

CHAPTER 3

DISCUSSION OF RESULTS

3.1 The actual cycle.

The ammonia concentration of 50.0 and 58.5% were used to determine the actual cycle. The cycle obtained for both concentration were similar as shown in fig. 8-9. At $X_r=0.585$ starting with 36.6°C initial solution temperature and 124.7 psia. initial solution pressure, the temperature of the condenser cooling water during regeneration and the absorber cooling water during refrigeration were both 30°C . The curves for the actual cycle were shown in fig. 8-9; cycle 1-2-3-4-1 represented the actual cycle and cycle 1-2-5-6-1 the theoretical cycle shown for comparison. During process 1-2 the theoretical and actual cycle are identical. In condensation process 2-3, the actual process does not proceed along a constant pressure line as the theoretical process. This discrepancy is due to the effect of temperature rise in the condenser during condensation. Hence the saturation pressure rises as the condenser temperature rise. Therefore, if the condenser temperature is kept constant, the condensation process 2-3 of the actual cycle should also proceed along a constant pressure line. As a result, the ammonia concentration after regeneration is 0.41 which is higher than the theoretical concentration of 0.36 at the same temperature (100°C), thus the amount of the actual ammonia condensation is 15.7% less than the theoretical value.

Sargent and Beckman⁸ suggested that process 5-6 is an adiabatic cooling and process 6-1 is isobaric. It was found during the experiment that, without shaking the absorber, the actual process first followed an adiabatic cooling line then it deviated sharply and nearly followed a constant pressure line. It is seen from fig. 7 that the rate of the pressure drop is slow at first but increasing as it proceeds from state 3A to 3B. At this point the absorber was shaken 10 times and then left untouched. It was found that the solution jumped from state 3B to 3C and proceeded along path 3C-3D which is almost parallel to path 3A-3B but at a lower pressure. The solution behaved like this as it went along paths 3E-3F, 3G-3H and so on until it reached the final state at 3K. It is believed that, without shaking the absorption can take place at the gas-solution interface only. After a while the concentration of the surface layer is so high that the absorption rate slows down. As a result the absorber temperature decreases since there is a small amount of exothermic heat release from the absorption process. The absorber pressure also decreases slightly due to the temperature decrease when the absorber is shaken, mixing process occurs and fresh layers of lower concentration solution are formed and the absorption process accelerates to a high rate again. The exothermic heat released then bring the conditions back to the saturation conditions again.

⁸Sargent and Beckman, W.A. "Theoretical performance of an NH₃-NaSCN intermittent absorption refrigeration cycle. Solar Energy 12, 137-146 (1968).

3.2 The coefficient of performance. (COP)

As stated earlier that the data of the differential heat of NH_3 -NaSCN are not available, the value of the COP. could not be calculated. Hence an indirect method was used to determine the COP.

The COP of the cycle was found from the net heat supplied by an electric heater after having accounted for the heat loss to the surrounding, the heat absorbed by the generator, the condenser and the insulator.

As seen from table 8, the COP increase from 0.43 to 0.54 as the ammonia concentration is increased from 0.500 to 0.583.

Chinnappa shows that the COP of the NH_3 -NaSCN is higher than that of the NH_3 - H_2O system but more or less the same as that of the NH_3 - LiNO_3 system, Another advantage, as compare to the NH_3 - H_2O system is that the NH_3 -NaSCN does not require a rectifying column. This is because the boiling point of the Nascn is rather high (287°C at atmospheric pressure) Therefore the possibility of having the absorbent vaporized into the condenser is rare. The NH_3 - LiNO_3 system has one serious disadvantage that it is explosivable.

The COP of the apparatus ranges from 0.267 to 0.357 which is somewhat lower than the COP of the cycle due to the fact that there are some heat loss to the surrounding and there are some heat absorbed in the apparatus during regeneration-absorption. Especially the heat capacity of the condenser vessel affects the COP of the apparatus a great deal. Therefore, the shape of the condenser vessel should be designed in such a way as to have the largest surface area with the smallest heat capacity.

3.3 The effect of rate of heat supplied to the condensed ammonia.

At $X_r = 0.535$, with the rate of heat supply of 1.57, 3.5, 4.25 and 5.30 Kcal/min it is found that as the rate of heat supply is increased the amount of the ammonia condensed increases only little (rate of heat increase 1%, ammonia condensed increase 0.001-0.002%). It is believed that, at lower rate of heat supply the time taken to supply a given amount of heat is longer so that more heat is lost to the surrounding. This result shows that the effect of the rate of heat supply depends on the degree of insulation. If good insulation were installed, the rate of the heat supply would not affect the amount of the ammonia condensed.

3.4 Effect of the condenser cooling water temperature.

Experiment conducted at the concentration of 0.50, shows that when the condenser cooling water temperature is decreased the amount of the ammonia condensed increases approximately 1% per degree celcius of the cooling temperature drop. This effect was seen to affect significantly on the amount of ammonia condensed. When the system is used in remote areas where most of the cooling water available is stagnant care must be exercised in order to keep the cooling water at lowest possible temperature. This may be done by having ample amount of water and covered the top surface of the cooling water vessel with bright sheet of metal to reflect the sun radiation.

3.5 The limitation of selected ammonia concentration

As the ammonia concentration is increased, the amount of the ammonia condensed as well as that of the COP increase. It is quite definite that when the amount of the ammonia condensed increases the absorption time will also increase. At some concentration the absorption time are over 24 hours (Fig. 10) which is not practical. Therefore the best practical concentration lies between 0.53 to 0.54.