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EFFECT OF SALT IN THE SEPARATION OF ETHANOL AND WATER MIXTURE

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Abstract - Separation of ethanol water system can not be done by simple distillation. When ethanol-water azeotrope is boiled, the vapor it produces has proportionate constituents as the original mixture. Because their composition is unchanged by distillation. In most cases, azeotropic mixtures require special methods to facilitate their separation such method utilizes a mass separating agent other than energy that causes or enhances a selective mass transfer of the azeotropic forming component.

Keywords- Ethanol,Water, Salt, Distillation, Azeotrope

I INTRODUCTION

Ethanol and water produces a highly distorted curve with a maximum vapour pressure for a mixture containing 95.6% of ethanol by mass. At higher vapour pressure in ideal mixtures, the intermolecular forces between molecules break easily because they are fewer forces in the vapour phase than in the pure liquids. If the mixture has a high vapour pressure it means that it will have a low boiling point. The molecules are escaping easily and there is no need to heat the mixture too much to overcome the intermolecular attractions. Hydrogen bonding is a term given to extremely strong polar molecular interactions (i.e ethanol and water). The hydrogen bonding makes the molecules "stickier" and more heat is necessary to separate them. Solutions that exhibit hydrogen bonding generally exhibit azeotropic behavior. Mixing involves breaking hydrogen bonds between water molecules. Breaking hydrogen bonds between ethanol molecules makes a strong stickier hydrogen bond between water and ethanol molecules.

II DIFFERENT METHOD OF BREAKING AZEOTROPE

2.1 Azeotropic Distillation

Azeotropic distillation is a widely practiced process for dehydration of number of compounds such as acetic acid,chloroform,ethanol,acetonitrile etc.The technique involves addition of third component in a homogeneous azeotrope, called an entrainer to form a minimum boiling ternary azeotrope, carrying water overhead and leaves near dry product in the bottom.The overhead vapours are condensed to two liquid phases: Entraner rich phase is refluxed while the aqueous phase is decanted.

2.2 Extractive Distillation

Extractive distillation can be defined as distillation in the presence of a miscible, high boiling relatively non-volatile component that forms no azeotrope with other components of the mixture. Solvent is continuously added near the top of the column so that an appreciable amount is present in the liquid phase throughout the column.The component having the greater volatility is taken overhead as a relatively pure distillate. The other component leaves with the solvent via the column bottoms. The solvent is then separated from the bottoms in second distillation column. Selection of an extractive distillation solvent is the most important step in developing a successful extractive distillation.

2.3 Pressure swing Distillation

Pressure swing distillation is gaining popularity for separation of a binary azeotrope over heterogeneous azeotropic distillation and extractive distillation.The technique is based on the principle that the composition of almost all azeotropes varies with the operating pressure. The technique is based on the principle that the composition of almost all

azeotropes varies with the operating pressure.Some binary azeotrope mixtures lose azeotropic behaviour when the system pressure is changed. In this case, separation can be achieved without using an additional entrainer. For example, in the case of ethanol-water mixture (azeotropic composition 89.4 mole% at 101.325 kPa), an azeotrope does not form below a pressure of approximately 9.2 kPa.

2.4 Pervaporation

Pervaporation is a selective membrane operation which can dehydrate organic solution. In the pressure pervaporation process , a solution to be separated contacts the pervaporation membrane at the feed side, where the retained retentate leaves the unit. On the permeate side, the partial pressure of pervaporated permeate is lowered by using a pressure pump. Membranes used in pervaporation can be either hydrophilic or hydrophobic, i.e. either producing water or ethanol as the permeate stream. The hydrophilic pervaporation membranes would be generally used at high concentrations of ethanol.

III. EFFECT OF CALCIUM CHLORIDE SALT IN EXTRACTIVE DISTILLATION

The salt decreases the solubility of the alcohol in water, resulting in the formation of a water-rich phase and an alcohol-rich phase. As with solvent processing in extractive or azeotropic distillation , salt processing is required in this technique. However, only the alcohol-rich phase would need to pass through distillation columns for separation; the water-rich phase would be removed in a decanter previous to the columns, as shown in Figure 1.

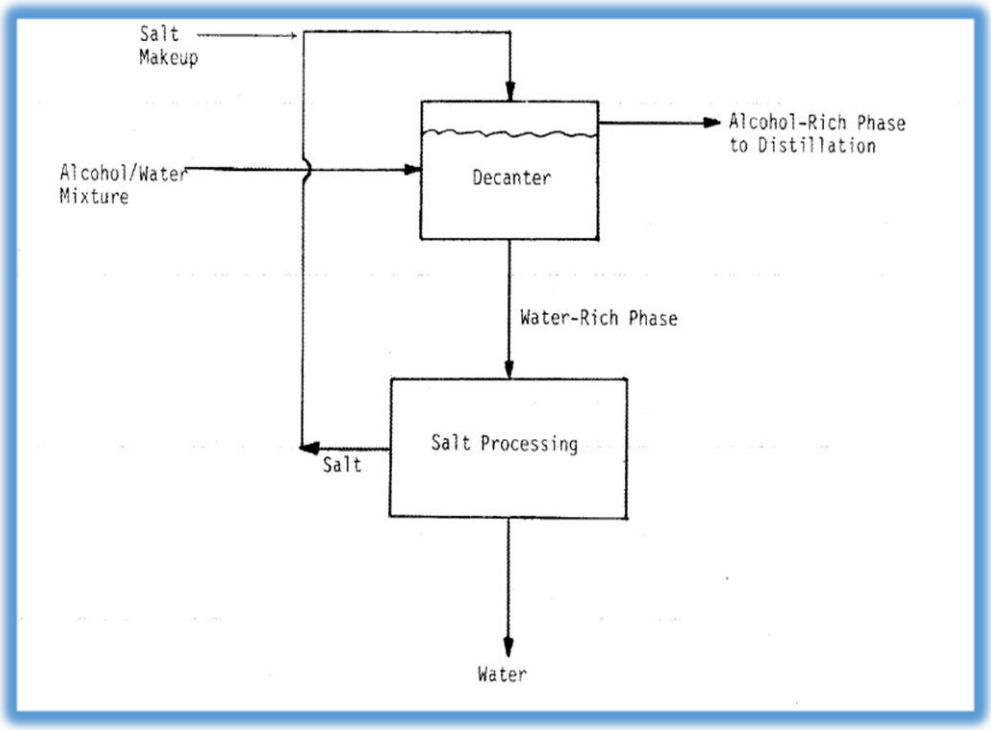

FIGURE 1. SEPARATION OF ETHANOL AND WATER MIXTURE USING SALT

Salt increases the boiling point of the water because calcium chloride was more soluble in water. The increase of the water boiling point causes the ethanol to become more volatility. Therefore, the elimination of the azeotrope takes place. Ethanol moves to the top of column were the pure vapours condensed to liquid. The liquid product was pure ethanol, and purity was found to be 99.8%. The volatile component is called a **"salting out"** from the liquid. The change in concentration from 0.2 g/ml to 0.3 g/ml , shows the significant impact on relative volatility which improves the separation. The use of solid salts instead of liquid separating agents has been gaining more attention in the past few years. By using salt as an extractive agent, the extractive distillation has the advantages of producing a solvent-free extract at the top of the column and requires no additional separating column. This consumes less energy when compared to conventional methods of extractive distillation. In addition, the calcium chloride salt is a common salt, which is much cheaper than liquid solvents. Thus, it is unnecessary to recover the salt ($CaCl_2$) at the bottom of distillation column It is known that when a salt is dissolved in a solution, it dissociates into ions so as to exhibit preferential salvation by one of the solvents (usually less volatile) and salting-out of the other solvent (usually more volatile).

TABLE 1. RELATIVE VOLATILITY,α WITH VARYING SALT CONCENTRATION AT PRESSURE OF 1 atm

Ethanol-Water mixture (%v/v)	**0.1 g/ml**	**0.2 g/ml**	**0.3 g/ml**
90/10	4.01	7.49	13.40
80/20	3.81	5.93	7.75
70/30	3.49	4.13	5.95
60/40	2.50	3.17	3.57
50/50	1.74	2.46	2.79
40/60	1.47	2.04	2.33
30/70	1.16	1.65	2.09
20/80	1.06	1.57	2.06
10/90	1.01	1.67	2.12

CONCLUSION

By adding salt in ethanol-water mixture , augmentation in relative volatility that facilitate the separation of the mixture. Calcium chloride provides the largest salting out effect on ethanol at high concentration other than salt like NaCl, KI, and KCl. Salt distillation consumes less energy when compared to conventional methods of extractive distillation. In addition, the calcium chloride salt is a common salt, which is much cheaper than liquid solvents.

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