Contents

CONTENTS CONTENTS | PAGES | 1) Abstract | 2-3 | 2) Introduction | 4-6 | 3) Objectives, Materials and Apparatus, Chemicals | 7 | 4) Method | 8 | 5) Results | 9-11 | 6) Discussion | 12 | 7) Conclusion | 13-14 | 8) References | 15 | ABSTRACT This experiment is about steam distillation by using Dalton’s Law. The objectives of this experiment are to demonstrate a separation of a mixture by using steam distillation and next to prove that Dalton’ Law and ideal gas law are applicable in steam distillation. Dalton’s Law; While Ideal Gas Law; This experiment is conducted by placing 2mL of Turpentine and 15mL of water into the flask. 10mL graduated cylinder is used as the receiver. All the connections are make sure tighten. Next, two boiling chips are added to ensure smooth bubbling and prevent bumping of the liquid up into the distillation head. The heating mantle is adjusted to give vigorous boiling. The first 1. 5mL of distillate is discarded and the next 5mL is collected. The volumes of the water and turpentine layers in this distillate are recorded. The recorded volume is then compared with the ideal steam distillation law using the tabulated vapour pressure and densities. The volume of water and turpentine recorded are: Turpentine= 1. 7mL Water= 3. 3mL turpentine -_-_-_-_-_-_- | -_-_--_-_-_-_Water-_-_-_-_-_--_-_-_-_-_--_-_-_-_-_-_--_-_-_-_-_-_- | In conclusion, it is proven that turpentine and water can be separated using the steam distillation. INTRODUCTION Dalton's Law of Partial Pressures states that for a mixture of gases in a container, the total pressure is equal to the sum of the pressures of each gas. Where P1 is the partial pressure of gas 1, P2 is the partial pressure of gas 2, and so on... OR In the experiment of the steam distillation, we applied the Dalton’s Law of Partiaal Pressure combined with Ideal Gas Law. Steam distillation is a special type of distillation (a separation process) for temperature sensitive materials like

natural aromatic compounds. Steam distillation is employed in the manufacture of essential oil, for instance, perfumes. In this method steam is passed through the plant material containing the desired oils. It is also employed in the synthetic procedures of complex organic compounds. Eucalyptus oil and orange oil are obtained by this method in industrial scale. Figure 1 : Laboratory set-up for steam distillation Distillation Temperature and Composition of Distillate As with ordinary distillations, the boiling point is the temperature at which the total vapor pressure equals the atmospheric pressure. If the vapor pressures of the two components are known at several temperatures, the distillation temperature is found readily by plotting the vapor pressure curves of the individual components and making a third curve showing the sum of the vapor pressures at the various temperature. The steam distillation temperatures will be the point where the sum equals the atmospheric pressure. Knowing the distillation temperature of the mixture and the vapor pressures of the pure components at that temperature, one can calculate the composition of the distillate by means of Dalton’s law of partial pressures. According to Dalton’s law, the total pressure(P) in any mixture of gases is equal to sum of the partial pressures of the individual gaseous components (Ï�A , Ï�B, etc). The proportion by volume of the two components in the distilling vapor will consequently be equal to the ratio of the partial pressures at that temperature; the molar proportion of the two components (Î·A and Î·B) in steam distillation will be given by the relationship Î·A/Î·B = Ï�A/ Ï�B, where Ï�A + Ï�B equals the atmospheric pressure. The weight proportion of the components is obtained by introducing the molecular weight (MA and MB) Weight of A / weight of B = (Ï�A x MA) / (Ï�B x MB) Example . Consider a specific case, such as the

steam distillation of bromobenzene and water. Since the sum of the individual vapor pressures (see Figure below) attains 760 mm at 95. 2º, the mixture will distill at this temperature. At 95. 2º the vapor pressures are bromobenzene, 120mm and water, 640mm. according to Dalton’s law, the vapor at 95. 2º will be composed of molecules of bromobenzene and of water in the proportion 120: 640. the proportion by weight of the components can be obtained by introducing their molecular weights. Weight of bromobenze / weight of water = (120 x 157)/(640 x 18) = 1. 63/1. 00 Bromobenzene = {1. 63/(1. 00 + 1. 63)} x 100% = 62% Water = {1. 00/(1. 00 + 1. 63)} x 100% = 38% The weight composition of the distillate will therefore be 62% bromobenzene and 38% water. OBJECTIVE To demonstrate a separation of a mixture by using steam distillation MATERIALS/APPARATUS/EQUIPMENT 100 ml round-bottomed flask, 50 ml Erlenmeyer flask, stoppers, naphthalene, salicylic acid. METHOD Steam Distillation of Turpentine 1. The apparatus for steam distillation are arranged as shown in Figure 1. 50 ml of distilling flask and 10 ml graduated cylinder is used as the receiver. 2. In the flask, 5 ml, (4. 3g) of turpentine (bp 156-165 at 760 mm) and 15 ml, of water is placed. 3. Two boiling chips are added and the heating mantle is adjusted to give vigorous boiling. It is essential for the success of this experiment that the mixture boiled rapidly with good mixing of the two phases. Because the point of this experiment is to measure an equilibrium composition and the initial distillate may not have time to equilibrate, the first 1. 5 ml of distillate is discarded and the next 5 ml is collected. 4. The volumes of the water and the turpentine layers at this distillate are recorded. 5. The ratio of the volumes actually found is compared with the ratio calculated from the ideal steam distillation law using the tabulated vapor pressure and densities. 6. The

distillation temperature observed is compared with the calculated value. RESULTS turpentine -_-_-_-_-_-_- | -_-_--_-_-_Water-_-_-_-_-_--_-_-_-_-_--_-_-_-_-_--_-_-_-_-_- | Turpentine = 5. 0mL Water = 15. 0mL Weight composition: Water = 15. 0 x 100 20. 0 = 75 % Turpentine = 5. 0 x 100 20. 0 = 25 % The weight composition that will be distillate will be 75 % water and 25 % turpentine. After the mixture have been distilled, here is the result: Total volume of distillate = 5. 0mL Turpentine = 1. 7mL Water = 3. 3mL Weight composition: Water = 3. 3 x 100 5. 0 = 66 % Turpentine = 1. 7 x 100 5. 0 = 34 % Ratio of turpentine to water : Turpentine : Water 0. 34 : 0. 66 Weight of turpentine/ Weight of water = [0. 34 x [12(10)+1(16)]] / [0. 66 x [1(2)+1(16)]] = (0. 34 x 136) / (0. 66 x 18) = 46. 24 / 11. 88 = 3. 8923 Turpentine = [46. 24 / (46. 24+11. 88)] x 100% = 79. 5595 % Water = [11. 88/ (46. 24+11. 88)] x 100% = 20. 4405 % Temperature, T/C | Volume of distillate, V/mL | 94 | 1st 1. 5mL | 94 | 1 | 94 | 2 | 94 | 3 | 94 | 4 | 94 | 5 | DISCUSSION 1. What properties must a substance have for a steam distillation to be practical? For steam distillation of a substance to be carried out, the substance must be heat sensitive. It must possess a lower boiling point than water. This method is also advisable for highly volatile liquids because highly volatile liquids denatures at high temperatures. 2. What are the advantages and the disadvantages of steam distillation as a method of purification? Among the advantages of steam distillation is organic compounds which is steam distilled will evaporate at lower temperatures, most probably below their temperature of denaturation. Besides that, heat sensitive aromatic compounds which cannot be distilled by direct heating can be processed. On the other hand, the disadvantages of this method are this method is not exactly suitable for all types of aromatic oils. Only certain

types of aromatic oils are suitable to be processed using this method. Furthermore the heat is difficult to control causing the rate of distillation to be variable. -Our group apparatus got some problems. The turpentine that has been distillated accumulated at the joint of the apparatus. This is because the apparatus less slope, leads the turpentine to accumulate, resulting long time to collect the distillated turpentine. CONCLUSION Steam distillation is a special type of distillation (a separation process) for temperature sensitive materials like natural aromatic compounds. Many organic compounds tend to decompose at high sustained temperatures. Separation by normal distillation would then not be an option, so water or steam is introduced into the distillation apparatus. By adding water or steam, the boiling points of the compounds are depressed, allowing them to evaporate at lower temperatures, preferably below the temperatures at which the deterioration of the material becomes appreciable. Therefore, as the conclusion, it is proven that turpentine and water can be separated by using steam distillation. It is also known that water has a higher density than turpentine. Next, Dalton's law (also called Dalton's law of partial pressures) states that the total pressure exerted by a gaseous mixture is equal to the sum of the partial pressures of each individual component in a gas mixture. This empirical law was observed by John Dalton in 1801 and is related to the ideal gas laws. On the other hand, the ideal gas law is stated as the equation of state of a hypothetical ideal gas. It is a good approximation to the behavior of many gases under many conditions, although it has several limitations Therefore, as both of these laws are involved, we can conclude that both Dalton’s Law and Ideal Gas Law are applicable in steam distillation. Based on the result of the experiment, water contains 80% and turpentine

contain 20% portion. Some errors might have occurred during the experiment that caused the results to be differed from the theory. During the experiment, the apparatus must handle carefully because it is easily broken. To increase the accuracy of the result, thermometer is used in the flask so we can read the temperature in the flask. We must use stopper to close the flask because it can avoid the water vapour escape to the environment

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