

TABLE 8. PRESSURE LOSSES IN DICHLORODIFLUOROMETHANE DISCHARGE OR HOT GAS LINES^a

CAPACITY BTU PER HOUR	PRESSURE DROP IN POUNDS PER SQUARE INCH PER 100 FT ^b									
	LINE SIZES, INCHES									
	3/8	1/2	5/8	1 1/8	1 1/4	1 3/8	2 1/8	2 3/8	3 1/8	3 3/8
10,000	2.3	1.0	0.6							
15,000	4.9	2.0	1.0							
20,000	8.5	3.4	1.7	0.6						
25,000		5.3	2.6	0.9						
30,000		7.5	3.6	1.2	0.5					
40,000			6.4	2.1	0.7					
50,000			9.8	3.1	1.0	0.5				
60,000				4.4	1.3	0.7				
70,000				6.0	1.9	0.9				
80,000				8.0	2.5	1.1				
90,000				10.2	3.1	1.4				
100,000					3.8	1.7	0.5			
125,000					6.0	2.6	0.7			
150,000					8.5	3.8	1.0			
175,000					11.6	5.1	1.3			
200,000						6.7	1.7	0.8		
250,000						10.4	2.6	0.9		
300,000							3.7	1.2	0.5	
400,000							6.7	2.2	0.9	
500,000							10.5	3.5	1.5	0.7
600,000								5.0	2.1	1.0
800,000								9.0	3.8	1.8
1,000,000									5.8	2.9
1,250,000									9.5	4.4
1,500,000										6.4
2,000,000										11.3

^aSoft annealed copper tubing up to and including 3/4 in. outside diameter. Hard copper pipe 3/4 in. outside diameter and larger.

^bLength of tubing includes the average number of fittings.

Compound Compression Cycles

In large systems the compression process can be carried out in steps as the refrigerant passes through a number of cylinder ends arranged for operation in series. Thermodynamically the advantage of compound compression arises from the fact that intercoolers can be placed between the stages of compression to extract heat from the vapor and thereby cause the over-all compression process to more closely approach the ideal condition of isothermal compression. Essentially, such intercoolers—whether of the water or the flash refrigerant type—serve the same purpose as a cooling jacket, but with greater effectiveness because of the more satisfactory heat transfer conditions.

Multiple Expansion Valves

In the simple saturation cycle the saturated liquid entering the expansion valve commences to vaporize as soon as its pressure starts to drop. The vapor produced during the expansion process has no further use, in terms of refrigerating effect, since it has already picked up its latent heat of vaporization as a result of heat which it has extracted from the unvaporized residue. Thus the instant such vapor forms, its usefulness is at an end, and to allow such material to undergo a further drop in pressure is uneconomical. Unfortunately, however, there is no effective means of extracting vapor continuously during the expansion

TABLE 9. PRESSURE LOSSES IN DICHLORODIFLUOROMETHANE LIQUID REFRIGERANT LINES

CAPACITY BTU PER HOUR	PRESSURE DROP IN POUNDS PER SQUARE INCH PER 100 FT ^a			
	PIPE SIZES, INCHES			
	3/8	1/2	5/8	3/4
100,000	0.6			
125,000	0.9			
150,000	1.3			
175,000	1.8			
200,000	2.3	0.6		
225,000	2.9	0.8		
250,000	3.6	1.0		
275,000	4.3	1.2		
300,000	5.1	1.4		
325,000	5.9	1.6		
350,000	6.9	1.8		
375,000	7.9	2.1		
400,000	9.0	2.3	0.8	
450,000		2.9	1.0	
500,000		3.5	1.3	
550,000		4.3	1.5	0.7
600,000		5.0	1.8	0.8
700,000		6.7	2.4	1.1
800,000		8.7	3.1	1.4
900,000			3.9	1.7
1,000,000			4.7	2.1
1,200,000			6.7	3.0
1,400,000			9.0	4.0
1,600,000				5.1
1,800,000				6.3
2,000,000				7.9
2,200,000				9.2

^aLength of tubing includes the average number of fittings.

and re-compressing it. Thus in the simple cycle the flash vapor must necessarily be allowed to drop to evaporator pressure.

When a compound compression cycle is used there is at least one intermediate pressure at which flash vapor can be extracted. In such cases all refrigerant from the condenser can be dropped through a first expansion valve to the higher suction pressure and the flash vapor then extracted and returned to the compressor. Some of the resultant liquid refrigerant then passes through the high-pressure evaporator while the remainder proceeds through a second expansion valve in which its pressure is dropped to the valve corresponding to the low-pressure evaporator.

Pipe Sizes and Friction Losses

The effect on performance of pressure losses in the piping of a refrigerating system has already been discussed. In all cases frictional losses should be kept to a minimum and piping should be selected which will give the smallest loss, consistent with over-all economy of the system. Actual losses vary, of course, with the physical characteristics of the particular refrigerants, but, by way of example, data will be given for one of the refrigerants, dichlorodifluoromethane (F-12) which finds wide use in air conditioning applications.

Tables 8, 9, and 10 give the pressure loss per 100 ft of piping (including an average number of fittings) for oil-free dichlorodifluoromethane;