Bulletin CV83

CHILL VACTOR

CHILLED WATER SYSTEMS/
VACUUM COOLING SYSTEMS

MULTI-STAGE EJECTOR SYSTEMS
YSTEMS □ THERMOCOMPRESSORS □
ATER CHILLERS – CHILL-VACTOR®
AROMETRIC CONDENSERS □ LIQUI
MS – SCRUB-VACTOR □ MULTI-STA
UID RING VACUUM PUMPS □ JET B
□ EDUCTORS □ CROLL-REYNOLDS □
□ COMBINATION EJECTOR/LIQUID
SYSTEMS □ DISTILLATE RECOVERY
E AND BAROMETRIC CONDENSE
POWERED VACUUM SYSTEMS □ CO
RING VACUUM PUMP SYSTEMS □

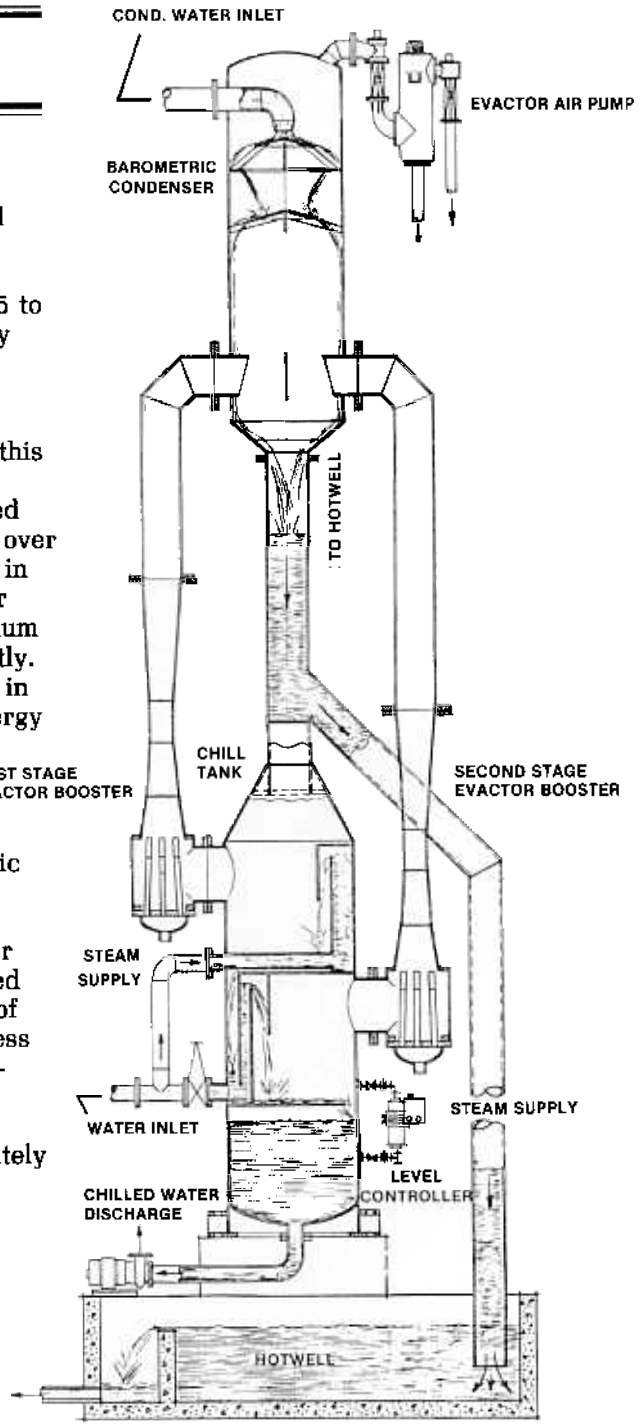
PRINCIPLE

The Croll-Reynolds CHILL-VACTOR is refrigeration equipment 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 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, raising the cost of the installation. 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 and industrial uses. Water is chilled usually to temperatures in the range of 35 to 60 degrees F., although in many processes liquids are cooled to much lower temperatures. The drawing shows how the 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 or through perforations in the 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 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. The greater the cooling range, the more additional stages are recommended. Three and four stage CHILL-VACTORS are common for 30 to 50 degree 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

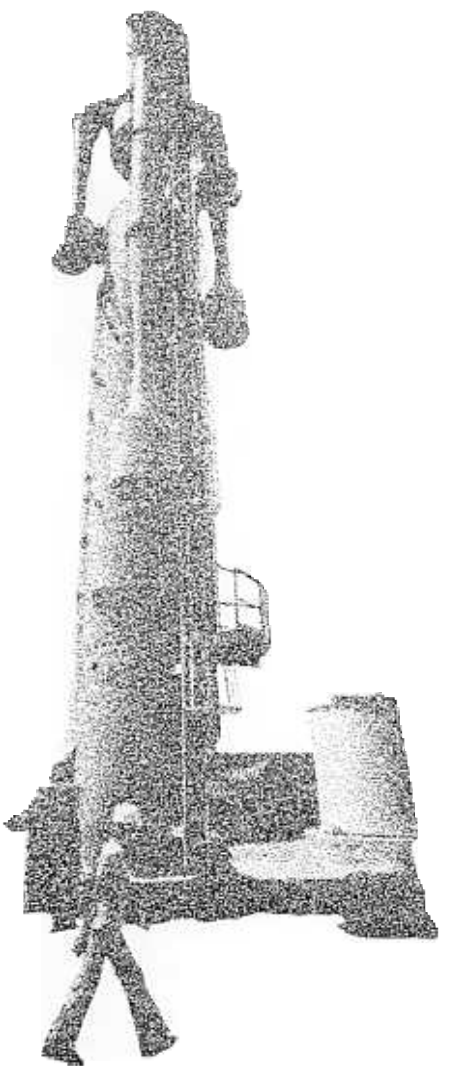
When water or any liquid is cooled by the CHILL-VACTOR, it is automatically deaerated; that is, the dissolved air, which is present in all natural water, is completely removed. Well water in certain areas contains substantial amounts of carbon dioxide. Depending upon the water purity, all or most of 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. Probably the most important is the total 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 figures. Another advantage of equal importance 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 a plant maintenance man. When a mechanical refrigeration unit or absorption unit requires service, it frequently has to be handled by an expert service man from the manufacturer's plant.

The CHILL-VACTOR can be mounted outdoors since no part of it 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.

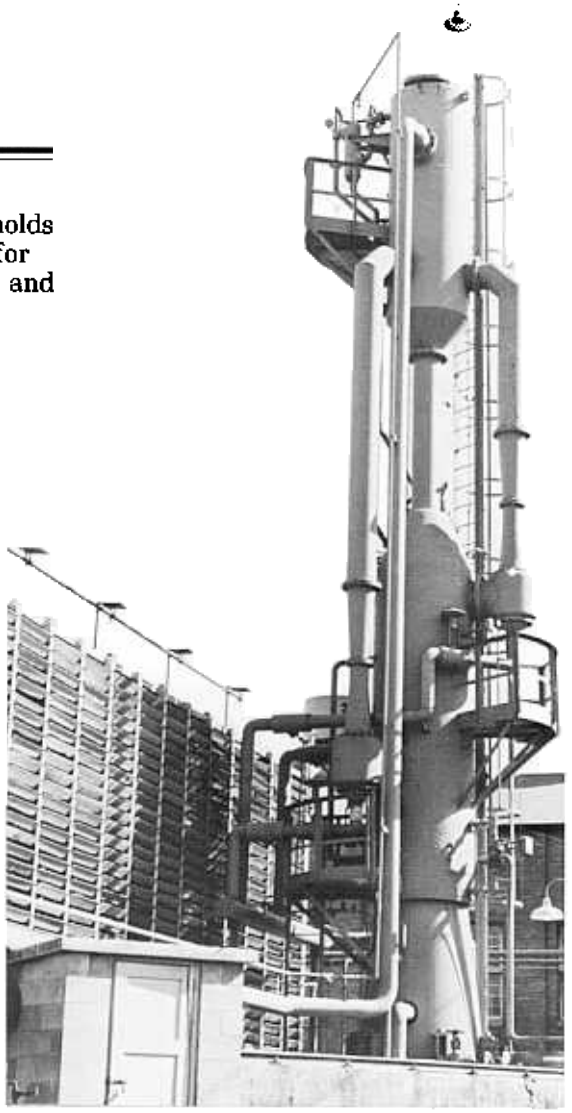
No operating supervision is required for CHILL-VACTORS. There is no noise or vibration. Scale can build up in Croll-Reynolds barometric condensers to thickness of over one inch without reducing operating efficiency—a big advantage in areas with hard industrial water. Since mechanical refrigerating units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



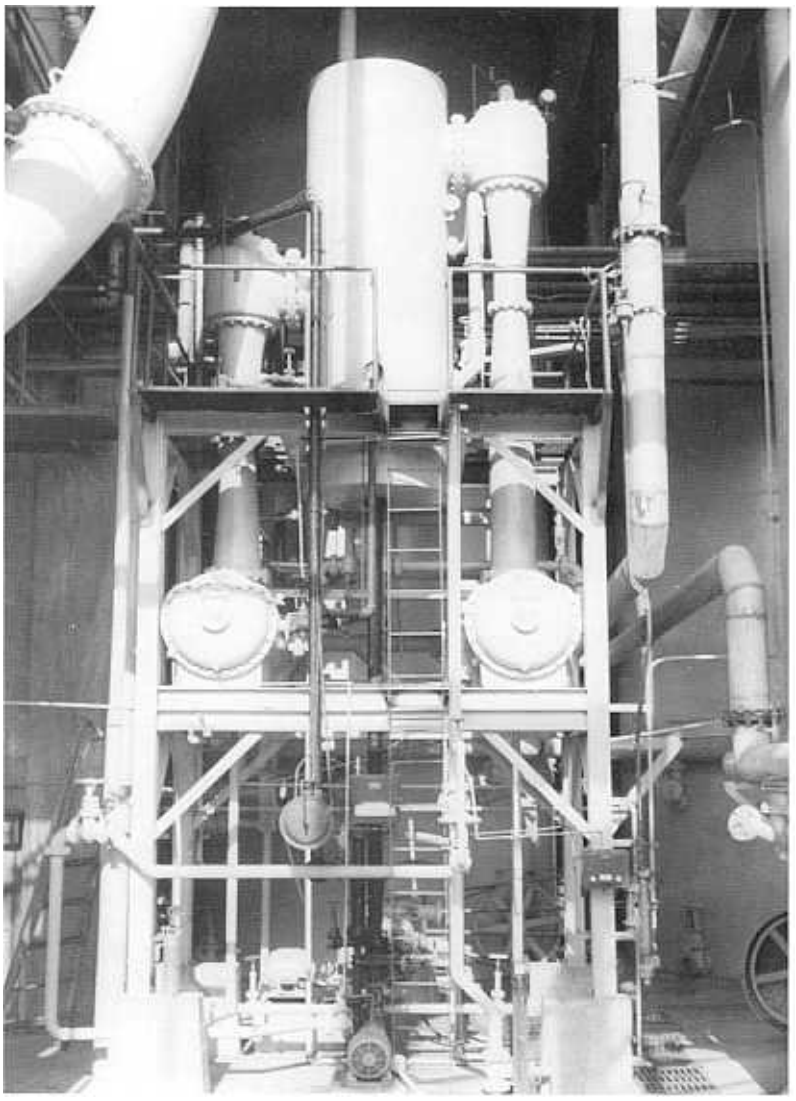
The system shown here was installed at the Jari Florestal Pulp & Paper Plant in Brazil, the largest and most modern facility of its kind.

CHILL VACTORS AT WORK

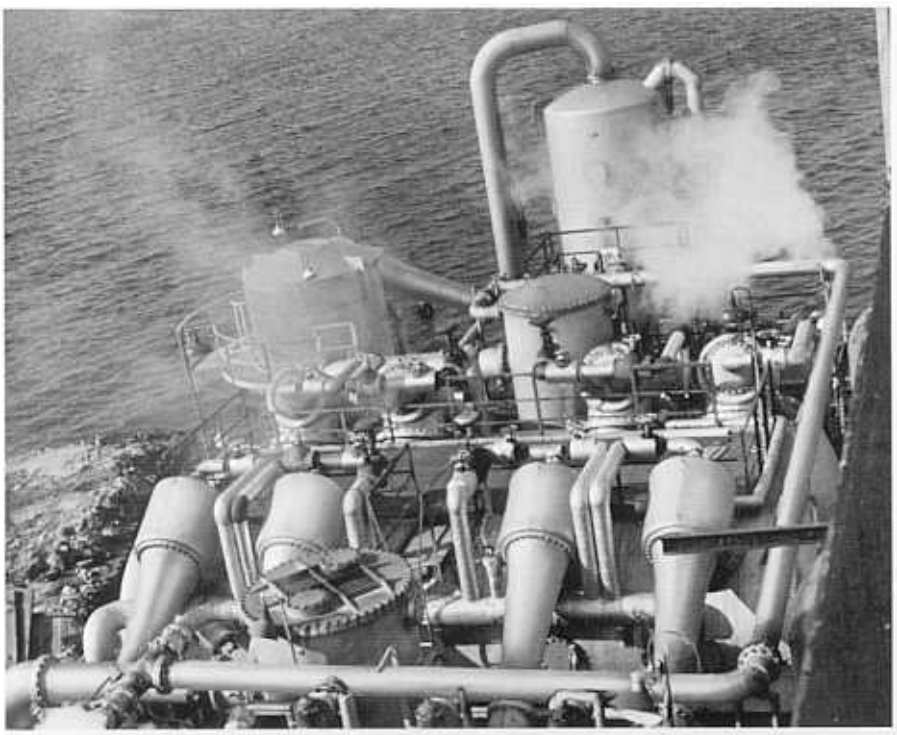
Over three hundred Croll-Reynolds CHILL-VACTORS are in service. Some have been performing continuously for forty years. Experience, intensive research and superior workmanship make Croll-Reynolds products the world standard for high-quality steam-jet vacuum and refrigeration equipment.



200 ton C-R CHILL VACTOR steam jet refrigeration unit chills water for bleaching operations at Crown-Zellerbach Corp.



This CHILL-VACTOR using surface condensers is one of twelve such units installed in plants of the largest paper producer in the United States.



The largest producer of antibiotics in the United States uses this CHILL-VACTOR to chill 12,000 gallons of process water per minute. The photograph shows only a portion of the large and complex installation.

A two-stage self-supporting CHILL-VACTOR is installed in a paper-mill chlorine dioxide bleaching process.

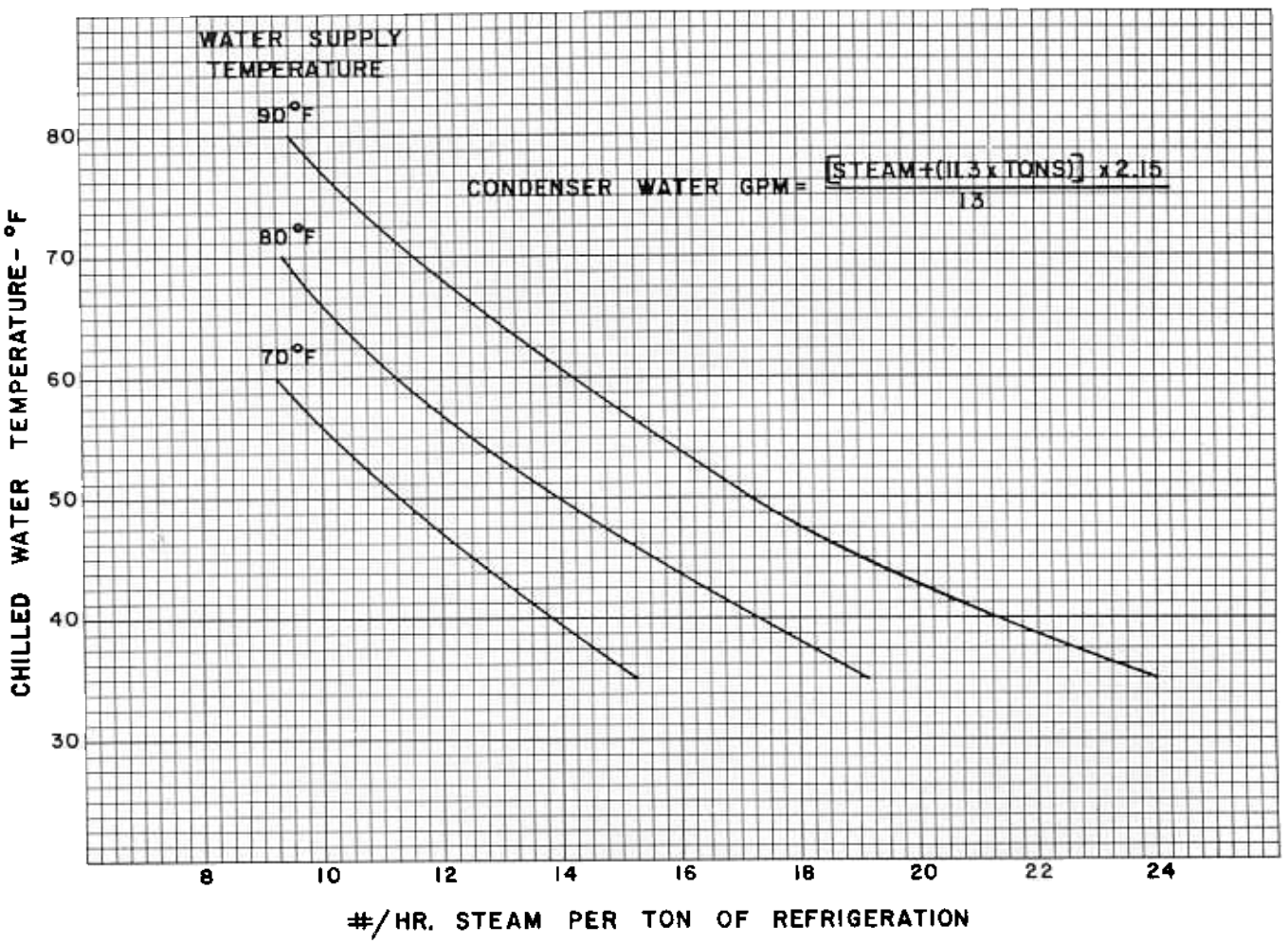
STEAM AND WATER REQUIREMENTS

Motivating steam pressure can be as low as atmospheric in the boosters, although pressures between 100 and 200 psig are the 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.

The maximum or summer condenser water temperature is required 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.**

Tons of refrigeration = $\frac{\text{GPM} \times \text{Cooling range, °F}}{24}$



AUTOMATIC CONTROL SYSTEMS

The steam and water requirements from the chart are based on the maximum tonnage through the CHILL-VACTOR and the warmest or summer condenser water temperature. In actual 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 the 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, rubber-lined 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. Only materials and workmanship of the highest quality are permitted. Critical components of the equipment are tested before shipment, and the purchaser is supplied with complete test data and operating instructions. He knows that his CHILL-VACTOR will perform exactly as specified.

PROPOSAL INFORMATION

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

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 temperature, 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. Here are some 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

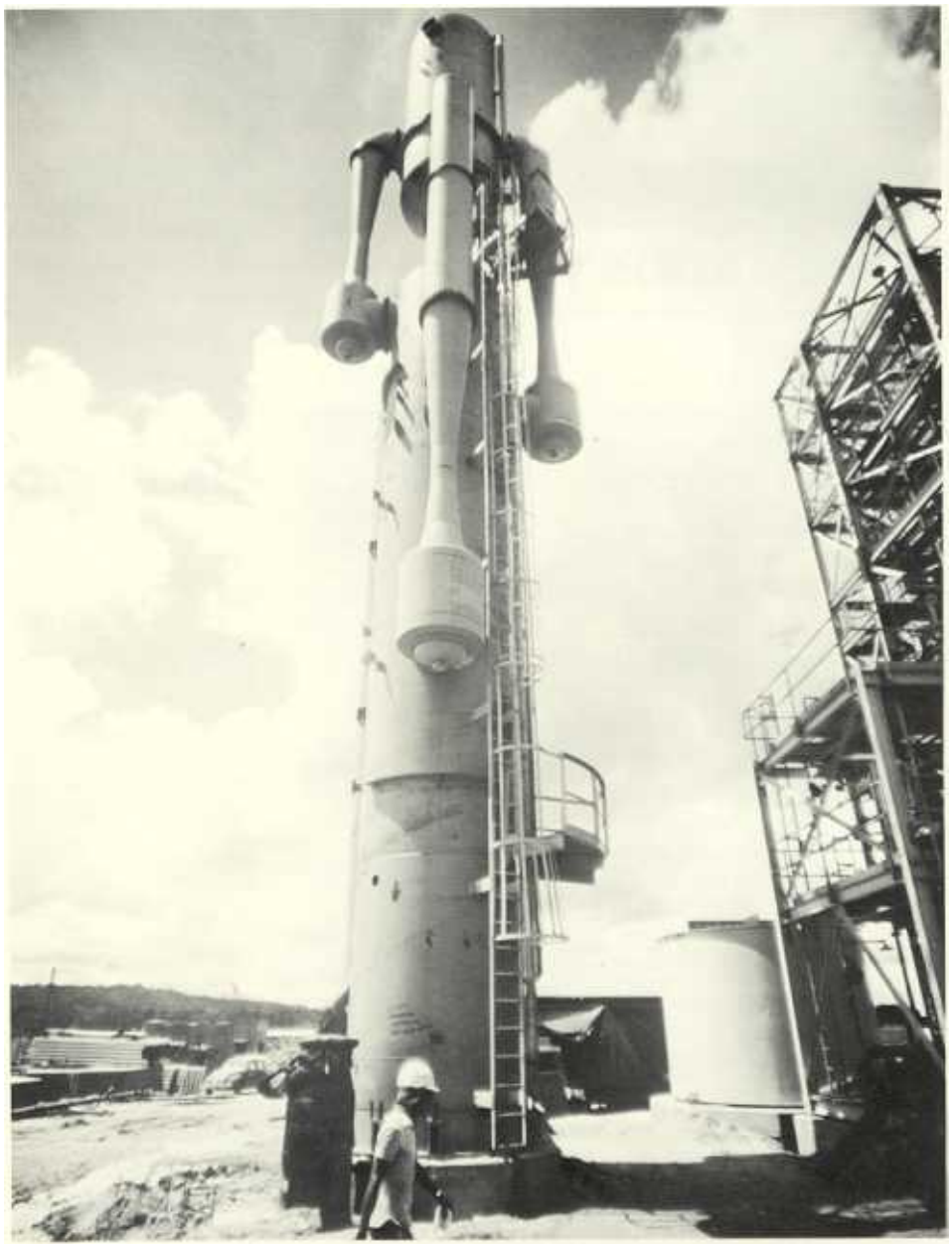
Tobacco—cooling and moisturizing

WARRANTY

Croll-Reynolds CHILL-VACTOR systems are warranted against defects in material and workmanship for a period of 12 months after shipment.

QUOTATIONS

All written quotations, unless specified otherwise, will be honored for 30 days from the date on which they are written.



TERMS

Croll-Reynolds standard terms are net cash 30 days from the date of shipment, payable in U.S. dollars.

DELIVERY

Delivery of CHILL-VACTOR systems is quoted on an individual basis depending on system configuration and materials of construction.

INSPECTION AND PERFORMANCE TESTING

Croll-Reynolds vacuum systems are inspected and tested prior to shipment. Customer inspection of vacuum systems at Croll-Reynolds facilities will be permitted at no extra charge provided that this inspection does not interfere with production flow. Croll-Reynolds charges a nominal fee for witnessed performance tests based on the time and manpower required to complete such testing. 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. Current charges for start-up and service calls are available from our sales offices.

CROLL-REYNOLDS CO., INC.

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