Ice Slurry Centre

with International Participation

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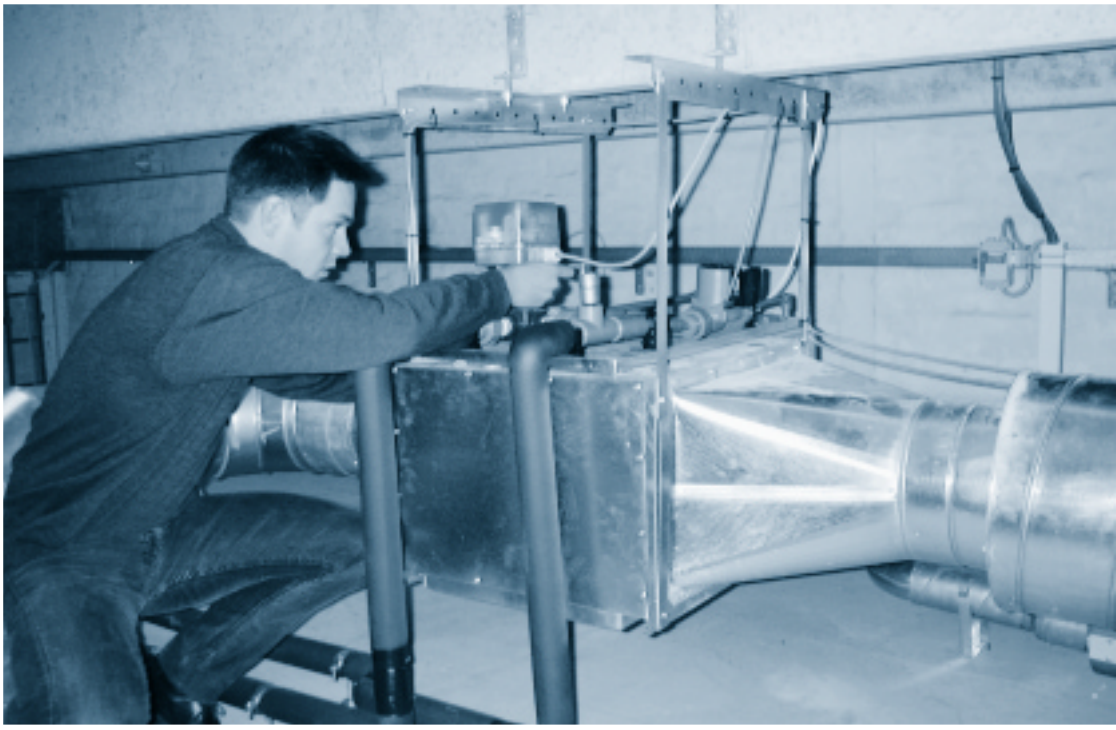
Ice Slurry Centre in Denmark

In the Ice Slurry Centre, managed by the Danish Technological Institute, the use of ice slurry as refrigerant is being further developed. All other components of the circulation system are included and hence also the ABS piping system from Georg Fischer.



This test section is used for component trials and for determination of the heat transfer coefficient and pressure drop with flowing, melting ice slurry.

In order to avoid possible future problems with constantly changing new synthetic refrigerants, one should use natural refrigerants[1] wherever possible. Before using natural refrigerants, however, one must always carry out a life cycle analysis to ensure that environmental friendliness of the system is at least equivalent or better. The effect on the environment would be worse, for example, if a refrigeration plant using natural refrigerants were to consume considerably more energy. In this case there are alternatives. In commercial refrigeration, for example, the use of ammonia in a central plant and the distribution of energy by evaporating carbon dioxide and melting ice slurry is an option. The phase changes taking place in these secondary refrigerants (evaporation and melting, respectively) allow significant energy saving compared with conventional refrigerants.
The use of ice slurry in refrigeration is not new. The ancient Romans mixed snow with various salts producing an «ice slurry» with temperatures down to –15° C. Its use in closed circulation, however, and the pumping of the ice slurry involved has only been practised for about the last 30 years and there are only a few specialized firms that have the necessary know-how in the application of this technology.

For the large numbers of potential users, applicable guidelines and hints have not been available up to now. In order to alleviate this problem, an Ice Slurry Centre was founded in Denmark in April 1998 with international participation. The centre is supported in part by the Danish Ministry for Economic Development with about 2 million CHF.
It is managed by the Danish Technological Institute and will continue development on the application of ice slurry as a secondary refrigerant up to June 2002. As well as the ice slurry generation itself, all the components for the circulation system are included and hence also plastic pipes from Georg Fischer.
The other partners in the Ice Slurry Centre are Grundfos (pumps, Denmark), Hans Buch (measuring and control, Denmark), Sabroe/York (refrigeration plants, inter alia ice slurry generators, Denmark/USA), Sunwell (ice slurry generators, Canada), Swep (plate heat exchangers, Sweden), Texaco (additives, Belgium/USA) and ttcoil (tube and fin heat exchangers, Denmark). In the course of the first year the necessary test

1) Natural refrigerants are substances that are and always have been found in the natural environment, such as ammonia, isobutane, propane, propylene, carbon dioxide and water. Many of these substances are being manufactured industrially to be used as refrigerant. Although they are no longer of natural origin, they are still called «natural refrigerants».

APPLICATION

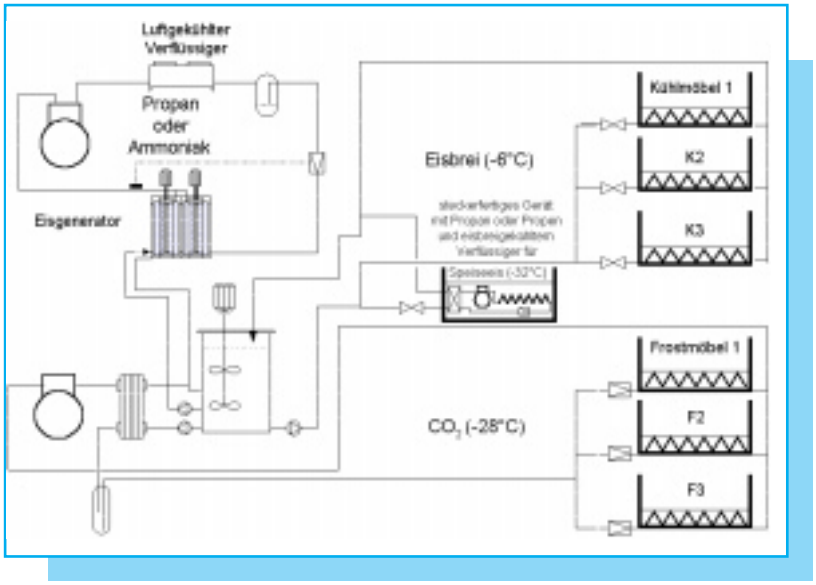
facilities have been set up at the Danish Technological Institute in Aarhus.

Secondary refrigerant

For all refrigeration systems in which the refrigerant is circulated in public areas, e.g. in commercial refrigeration, a non-alarming, non-toxic and non-flammable refrigerant is essential. In the case of modern combined refrigeration plants with direct evaporation in the individual cooling and freezing areas, the amount of refrigerant is relatively large and it would be irresponsible to use ammonia (NH_3 - R717) or propane (C_3H_8 - R290) as a replacement in the same refrigeration systems, because theY are flammable. An alternative is the so-called indirect refrigeration system, which has a central refrigerating machine in its own room, using e. g. ammonia, and a secondary circuit with a fluid that distributes the energy to the cooling/freezing area.

Various secondary refrigerants are used in refrigeration plants and heat pumps. Criteria for selection are heat transfer characteristics, viscosity, toxicity, flammability and price. For temperatures above the freezing point, water is one of the best secondary refrigerants available. For temperatures below freezing point, use of salt solutions (brines), water-glycol mixtures or other alcohol-water mixtures, and also various non-aqueous substances is common.

A disadvantage of all these secondary refrigerants is that the energy content is solely controlled by sensitive energy sources. The stored energy is much smaller than that of directly evaporating refrigerants. The amount of fluid circulating is therefore relatively large and the pipe dimensions must be greater than with a direct evaporating refrigerant. To avoid these drawbacks, one can utilize not only the heat of evaporation but also the heat of fusion of a medium. As an evaporating secondary refrigerant in commercial refrigeration one can use carbon dioxide (CO_2 - R744) and as a melting secondary refrigerant a mixture of ice, water and antifreeze (e. g. ethanol, glycol or salt). Because of the high pressure required for carbon dioxide (35 bar at 0° C), it is primarily used in the freezing domain, whereas ice/water/antifreeze mixtures, because



This plan shows a possible implementation of an indirect cooling system in a supermarket.

Test facility for component trials and for the determination of heat transfer coefficients.

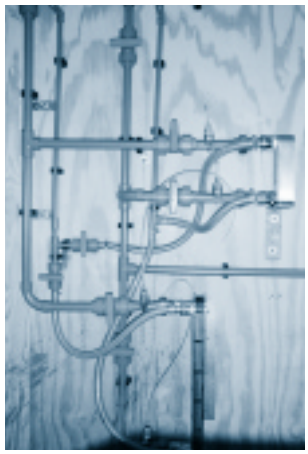
of their high viscosity at low temperature, are mainly considered for the normal cooling range.

In such a system it is advantageous to use an ice store to smooth out the large variations in cooling demand occurring in a supermarket. This reduces operating costs and leads to a shorter amortization time for the overall refrigeration plant.

Ice slurry

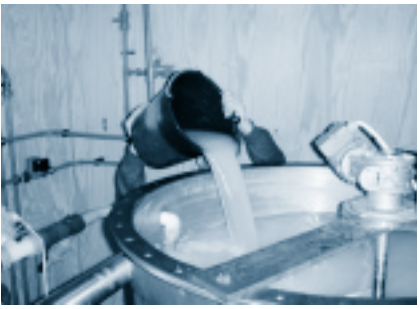
The use of ice slurry as a secondary refrigerant is a relatively new technology (20 to 30 years old). Ice slurry offers numerous advantages compared with conventional single-phase secondary refrigerants:

- higher specific cooling capacity, leading to smaller pipe cross-sections, smaller pumps and lower energy consumption;



The Ice Slurry Centre is a welcome opportunity for Georg Fischer to have the ABS pipes and components tested in such plants.

APPLICATION



The ice slurry is being collected in 9 m³ storage tanks.

The technical data are not binding. They are not warranted characteristics and are subject to change. Please consult our General Conditions of Supply.

- high heat transfer coefficient, leading to smaller heat exchangers and lower energy consumption;
- direct cooling of certain foodstuffs in the slurry, e.g. immersion of fish or chicken;
- the option of storing energy in the medium itself.

For practical applications, the questions that are especially pertinent are the pressure drop for ice slurry flow, the design of valves and other components and the heat transfer characteristics of melting ice slurry.
In respect of the pressure drop in flowing ice slurry, various studies have been published showing quite contradictory results in some cases. These studies differ especially with regard to the ice particle size in the slurry, a parameter that depends upon the concentration and type of antifreeze added and hence upon the temperature of the slurry.

Test facility

Within the framework of the Ice Slurry Centre, the test facility has been set up at the Danish Technological Institute. The ammonia refrigeration plant is connected to an ice slurry generator with a capacity of approx. 12 tonnes of ice per day. The ice slurry is collected in a 9 m^3 storage tank. The slurry is pumped through a widely distributed pipe system for the air conditioning of a measuring room, an office and a meeting room. The goal of this system is to build up experience with the continuous operation of an ice slurry system. Furthermore, test sections are included for component trials and for determination of the heat transfer coefficient and pressure drop with flowing, melting ice slurry.
For the pipework of the various test facilities, ABS pipes and fittings from Georg Fischer AG were mainly used. In addition, automatic valves and Signet flow meters from Georg Fischer are being tested.
For Georg Fischer, participation in the Ice Slurry Centre offers the unique opportunity to test all pipes, fittings and measuring equipment for this still relatively new, but extremely promising, secondary refrigerant ice slurry concept. Thus potential customers can be offered, right from the start, economic solutions with plastic pipes (ABS and/or PE).

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