel feed is a petroleum fraction.

[54] Still another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein said process is performed at a Liquid Hourly Space Velocity in the range of 4.0 hr⁻¹ to 6.0 hr⁻¹ with respect to the fresh feed.

[55] Further embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the catalyst is cobalt molybdenum catalyst or nickel molybdenum catalyst.

[56] Another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the catalyst is supported on a support material such as alumina.

[57] Still another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the catalyst is sulfided prior to use.

[58] Another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the physical surface area of the support material is between 150-200 m²/g, the pore volume of the catalyst is between 0.3-0.6 cc/gm. The average pore diameter is between 60-100 °A. The metal content in the cobalt molybdenum catalyst is 2.5-3.5 wt % cobalt oxide and 13-15 wt % of molybdenum oxide.

[59] Further an embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the partial pressure is in the range of about 5 bar to about 15 bar.

[60] Yet another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the partial pressure is in the range of about 8 bar to about 12 bar.

[61] Still another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed, wherein the temperature is in the range of 225°C-300°C.

[62] An embodiment of the present invention provides an aviation turbine fuel product having less than 10 ppm mercaptan prepared by a process of the present invention.

[63] Yet another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed which in addition to selective mercaptan removal, improves other product properties such as colour, acidity thereby providing flexibility of processing feed composition with high mercaptan as well as high acidity and does not require handling of caustic.

[64] An embodiment of the present invention provides an aviation turbine fuel product having superior properties in comparison to the products obtained through Merox process (known process). These superior properties of the aviation turbine fuel product of the present invention are given in the table below:

	Product Properties	Merox Process	Present Invention
1.	Mercaptan (ppm)	10-20	0-5
2.	Acidity (mg KOH/g)	~40% reduction	~70% reduction
3.	Colour (Saybolt)	worse than the feed	Better than the feed
4.	Doctors Test	Negative to Slightly +ve	Negative

5.	Sulfur (ppm)	Same as Feed	Can be controlled
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[65] Another embodiment of the present invention provides a process for selective removal of mercaptan from aviation turbine fuel feed which employs a Ni-Mo or Co-Mo type hydrotreating catalyst at low severity.

[66] The feed for the process of the present invention is an aviation turbine fuel containing mercaptan not more than about 350 ppm and sulfur content not more than about 2500 ppm, with a boiling point ranges from about 120°C to about 330°C.

[67] The product of the process of the present invention is an aviation turbine fuel containing less than 10 ppm of mercaptan.

[68] The process of the present invention is flexible and can be employed for a grass root unit or retrofitting existing conventional hydrotreating units. For grass root unit, the process utilizes mixing of hydrotreated product with feed composition and negligible hydrogen for meeting chemical hydrogen consumption and losses. The process can also be operated with excess hydrogen gas for retrofitting in existing units having recycle gas compressor.

[69] The process of the present invention selectively removes mercaptan from feed composition with minimum removal of other sulfur compounds thereby not affecting the product lubricity. Also, selective removal helps in minimizing chemical hydrogen consumption compared to conventional hydroprocessing technologies for ATF. The process is particularly suitable for production of commercial ATF. The process has distinct advantage over competing Merox process in terms of improved colour, acidity of the product and does not require handling of caustic.

[70] Liquid Hourly Space Velocity (LHSV) is the ratio of the hourly volume of oil processed to the volume of catalyst. It is generally expressed as $v/v/hr$ or h^{-1} .

[71] This invention is illustrated in the accompanying drawings, throughout which like reference letters indicate corresponding parts in the various figures.

[72] The process of present invention for new grass root unit, which is schematically illustrated in Figure 1, comprising: mixing aviation turbine fuel (ATF) feed via line 1 and hydrogen gas for meeting chemical hydrogen consumption and losses via line 2 to obtain a mixture, heating the mixture to a reaction temperature of 225-300°C in an exchanger 3, the heated mixture along with hydrotreated ATF product from stripper bottom via line 4 and through

control valve 5 is sent to the reactor 7 via line 6, in reactor 7 mercaptan from ATF feed are selectively removed over a Co-Mo catalyst and the reactor effluent is then further heated in a furnace 8 for stripping H_2S in a stripper 9. H_2S is removed from the top of the stripper via line 10 and part of stripper bottom product after heat exchange in exchanger 3 is sent via line 11 to the sand filter 12 and then via line 13 to the salt dryer 14 for moisture removal. The finished hydrotreated ATF product is sent to the storage via line 15.

[73] The process of the present invention for retrofitting in existing unit, which is schematically illustrated in Figure 2, comprising: preheating ATF feed via line 1 in exchanger 2, mixing preheated ATF feed with recycle gas from recycle gas compressor 4 via line 5 after combining with make up hydrogen gas via line 3 to obtain a mixture, the mixture of hydrogen gas and ATF feed are heated in furnace 7 via line 6 to a reaction temperature of 225-300°C and the heated mixture is sent via line 8 to the reactor 9. In reactor 9, mercaptan from ATF feed are selectively removed over a Co-Mo catalyst and the reactor effluent after exchanging heat in the exchanger 2 is sent to the separator 11. The liquid product from separator 11 is sent via line 13 to stripper 14. H_2S is removed from the top of the stripper via line 15 and stripper bottom product is sent via line 16 to sand filter 17 and then via line 18 to salt dryer 19 for removal of moisture. The finished hydrotreated ATF product is sent to the storage via line 20.

EXAMPLES

[74] The following examples are given by way of illustration of the present invention and should not be construed to limit the scope of present disclosure. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are intended to provide further explanation of the claimed subject matter.

Example – 1

[75] The process of the present invention was conducted using aviation turbine fuel (ATF) feed. Aviation turbine fuel (ATF) feed and hydrogen gas for meeting chemical hydrogen consumption and losses are mixed to obtain a mixture, the mixture is heated to a reaction temperature of 150-300°C in an exchanger, the heated mixture along with hydrotreated ATF product from stripper bottom and through control valve is sent to the reactor. In reactor mercaptan from ATF feed are selectively removed over a Co-Mo catalyst and the reactor effluent is then further heated in a furnace for stripping H_2S in a stripper. H_2S is removed from the top of the stripper and stripper bottom product after heat exchange in exchanger is sent to the sand filter

and then to the salt dryer for moisture removal. The finished hydrotreated ATF product is sent to the storage.

[76] The properties of ATF feed used for the experiment is given in Table-1. The summary of operating conditions is provided in Table - 2 and the salient results and products' properties tabulated as Table - 3.

Table – 1: Typical Feed (ATF) Properties

	Properties	Value
1.	Mercaptan (ppm)	110
2.	Acidity (mg KOH / g)	0.006
3.	Colour (Saybolt)	+21
4.	Doctors Test	Positive
5.	Sulfur (ppm)	2000

Table - 2: Summary of Operating Conditions

	Operating Conditions	Low	High
1.	Reactor Temperature ($^{\circ}$ C)	225	300
2.	System Pressure (bar)	3	20
3.	H ₂ flow, wt % on fresh feed	0.05	0.1
4.	Liquid LHSV (h^{-1}) on fresh feed	4.0	6.0
5.	Ratio of hydrotreated to fresh ATF	1.0	10.0

Table-3: Summary of Results

Sl. No.	Hydrotreated / Fresh ATF ratio	Pressure (bar)	Temp. (deg. C)	Mercaptan (ppm)
1.	1	10	240	9
2.	5	10	240	7
3.	10	20	230	5

Example - 2

[77] The process of the present invention was conducted using aviation turbine fuel (ATF) feed.

[78] ATF feed is preheated in an exchanger, preheated ATF feed is then mixed with recycle gas from recycle gas compressor after combining with make up hydrogen gas to obtain a mixture, the mixture of hydrogen gas and ATF feed is heated in furnace to a reaction temperature of 225-300°C and the heated mixture is sent to the reactor. In reactor mercaptan from ATF feed are selectively removed over a Co-Mo catalyst and the reactor effluent after exchanging heat in the exchanger is sent to the separator. The liquid product from separator is sent to stripper. H₂S is removed from the top of the stripper and stripper bottom product is sent to sand filter and then to salt dryer for removal of moisture. The finished hydrotreated ATF product is sent to the storage.

[79] The properties of ATF feed used for the experiment are given in Table-4. This ATF feed was fed along with hydrogen to a tubular reactor having Co-MO catalyst. The properties of Co-Mo catalyst, which is used in the present process, are provided in Table -5. The summary of operating conditions is provided in Table - 6 and the salient results and product's properties tabulated as Table - 7.

Table - 4: Typical Feed (ATF) Properties

	Properties	Value
1.	Mercaptan (ppm)	100 - 350
2.	Acidity (mg KOH / g)	0.005 – 0.02
3.	Colour (Saybolt)	+ 16
4.	Doctors Test	Positive
5.	Sulfur (ppm)	1750 - 2200

Table - 5: Typical Catalyst Characteristics

Chemical Composition:	Co-Mo / Al ₂ O ₃
Physical Surface area:	200 cm ² /gm
Pore volume:	0.42 cc / gm
Av. Pore diameter:	80 Å ⁰
Cobalt oxide:	2.8 %
Molybdenum oxide	13.5 %

Table - 6: Summary of Operating Conditions

Operating Conditions	Low	High
Reactor Temperature (°C)	150	300
System Pressure (bar)	3	20
H ₂ : HC Ratio	20	50
Liquid LHSV (h ⁻¹)	4.0	6.0

Table - 7: Summary of Results

Sl. No.	H ₂ :HC ratio	Pressure (bar)	Temp. (deg. C)	Mercaptan (ppm)	Sulfur (ppm)	Acidity mg KOH/g
1.	25:1	3	240	9	1500	0.003
2.	25:1	12	240	7	1420	0.002
3.	50:1	3	240	8	1470	0.003
4.	50:1	12	240	6	1400	0.002
5.*	25:1	12	270	9	1140	0.001

* Feed with higher mercaptan and sulfur used

[80] Other Typical Product Properties:

Flash Point (at 12 bar, 270°C and H₂/HC ratio 25) = 44°C

Freezing Point (at 12 bar, 270°C and H₂/HC ratio 25) = - 49°C

Copper Strip Corrosion Test: 1

BOCLE Lubricity test (at 12 bar, 270°C and H₂/HC ratio 25) = 0.560 mm

Example – 3

[81] The process of the present invention was conducted using aviation turbine fuel (ATF) feed. The property of ATF feed used for the experiment is given in Table-8. ATF feed was fed along with hydrogen gas to a tubular reactor having Co-Mo catalyst. The summary of operating conditions is provided in Table - 9 and the salient results are tabulated as Table - 10.

[82] It has been observed that the violation of operating range in this case with respect to Liquid Hourly Space Velocity (LHSV) results in product not meeting the desired objective of achieving less than 10 ppm mercaptan in the product.

Table – 8: Typical Feed (ATF) Properties

	Properties	Value
1.	Mercaptan (ppm)	100
2.	Acidity (mg KOH / g)	0.008
3.	Colour (Saybolt)	+ 16
4.	Doctors Test	Positive
5.	Sulfur (ppm)	1750

Table - 9: Summary of Operating Conditions

	Operating Conditions	
1.	Reactor Temperature (° C)	240
2.	System Pressure (bar)	12
3.	H ₂ : HC Ratio	25:1
4.	Liquid LHSV (h ⁻¹)	6.5

Table-10: Summary of Results

Mercaptan in product, ppm	30
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Example – 4

[83] Experimentation was conducted using ATF feed (Properties in Table-11) with operating conditions similar to conventional hydrotreating. The summary of operating conditions and the salient results and products' properties are tabulated Table-12. It has been observed that with conventional hydrotreating operating conditions, the product does not meet the specification with respect to lubricity.

Table-11: Typical Feed (ATF) Properties

Sl. No.	Properties	Value
1.	Mercaptan (ppm)	110
2.	Acidity (mg KOH/g)	0.015
3.	Sulfur (ppm)	2000

Table-12: Summary of Results

Sl. No.	H ₂ /HC ratio	Pressure (Bar)	Temperature (°C)	Mercaptan (ppm)	Sulfur (ppm)	Boole Lubricity (mm)
1.	250	30	325	5	80	0.850
2.	250	30	350	3	50	0.900

[84] Although the subject matter has been described in considerable detail with reference to certain preferred embodiments thereof, other embodiments are possible. As such, the spirit and scope of the appended claims should not be limited to the description of the preferred embodiment contained therein.

CLAIMS:

1. A process for selective removal of mercaptan from aviation turbine fuel (ATF) feed comprising:

mixing aviation turbine fuel feed with hydrogen, at a pressure in range of 3 bar to 20 bar to obtain a reaction mixture,

heating the reaction mixture at a temperature range of 150°C to 350°C to obtain a heated mixture,

reacting the heated mixture with a hydrotreating catalyst in a reactor to obtain a reactor effluent,

stripping H₂S gas from the reactor effluent to obtain a stripper bottom product, and

removing moisture from the stripper bottom product to obtain aviation turbine fuel product having less than 10 ppm mercaptan.

2. The process for selective removal of mercaptan from aviation turbine fuel (ATF) feed as claimed in claim 1, comprising:

mixing aviation turbine fuel feed with hydrogen gas at the hydrogen gas to aviation turbine fuel feed ratio in the range of 20:1 to 50:1, and at a pressure in range of 3 bar to 20 bar to obtain a reaction mixture,

heating the reaction mixture at a temperature range of 150°C to 350°C to obtain a heated mixture,

reacting the heated mixture with a hydrotreating catalyst in a reactor to obtain a reactor effluent,

stripping H₂S gas from the reactor effluent to obtain a stripper bottom product, and

removing moisture from the stripper bottom product to obtain aviation turbine fuel product having less than 10 ppm mercaptan.

3. The process for selective removal of mercaptan from aviation turbine fuel (ATF) feed as claimed in claim 1, comprising:

(a) mixing aviation turbine fuel feed with hydrogen, at the hydrogen to aviation turbine fuel feed ratio in the range of 0.0003:1 to 0.0007:1, and at a pressure in range of 3 bar to 20 bar to obtain a first reaction mixture,

(b) heating the first reaction mixture at a temperature range of 150°C to 350°C to obtain a heated mixture,

(c) reacting the heated mixture with a hydrotreating catalyst in a reactor to obtain a reactor effluent,

(d) stripping H₂S gas from the reactor effluent in an stripper to obtain a stripper bottom product,

(e) mixing the stripper product with the heated mixture obtained in step (b), at the stripper product to heated mixture ratio in the range of 1: 1 to 10:1 to obtain a second reaction mixture,

(f) reacting the second reaction mixture with a hydrotreating catalyst in a reactor to obtain a reactor effluent,

(g) stripping H₂S gas from the reactor effluent in an stripper to obtain a stripper bottom product,

(h) repeating steps (e) to (g), and

(i) removing moisture from the stripper bottom product to obtain aviation turbine fuel product having less than 10 ppm mercaptan.

4. The process as claimed in any of claims 1 to 3; wherein the aviation turbine fuel feed has boiling range of about 120°C to about 300°C, preferably between about 140°C to about 280°C.

5. The process as claimed in claim 2, wherein the hydrogen gas is reformer off-gas or recycle gas from diesel hydrotreating (DHDT) unit or diesel hydrodesulfurisation (DHDS) unit.

6. The process as claimed in any of claims 1 to 3, wherein said process is performed at a Liquid Hourly Space Velocity in the range of 4.0 hr⁻¹ to 6.0 hr⁻¹.

7. The process as claimed in any of claims 1 to 3, wherein the hydrotreating catalyst is cobalt molybdenum catalyst or nickel molybdenum catalyst.

8. The process as claimed in claim 7, wherein the catalyst is supported on alumina.
9. The process as claimed in claim 7, wherein the catalyst is sulfided prior to use.
10. The process as claimed in any of claims 1 to 3, wherein the pressure is in the range of about 5 bar to 15 bar, preferably 8 bar to 12 bar.
11. The process as claimed in any of claims 1 to 3, wherein the temperature is in the range of 225°C-350°C.
12. An aviation turbine fuel product having less than 10 ppm mercaptan prepared by a process as claimed in any of claims 1 to 11.

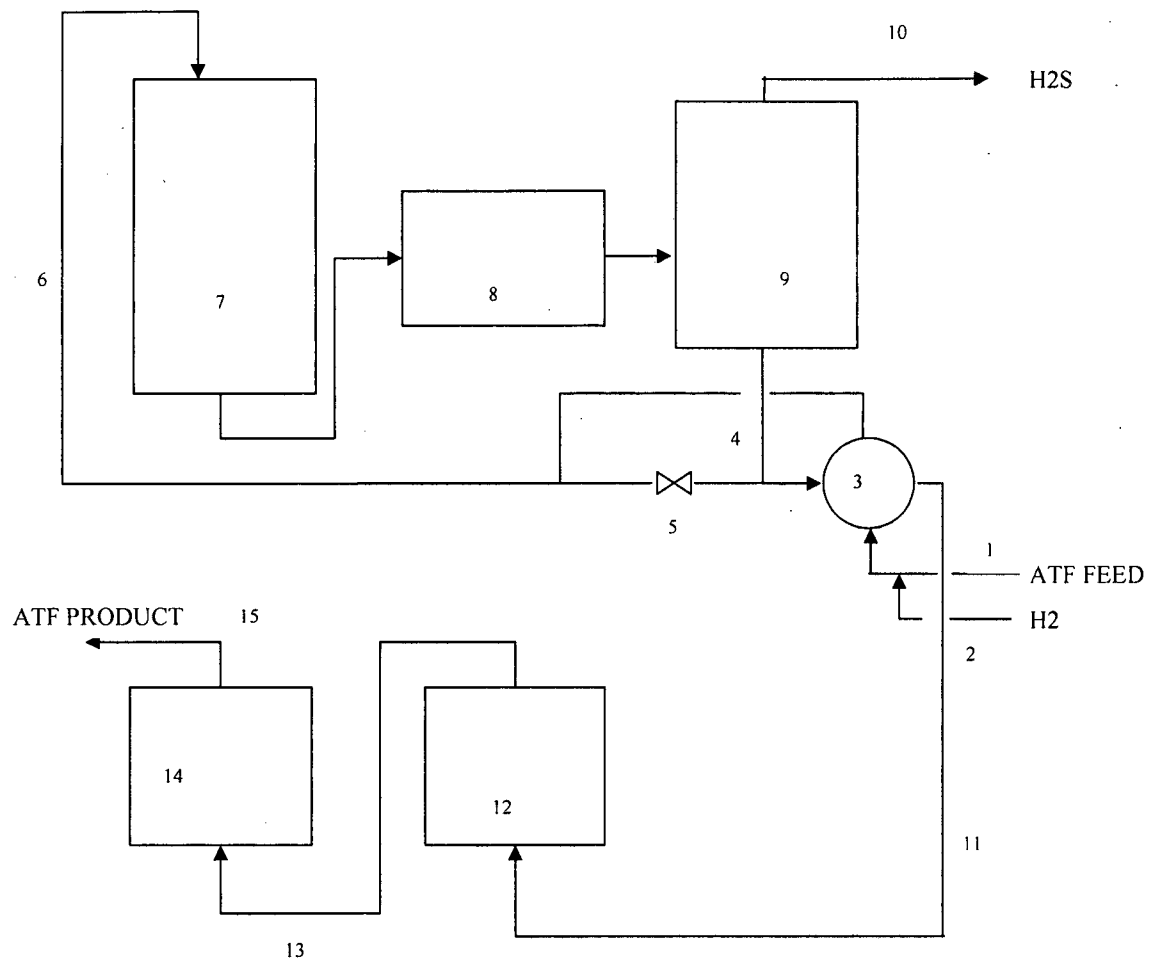


FIGURE 1

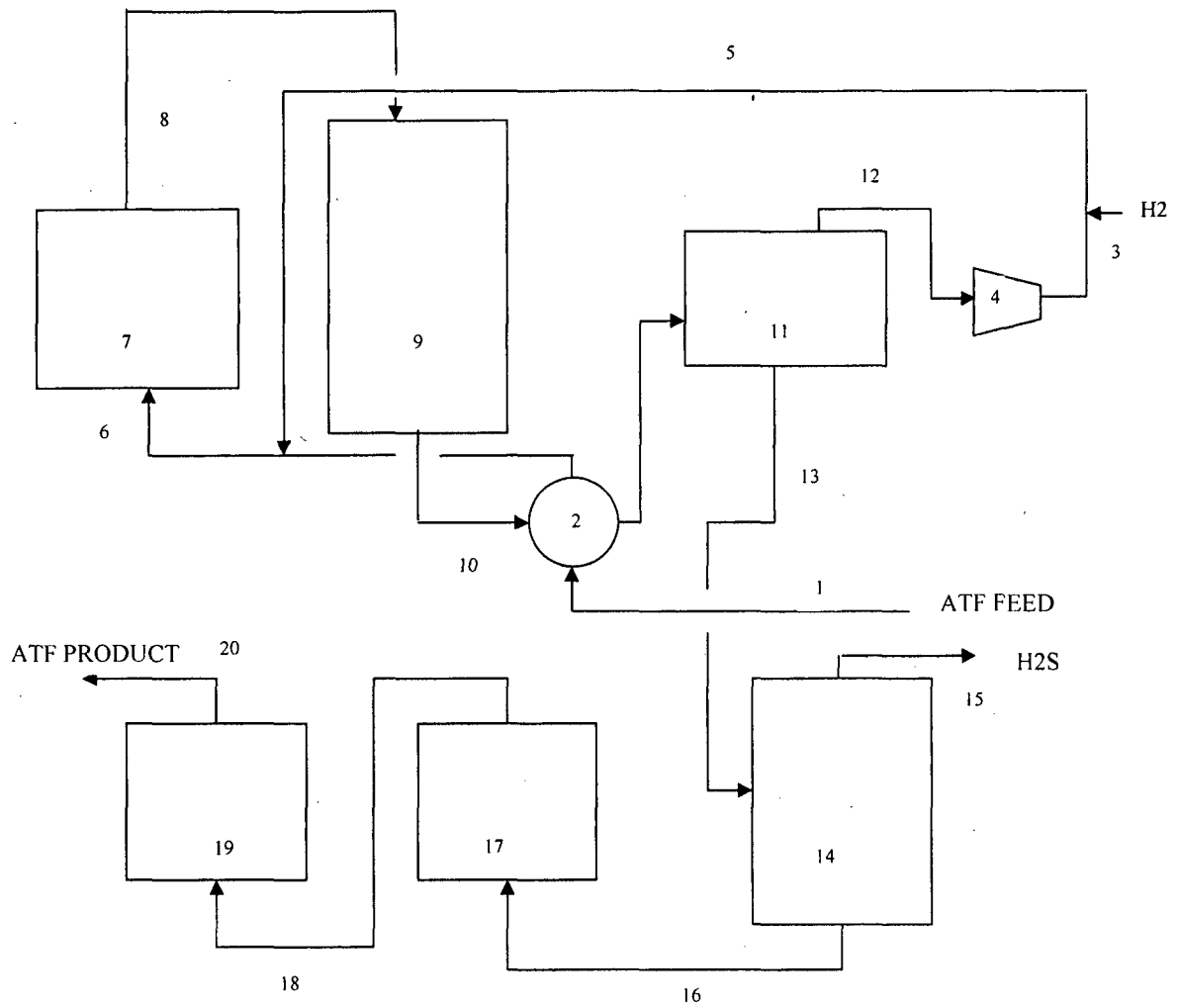


FIGURE 2