Use of Ice Slurry in a Supermarket Display Cabinet

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Secondary refrigerants are the most common way to address restrictions placed by environmental and safety concerns posed by primary refrigerants. The primary refrigerant is used to cool a secondary heat transfer fluid, which is then circulated to cooling applications. In this way the charge of the primary refrigerant can be lowered and a potentially hazardous refrigerant (such as ammonia) can be kept physically separate from the cooling application, which makes this arrangement beneficial where there are laws regulating the amount of primary refrigerant (in the form of set limits or refrigerant taxes) in a system. In these places, secondary loops in supermarkets are common, and are growing more popular. With supermarket refrigeration consuming a large portion of overall commercial energy usage, the additional energy required to circulate the secondary refrigerant makes this a prime area of interest for improving refrigeration efficiency.

A chilled propylene glycol-water mixture is the most common secondary refrigerant in supermarket applications. This paper investigates the use of a propylene glycol-based ice slurry in a medium temperature (M2) coffin display case as compared to chilled glycol. In particular, varying the concentration of additive in the ice slurry can allow the temperature of the slurry to be higher than a mixture of single-phase glycol which contains the same amount of thermal cooling energy. This increased temperature leads to a reduced frost formation and can eliminate the need for electrical heaters to assist with defrosting the coil. Ice slurry also produces a more even temperature profile across the evaporator as compared to a single-phase fluid. It was found that ice slurry can be used satisfactorily in standard evaporators that were designed for evaporating refrigerants. No modifications to the refrigerant side were made on the evaporator to accommodate ice slurry with the exception of removing the expansion device. In this way, a secondary refrigerant can be retrofitted to a display cabinet that was designed for primary refrigerant. In a second test series enhancement of the air side by fin staging was done with a noticeable improvement.

Also investigated in this paper is the use of an individual pump regulated refrigerant supply for the cabinet. A temperature sensor located inside the cabinet controled the pump speed. By using this arrangement the main circulation pump power can be reduced and the individual cabinet pump power consumption can be minimized depending on the operating conditions of the cabinet (such as frost growth on the evaporator or improper stocking of the products). The energy savings of this pump-regulated control were demonstrated for chilled propylene glycol, as the pump usage was 40% of full speed for ideal refrigeration conditions.

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