Application Engineering

Water Flow Requirements and Water Pressure Drop for Copeland Water-Cooled Condensing Units

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Safety

Important Safety Information

Those involved in the design, manufacture, and installation of a system, system purchasers, and service personnel may need to be aware of hazards and precautions discussed in this section and throughout this document. OEMs integrating the compressor into a system should ensure that their own employees follow this bulletin and provide any necessary safety information to those involved in manufacturing, installing, purchasing, and servicing the system.

Responsibilities, Qualifications and Training

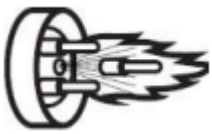
• OEMs are responsible for system design, selection of appropriate components, integration of this component into the system, and testing the system. OEMs must ensure that staff involved in these activities are competent and qualified.

• OEMs are also responsible for ensuring that all product, service, and cautionary labels remain visible or are appropriately added in a conspicuous location on the system to ensure they are clear to any personnel involved in the installation, commissioning, troubleshooting or maintenance of this equipment.

• Only qualified and authorized HVAC or refrigeration personnel are permitted to install, commission, troubleshoot and maintain this equipment. Electrical connections must be made by qualified electrical personnel.

• Observe all applicable standards and codes for installing, servicing, and maintaining electrical and refrigeration equipment.

Terminal Venting and Other Pressurized System Hazards



If a compressor's electrical terminal pin loses its seal, pressurized oil, refrigerant, and debris may spray out. This is called "terminal venting".

The ejected debris, oil, and refrigerant can injure people or damage property. The oil and refrigerant spray can be ignited by electrical arcing at the terminal or any nearby ignition source, producing flames that may project a significant distance from the compressor. The distance depends on the pressure and the amount of refrigerant and oil mixture in the system. The flames can cause serious or fatal burns and ignite nearby materials.

Each compressor has a terminal cover or molded plug that covers electrical connections. The cover or plug helps to protect against electric shock and the risks of terminal venting. If terminal venting occurs, the cover or plug helps contain the spray of refrigerant and oil and reduces the risk of ignition. If ignition occurs, the plug or cover helps contain the flames. However, neither the terminal cover nor the molded plug can completely eliminate the risk of venting, ignition, or electric shock.

See copeland.com/terminal-venting for more details about terminal venting. Additionally, a compressor's refrigerant lines keep refrigerant and oil under pressure. When removing or recharging refrigerant from this component during service, this can pose a pressurized fluid hazard.

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Flammable Refrigerant Hazards



If flammable refrigerant is released from a system, an explosive concentration can be present in the air near the system. If there is an ignition source nearby, a release of flammable refrigerant can result in a fire or explosion. While systems using flammable refrigerant are designed to mitigate the risk of ignition if the refrigerant is released, fire and explosion can still occur.

See copeland.com/flammable-refrigerants for more information on flammable refrigerant safety.

Electrical Hazards



Until a system is de-energized, and capacitors have been discharged, the system presents a risk of electric shock.

Hot Surface and Fire Hazards



While the system is energized, and for some time after it is deenergized, the compressor may be hot. Touching the compressor before it has cooled can result in severe burns. When brazing system components during service, the flames can cause severe burns and ignite nearby combustible materials.

Lifting Hazards



Certain system components may be very heavy. Improperly lifting system components or the compressor can result in serious personal injury. Use proper lifting techniques when moving.

POE Oil Hazards

This equipment contains polyol ester (POE) oils. Certain polymers (e.g., PVC/CPVC and polycarbonate) can be harmed if they come into contact with POE oils. If POE oil contacts bare skin, it may cause an allergic skin reaction.

Precautions

• Always wear personal protective equipment (gloves, eye protection, etc.).

• Keep a fire extinguisher at the jobsite at all times.

• Keep clear of the compressor when power is applied.

- IMMEDIATELY GET AWAY **if you hear unusual sounds in the compressor. They can indicate that terminal pin ejection may be imminent. This may sound like electrical arcing (sizzling, sputtering or popping). However, terminal venting may still occur even if you do not hear any unusual sounds.**

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• Never reset a breaker or replace a blown fuse without performing appropriate electrical testing

- **A tripped breaker or blown fuse may indicate an electrical fault in the compressor. Energizing a compressor with an electrical fault can cause terminal venting. Perform checks to rule out an electrical fault.**

• Disconnect power and use lock-out/tag-out procedures before servicing.

- Before removing the terminal cover or molded plug, check that ALL electrical power is disconnected from the unit. Make sure that all power legs are open. (Note: The system may have more than one power supply.)

- Discharge capacitors for a minimum of two minutes

- Always use control of hazardous energy (lock-out/tag-out) procedures to ensure that power is not reconnected while the unit is being serviced.

• Allow time for the compressor to cool before servicing.

- Ensure that materials and wiring do not touch high temperature areas of the compressor.

• Keep all non-essential personnel away from the compressor during service.

• For A3 refrigerants (R290) remove refrigerant from both the high and low sides of the compressor. Use a recovery machine and cylinder designed for flammable refrigerants. Do not use standard recovery machines because they contain sources of ignition such as switches, high- and low-pressure controls and relays. Only vent the R290 refrigerant into the atmosphere if the system is in a well-ventilated area.

• Never use a torch to remove the compressor. Only tubing cutters should be used for both A2L and A3 refrigerants.

• Use an appropriate lifting device to install or remove the compressor.

• Never install a system and leave it unattended when it has no charge, a holding charge, or with the service valves closed without electrically locking out the system.

• Always wear appropriate safety glasses and gloves when brazing or unbrazing system components.

• Charge the system with only approved refrigerants and refrigeration oils.

• Keep POE oils away from certain polymers (e.g., PVC/CPVC and polycarbonate) and any other surface or material that might be harmed by POE oils. Proper protective equipment (gloves, eye protection, etc.) must be used when handling POE lubricant. Handle POE oil with care. Refer to the Safety Data Sheet (SDS) for further details.

• Before energizing the system:

1. Securely fasten the protective terminal cover or molded plug to the compressor, and

2. Check that the compressor is properly grounded per the applicable system and compressor requirements.

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Signal Word Definitions

The signal word explained below are used throughout the document to indicate safety messages.



DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.



WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

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Introduction

Copeland water-cooled condensing units are available in a wide variety of sizes, and three different styles of condensers are currently in production: shell and tube, shell and coil, and tube within a tube.

Table 1 lists the approximate water flow requirement on Copeland condensing units for various evaporating and condensing temperatures. Water flow requirements may vary on different units, but the figures shown should be satisfactory for line and pump sizing. Note that the water requirement is shown in terms of gallons per hour per 1000 BTU/Hr net refrigeration capacity. The additional heat to be rejected due to the heat of compression has already been taken into account in calculating the water requirement.

On smaller Copelametic water-cooled motor compressors from 1/3 H.P. through 2 H.P., the compressor body is wrapped with an external water coil formed from copper tubing. Larger Copelametic compressors and all Copelaweld compressors are refrigerant-cooled.

The Copelametic compressors provided with water coils will be adequately cooled at any operating temperature. Refrigerant-cooled compressors operating at evaporating temperatures above 0°F. require no auxiliary cooling, but for evaporating temperatures below 0°F., refrigerant-cooled motor compressors cannot be cooled adequately by the refrigerant vapor, and additional cooling by means of an auxiliary fan is required.

Installation Recommendations

Cooling water circuits in some tube within a tube and shell and tube water-cooled condensers may be either series or parallel as required by the particular application. The use of parallel circuits results in a low pressure drop through the circuit and may be necessary when the temperature of the cooling water is such that the water temperature rise must be held to a minimum. Shell and coil condensers have only one possible water circuiting. On very large condensers, the water circuiting may be entirely internal with only an inlet and outlet water fitting. The water inlet is always at the bottom connection.

Electrical or pressure operated water control valves should be installed between the water supply and the condenser inlet - never between the condenser and the drain. If water supply pressure is *excessive, a pressure reducing valve must be used since the allowable working pressure of water valves is normally 150 psig. Shell and tube water condensers now in production have a working pressure on the water side of 150 psig. Condensers manufactured prior to 1975 had a working pressure of 80 psig.

Care should be exercised in locating the condensing unit so that the condenser will never be exposed to temperature below freezing.

Occasionally condensers may be damaged by excessive water velocities or cavitation on the water side of the condenser tubes. In order to prevent operating difficulties, care should be taken to follow the installation recommendation as outlined below:

A. Water velocities through the condenser should not exceed 7 feet per second. Higher velocities can result in “impingement corrosion”. This is a condition in which progressive erosion of the tube can occur due to the high-water velocity washing away the inner oxidized surface of the tube at points where excessive turbulence may occur. This can originate with a minute imperfection on the tube inner surface, but it becomes progressively worse as the pitting increases.

   In order to maintain water velocities at an acceptable level, parallel circuiting of the condenser may be necessary when high water flow is required.

B. If a water circulating pump is used, install so that the condenser is fed from the discharge side of the pump. If the pump were on the discharge side of the condenser, the condenser could have a slight vacuum in the water system, and therefore the water would be much nearer its boiling point. A combination of a localized hot spot in the condenser together with a localized velocity increase that might reduce pressures even lower, could result in triggering a cavitation condition.

   collapse of the bubbles as the conditions varies. This can result in very rapid erosion and destruction of the water tube. Maintaining a positive pressure

and limiting velocities in the condenser will prevent this condition.

C. If the condenser is installed more than 5 feet higher than the outlet drain point of the condenser, a vacuum breaker or open vent line should be provided to prevent the discharge line from creating a partial vacuum condition in the condenser water system. An unvented discharge connection with a high vertical drop could result in cavitation in a manner similar to a pump on the outlet of the condenser.

Tables and Figures

Figure 1- Standard condenser circuit

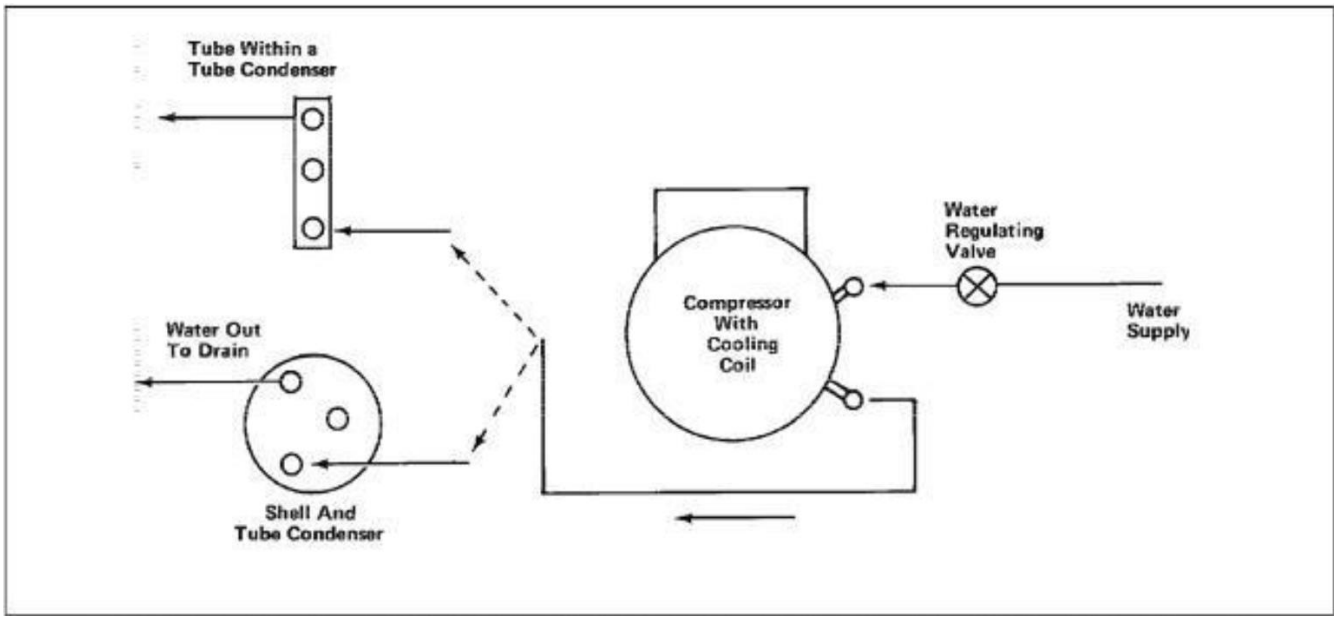


Figure 1 illustrates the type of circuiting normally used on all standard condensing unit using city water supply. All water-cooled condensing units are shipped from the factory with the connections as shown above, and water connections must be modified in the field if parallel circuits are desired.

Connect the water supply through the water regulating valve through the compressor water coils as shown if the compressor is water-cooled. For suction or air-cooled compressors, the connection is similar except the compressor is bypassed.

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Figure 2 – Condenser with parallel circuit

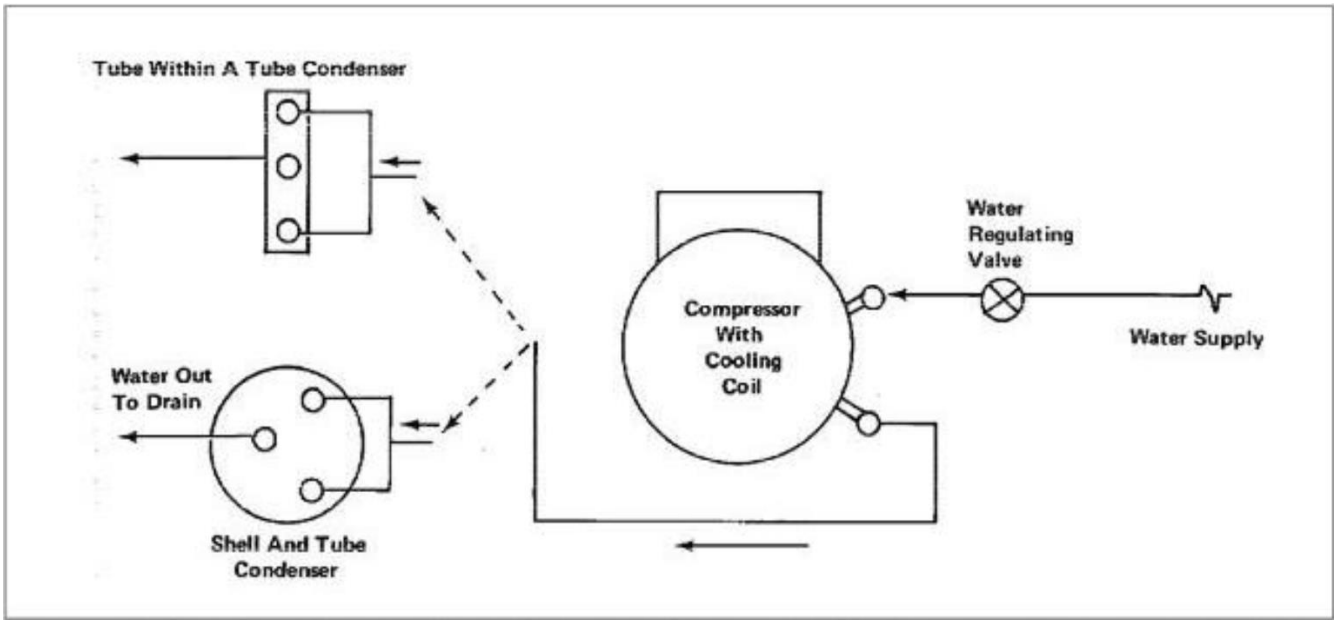


Figure 2 illustrates a condenser with parallel circuits. This type of circuiting is frequently used when the condensing water is cooled by a water tower.

Connect the water supply through the water regulating valve and through the compressor water coils as shown if the compressor is water-cooled. For suction or air-cooled compressors, the connection is similar to except the compressor is bypassed.

Table 1 - Water Flow Requirement for Copeland Water-cooled Condensing Units

Gallon per hour per 1,000 BTU/hr. (Net)

Operating Conditions	Temperature Difference, Entering Water to Condensing			
	20°F T.D.		30°F T.D.	
	Series Water Flow	Parallel Water Flow	Series Water Flow	Parallel Water Flow
	90°F Condensing			
45°F Evap.	8.1	10.1	5.5	6.8
15°F Evap.	8.9	11.1	6.0	7.5
-10°F Evap.	10.0	12.5	6.8	8.5
-30°F Evap.	11.0	13.6	7.4	9.2
	100°F Condensing			
45°F Evap.	8.2	10.3	5.6	6.9
15°F Evap.	9.2	11.5	6.2	7.8
-10°F Evap.	10.4	13.0	7.1	8.8
-30°F Evap.	11.4	14.2	7.7	9.6
	110°F Condensing			
45°F Evap.	8.5	10.5	5.7	7.1
15°F Evap.	9.5	11.8	6.4	8.0
-10°F Evap.	10.9	13.5	7.4	9.2
-30°F Evap.	12.0	15.0	8.1	10.1

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Table 2 – Copelametic Water-Cooled Condensing Units Water Pressure Drop

Condensing Unit Model No.	Compressor		Condenser type	Flow GPM	Pressure Drop PSIG			Water Valve Size
	Model	Cooling			Compressor	Std.	Split	
E - Line 0025 0033	All	Coil	Shell & Coil	0.5 1.0 1.5	0.7 2.3 5.0	0.6 1.9 3.6		3/8
E - Line 0050	All	Coil	Tube & Tube	0.5 1.0 1.5	0.5 1.7 3.75	0.3 0.5 1.0		3/8
E - Line 0075	All	Coil	Tube & Tube	0.5 1.0 1.5	0.5 1.7 3.75	0.3 0.5 1.0		3/8
D - Line 0100	All	Coil	Tube & Tube	1.0 2.0 3.0	1.7 6.2 13.50	0.3 1.0 2.0		3/8
D – Line 0150	K	Coil	Tube & Tube	1.0 2.0 3.0	1.7 6.20 13.5	0.2 0.5 1.0		3/8
D – Line 0150	E	Coil	Tube & Tube	1.0 2.0 3.0	1.0 1.2 2.75	0.2 0.5 1.0		1/2
W – Line 0075	All	Coil	Shell & Tube	0.5 1.0 1.5	0.5 1.7 3.75	2.0 4.5 9.0	1.5	3/8
W – Line 0100	All	Coil	Shell & Tube	1.0 1.5 2.0	1.7 3.75 6.20	3.2 7.0 11.0	3.2	3/8
W – Line 0150	K	Coil	Shell & Tube	1.0 2.0 3.0	1.7 6.2 13.5	4.0 12.2 *	1.7 3.5	3/8
W – line 0150	E	Coil	Shell & Tube	1.0 2.0 3.0	0.5 1.25 2.80	4.0 12.2 *	1.7 3.5	1/2
W – Line 0200	ER	Suction	Shell & Tube	1.5 3.0 4.5		2.0 5.75 12.4	2.0	1/2
W – Line 0200	EW 3W	Coil	Shell & Tube	2.0 3.0 4.0	1.25 2.8 5.9	3.0 5.7 10.0	1.5	1/2

***Velocity greater than 7FPS. Use not recommended.**

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Table 2 - Continued Copelametic Water-Cooled Condensing Units Water Pressure Drop

Condensing Unit Model No.	Compressor		Condenser type	Flow GPM	Pressure Drop PSIG			Water Valve Size
	Model	Cooling			Compressor	Condenser		
						Std.	Split	
W-Line				1.5		1.0		
0300	All	Suction	Shell & Tube	3.0		2.1		
				4.5		4.2		1/2
				6.0		8.0	1.0	
W-Line				3.0		3.0		
0500	All	Suction	Shell & Tube	5.0		6.0		
0600				10.0		*	3.0	3/4
				12.0		*	4.0	
W-Line				5.0		3.0		
0750	All	Suction	Shell & Tube	10.0		10.0	1.5	
				15.0		*	3.0	3/4
				17.5		*	4.0	
W-Line				10.0		3.75		
1000	All	Suction	Shell & Tube	15.0		7.5	1.0	
				20.0		12.5	1.75	1
				25.0		*	2.75	
W-Line				12.0		3.0		
1500	All	Suction	Shell & Tube	20.0		7.2	1.0	
				30.0		*	2.2	1-1/4
				35.0		*	3.0	
W-Line				15.0		5.0		
2000	All	Suction	Shell & Tube	25.0		12.0	1.6	
				35.0		*	2.5	1-1/4
				40.0		*	4.0	
W-Line				15.0		1.0		
2500	All	Suction	Shell & Tube	30.0		4.5		
				40.0		7.5	1.0	1-1/2
				45.0		9.0	1.3	
W-Line				20.0		2.0		
3000	All	Suction	Shell & Tube	35.0		6.0	0.8	
				50.0		11.0	1.6	1-1/2
				60.0		*	2.2	
W-Line				30.0		4.6		
3500	All	Suction	Shell & Tube	45.0		10.0	1.5	
				60.0		*	2.5	1-1/2
				80.0		*	4.0	

***Velocity greater than 7FPS. Use not recommended.**

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Condensing Unit Model No.	Compressor		Condenser type	Flow GPM	Pressure Drop PSIG			Water Valve Size
					Compressor	Condenser		
	Model	Cooling				Std.	Split	
W-Line 0400	All	Suction	Shell & Tube	30.0 50.0 70.5 90.0			0.5 1.3 2.3 3.7	2-1/2
W-Line 2000	All	Suction	Shell & Tube	15.0 25.0 35.0		2.0 5.0 9.0	1.3	1-1/4
W-Line 3000	All	Suction	Shell & Tube	20.0 35.0 50.0 60.0		2.0 6.0 11.0 *	0.8 1.6 2.2	1-1/2
W-Line 4000	Std.	Suction	Shell & Tube	30.0 50.0 70.0 90.0			0.5 1.3 2.3 3.7	2-1/2
W-Line 4000	Two Stage	Suction	Shell & Tube	20.0 30.0 40.0		2.0 4.5 7.5	1.0	1-1/4
W-Line 5000	All	Suction	Shell & Tube	50.0 70.0 90.0 110.0			0.2 0.4 0.6 0.8	2-1/2
W-Line 6000	All	Suction	Shell & Tube	60.0 90.0 120.0			0.2 0.4 0.7	3
W-Line 7000	All	Suction	Shell & Tube	75.0 100.0 125.0 150.0			0.2 0.4 0.6 0.9	3
W-Line 8000	All	Suction	Shell & Tube	80.0 120.0 150.0 175.0			0.5 0.7 1.0 1.25	3

***Velocity greater than 7FPS. Use not recommended.**

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Table 3 – Copelaweld Water-Cooled Condensing Units Water Pressure Drop

Condensing Unit Model No.	Compressor	Condenser Type	Flow GPM	Pressure Drop PSIG	Water Valve Size
F-Line 0050	All	Shell & Tube	0.5 0.75 1.0	1.5 2.5 4.5	3/8
F-Line 0075	All	Shell & Tube	0.75 1.0 1.5	3.0 5.5 10.5	3/8
F-Line 0100	All	Shell & Tube	1.0 1.5 2.0	1.4 2.7 4.5	1/2
F-Line 0150	All	Tube & Tube	1.5 3.0 4.0	0.7 2.0 2.5	3/8
F-Line 0200	All	Tube & Tube	2.0 3.0 5.0	0.5 1.0 2.0	3/8
F-Line 0300	All	Tube & Tube	4.0 6.0 8.0	2.0 6.0 13.0	1/2
F-Line 0400 0500	All	Tube & Tube	4.0 8.0 12.0	1.9 6.0 13.0	1

How to use the Tables:

Obviously, data cannot be tabulated for every field operating condition, but by interpolating the data presented, water flow and pressure drop can be estimated with sufficient accuracy for line and pump sizing.

Example No. 1

Determine the required water flow and the resulting pressure drop for a W3DD-1500 condensing unit to be applied with R-502 on a medium temperature application with 85° entering water and a desired condensing temperature of 105°F.

(A) Net capacity of W3DD-1500 @ 15°F evap. (from W-Line brochure) 115,700 BTU/Hr.
Water requirement, 20° TD @ 105° condensing by interpolation from Table I for series flow 9.35 GPH/MBTU

Water flow required:
115.7 MBTU x 9.35 GPH = 1082 GPH
1082 ÷ 60 = 18 GPM

(B) Pressure drop from Table 2 approximately 6.1 PSI

Example No. 2

Determine the required water flow and the resulting pressure drop for a W3DD-3500 condensing unit to be applied with R-22 on a high temperature application with 80° entering water and a desired condensing temperature of 105°F.

(A) Net capacity of W3DD-3500 @ 45°F evaporator
460,000 BTU/Hr.
Water requirement (be interpolation from Table 1)
Series 7.0 GPH/MBTU
Parallel 8.7 GPH/MBTU

Series water flow:
460 MBTU x 7.0 GPH ÷ 60 = 53.7 GPM

Parallel water flow:
460 MBTU x 8.7 GPH ÷ 60 = 66.7 GPM

With series flow, velocity exceeds 7 FPS, so parallel flow must be used (from Table 2).

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Revision Tracking R8

The document format has been updated to the new Copeland format

All occurrences of "Emerson" have been removed

A note regarding A3 and R290 venting has been updated

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