



BY JOHNSON CONTROLS

# REFRIGERANT CHARGE VOLUME

TECHNICAL DATA

New Release

Form 160.00-TD8 (211)

## REFRIGERANT CHARGE

Johnson Controls is continually working to improve products to meet our customer needs. As customers seek “green” products, we identify and develop methods to deliver products more efficient, more reliable and easier to control. One recent change in the YORK centrifugal water chiller unit product line is to the introduction of hybrid falling film evaporators for YMC<sup>2</sup> and YK Mod G – a development that improves efficiency and simultaneously reduces the required refrigerant charge amount. Another improvement is the method by which we calculate refrigerant charge volume.

A falling film evaporator uses significantly less refrigerant charge than a flooded evaporator – as much as 40% less refrigerant! The amount of charge for chillers with hybrid falling film evaporator is now calculated based on unit selection and application considering the dimensions of the heat exchanger such as length, tube quantity and tube geometry, as well as properties of the refrigerant such as density. The calculation method also considers the open volume in the evaporator tube bundle of liquid refrigerant relative to refrigerant gas bubbles. This calculation can be impacted by heat flux (Btu/ft<sup>2</sup> or kW/m<sup>2</sup>) of the evaporator tube bundle and liquid/vapor “quality” entering the bottom of the flooded evaporator. A very efficient chiller with low energy consumption will have above average heat transfer area and a lower boiling rate which will increase the amount of required charge. A chiller designed for low lift application experiences less flash after the expansion valve which delivers the highest efficiency performance, but will also requires more refrigerant charge.

To properly calculate the required amount of refrigerant charge, it is necessary to know how much liquid is spraying from the falling film header and coating the tubes on the falling film section. A mathematical model was developed that determines the volume of liquid and vapor in all of the heat exchanger sections. Factors are applied for heat flux and rated operating temperatures. Therefore, any chiller with hybrid falling film evaporator can have variations in the amount of charge depending on the operation conditions. An example of this can be seen in the table below for YK Mod G chillers.

MODEL	TONNAGE	LEAVING EVAPORATOR WATER TEMP (°F)	ENTERING CONDENSER WATER TEMP (°F)	REFRIGERANT WEIGHT (LB)	LB/TON
YKEEETQ5	350	44	85	1126	3.217
YKEEETQ5	450	44	85	1113	2.473
YKEEETQ5	450	70	85	1237	2.749

This table is meant to show the changes of refrigerant on the same hardware. This does not represent the best chiller for the given conditions.

The YORK Model YK water chiller unit with newly designed evaporator requires less refrigerant charge by changing from a flooded design to a hybrid falling film design. Customers working to increase their LEED position by obtaining the EA4 enhanced refrigerant management credit can make use of falling film YORK Model YK water chillers to bring them closer to that goal. By calculating the charge based on each jobs specific conditions, more of the YK water chiller product line chillers meet the LEED requirement than in the past.

YORKworks performance simulation and ordering software will output the correct charge amount for each chiller based on its rated condition. For YORK model YMC<sup>2</sup> and YK Mod G water chiller hybrid falling film evaporators, the refrigerant charge amount will be calculated based upon the unique design conditions. The YORKworks order requirement will drive the factory or field refrigerant supply, and will be clearly indicated on the chiller nameplate.