4.5 Refrigeration

Applicability

This BMP is intended for any water user which utilizes water as a primary refrigerant fluid to remove heat. Water conservation practices for cooling towers that use evaporation of water to remove the heat at the "condenser" where the refrigerant is changed from high temperature to a lower temperature are described in the Cooling Towers BMP. Additionally, the Cooling Systems (other than Cooling Towers) BMP covers processes that use a circulating flow of water at ambient temperatures as a coolant medium to convey heat away from machinery or a process. Examples of refrigeration processes that this BMP is intended for are primarily chilled water facilities that circulate refrigerated water for use in precision cooling of process units or large scale air conditioning systems of buildings or campuses.

Description

Using the latent heat properties of the refrigerant, mechanical refrigeration removes heat from a colder medium and rejects it to a warmer medium. A chilled water system is for all intents a refrigeration system that cools water. Most chillers are used as closed loop systems with the heat removed by air-cooling or through a cooling tower, and water consumption can be reduced. All chilled water systems require a reservoir for the returned fluid to act as a heat sink, but very little water is lost due to evaporation.

The major water use in these systems, other than at the cooling towers, occurs when water is replaced due to leaks or equipment problems. The primary maintenance recommendations for the closed chilled water loop include treatment of the water periodically with rust inhibitor and biocides, use of strainer screens and filters, and regular inspection and maintenance of pipes, valves, and pumps. For larger systems condensate water from the condenser coils can potentially be collected as an alternative to potable water for cooling tower make up or for some other use.

Water is not the only fluid that can be used as a liquid refrigerant. For example, direct cooling of deionized water, hydraulic oil, glycol solutions, and water soluble oils is possible in refrigerated systems.

Implementation

Implementation of this BMP should consist of the following actions:

1) Perform a water efficiency evaluation on each water-using refrigeration process within a facility to identify areas of improvement for water savings. The evaluation should review amounts of water used, use of automatic controls, repair and maintenance schedules and procedures, and water quality characteristics. Based on the requirements and uses of the system, alternative refrigerants should be considered.

2) Institute a routine schedule of optimal repair and maintenance measures for all equipment, such as using chemical additives to minimize corrosion. Make-up water to all closed loop systems should be metered to assist in evaluation for leaks. Chilled water systems or other refrigeration systems that use cooling towers should be operated following the guidelines of the Cooling Towers BMP.

Schedule

If the water user chooses this BMP, the following is a recommended schedule:

1) The facility survey and cost-effectiveness survey should be completed in a timely manner. Surveys of very large or complex facilities should be completed within the first twelve (12) months of implementing this BMP. This is considered a reasonable time period to complete the survey.
2) The action plan should be completed and implemented in the normal business cycle immediately following the completion of the facility survey and cost effectiveness analysis. For most facilities, twelve (12) months should be a reasonable time period to implement the action plan. Major facilities may need additional time for completion and implementation of the action plan.
3) Water-using refrigeration equipment should be operated optimally at all times following the guidelines of this BMP.

Scope

To accomplish this BMP, the industrial water user should do the following:

1) Industrial water users with one or more chilled water or water-using refrigeration systems which are operated with the same or very similar parameters should perform an efficiency evaluation and perform upgrades or replacements as outlined in the schedule of Section D.
2) For industrial water users with multiple systems, or multiple sites that have systems with significantly different operational parameters, a progressive implementation schedule should be followed, implementing the BMP in successive facilities until all facilities have been evaluated and conservation measures implemented.
3) Cost-effectiveness considerations may result in partial implementation of this BMP at one or several of a large number of facilities.

Documentation

To track the progress of this BMP, the industrial water user gathers and maintains the following documentation and can utilize industry accepted practices:

1) Operating information on the chilled water systems, including cooling capacity design heat loads, description of the process utilizing the refrigeration system, system requirements for cooling including temperature, volume, and duration of

flows (hr/day). Operating information should also include cooling system metallurgical design information for maximum levels of contaminants that can be tolerated while maintaining an acceptable corrosion rate;

2) Water use records for each refrigeration system that include the frequency and number of gallons of make-up water used;
3) Description of chemical compounds and amounts used for corrosion control; and
4) Description of and amounts used of any alternate refrigerant used or considered.

Determination of Water Savings

Using historical records and manufacturers' data as appropriate, water savings can be estimated.

Cost-Effectiveness Considerations

The industrial water user should determine the cost effectiveness to implement each identified replacement or upgrade to refrigeration equipment and operations, utilizing its own criteria for making capital improvement decisions. Many operating procedures and controls that improve the water use efficiency, such as repair of leaks, should be implemented simply as a matter of good practice. A cost effectiveness analysis under this BMP should consider capital equipment costs, staff and labor costs, chemical and treatment costs, and additional costs or savings in energy use.

References for Additional Information

1) There are many chemical vendors, equipment manufacturers, and consultants that specialize in refrigerated systems and chilled water systems. They can be an excellent source of information related to specific refrigeration applications. Many vendors have published literature available to assist an industry in optimizing its cooling water treatment systems.
2) *Process Cooling & Equipment,* magazine published by BNP Media. http//www.process-cooling.com
3) American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) is an international membership organization founded to advance the arts and sciences of heating, ventilation, air conditioning, refrigeration and related human factors. www.ashrae.org