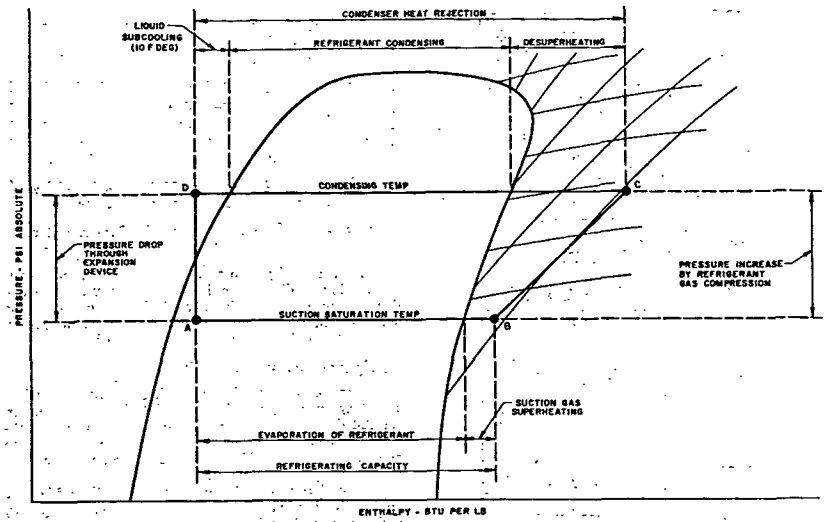

Fig. 7 .... Typical Pressure-Enthalpy (Mollier) Diagram for Complete Refrigeration Cycle

gain characteristics of the conditioned space on the capacity characteristic of the cooling system often will be of value in determining the degree of complexity actually required to meet the objectives of the system.

While the component balancing process is essential to the detailed technical problems of component selection, it also helps in the development of an overall appraisal of system performance. The designer may consider the system as merely an assembly of components, each having a known sensitivity to the variables which affect its performance, thereby overlooking the fact that the sensitivity of the system as a whole to the external variables is generally of a lower order. This can result in unwarranted system and control complexity, which will have an important influence on the cost and reliability of the overall system. A study of the way in which components balance out when combined will yield valuable information on the overall response of the system to its environment. This information can be applied to the more detailed considerations of determining the extent to which specific refinements are warranted.

TYPICAL COMPONENT BALANCE EXAMPLE

The typical pressure-enthalpy (Mollier) diagram shown in Fig. 7 illustrates a component balance used through a complete refrigeration cycle.

The refrigerating capacity (line AB) is determined from Fig. 1, and represents the evaporator capacity minus the refrigeration effect.

Point C is determined from Part B of Fig. 2. The length of line CD is determined by the condenser heat rejection found from Part A of Fig. 2.

The relative position of system points A, B, C, and D are subject to limited change, as indicated in the preceding text, due to line pressure drops, compressor and expansion device characteristics, and other factors.

A similar approach to load balance for heat pump systems is discussed in Chapter 66.

CHAPTER 45

REFRIGERANT CONTROL DEVICES

CONTROLLERS: Pressure Controllers, Temperature Controllers, Differential Controllers, Float Switches; CONTROL VALVES: Thermostatic Expansion Valves, Constant Pressure Expansion Valves, Discharge Bypass Regulators, Evaporator Pressure Regulators, Suction Pressure Regulators, Condenser Pressure Regulators, Condenser Bypass Valves, High-Side Float Valves, Low-Side Float Valves, Solenoid Valves, Refrigerant Reversing Valves, Condensing Water Regulators, Check Valves, Relief Devices; CAPILLARY TUBES: Theory, Design Factors, Application, Preliminary Selection, Simplified Calculation Procedure

THE control of refrigerant flow is an essential feature of any refrigeration system. Part I of this chapter discusses the operation and selection of controllers, including: (1) pressure controllers, (2) temperature controllers, (3) differential controllers, and (4) float switches. Part II discusses the operation and selection of control valves, including: (1) thermostatic expansion valves, (2) constant pressure expansion valves, (3) discharge bypass regulators, (4) evaporator pressure regulators, (5) suction pressure regulators, (6) condenser pressure regulators, (7) condenser bypass valves, (8) high-side float valves, (9) low-side float valves, (10) solenoid valves, (11) refrigerant reversing valves, (12) condensing water regulators, (13) check valves, and (14) relief devices. Part III discusses capillary tubes. For further information on automatic control, see Chapter 13.

PART I: CONTROLLERS

The controller is a device which operates one or more sets of electrical contacts and, in some cases, water or refrigerant valves, in response to changes in pressure, temperature or liquid level. Pressure and temperature responsive controllers have one or more power elements which may utilize bellows, diaphragms, or bourdon tubes, to produce the force needed to operate the mechanism. Level responsive controllers utilize either a float or an electronic type probe to directly or indirectly operate one or more sets of electrical contacts.

PRESSURE CONTROLLERS

The refrigerant pressure is applied directly to the power element which moves against a spring that can be adjusted to control any operation at the desired pressure. If the controller is to operate in the subatmospheric, or vacuum, range the bellows or diaphragm force will be reversed and act in the same direction as the adjusting spring. To counteract this, an additional spring must be used to overcome the reversed bellows force, in which case the force of both the bellows and the *vacuum* spring oppose the adjusting spring.

The force available for doing work in a controller of this type is dependent first upon the pressure in the system and secondly upon the area of the bellows or diaphragm. With proper area a sufficient force can be produced to operate heavy switches, water valves, or even refrigerant valves. In these heavy-duty controllers the minimum differential is necessarily quite large because of the massiveness of the bellows and opposing spring system.

TEMPERATURE CONTROLLERS

Temperature controllers for refrigeration are basically pressure controllers in which the pressure responsive power element is replaced by a temperature responsive power element. The exact temperature-pressure relationship of the fluid used in the power element allows the temperature of the bulb to accurately control the pressure. Operation of the controller results from these changes in pressure.

DIFFERENTIAL CONTROLLERS

Controllers used to maintain a given difference in pressure or temperature between two pipe lines or spaces are known as differential controllers. A typical example of this type of controller is the oil safety switch used with reciprocating compressors having forced feed pressure lubrication. These controllers, since they must sense conditions in two different locations, must have two elements, either pressure- or temperature-sensitive.

Fig. 1 is a schematic diagram of a *differential-pressure* controller using bellows as power elements.

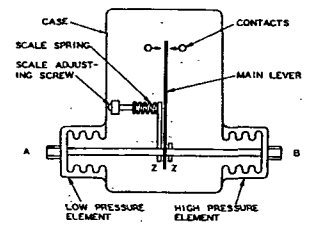

Fig. 1 .... Differential-Pressure Controller

The general responsibility for this chapter is assigned to TC 10.2, Refrigerant Flow Controls and Accessories, and TC 1.3, Heat Transfer and Fluid Flow.