CHILL VAktor

The Croll-Reynolds CHILL-VACTOR is a chiller that uses a vapor flashing process. Water has a pressure-temperature relationship which is its boiling point. If its equilibrium is disturbed by either raising the temperature at constant pressure or lowering the pressure at constant temperature, the water will boil or flash off vapor. Approximately 1000 BTU are required for each pound of water evaporated or flashed off. This heat is removed from the liquid, thus causing it to cool. At sea level atmospheric pressure is 14.7 psia and water will boil when heated to 212° F. If water at a temperature above 175° F is submitted to an elevation of 20,000 feet, 13.7 psia, it will boil until it cools to 175° F, its saturation temperature.

In a CHILL-VACTOR the pressure is reduced by a series of ejectors to a pressure corresponding to the saturation temperature of the chilled water. An EVACTOR booster is sized to remove the calculated amount of water vapor necessary for the required cooling rate. The booster compresses the vapor to a condenser at a higher pressure where it is condensed along with the motivating steam. The non-condensables from the chilled water, condenser water and system leaks are removed by the EVACTOR air pump. The drawing below shows a barometric condenser, the most frequently used type in vacuum refrigeration because it is the most economical. This type of condenser requires a discharge or barometric leg approximately 36 feet long to remove the water by gravity and overcome friction. A pump may be used where sufficient height is not available. When the condensate must be recovered, a surface condenser is used. A CHILL-VACTOR with a surface condenser not only recovers the motivating steam as condensate but provides an additional amount of condensate from the water vapor handled and requires no barometric leg.

OPEration

Vacuum refrigeration finds its widest application in chilling water for air conditioning, food processing, paper processing and industrial uses. Water is chilled usually to temperatures in the range of 35 to 60 degree’s F., although in many processes, liquids are cooled to much lower temperatures. The drawing below shows how Croll-Reynolds’ CHILL-VACTOR uses this principle in a typical water-chilling unit. Water to be chilled enters the chill tank and flows over a weir plate. When the water comes in contact with the vacuum in the chill tank, it boils instantly. The weir distributes the water in the vacuum chamber. Heat energy is released as the water vapor expands and the water temperature is lowered. The chilled water is then removed by a barometric leg or pump. It is circulated through heat exchangers, air conditioning equipment or other process equipment and returned to the chill tank. If part or all of the water is required for process use, fresh water is fed continuously into the chill tank. In circulating systems, make-up water amounting to approximately 1% for each 10 degree F. of cooling is added.
MULTI-STAGE CHILL-VACTORS

The drawing at right shows a two stage CHILL-VACTOR. The chill tank is divided into two compartments, each having a separate booster. Single stage units cost less but multi-stage units require less steam and cooling water. If a greater cooling range is specified, more additional stages are recommended. Three and four stage CHILL-VACTORS are common for 30 to 50 degrees F. ranges. When less than design tonnage is required, flexibility or turn down is obtained by turning off or bypassing one or more stages.

CHILL-VACTOR PROVIDES EXTRA BONUS

When water or any liquid is cooled by a CHILL-VACTOR, it is automatically deaerated: that is, the dissolved air, which is present in all natural water, is removed. Well water in certain areas contains substantial amounts of carbon dioxide. Depending upon water purity, all or most of the carbon dioxide is removed, increasing the alkalinity of the water. The deaerated water will thus minimize corrosion in piping and equipment. The most important bonus of this deaerating feature is in processes where the water is to be used for dissolving other gases. The solubility of all gases is greater in cold water than in warm water and greater still in deaerated water. Accordingly, it is advantageous to use water cooled by a CHILL-VACTOR in bottling plants for carbonated beverages, for dissolving chlorine dioxide in paper bleaching, sulphur dioxide in sulphite digesters, or for dissolving any gas.

ADVANTAGES

Vacuum refrigeration has many advantages. The most important of which is the absence of moving parts in the unit. Only accessory equipment, such as pumps and valves, need move and they are readily accessible for maintenance purposes. This simplicity compared to high-speed rotary or reciprocating compressors is very important in operating cost calculations. Another advantage is the absence of Freon, other chemical refrigerants, or an absorption solution in the CHILL-VACTOR. Any leak can be found easily and repaired by plant maintenance. When a mechanical refrigeration unit or absorption unit requires service, it frequently has to be handled by an expert service from the manufacturer’s plant.

The CHILL-VACTOR can be mounted outdoors since no part is sensitive to weather. A large number of plants have been operating outdoors for many years throughout the United States and Canada in all sorts of weather with no impairment of efficiency or increase in maintenance.

No operating supervision is required for a CHILL-VACTOR. There is no noise or vibration. Scale can build up in Croll-Reynolds barometric condensers to thickness of over one inch without reducing operating efficiency – a significant advantage in areas with hard industrial water. Since mechanical refrigerating units cannot use barometric condensers, they must be shut down periodically for tedious and expensive cleaning and scraping in those areas.
CHILL VACTORS AT WORK

Over three hundred Croll-Reynolds Chill-Vactors are in service. Some have been operating continuously for over forty years. Experience, intensive research and superior workmanship make Croll-Reynolds products the world standard for high-quality steam-jet vacuum and refrigeration equipment.

See them in action: (Flash plugin necessary)
- Two Stage Air Pump Startup
- Main Barometric Condenser
- Two Stage Chilling Cycle
  - Design Temp
  - Seasonal Decrease
- Chill Tank Water Flow
  - Design Temp
  - Seasonal Decrease

STEAM AND WATER REQUIREMENTS

Motivating steam pressure for a CHILL-VACTOR can be as low as atmospheric pressure in the boosters, although pressures between 100 and 200 psig are most efficient. Several CHILL-VACTORS have been made using 7 to 15 psig steam and systems using 30 to 50 psig are common. Low pressure steam is often available at considerably lower cost than high pressure steam.

Maximum or summer condenser water temperature is a critical factor for design. Utility consumptions are quoted based on the maximum cooling water temperature. The actual average consumption is generally less than 50% of the maximum.

The following chart can be used to approximate steam and condenser water requirements for most CHILL-VACTOR applications. It is based on a motive steam pressure of 100 psig and a condenser water temperature rise of 13° F. The temperature rise may be varied depending on the relative cost of steam versus water. The chart assumes that the water to be cooled and the condenser water enter at the same temperature.
AUTOMATIC CONTROL SYSTEMS

The steam and water requirements from the chart are based on the maximum tonnage through the CHILL-VACTOR and the maximum or summer condenser water temperature. In practice, required tonnage will fluctuate due to a lower chilled water flow rate or lower than design return chilled water temperature. With an automatic temperature control system, steam savings proportional to the decrease in tonnage can be realized.

Where condenser water temperature varies seasonally by several degrees from the design temperature an additional steam savings of over 40% is possible with an automatic pressure control system.

MATERIALS AND CONSTRUCTION

Croll-Reynolds CHILL-VACTORS are furnished in materials specifically chosen for the particular operating conditions, thus assuring long life and freedom from repair. Normal construction materials are steel and cast iron with steam nozzles of stainless steel. For applications requiring special–purpose materials, stainless steel, rubberlined steel, bronze, Monel, Ni-Resist, plastics and lead are available, among many other materials. Numerous highly corrosive liquids are being cooled in simple rubber-lined tanks, possible only in vacuum refrigeration, at a considerable cost savings over heat exchangers required for mechanical refrigeration systems.

Construction of CHILL-VACTORS follows all standard codes and practices with generous margins of safety. Critical components of the equipment are tested before shipment, and the purchaser is supplied with complete test data and operating instructions.
PROPOSAL INFORMATION

The Croll-Reynolds Co., Inc. will submit a detailed proposal to your requirements, giving cost, size, arrangement, and operating specifications. We suggest that you supply the following information:

COOLING REQUIREMENTS

• Load to be cooled, flow rate, inlet and desired outlet temperatures

CONDENSER

• Available water flow rate and temperature

• Surface or barometric type

STEAM

• Available temperatures, pressure and minimum pressure

• Any Special Conditions

SPECIAL VACUUM COOLING APPLICATIONS

The vacuum method of cooling leafy vegetables and small fruits was developed by Croll-Reynolds engineers over 40 years ago. The following is a sample of the materials we have chilled:

• Leafy vegetables – batch lettuce, cabbage, etc.
• Potatoes – cut, diced or mashed, both cooking and cooling
• Small fruits and berries
• Mushrooms – cooling and hydrating continuous or batch
• Grains – continuous or batch
• Meat and Fowl parts – batch
• Fish and Shrimp – batch or continuous
• Sand, Gravel and other granular materials – batch or continuous
• Turf or Sod- batch
• Tobacco – cooling and moisturizing

WARRANTY

Croll-Reynolds CHILL-VACTOR systems are fully warranted against defects in material and workmanship.
INSPECTION AND PERFORMANCE TESTING

Croll-Reynolds vacuum systems are inspected and often tested prior to shipment. Customer inspection of vacuum systems is, of course, welcomed. Complete details concerning the inspection and testing procedures required should be submitted with your original request for quotation.

START UP AND SERVICE CALLS

Croll-Reynolds engineers are available to assist your plant personnel with start-up and service of CHILL-VACTORS.