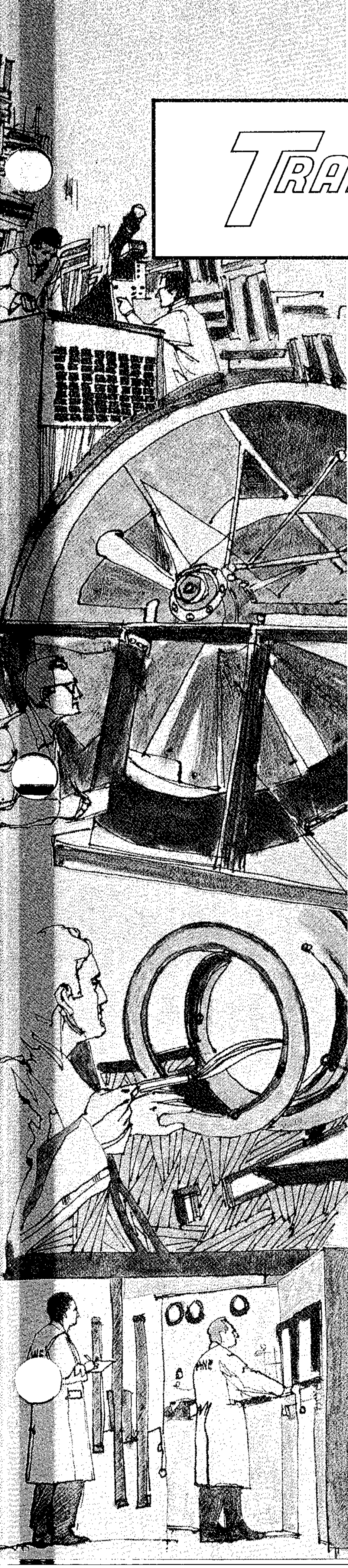

TRANE engineer's newsletter

THE COIL RUN-AROUND CYCLE — Part I

Building designers, developers, owners and managers, all leaders in business and industry, are now turning their eyes to energy conservation as an item of top priority. And, air-to-air heat recovery, with its ability to precondition ventilating or process air with energy recovered from exhaust or "throw away" air, is one of the most fertile areas of investigation for potential energy and cost savings.

Although ideally suited for hospitals, office buildings, apartments, hotels, schools, auditoriums and factories, air-to-air heat recovery equipment is applicable to almost any commercial, institutional or industrial facility. Therefore, it **should be carefully considered wherever wasted energy is being discharged from a process or a building.**

Look at the typical building load analysis. (Figure 1) Up to 70% of the make-up air heating loads can be eliminated by transferring the thermal energy from the exhaust air to make-up air with the coil run-around cycle.

This type of air-to-air heat recovery system also has the capability of recovering a portion of the summer cooling load. However, because it is essentially a sensible heat transfer device and because much of the summer load is latent cooling, it is possible to transfer up to 70%

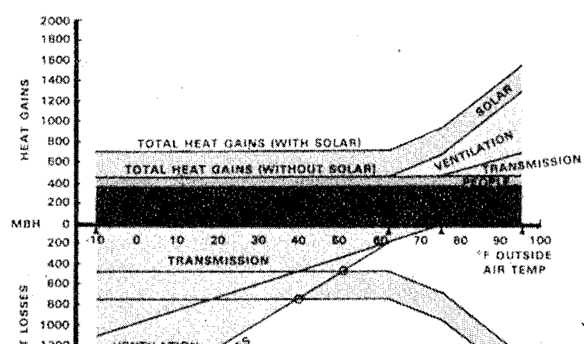

FIGURE 1

of the summer ventilation sensible load; but only about 20% of the total cooling load shown. When comparing the 70% savings of relatively large winter ventilation energy requirements with the 20% savings to be had on the smaller summer ventilation energy requirements, it becomes quite apparent that for normal comfort air conditioning requirements, the coil run-around cycle is primarily justified based on winter operation.

How does the coil run-around cycle work? One 4 to 8 row coil is placed in the exhaust air stream and a similar coil is placed in the make-up air stream. (Figure 2) The two coils are linked together by a loop of pipe. A pump continuously circulates a heat transfer media, such as ethylene glycol, between the two air streams. During winter operation, as the warm exhaust air passes through the exhaust coil, it gives up a large part of its sensible and latent heat to the glycol fluid. This is pumped to the make-up air coil where it gives up its energy to the make-up air, increasing the air temperature by up to 69% of the temperature difference between the two air streams.

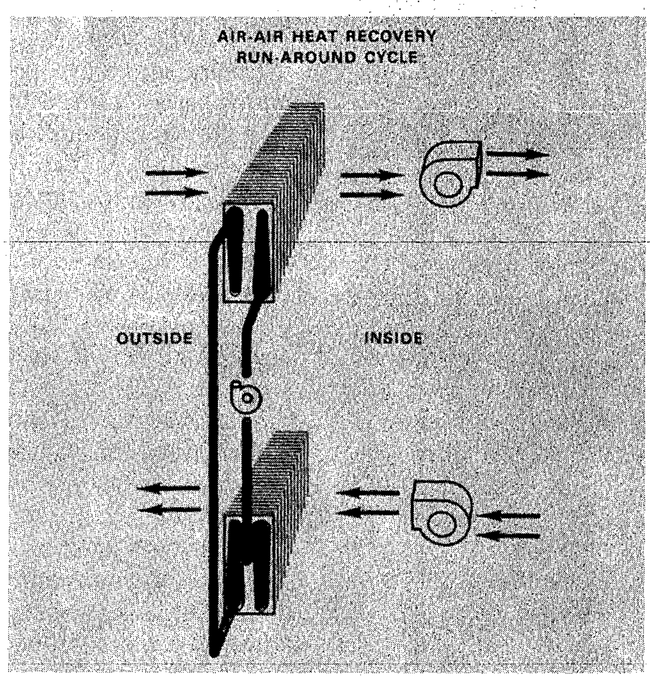

FIGURE 2

The fans blow-thru on the exhaust air coil and draw-thru on the make-up air coil. This provides maximum air temperature difference between the two coils and, therefore, the greatest heat transfer capacity or system efficiency. Also note that the pump is located just prior to the heating coil. In this position its heat of compression raises the liquid temperature at the heating coil and thus increases its heat transfer capacity and system efficiency. If the location of the fans and pump were reversed, the system efficiency would be noticeably reduced.

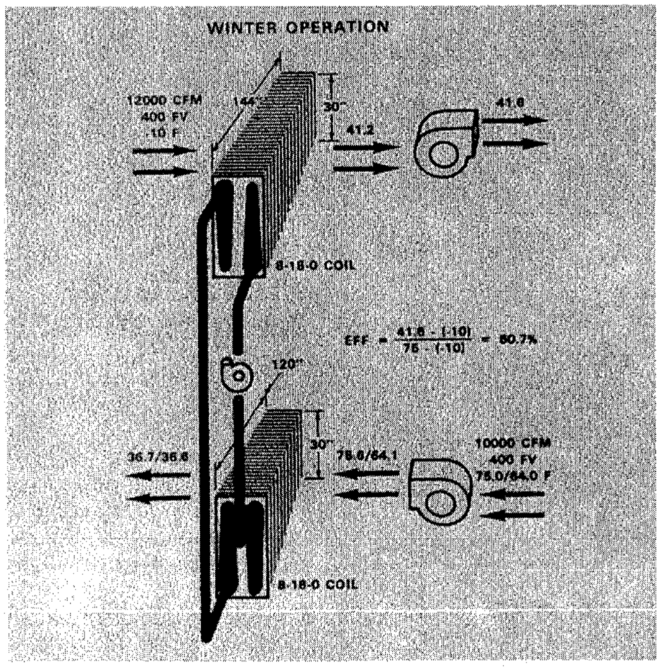

FIGURE 3

(Figure 3) This is a typical winter operation schematic showing the changes in temperature on both the air and glycol sides. In this particular case, 61% of the sensible energy difference between the two air streams is transferred from the exhaust air to the make-up air.

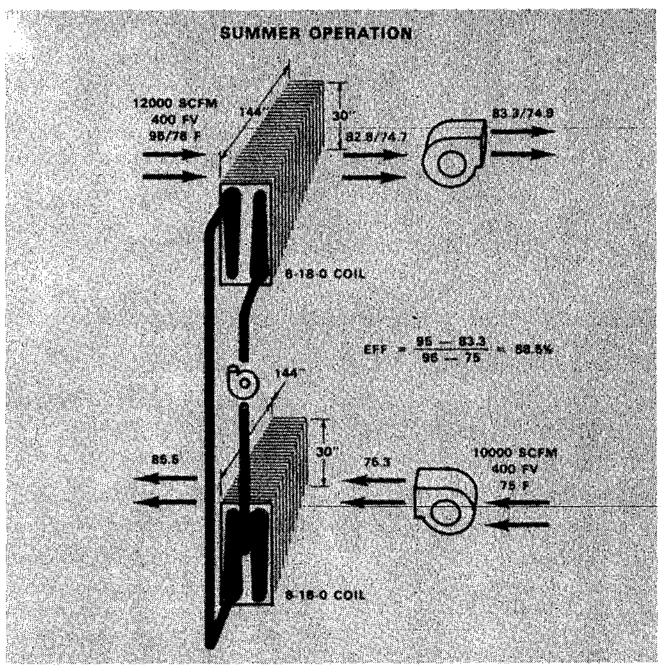

FIGURE 4

Here is a typical summer operating condition. (Figure 4) Cooling of outside air is sensible only and recovers only about 20% of the enthalpy difference between the two air streams. This type of sensible heat recovery system can rarely be justified when based solely upon summer operation. The temperature differences, and thus the magnitude of heat transfer, is simply not large enough. The system **is** operated during the summer months because the air side fan energy, which is the major operating cost, **is** always there, Therefore, it is wise to allow the pump to operate and reap whatever operating savings are available.

The coil run-around cycle has two important advantages over all other air-to-air heat recovery equipment. They are:

1. Remote locations of exhaust air outlet and make-up air inlet ports. This eliminates the cost of bringing large volumes of exhaust air back to the equipment room for processing.
2. Exhaust air condensate freeze control may be achieved by either:
   a. Specifying the GPM such that the minimum tube-wall temperature is at or above 32 F, or
   b. Employing a temperature control mixing valve at the exhaust air coil to maintain a minimum 30 F entering glycol temperature.

Other types of air-to-air heat recovery equipment require preheating of the cold make-up air to about 20 F to prevent freezing of the exhaust air condensate.

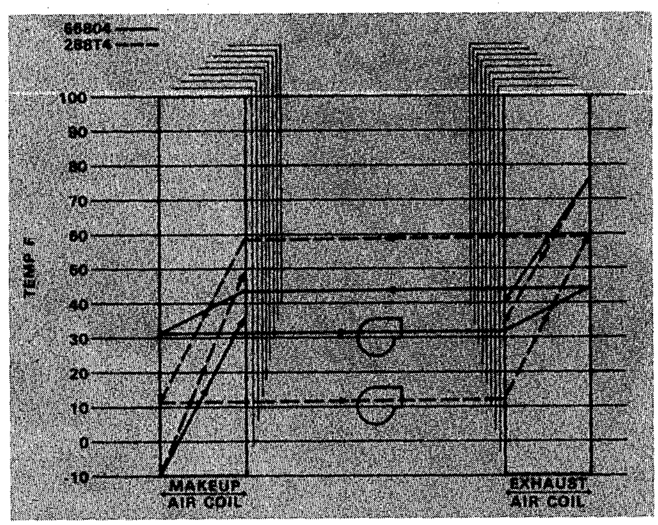

FIGURE 5

(Figure 5) This is an illustration of how the tube-wall temperature can be effectively controlled by selecting the proper GPM circulation between the two coils. To illustrate the effect of the GPM flow rate on the condensate freeze characteristics of the exhaust coil, analyze the balanced temperatures of a low GPM design (broken line) and a high GPM design (solid line), corresponding to glycol tube velocities of 2 FPS and 6 FPS respectively.

For a −10 F make-up air temperature and a 75 F exhaust air temperature, the low GPM (2 FPS, broken line) glycol temperatures balance out at 11 F to the exhaust coil and 58 F to the make-up air coil. If the 75 F exhaust air coil were very dry and the cooling were sensible, there would be no freeze problem with the 11 F glycol coolant at the exhaust coil. Thus, the outside air would be heated from −10 F to 48 F. However, there is usually sufficient moisture in the exhaust air to result in latent cooling. In this case, the 11 F glycol would result in a tube wall temperature well below 32 F with consequent freezing of the condensate. When such freezing occurs, depending on the severity of the temperature, the system efficiency can drop all the way to zero.

To combat this freezing problem, and its decaying affects on the system capacity, it is usually possible to increase the GPM and thereby raise the entering glycol temperature to the exhaust coil (above 30 F) preventing condensate freezing. In this case, tracing the solid line for a high GPM (6 FPS) design shows the glycol temperature to be 31 F at the exhaust coil and the outside air to be heated from −10 F to 36 F. Although the system capacity is reduced by going to the higher GPM (48 F vs 36 F preheated make-up air) the energy exchanged is still about 20% greater than would be realized from preheating the make-up air to 20 F to prevent condensate freezing, as required in other systems.

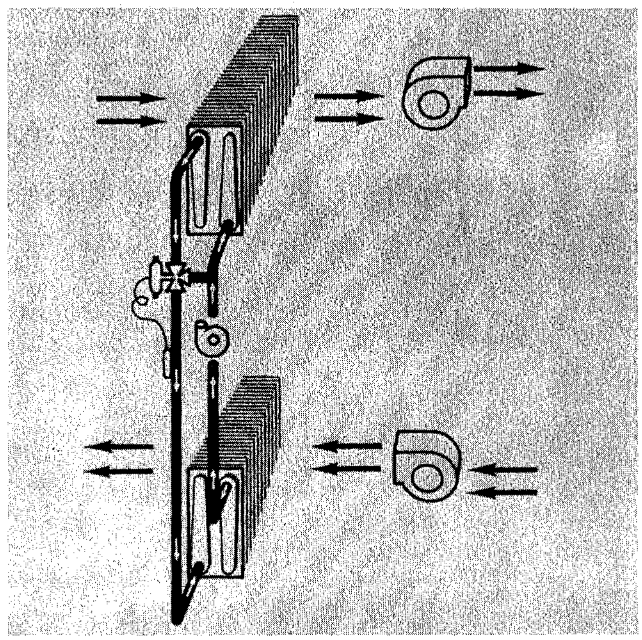

FIGURE 6

(Figure 6) This shows how a 3-way temperature control valve can be used to provide positive insurance against the hazards of condensate freezing. The valve is set to maintain a 30 F minimum entering temperature to the exhaust air coil. This assures a tube wall temperature above 32 F and, in turn, no freezing of the condensate. As the glycol temperature entering the exhaust air coil falls below 30 F, the third port of the valve is opened sufficiently to allow passage of warmer glycol into the coil, stabilizing its temperature.

RUN-AROUND CYCLE DESIGN

Why, with the age and relative simplicity of the run-around cycle, has it not been highly popular through the years? Its popularity is just now becoming quite pronounced. First, because of the energy crisis and the focussed need for this type of equipment; and secondly, the computer solution of the problems involved in properly designing the run-around cycle. Now it is possible to determine the optimum combination of:

GPM/WTD

Coil Circuiting (Coil types P2, P4, P8, W or DD)
Face Velocity (W x L)
Rows
Fin Series
Turbulators
APD/WPD . . .
. . . to give:
Lowest payback period or
Highest cost recovery per year.

to be continued . . .

WHERE TO USE - THE DIRECT-FIRED MAKE-UP AIR UNIT

PRIMARY USE —

The direct-fired make-up air unit is used to heat outside air introduced into a space to compensate for exhaust air. It is primarily applied in those industrial and commercial heating installations with high ventilation requirements. Factories engaged in plastic fabrication, chemical laboratories, electronic assembly areas where heavy soldering is done, are only a few of the applications with fume problems that can be readily solved with proper ventilation and direct-fired make-up air units.

Quite often, the make-up air unit can solve the problem of reverse air flow, in the flues and vents of furnaces, boilers and hot water heaters, that causes back-drafts and inefficient operation. By creating a positive pressure, make-up air units also help solve the problems of drafts around windows and doors and cold perimeters inside the building.

Make-up air units reduce original equipment cost by minimizing the need, complexity and cost of power venting equipment. In addition, they help meet OSHA requirements for the building and interior working conditions.

OTHER USES ALSO —

The make-up air unit is often used to offset a portion of the building heat loss, while also supplying ventilation air heating requirements. For instance, if interior design air temperature is 75 F, Trane make-up air units are capable of heating discharge air up to 140 F. (Local codes should be checked for discharge temperature limitations.) With 0 F outside design, 75 F room condition and handling 20,000 SCFM at 120 F discharge, a Trane make-up air unit can add as much as 976,500 BTUH to the space above and beyond ventilation air heating requirements.

AND FREE COOLING TOO —

Make-up air units can also be used to provide free cooling. Trane make-up air units, or Direct-Fired Torrivents as they're called, will provide free cooling down to 55 F. However, since the fan is a constant volume device, the heavier 55 F air will require more BHP and the unit should be ordered with motors sized accordingly.

THE TRANE DIRECT-FIRED TORRIVENT —

The Trane Direct-Fired Torrivent is a gas-fired heating product with the gas burned directly in the air stream. This is common practice with make-up air heaters since combustion is so complete by-products are well within safe limits. Also, because an amount of air equal to the make-up air is exhausted from the building, products of combustion do not accumulate in the conditioned space. The Torrivent has combustion efficiency of 90% compared to the 60 to 80% of typical heat exchanger type equipment.

The Trane Direct-Fired Torrivent can be curb-mounted, pier-mounted or suspended from the ceiling. The Trane curb, approved by the National Roofing Contractors Association is a major step in assuring a low cost, leaktight installation.

The Direct-Fired Torrivent control system is designed to provide the utmost in safety and day-to-day operational reliability. Should flame failure occure, or any of the safety controls open, combustion and fan operation are terminated and will not recycle until the system is manually reset.

In summary, the direct-fired make-up air heater is a very flexible unit. Imaginative application may find many installations, other than those listed here, where the unit may be used successfully.

TRANE®
AIR CONDITIONING

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