DMSO as a Solvent for Distillation of IPA and Water

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Abstract: Distillation is the process of separation of two components based on their boiling point. If the boiling point of two components are same then third component is use as a solvent or entrainer for separation. IPA and water when undergoing distillation form a minimum boiling azeotrope showing positive deviation from ideality with a composition of about 67.28 mol% IPA and 32.72 mol% water at 1 atm and 80.18°C. For the separation of IPA and water, more conventional mechanism i.e. extractive distillation where Dimethyl Sulfoxide (DMSO) was used as an entrainer. In this paper batch distillation process is demonstrated for the separation of IPA and water using DMSO as solvent and the result are analysis using Gas chromatography.

Keywords: Distillation, extractive, IPA, Water, DMSO.

1. INTRODUCTION
Chemical separation technology is an important branch of chemical engineering, any chemical processes are inseparable from this technology [2]. Distillation plays a very vital role in chemical industry. Distillation process are used very widely in industries to separate two or more components into pure product streams. In distillation relative volatility plays a very important role. Component having higher relative volatility has low boiling point and the component with lower relative volatility has higher boiling point. For example, a mixture of methanol and water can be separated by distillation because methanol is more volatile or boils at a lower temperature than water. If the relative volatility is less than one then then separation is impossible. If relative volatility is equal to one or more than one then separation is possible. In a distillation column, the components with higher relative volatility are removed from the top of the column and called as light key, and the component with less volatile, or heavier, that components are removed from the lower part in distillation column and called as heavy key.

When two component is having less difference in their boiling point then it forms azeotrope. IPA is soluble in water and it forms homogeneous minimum-boiling azeotrope with water at temperature 80.3-80.4°C and 87.4-87.7 mass% [4]. The term azeotrope means “nonboiling by any means”, and denotes a mixture of vapour and liquid components which are in equilibrium with each other at a given pressure and temperature. More specifically, equilibrium means the vapour and liquid has the same composition and the mixture boils at a temperature other than that of the pure components boiling points. Because of boiling at a same temperature azeotropes have sometimes been consider as a single components. Binary azeotrope may be homogenous azeotrope or heterogeneous azeotrope. Homogeneous azeotropic distillation is the process in which the entrainer which is used as a third component alters the relative volatility of the two azeotropic constituents without inducing liquid-liquid separation. Heterogeneous azeotropic distillation is the process in which the entrainer alters the relative volatility of the two azeotropic constituents and induces liquid-liquid separation [3].

The heterogeneous azeotropic distillation systems are frequently used in the chemical industry for separating mixtures of close boilers or breaking azeotropes [9]. Azeotropic and extractive distillation are generally used for the separation of azeotrope. In azeotropic distillation third component which is added is known as entrainer [8], which may be added to the binary mixture to form a new low-boiling azeotrope with one of the original constituents, whose volatility is such that it can easily be separated from the other original constituent [6]. The entrainer added is of high volatility and comes out from the top of distillation column along with distillate which further need to separate in another column. Extractive distillation is a multicomponent-rectification method which is similar azeotropic distillation. The components which forms azeotrope and which is difficult or impossible to separate by ordinary means a third component, termed a solvent, is added which alters the relative volatility of the original constituents, thus permitting the separation. The third component added is, however, of low volatility and taken out from the bottom of distillation column [6]. Isopropyl alcohol is generally use as a cleaning agent and solvent in chemical industries. Because of its cleaning property it is also known as rubbing alcohol [7]. Entrainer plays a very important role in distillation process for separation. It makes a boiling point difference in the components whereas a criterion for entrainer selection is dependent on the behaviour of the system [5].

Generally the requirements of a satisfactory extractive-distillation solvent are:
1. High selectivity or it should have ability to change the vapour-liquid equilibria of the original mixture.
2. High capacity or it should dissolve the components in the mixture to be separated.
3. Low volatility in order to maintain high concentration in the liquid phase and to prevent vaporization of the solvent with the overhead product.
4. Separability; the solvent should be easily separated from the mixture to which it is added, and it should not form azeotropes with the original substances.
5. The same consideration of cost, toxicity, corrosive character, chemical stability. Low latent heat of vaporization, Low viscosity to provide high tray efficiencies, Low freezing point to allow ease of handling and storage and viscosity apply as for entrainers for azeotropic distillation [1].
2. MATERIALS AND METHOD

2.1 Materials

All chemicals used were of Analytical reagent (A.R) grade. Methanol was used to wash the apparatus. Batch distillation column along with laboratory heater were used for carrying out experiment. For result analysis Gas Chromatography is used. Stop watch were used to measure time.

![Batch distillation column and Gas chromatography](image_url)

**Figure (a): batch distillation column (b) Gas chromatography**

2.2 Batch Distillation Experiment

Experiment were carried out at 85°C the temperature were maintain by using heater. In experiment 180 ml of Isopropyl alcohol with 20 ml of water were used which in the proportion of 90:10. The column was design such that with increase in the amount of distillate the reflux is automatically provided. Mixture of Isopropyl alcohol and water were added in round bottom flask with 50 ml of DMSO and the experiment is carried out. The experiment is carried out for 30 min. Product obtain has a 95 ml of distillate with density of 0.995 gm/cc and 105 ml of residue with density 0.998 gm/cc. The distillate obtain were analysis by using Gas Chromatography.

3. RESULT AND DISCUSSION

The sample obtain from batch distillation were analysis using Gas chromatography and the result obtain were are as follows

![Graph](image_url)

**Data File:** G:\ip and water 2 be 2019-20.Dat

**Method File:**
Sample Name : Sample1  Analysis Type : Percent
Detector : FID  Time : 2:23:57
System : PM  GC
Run Date : 2/4/2020  Chan No : Chan 1

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<th>Area Reject</th>
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<td>60</td>
<td>500</td>
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Table 1: AREA%, HEIGHT %

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SUMMARY

Total Peaks : 3  Dilution Factor : 1.0000
Multiplication Factor : 1.0000  Syssuit Standards : IP
Sample Amount : 100.0000  ISTD Amount : 0.0

4. CONCLUSION

In this article, we have analyzed from the result that almost 99.9% of area and height were covered by IPA which shows that the DMSO can be used as an effective entrainer for the separation of IPA and water mixture. As the time of distillation increase in batch distillation the amount of distillate goes on increasing. It is found that two distillation column will be needed for the separation of IPA and Water by using DMSO as an entrainer.

REFERENCES