ISOPROPYL ALCOHOL
THE PROCESS FLOW DIAGRAM IPA
ISOPROPYL ALCOHOL

IUPAC

ECONOMIC

PRODUCTION

CHEMICAL PROPERTIES

HEALTH AND SAFETY

USES

PHYSICAL PROPERTIES
PHYSICAL PROPERTIES

- Odour: Strong alcohol
- Colour: Colourless
- Molar mass: 60.09 g mol⁻¹
- Solubility: Soluble in all organic, insoluble in salt
- Boiling point: 82.5°C
- Melting point: -89°C
- Fairly volatile, evaporates easily
- Miscible in water
- Melting point: 89°C
- Colourless
• Dehydrogenation
• Oxidation
• Etherification
• Halogenations
PRODUCTION METHOD

- Direct
- Indirect
USES

- Pharmaceutical industry
- Construction field – wood
- Plantation industry – pesticides
- Cosmetics – baby oils, lotions, etc.
- Aerosol – hair spray, detergents, etc.
- Removing sticky residue
HEALTH AND SAFETY

- Industry (not harm)
- Highly flammable/explosion — away from heat, open flame, ignition sources and incompatibles
- Defect to human skin — use glove
ECONOMICS

- rose by 5% to $1240/tonne from $1200/tonne in mid-April
- Geo Chem Trading located in Penang Port, Butterworth Penang.
BLOCK DIAGRAM FOR INDIRECT HYDRATION OF ISOPROPYL ALCOHOL
Title: PFD study of the Production of Isopropyl Alcohol-indirect hydration method

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INITIAL INPUTS:
- RAW MATERIALS CONSIST OF:
  1. SULPHURIC ACIDS (60%-70% WT)
  2. PROPYLENE GAS (45%, WT)

PRODUCTS:
1. ANHYDROUS ISOPROPYL ALCOHOL
2. AZETIOPE ISOPROPYL ALCOHOL
3. DIBOISOPROPYL ETHER
STEP 1

- **Stream 1** (concentrated Sulphuric Acid *(60-70 wt%)*) + **stream 2** (Propylene Gases *(45 wt%)*)
- Occur in the absorber **C100**
- Condition for the absorber **C100** are:
  1. At the pressure **150-300 psig**.
  2. At temperature **85-115°C**.
PROPYLENE FEED

CONCENTRATED SULFURIC ACID FEED

ABSORBER C100
STEP 2

- **Stream 1 + Stream 2** = extract liquid in the absorber C100.

- Extract liquid consist of:
  1. **40 to 65 wt%** of Sulphuric Acid,
  2. about **10 to 40 wt%** of absorbed Propylene values,
  3. balance water,
  4. Absorbed propylene=all molecule in the liquid (propyl \((C_3H_7)\), and propylene \((C_3H_6)\))
  5. IPA at **10-45 wt%**,
  6. Diisopropyl Ether at **3-6 wt%**,

- The extract liquid is withdrawn from the bottom portion of absorber via **Stream 3** to the **mixer M100**.
PFD DESCRIPTION

STEP 3

- *Unabsorbed gas*- Propylene gas are withdrawn and compressed to propylene column by **c104** via **stream 4**.
- It will refined- produced recovered Propylene Gas and some Propane.
- The recovered gas-being *recycled* by **stream 5**.
PFD DESCRIPTION

STEP 4

• In the mixer M100.
  1. **Stream 3** mixes with **stream 7** which feed with water.
  2. Water is added in an amount from about **1.5 to 6 wt% water**, based on the weight of absorbed Propylene values in the extract liquid.
  3. It will make sure the moles of water **stoichiometrically** required to form the amount of Diisopropyl Ether and Isopropyl Alcohol withdrawn as vapor in the flash vessel C101.
PFD DESCRIPTION

STEP 5

• Flash vessels C101 is operate in the condition of:-
  1. At temperature between 80 to 160°C.
  2. At pressure from about 5 to 10 psig.

• The overhead products is withdrawn and being compressed by C101 via stream 10 comprising:
  1. Diisopropyl Ether from about 30 to 50 wt%,
  2. Isopropyl Alcohol from about 30 to 40 wt%,
  3. Propylene from about 10 to 20 wt%.

• Liquid which is withdrawn from the flash vessel via stream 9 comprises the depleted extract:-
  1. Absorbed Propylene - 5 to 35 wt%,
  2. Sulphuric acids- 45 to 65 wt%,
PFD DESCRIPTION

STEP 6

- Depleted extract have 2 portions:
  - First portion (40 to 60 wt% of total) will be recycled, pump by P100 through stream 11 and 1 to absorber C100.
  - A control valve V100 – increase or decrease liquid flow between stream 11 and 12 and control Diisopropyl Ether and Isopropyl Alcohol production.
  - Second portion is sent to second water mixing zone M101.
The depleted liquids in stream 12 flow to mixer M101.

In the mixer M101:

Depleted extract mixes stream 13 which feed with water (35 to 100 parts by weight of water per part by weight of absorbed Propylene Values).

The liquid residence time in water mixing zone ranges from about 1 to 30 minutes.
The mixture sent via stream 14 to alcohol generator C102 to be heated.

Direct injection steam at stream 15 to generator.

Unit operation for Alcohol generator are:
1. At temperature about 70 to 130°C
2. Pressure about 1 to 5 psig

Alcohol vapor are formed as overhead product and sent to scrubber C103 via stream 17-comprised IPA and Diisopropyl Ether.

Sulphuric acid about 45 to 55 wt% is withdrawn from lower portion of alcohol generator to acid concentrator via stream 16.
PFD DESCRIPTION

STEP 9

- Product **stream 10** mixed with product in **stream 17**-flow to the scrubber **C103**.
- Product in scrubber have been *neutralized* using NaOH at concentration **10 wt%** of the alcohol and Sulphuric mixture.
- Unit operation of the Scrubber C103:-
  1. At temperature **373K**.
  2. Pressure **14.7 psi**.
- The product at **55 wt%** IPA is withdrawn from a lower part to crude isopropyl alcohol tank **F100**.
- From the tank, mixture is sent to ether column **C105**
Mixture in **F100** will send to ether column **C105** via stream 20.

Unit operations for Ether column **C105** are:

1. At the temperature **362 K**.
2. Pressure **14.7 psi**.

Distillation take place to separate Diisopropyl Ether and Hexene.

Diisopropyl Ether is withdrawn to Diisopropyl Column **C109**.

Washed to produce washed Ether at **95 wt.%**.
PFD DESCRIPTION
STEP 10

- Wet IPA from Ether column C105 will be send to Alcohol column C106 via stream 22.
- Unit operation for Alcohol Column C106:
  1. At pressure about 3 to 7 atm.

- Azeotroping agent is feed near the top of column C106 via stream 23 which is produce in drying column C107.
- CBM or azeotropic isopropyl alcohol at 87 wt% is withdrawn from upper part of alcohol column via stream 24 (product) while water is withdrawn from bottom of column via stream 25.
PFD DESCRIPTION
STEP 11

• Unit operation for Drying column C107:
  1. At pressure 14.7 psi.
  2. Temperature 347 K.

• Product form: Ternery Azeotrope.
• Latter concentrate at head column in concentration about 60% is piped into condenser.
• Liquefaction of vapor enter decanter F101 to separate the layers into virtually water-free upper layer and lower layer containing the residual water.
• The upper layers in F101 (mainly azeotroping agent and alcohol) is return to the top of column C107.
• While anhydrous Isopropyl Alcohol at 99.8 wt% is removed from the lower part of column C107 via stream 29.
PFD DESCRIPTION

STEP 12

• The lower layer in the decanter F101 is mostly water.
• It is fed into stripping column C108.
• Unit operation for Stripping column C108:
  1. a temperature 466K.
  2. pressure about 155 psi.
• The waste water in F101 is send to C108 via stream 30 for recovery of Isopropyl Alcohol and azeotroping agent.
• This product is send back into column C107 via stream 31 and waste the water at stream 32.
CONCLUSION

- The indirect process = Propene with sulfuric acid to form a mixture of sulfate esters and subsequent hydrolysis will produce isopropyl alcohol.

- Direct hydration = Propene and water, either in gas or liquid phases, at high pressures in the presence of solid or supported acidic catalysts.
• Use of IPA in direct solvent applications accounted for 62% of total IPA demand in 2008.

• Global IPA-based acetone production is expected to decrease with the increase of phenol capacity (acetone is a coproduct of phenol by the cumene peroxidation process). Acetone will be producing after 2010 in Western Europe.

• In 2008, global supply/demand was relatively balanced as demand decreased because of the weakened global economy.

• The future demand of IPA is expected to remain flat or to grow slightly.

• Its main usage as a chemical intermediate is growing, and this should offset the pressure on use as a solvent from tighter volatile organic chemicals (VOC) regulations.