3.3.2.5 Effect of recirculation air ratio on the specific energy consumption.

Figure 3.11 shows the specific energy consumption versus recirculation air ratio. The other parametric values are the ambient temperature of 30 °C, 120-kg whole longan, drying temperature of 75 °C, by pass air ratio of 10% and the airflow rate of 1350 m^3/hr. When the recirculation air ratio increases from 40 to 90 % the specific energy consumption decrease from 22000 to 17500 kJ/ kg water removed. The specific energy consumption decreases to a minimum value at the recirculation air ratios of 90%. This is because when the recirculation air ratios increases it means that the recovery the waste heat is increased. So, it can save the energy consumption of the system. There fore, increasing the recircuration air ratio until the maximum value. After this value the specific energy consumption increases again with the increase of recirculation air ratio. This is because the recirculation air ratio more than 90% the equilibrium moisture content occurs in the drying system and the moisture content of longan cannot be reduced further. The drying time more limited values (60 hrs). This is the inherent drying mechanism and this result agrees with the result of Achariyaviriya *et al*. (2000).

From this study, it can be concluded that the higher recirculation the lower specific energy consumption of the system. The suitable condition of RAR for the design will be 90% in this condition.

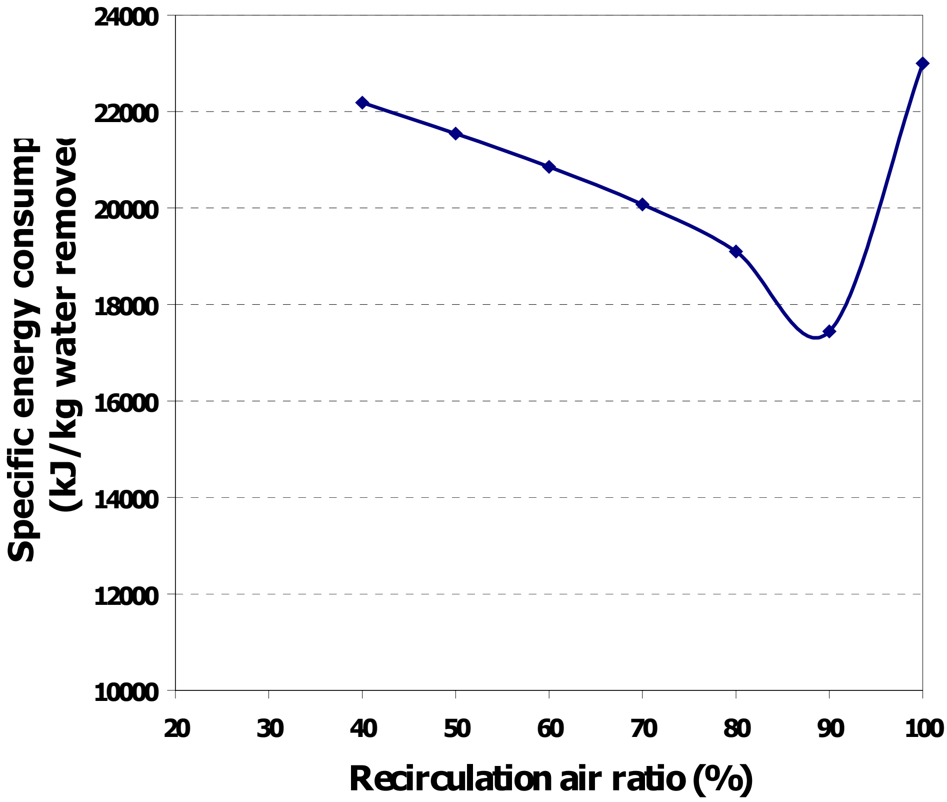

Figure 3.11 Effect of recirculation air ratio on the specific energy consumption of the heat pump dryer. (Simulation condition: Md=1350 m^3/hr, Ta = 30°C, RH=70%, Tdi=75°C and BAR= 10%. The initial and final moisture content of product were 300 and 25 % dry-basis)

3.3.2.6 Effect of bypass air ratio on the specific energy consumption

Figure 3.12 shows specific energy consumption versus the bypass air ratio. The other parametric values are the ambient temperature of 30°C, 120-kg whole longan, drying temperature of 75 °C, recirculation air ratio of 40% and the airflow rate of 1350 m^3/hr. When the bypass air ratio increases from 0 to 80% the specific energy consumption rapidly decreases from 20000 to 14500 kJ/kg water removed. After that the specific energy consumption increases again with the increase of bypass air ratio. The reason is the same as discussed in the previous section. When the bypass air ratio increase the specific energy consumption decreases. If the bypass air ratio more than 80% the specific energy consumption increases again. Because the equilibrium moisture content occur in the drying system. The drying air cannot absorb moisture from whole longan. The program will be stopped by the drying time over the limitation (60 hrs). These results correspond with the result of Achariyaviriya *et al*; 2000 that increasing the bypass air ratio affect the specific energy consumption as same as increaseing the recirculation air ratio. It can be seen that the effect of the recirculation air ratio and by pass air ratio are similar.

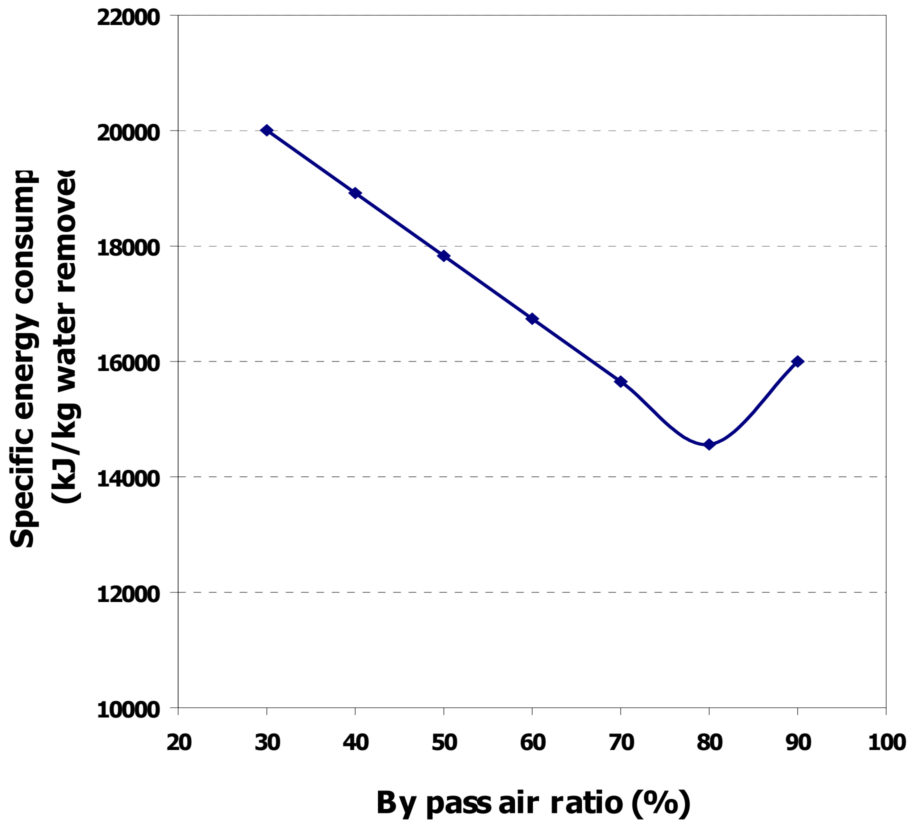

Figure 3.12 Effect of by-pass air ratios on the specific energy consumption of the heat pump dryer. (Simulation condition: Md=1350 m^3/hr, Ta = 30°C, RH= 70%, Tdi=75°C, and RAR = 40%. The initial and final moisture content of product were 300 and 25 % dry-basis)

From this study, we now have the specification of the heat pump dryer. For verifying the mathematical program, the following values were used:

The air the relative humidity of 70 %, the ambient temperature of 30 °C, the drying temperature for whole longan of 75°C were used. These are fixed parameters for the experimental work. The by-pass air ratio and the recirculation air ratio behave similarly. As discussed earlier, the following values were used:

3.3.2.5 Experimental parameters

The controlled parameter were:

-Ambient temperature 30 °C

-Relative humidity 70 %

-Drying temperature 75 °C

-By pass air ratio 15%

The variable parameters were:

-Airflow rate of 937, 1350 and 1620 m^3/h

-Recirculation air ratio of 30, 35 and 40%

3.4 Experimental procedures

The schematic diagram of experimental set up is shown in Figure 3.13. The drying air temperatures, relative humidity, and velocity were recorded before entering and after passing the evaporator, the condenser, and the drying chamber. The air velocity and the amount of by pass air ratio and recirculation air ratios were also recorded when it passed through the evaporator and condenser of the heat pump.

All the temperature and velocity sensors were installed in the system to monitor the necessary data. TESTO model 454 with accuracy $\pm 0.4\ ^{\circ}C$ and $\pm$ 2 %RH were used to record the temperature and relative humidity. In addition, the type-K thermocouples were also employed with the YOKOGAWA Model-200 data logger to monitor the temperature at all the points. The consumed electrical power was measured using DIGICON MG51 wattmeter with an accuracy of $\pm 1\%$. The air velocity was also recorded by using TSI model 8384-M flow meter with $\pm 3\%$

accuracy. The experiment began by starting the heat pump and the blower. The circulating air was heated when it passed through the condenser of the heat pump dryer. Its temperature was raised to the desired level by the electric heater.

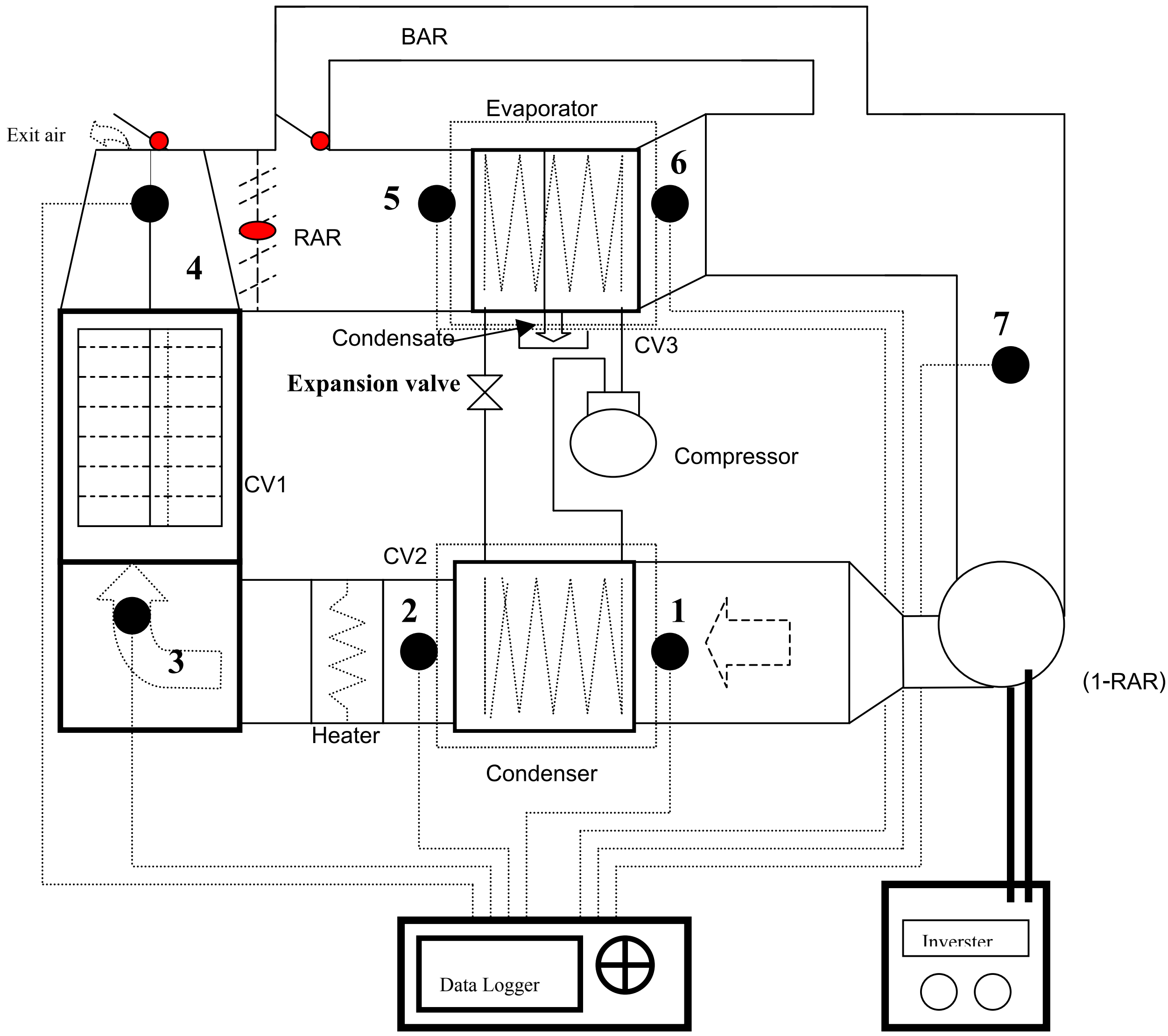

Figure 3.13 Schematic diagram of the experimental set up for the heat pump dryer