Chapter 2 – Professional Air-conditioning Systems

EXPERIMENT 2.2 – DISTRIBUTION

Name	Class/Period	Date

1. Objectives:

At the end of this experiment session, you will be able to:

- Explain what reheating is.
- Explain what the recycled air is used for.
- Explain air cleaning methods.
- Explain why we need the distribution control.
- Explain what air mixing is.
- Explain what air ducts are.

2. Equipment Required:

- Main Platform Unit
- Professional Air Conditioning Panel

3. Discussion: **Reheating**

Reheating is raising the temperature of air that has been previously cooled by an air-conditioning system.

The air-conditioning system is a cyclical system. As such, it has to manage with recurring changes from heating to cooling and with differences between temperatures in room areas. Air-conditioning systems are frequently planned as basic cooling systems with reheat.

Air is returned from all room areas to the central plant. It is mixed with the amount of fresh air required to fit a temperature below the room area temperature and supplied through reheat coils in the supply ducts for each of the room areas. The supply temperature to each room area may be either above or below the area temperature; whichever is appropriate for either heating or cooling loads.

The moisture content of the air leaving the central plant is limited to that at saturation; therefore, its temperature can be selected to limit the maximum room area humidity to some desired level.

The air rate to each area is determined on the basis of the cooling load of the area and the temperature of the air leaving the central plant. If the cooling load is minor, the supply rate might be based on the minimum supply required to provide sufficient air circulation and fresh air.

The actual cooling load will be considerably less than the design load most of the time, so that the reheat coils supply this difference plus any heating load. When outside temperatures are low enough, return air from the room area may be mixed with outside air in a proportion to produce the desired temperature. During cold weather, the minimum fresh air quantity may cool the mixture too far, so that preheating and humidifying may be necessary. Refrigeration is required whenever the outside air temperature exceeds the central supply air temperature.

If humidity control is specified, the air leaving the plant must always be saturated at the dew-point temperature required and then reheated to achieve the desired area temperature. When several areas are involved, the air may have to be over-dehumidified as well as overcooled in the central plant and reheated and re-humidified in separate units for each area. If the moisture loads and their variations are small, the re-humidifier may be omitted. Air-conditioning in the central plant can be accomplished in an adiabatic spray whenever outside temperatures enable the mixing of outside air and return air to produce a wet-bulb temperature in the mixture equal to the desired leaving temperature.

A cooling-with-reheat system, with or without humidity control, provides a flexible system for year round use. No particular change is required for summer and winter operation, and heating and cooling are available at all times. The operating expense of the system is rather high, because it essentially operates on the principle of overcooling and then reheating as necessary. In effect, the load on the air-conditioning system is always near the maximum design load.

4. Discussion: **Use of air**

4.1. **Use of recycled air for the air-conditioning system:**

Recycled air is: the Indoor air that is taken in from the conditioned space and sent through the air-conditioning system. It must be mixed with sufficient outdoor air to prevent the build-up of contaminants.

A good example of recycled air is in the car air-conditioning system, when the ducts are closed off with no "fresh air", the air inside the car is circulated back through the evaporator. This circulated air that was cooled by the evaporator is brought back (and it is cooler then the air outside the car), and in this way the cooling process is done much faster.

4.2. **Cleaning:**

The circulation of air and the use of outdoor air can cause the air used by the air-conditioning system to be polluted.

Air cleaning can be done in many ways and the type of cleaning is determined by the source of the pollution.

To clean solids like dust and smoke one of the following methods are used:

- Air washing.
- Air screening, the air is screened in order to stop larger pieces.
- Air charging with an electrical charge; the air is charged to an opposite charge of the pieces.

To clean gases and vapors:

- Air condensation, cooling the polluted air/gas to its dew point and eliminate as liquid.
- Air dilution.

Filters:

The following types of filters are in use the most:

- **Standard throw away filter** – this type of filter needs to be replaced when it loses its efficiency.
- **Adhesive filter** – usually this type of filter is made of fiberglass, cotton, synthetic material or aluminum. It comes in two types: fire resistance or non-fire resistance.
- **Electrical air cleaners** – this type of filter is charged with an electrical charge, so that the air is charged to an opposite charge of the particles.
- **Carbon filter** – this type of filter is made of activated carbon and will remove solid particles.

All the filters serve the same function. The main differences between the filter types are the quantity of pollution it removes and the time needed for this to happen.

4.3. Distribution:

Distribution control is a control method used in an air-conditioning system in order to evenly and efficiently distribute the cooled or heated medium to the needed area. In the air-conditioning system the thermostat will signal the zone control valves to operate. There are many types of control methods used in air-conditioning systems. The thermostats may control ducts or the blower motor.

4.4. Mixing:

A typical air-conditioned process can be defined with fresh air or without fresh air.

Fresh air – to supply fresh air to the cooled central plant in order to renew the oxygen stock in it. Fresh air is vital in an air-conditioning system for human comfort. Fresh air is supplied to the humidity and temperature, and the air-conditioned system must overcome the heat load caused by it.

Four points define a typical air-conditioned process with fresh air:

1. Air condition required in the cooled central plant (interior condition).
2. Fresh air conditioning that flows into the cooled center (exterior condition).
3. The mixing point condition between the central plant's air and the fresh air.
4. The air's condition as it is supplied to the central plant by the unit.

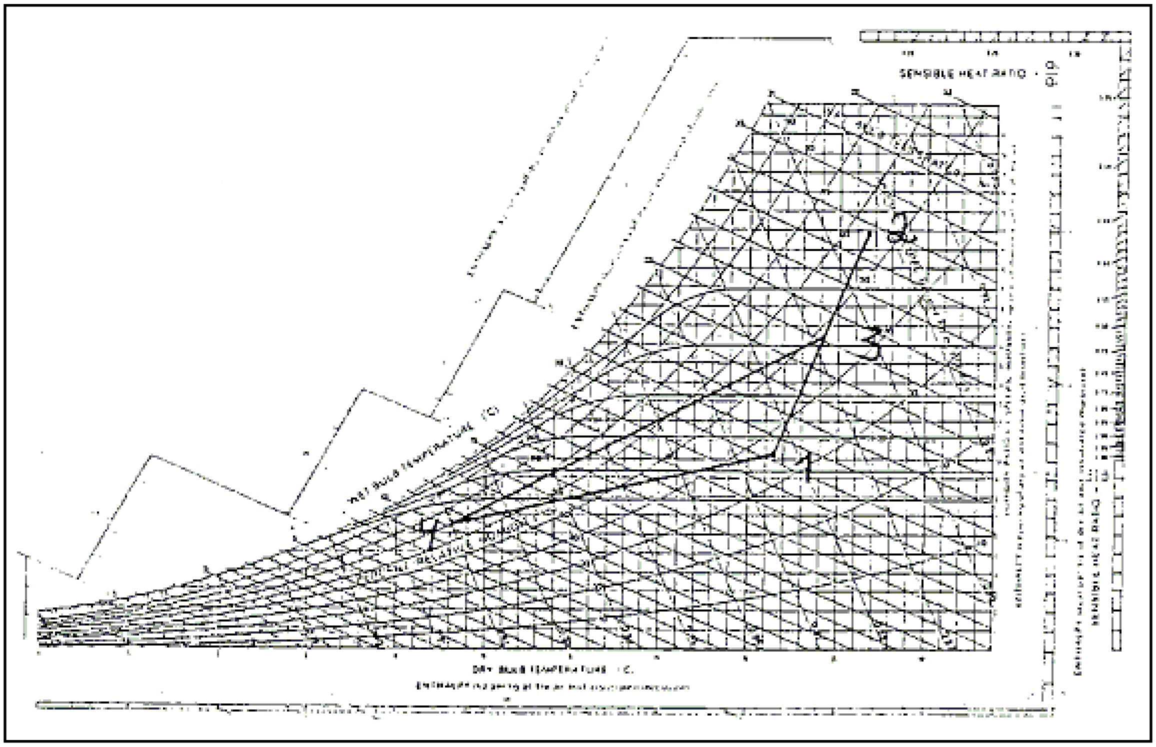

Figure 2-4

Fresh air (2) is mixed with center air (1). This mixture enters the air-condition unit (3), the air flows through the air-condition unit (process 3-4) and supplied to the center (4). The airflows inside the air-conditioned center along process 4-1, and meets the heat loads existing in it. This process is not cyclic. This cycle includes two processes:

1. Process 3-4 (type 0-8 – cooling and drying). This process occurs in the air-condition unit. The air cools down and creates condensed water drops. These water drops drain into a drainage pool located in the air-conditioner, and flow outside the structure. The air-conditioner manages to squeeze water vapor from the air using a cold body installed inside it. This cold body has a lower temperature from the air's dew point, and the air flows through this body.

   The sensible heat coefficient describing this process is called GSHF (Grand Sensible Heat Factor).

2. Process 4-1 (type 0-4 – heating and humidification). This process occurs in the air-conditioned unit. The air that exits the air-conditioner and flows through the center's space meets the heat loads existing in it while it heats up and absorbs moisture from the air in the center space.

4.5. Air ducts:

In order to deliver air to the conditioned area, air carriers are needed. Those carriers are called ducts. The ducts made of material that will be able to hold the heat and cooling temperature. The principal of air flowing through the ducts is the pressure difference principal. If pressure difference occurs, the air will flow. The air will flow from the higher pressure to the lower pressure.

The pressure in the ducts is low, so the materials that the ducts are made of are not very strong.

There are three types of ducts:

- Conditioned air ducts.
- Recalculating air ducts.
- Fresh air ducts.

Ducts can came in a round, square or rectangular shape. The round ducts are more efficient; the resistance to air is less.

Tables to compare air flow, friction and capacity for ducts have been developed.

5. Procedure:

Step 1: Check that the PROFESSIONAL AIR CONDITIONING PANEL is properly installed on the refrigeration and air-conditioning general system MAIN PLATFORM UNIT according to the instructions described in the book preface.

Step 2: Check that the MAIN PLATFORM UNIT MONITOR and PROGRAM switches are at OFF position.

A ground leakage relay, a semi-automatic switch, and a main power switch are installed in a main power box located on the rear panel.

Step 3: Connect the MAIN PLATFORM UNIT power supply cable to the Mains.

Step 4: Check that the high voltage ground leakage relay and the semi-automatic switch are ON.

Step 5: Set the Auto/Manual switch (located on the bottom left of the simulator) to the Manual position.

Step 6: Turn ON the main POWER switch located on the main power box on the rear panel.

Step 7: Turn ON the monitor power switch.

Step 8: The FAULT display should display the number 00. If not, use the keys above the FAULT display to display the number 00 (no fault condition) on the FAULT 7-SEG. display and press the ENTER key beneath this display.

Step 9: The STATE display should display the number 00 (no operation program).

Step 10: On the LCD display you should find the following table:

V1	V2	V3	V4	V5	V6	V7	RV	CM	OF

In this experiment we shall measure the temperature difference of the evaporator and the condenser and we shall calculate their heat transfer in BTU.

We will check it in two speeds of the evaporator fan and with and without thermal load.

<u>TEV mode:</u>

Step 11: Change the STATE number to 11 (for °C) or 12 (for °F) and press ENTER.

Step 12: Lower the PROGRAM switch and raise it.

Step 13: On the LCD display you should find the following tables:

V1	V2	V3	V4	V5	V6	V7	RV	CM	OF
ON	ON			ON	ON			ON	ON

S1	D1	S2	D2	SP	PD	E1	L1	E2	RT
20°C	5°C					LO			

LP	HP	T1	T2	T3	T4	T5	T6	T7	T8

If "on" (lowercase) appears on the CM and OF columns, it means that the compressor is in a 3 minutes delay state before it starts to work. This delay protects the compressor.

The TEV mode is controlled by temperature and this is why a dash appears in the pressure squares.

Identify the system's default values of S1 and D1.

Observe the sight glass and check that there are no bubbles and that the LP value reached the stabilization point.

Step 14: The cooling chamber's temperature should continue to go down even after the LP is stable.

Observe that.

Step 15: The chamber temperature T6 goes down as long as the system is cooling (the compressor works).

The compressor should turn OFF when the chamber temperature reaches the S1 (Setup Point) and should turn ON when the chamber temperature goes over S1 + D1.

The default value of S1 is 20°C (68°F), the default value of D1 is 5°C (9°F).

Check that.

Step 16: See what happens when the cooling chamber temperature reaches the S1 point.

Step 17: Record the pressures and temperatures.

Step 18: Wait until the compressor turns ON.

Step 19: Record the pressures and temperatures.

Step 20: Wait until the compressor turns OFF.

Step 21: Record the pressures and temperatures.

Step 22: Press the '*' key and check that the evaporator fan (E1) changes to HI.

Step 23: Wait until the compressor turns ON.

Step 24: Record the pressures and temperatures.

Step 25: Wait until the compressor turns OFF.

Step 26: Record the pressures and temperatures.

Step 27: Press the '*' key again and check that E1 is changed into 'LO'.

Step 28: Fill in the following table with the stabilization point's values of the two setup points.

No.	Comp.	E1	Time	S1	D1	LP	HP	T1	T2	T3	T4	T5	T6
1.	ON	LO											

2.	OFF	LO											
3.	ON	HI											
4.	OFF	HI											

Step 29: The air supply of the evaporator fan is 100 M^3/h (900 ft^2/h) at low speed and 200 M^3/h (1800 ft^3/h) at high speed. The condenser air supply is 430 M^3/h (3870 ft^3/h) and it has only one speed.

Calculate the heat transfer of the evaporator and condenser.

Q = cfm · 1.08ΔT (see Experiment 1.5, paragraph 7.1).

Step 30: Change the STATE number to 14 (for °C) or 15 (for °F) and press ENTER.

This will operate the thermal load.

Step 31: Wait until the compressor stops working.

Step 32: Record the pressures and temperatures.

Step 33: Wait until the compressor turns ON.

Step 34: Record the pressures and temperatures.

Step 35: Change the fan speed to High.

Step 36: Wait until the compressor turns OFF.

Step 37: Record the pressures and temperatures.

Step 38: Wait until the compressor turns ON.

Step 39: Record the pressures and temperatures.

Step 40: Fill in the following table with the stabilization point's values of the two setup points:

No.	Comp.	E1	Time	S1	D1	LP	HP	T1	T2	T3	T4	T5	T6
1.	ON	LO											
2.	OFF	LO											

3.	ON	HI											
4.	OFF	HI											

Step 41: Calculate the heat transfer of the evaporator and condenser.

Heating system:

Step 42: Change the STATE number to 31 (for °C) or 32 (for °F) and press ENTER.

Step 43: Lower the PROGRAM switch and raise it.

Step 44: On the LCD display you should find the following tables:

V1	V2	V3	V4	V5	V6	V7	RV	CM	OF
								ON	ON

S1	D1	S2	D2	SP	PD	E1	L1	E2	RT
20°C	5°C					LO			

LP	HP	T1	T2	T3	T4	T5	T6	T7	T8

If "on" (lowercase) appears on the CM and OF columns, it means that the compressor is in a 3 minutes delay state before it starts to work. This delay protects the compressor.

RV turns ON.

No value is turning ON. The system uses the one-direction values and works at capillar mode.

E1 heats up and OF cools down.

Step 45: Wait until the compressor turns OFF.

Step 46: Wait until the compressor turns ON.

Observe the system reaction.

Step 47: Change the STATE no. to 00 and press ENTER.

Lower the PROGRAM switch and raise it.

All the devices should shut OFF.