replaced by a bed of adsorptive material and a separate water cooling coil, and a second section of adsorber must be provided for alternate reactivation while the first is adsorbing. A set of dampers or a rotary device must be arranged to connect the beds alternately to the air to be conditioned and to the hot gases for regeneration. Otherwise the liquid adsorption and solid adsorption systems are identical.

The most efficient solid adsorption systems use some internal means of heating the adsorber bed before activation, and cooling it after activation, and other means may also be employed for improving the performance.

These systems are especially affected by the temperature of the cooling water, since if the air leaving the cooling surface is at a higher temperature than the air entering, additional work must be done in the generator or activator in order to compensate for the extra sensible heat of the leaving air. On the other hand, if the leaving temperature is lower than the entering temperature, the reverse is true. When the cooling water

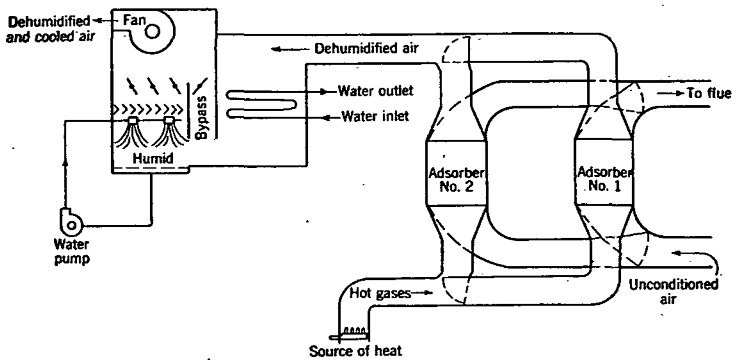

Fig. 10. Open Solid Material Adsorption System

temperature is low, similar economies may, however, be obtained with compression systems by the use of an air pre-cooling coil.

From this discussion it may be seen that these systems function to best advantage on a high air temperature, and on one in which the initial moisture content is high. Thus the use of high room temperatures and comparatively large amounts of outside air are encouraged in connection with these systems. In order to offset the effect of high air temperature, some effort is made to keep the humidity lower than usual. The ratio of the heat input to the refrigerant output, where the temperature of the air entering and leaving the adsorber cooler is not widely different, may vary from 4 to 1 for some of the solid adsorption systems, to as low as 1.5 to 1 for some of the liquid adsorption systems.

THE REVERSE CYCLE

The idea of heating by the reverse refrigeration cycle has captured the imagination of many people and has been much discussed. In principle, heat is absorbed in an evaporator from some available source of heat, pumped to a higher temperature and delivered to a condenser. The heat

from the condenser is used for heating purposes. The compressor acts as a heat pump whose fundamental function is to raise the potential of the heat. The theoretical work of compression in relation to the heat delivered is:

$$\frac{T_2}{T_1 - T_2}$$

where

T_1 = absolute temperature of evaporator.

T_2 = absolute temperature of condenser.

Thus, with a small spread of temperature between the evaporator and the condenser, 6 or 8 times as much heat may be obtained theoretically and 4 or 5 times practically, as the work put in. There are a number of limitations, however, the most serious of which is the lack of ready availability of a practical source of heat.

1. Well water is the most desirable since its temperature is high even in the winter and thus a large amount of heat may be removed in relation to the weight of water handled.

2. Air may be used but its specific heat is low and its temperature uncertain. When the most heat is needed, the temperature of the air is lowest, thus resulting in the least favorable temperature combination.

3. It has been proposed to obtain heat by freezing water, but this is still in the theoretical stage.

Some of the other factors which act as limitations are the large temperature spread when using air as a source of heat and when attempting to cool with even moderately low outside temperatures, the frequent disparity between the size of the cooling load and heating load requiring extra equipment for a complete heating load, and the relatively high initial cost of equipment at present available for the reverse cycle in comparison with that available for heating by conventional means.

Because of these limitations, the present application of the system is largely limited to temperate climates, such as Florida and Southern California, or to heating only for intermediate seasons, or to other localities which have peculiar advantages as, for instance, the ready availability of well water. In these locations it is frequently possible to do all of the heating necessary with the refrigeration equipment so that the extra cost is only that of reversing the functions of the condenser and evaporator.

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