Name: Idaye Tamunonengiofori Peniel.

Department: Mechanical Engineering.

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**Question**

1. Discuss the two major classification of Alkanols. Give two Examples each for each class.
2. In the Grignard synthesis of Alkanols, react a named Grignard reagent with CH3CH2CH2CH2C$=$OCH2CH2CH3. Show the reaction steps.
3. Discuss the industrial manufacture of ethanol showing all reaction equations and necessary enzymes and temperature of reaction.
4. Determine the product obtained in the reduction of Alkanone and Alkanal. Use a specific example for each and show the equation of reaction.

**Answers.**

**(1)**

The two major classification of Alkanols are;

1. Based on the number of Hydroxyl group per molecule.
2. Based on the number of Alkyl group per molecule.
3. Based on the number of Hydroxyl group per molecule, Alkanols can be group into;
* Monohydric Alkanols – These are Alkanols having one hydroxyl group in their molecules. Examples are:

 H H H

 │ │ │

H―C―OH H― C―C―OH

 │ │ │

 H H H

 **Methanol Ethanol**

* Polyhydric Alkanols –This are Alkanols having more than one hydroxyl group in their molecules. Polyhydric Alkanols can be Dihydric(2), Trihydric(3), e.t.c.

Examples are:

H H H H H

│ │ │ │ │

H―C—C—H H—C—C—C—H

│ │ │ │ │

OH OH OH OH OH

**Ethane 1,2 - diol Ethane 1,2,3 - Triol**

 **(Dihydric Alkanol) (Trihydric Alkanol)**

1. Based on the number of Alkyl group per molecule, Alkanols can be classified into;
* Primary Group ― These Alkanols have only one Alkyl group attached to the carbon atom that carries the hydroxyl group.

Examples include:

CH3 H C2H5 H H

│ │ │ │ │

H3C—C—C—OH H3C—C— C—C—OH

│ │ │ │ │

H H H H H

**2-methylpropan-1-ol 3-ethylbutan-1-ol**

* Secondary Group ― These Alkanols have two Alkyl group attached to the carbon atom that carries the hydroxyl group.

Examples include:

CH3 CH3 H

│ │ │

H5C2—C—OH H3C—C— C—CH3

│ │ │

H H OH

**Buthan-2-ol** **3 methylbuthan-2-ol**

* Tertiary Group ― These Alkanols have three Alkyl group attached to the carbon atom that carries the hydroxyl group.

Examples include:

 CH3

 │

H3C—C—OH

 │

 CH3

**2-methylpropan-2-ol**

**(2)**

STEP I: The Grignard reagent add across the carbon-oxygen double bond

 O CH3CH2CH2CH2

 ││ │

CH3CH2MgBr + CH3CH2CH2—C—CH2CH2CH3 CH3CH2—C—O—MgBr

 │

 CH2CH2CH3

STEP II :Dilute acid is then added to the above reaction to hydrolyze it

 CH3CH2CH2CH2CH3CH2CH2CH2

 **│** H3O+**│**

 CH3CH2—C—O—MgBr CH3CH2—C—OH + MG(OH)BR (**4 ethyloctan-4-ol)**

│ │

 CH2CH2CH3 CH2CH2CH3

 **(3)**

Ethanol is manufactured by reacting ethane with steam (heat). The catalyst used is solid silicon dioxide coated with phosphoric (V) acid. The reaction is reversible.

 H3PO4

CH2=CH2(g) CH3CH2OH(g)

Only 5% of the ethane is converted into ethanol at each pass through the reactor. By removing the ethanol from the ethanol from the equilibrium mixture and recycling the ethane, it is possible to achieve an overall 95% conversion.

A flow scheme fodr thew reaction looks like this:

300oc

60-70 atm phosphorus (V) acid catalyst

1 volume of ethane + 0.6 vol. of stream

Ethanol

Gases are cooled and ethanol turns to liquid

Unreacted gases recycled

**(4)**

Alkanals are reduced to primary alkanols while Alkanones are reduced to secondary alkanols by reducing

Agents like lithium tetrahydridoaluminate (III), LIAH4, and Sodium tetrahydridoborate(III), NaBH4

 H

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CH3— C = O + 2[H] CH3CH2—OH

 **Ethanal Ethanol**

CH2 CH3

│ │

CH3—C=O + 2[H] CH3—C—OH

│

H

**Propan-2-one Propan-2-ol**