Secondary Loop Systems

Natural refrigerants – the natural choice for secondary systems

Information paper No. 1

Introduction to Secondary Loops

Secondary systems

Secondary loops are an effective and simply way of distributing cooling. The primary refrigerant, preferably a natural fluid, evaporates inside a heat exchanger (typically inside the machinery room or on an external packaged chiller) and cools the secondary fluid to the desire temperature. Secondary fluids are widely used in applications including air conditioning, data centers, food processing, temperature-controlled storage and ice rinks.

The aim of this series of information papers is to help contractors and installers design secondary loops for fluid temperatures below 0°C as far as refrigeration systems are concerned. Technical information and training material on the design of water-based systems for higher temperature applications is available from other sources and isn't included in these documents.

The simplicity of design and ability to deliver large cooling capacity across long distances are key benefits of secondary systems. They are easy to design for addition of future capacity and help to minimize refrigerant charge. This has both environmental and safety benefits.

Secondary system design can vary from a single pipe cooling loop to systems with multiple pipes where warm fluid is used for heating and defrosting. Different methods of defrosting and heating are possible including the use of waste energy from the refrigeration plant to reduce and even eliminate the need for gas or electrical calorifiers.

A number of secondary fluids are available for use below 0°C and the thermophysical properties of commonly used fluids are reviewed and summarized in property tables. The selection of fluid types is discussed in terms of optimizing systems regarding capital cost and operational efficiency.

Secondary loops require a number of components to circulate the fluid effectively and deliver cooling to the points where it is required. These information papers aim to cover the key components in any system i.e., heat exchangers, pumps, and valves.

The longevity and efficiency of a secondary system is influenced by the standards used during installation and ongoing maintenance of the system. Different pipework and component materials will be presented, along with information on when and where they can be used. Installation standards and good practice suggestions to ensure cleanliness are important,

including storage of materials, welding techniques, inspection requirements, pressure testing and the flushing of systems prior to putting into operation.

Maintaining the cleanliness and preventing the conditions for corrosion during operation are also important in terms of secondary system longevity. The use of corrosion inhibitors and eliminating air in secondary loops using automatic purge valves and deaerators is recommended. Using properly sized strainers and installing them in the correct location needs to be considered as well.

Insulation of secondary pipework, vessels and components is important to avoid heat increase and the development of ice. This is particularly important when corrosion becomes a factor.

Secondary loops are traditionally used in food processing (i.e., dairies and breweries) where the cooling load can rapidly change and are becoming increasingly popular for a wide range of applications including cold storage, food and beverage, winter sports facilities, underground construction with the need to freeze the ground, and climate chambers.

With these information papers eurammon intends to provide the basic knowledge on what needs to be considered when planning a secondary refrigeration system using natural refrigerants.

Benefits and disadvantages of secondary systems:

When deciding to choose a secondary system the decision is normally based on either safety reasons or the need to compensate large demand fluctuations.

Benefits

- The primary refrigerant is kept to a limited space (i.e., machinery room or standard container plants)
- The refrigerant charge is greatly reduced (a reduction down to 5-15% of the charge in a direct system can be achieved).
- Toxic or flammable primary refrigerants can be used even in refrigeration systems meant for public spaces or for cooling of sensitive products
- Secondary fluids can easily be stored in a buffer to compensate demand fluctuations
- Buffer and the pipe volume are storages of energy, and both are helpful for energy savings due to optimize operation points
- It is possible to choose secondary fluids that will not harm products in the event of a leakage (i.e., food-grade approved)
- Installation is easier compared to evaporating refrigerants (i.e., use of pre-insulated plastic piping possible)
- Controlling the system is easier (valves and pumps), particularly for wide-spread systems
- Large range of pumps for secondary fluids is available (also with demand control) at low cost
- More precise inlet temperature control is possible on the air coolers

- The secondary system part can be easier maintained by experts outside of production or storages.
- Secondary systems have higher flexibility when it comes to need for changes (e.g., need for additional cooling units).
  A small leakage in the secondary system involves less risk of downtime than leaks in a refrigerant system and also the total possible refrigerant leakage will be reduced due to lower refrigerant charge.

Disadvantages

- An additional heat-exchanger is needed to cool the secondary fluid with the primary refrigerant
- Components and piping for the secondary refrigerant are larger in dimension
- Pumps for the secondary fluids are larger and consume more energy than refrigerant pumps
- Need for a secondary fluid that may be higher in price than the refrigerant
- Investment cost may be higher due to the additional and larger equipment needed
- Operation cost may be higher due to the additional heat-exchanger (evaporation temperature must be lower for the same cooling temperature at the consumer side) and the higher pumping capacity
- Non-evaporating secondary fluids have a temperature gradient, that means the fluid gets warmer while absorbing heat from the consumers (phase change fluids, i.e., ice-slurries or evaporating fluids will avoid this disadvantage). This may result in poorer product quality.
- Design of secondary loops sometimes underestimated (i.e. hydraulic switch and buffer design does not always prevent unacceptable pressure fluctuations that may result in damaging components)

Applications

Secondary systems can be used in a large variety of different types of applications, although these information papers focus on refrigeration applications. Common applications are among others:

- Air conditioning
- Data centres
- Food & beverage processing
- Supermarkets
- Temperature controlled storage
- Sport installations, i.e., ice rinks
- Test chambers for different types of equipment (vehicle, heat pumps etc.)
- Heat pumps
- Waste heat defrost
- Heat recovery
- Chemical & Pharmaceutical industry

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