Reaction between Sulphuric Acid and Alkenes

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1.0.0

Revision History

Revision	Date	Author(s)	Description
1.0.0	14.10.2016	Sam White	Initial Version

1 Sequential Method

1. Place $1\,cm^3$ or $2\,cm^3$ of concentrated sulphuric acid into a test tube held in a test tube rack and add $0.5\,cm^3$ of the alkene.
2. Shake the test tube gently.

1.1 Diagram

N/A

1.2 Reasons for Method

- A test tube rack is used to minimise the risk of contact between the concentrated sulphuric acid and the skin since the concentrated acid is highly corrosive.
- The test tube is gently shaken to encourage the interactions between the two reactants, hence increasing the rate of reaction between them since they are immicible.
- Small volumes of the reactants are used due to reduce the danger and risk of contact with the sulphuric acid.

1.3 Uncertainties in any Measurements

N/A

2 Results and Observations

The concentrated sulphuric acid is initally fairly viscous. When the alkene is added two layers initally form however these slowly become homogenous, the solution become more viscous and it changes colour from colourless to orange.

2.1 Processed Results

N/A

2.2 Calculations

N/A

2.3 Uncertainty in Final Answer

N/A

3 Conclusions Drawn

The sulphuric acid reacts with the alkene to produce a alkyl hydrogensulphate. This is responsible for the increase in the viscosity of the mixture and the colour change. Two layers initally form since the alkene is insoluble in the H_2SO_4, however the alkyl hydrogensulphate is soluble in the acid, hence the miture becomes homogenous as the reaction progresses.

The mechanism for this reaction involves the H_2SO_4 acting as an electrophile where the highly polar O−H bond undergoes heterolytic fission resulting in the addition of a hydrogen to the alkene and the formation of a carbocation. The hydrogensulphate ion ($HSO_4{}^-$) produced then combines with the carbocation to form the alkyl hydrogensulphate. This would then by hydrolysed to an alcohol if warmed with water.

$$C_2H_4(l) + H_2SO_4(l) \longrightarrow CH_3CH_2OSO_2OH$$

$$CH_3CH_2OSO_2OH + H_2O \xrightarrow{\text{heat}} CH_3CH_2OH + H_2SO_4$$

In industry alcohols are instead manufactured by the direct hydration of the alkene by passing the alkene mixed with steam over a catalyst coated in acid at realtivly high pressures and temperatures (for example a solid silcon dioxide coated in phosphoric(V) acid, at 60 to 70 atmospheres at 300 °C). This process is used instead as it is cheaper and easier to complete on a production scale.

4 Evaluation

4.1 Systematic Errors

N/A

4.2 Uncertainties

N/A