EVAPORATIVE CONDENSERS

MANAGING WATER CONSUMPTION

Evaporative condensers are the preferred method of condensing the hot gas that is discharged from a refrigeration system. This is how the heat that is removed from the cold store/chilling process is discharged to the atmosphere.

Evaporative condensers have a high daily water consumption rate but in return they offer reduced electrical running costs vs most other forms of condenser.

As an example a typical ammonia plant for a 1000 Pallet freezer store will consume an estimated 10 000 to 12 000 litres of water daily in summer.

Condenser Water Consumption

This water consumption is made up of the following:

1. Evaporation from condensing the hot gas that has been discharged to the condenser
2. Water bleed losses which are required to limit the build up of solids/scaling in the water
3. Losses due to leakage from joints, wind carry over and water droplets discharged to the atmosphere as a result of poor condenser maintenance.
Managing Water Consumption

The water consumption can be managed as follows:

1. Evaporation losses:

The evaporation losses are equivalent to the heat rejected to the atmosphere. So, the higher the heat load from the cold stores the higher the heat rejection and as a result the higher the water consumption.

This water consumption can only be reduced by managing the heat load from the cold store and ensuring that the plant is designed and operated efficiently.

This could include managing item such as reducing door openings, installing high speed doors, installing air curtains, repairing any damage to the walls or ceilings, loading product that is close to the room temperature and not leaving product outside the cold store for extended periods prior to loading into the freezer/chiller.

2. Water bleed losses:

Water has to be bled off a condenser to control the dissolved solids in the water. If the solids are not controlled then the condenser coil performance is affected by the build up of the solids/scale on the coil.

If the water is treated and closely monitored then the bleed off quantity can be reduced which reduces the water consumption.

3. Water leakage (maintenance):

Water losses can be reduced by ensuring that any water leaks are noted and attended to.

The drift eliminators are designed to catch the water droplets from the water spray nozzles. If the eliminators fail then the water droplet carry over increases and the water consumption increases.

If the drift eliminators block up with scale then the air flow reduces and the condenser performance reduces.

Drift eliminators being cleaned
SUPPLEMENTING WATER

Defrost water can be collected from the evaporator’s drip trays and piped back to a central collection tank. The condenser make up can be supplemented with this water.

IMPROVING CONDENSER EFFICIENCY

Condenser efficiency can be improved during periods of low load by the use of variable frequency drive (VFD) control for the fans. As the discharge pressure decreases the fans can be slowed down to maintain a preset discharge pressure.

Fan power reduces in accordance with the cube root law. This implies that at half fan speed (half air flow = half condenser capacity) then the fan power is reduced to $1/8^{th}$ of its full speed power consumption.

This implies that fan power consumption savings can be achieved with reduced heat loads or when winter ambient conditions improve the condenser effectiveness.

NEW TECHNOLOGY

Adiabatic Condensers:

Adiabatic condensers are a relatively new technology in our industry.

Adiabatic condensers precool the air before it is drawn over the condenser coil. The air is cooled but not wetted so the coil has fins for enhanced surface area.

The finned coil allows the condenser to operate as an air cooled condenser when the ambient drops below a preset temperature. This implies that adiabatic condensers would typically operate with a higher discharge pressure than an evaporative condenser.

Adiabatic condensers typically consume between 30 to 50% of the water consumption of an evaporative condenser but the fan power consumption is considerably higher. The higher discharge pressure also leads to higher compressor motor consumption.

Adiabatic condensers have a foot print that is approximately 50 to 60% larger than an equivalent evaporative condenser and are available at a premium in cost.
SUMMARY

Evaporative condensers offer the best compromise between capital cost and overall electrical running costs.

However, when there is limited water available then additional effort must be made to reduce water wastage and water consumption through effective cold store house keeping and equipment maintenance.

Adiabatic condensers offer an option to operate with reduced water consumption but only during periods of lower ambient temperatures.

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