Smart Thinking

Topic

Low Temperature Chillers for Pharma and Petrochemical Industries

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What to look for when purchasing Low Temperature Chillers for Pharma and Petrochemical industries

Chiller technology has been around for almost 100 years. In that same period, chillers have been used for a myriad of applications in equally numerous configurations and set-ups. It is therefore imperative to consider and compare individual use cases with equipment and products available on the market before making a serious business decision about what type of system to install. The purpose of this editorial is to explore low temperature chilling technology which can often be considered a niche but is an area of great importance to customers in the petrochemical and pharmaceutical industries. These businesses tend not to benefit from the mass-manufactured commodity of traditional comfort cooling chillers and often are faced with a need for bespoke solutions and tailor made equipment to satisfy their specific design requirements.

So, what exactly is "Low Temperature" chilling? The European Ecodesign Directive defines "HT", "MT" and "LT" (High, Medium and Low Temperature) Chillers as having fluid off temperatures of +7°C, -8°C and -25°C respectively. For the purposes of this article, we shall consider "Low Temperature" to define a system with fluid off temperature less than -15°C but more than around -35°C. This 20K range is slightly higher than the MT and HT ranges and the reason we have set the lower limit is because after this point we enter the realm of more bespoke refrigeration systems which are quite far removed from what a user might define as a conventional "fluid chiller". The F-Gas Regulations have further limited options for low temperature cooling with many high Global Warming Potential refrigerants being phased out in 2020 or suffering from availability and pricing fluctuations as the market moves toward more environmentally conscious solutions. Refrigerant selection is a topic in and of itself, however options are limited for low temperature applications with the main natural contenders in the industrial landscape being Ammonia (R717) and Carbon Dioxide (R744) with HFO-blends such as R449A and hydrocarbon solutions such as Propane (R290) presenting themselves at the smaller end of the scale. Bitzer's refrigerant report is a great resource for those looking to explore this topic further.

-18oC Air-Cooled Fluid Chillers in Petrochemical Application

Before we delve into component choice and regulatory considerations of low temperature chilling, it is worth highlighting that it is extremely important for both the end-user (or operator) as well as the chiller designer to be confident and competent in the exact requirements of the cooling load. A firm understanding of the peak, average and minimum loading, site operations (continuous or batch) and anticipation of any future expansion is key in the successful design and implementation of this type of system. Certain industries are fortunate that there may be several full time members of staff devoted to the process or operation who already possess this knowledge, but for some users this can be a steep learning curve and engaging a consultant to assist with load determination and profiling can often prove beneficial in the early stages of a project.

Low temperature chiller systems typically use an evaporative or water cooled condenser in order to keep overall temperature lift of the compressor to a minimum. These condensers have a reliance on ancillary services and utilities in order to function such as water supplies, treatment stations, secondary pump sets and other components (such as cooling towers, expansion vessels, strainers etc.) This reliance on other equipment could be considered one of the primary drawbacks of traditional low temperature chilling and leads us on to discuss recent developments within the industry where some manufacturers are pushing the boundaries and offering low temperature air-cooled chiller packages. Air-cooled systems use condensers which comprise a heat exchanger and fans and use ambient air in order to condense the refrigerant gas, furthermore, the modern trend for air-cooled systems is to have the condenser mounted above the refrigeration equipment on a single skid so the complete refrigeration system is packaged together.

These configurations have historically been used for traditional water chilling or where there are few site utilities (i.e. no cooling water) available. Packaged air-cooled solutions are also suited to installations where

where assembly and site installation costs of other systems may be uneconomic, impractical or prohibitive to the project timeline. An increasing number of users are now reaping the benefit of air-cooled systems, particularly in colder areas of the UK where the cool ambient conditions means the efficiency of these systems is comparable to water-cooled and evaporative-cooled systems. One major benefit of this outdoor "package unit" concept is that there is no need for a plant room as all of the equipment is installed on a single, outdoor skid. Often, this can help operators achieve massive cost savings by eliminating all of the ancillary costs associated with planning, approving, building and operating a new structure to house refrigeration plant. That said, it is no secret that air cooled chillers require a fairly large footprint as well as free area around their perimeter in order to have a successful installation, so this may be impractical in areas where space is at a premium.

The capital cost of the refrigeration equipment is a major consideration for low temperature systems, but it is also worth remembering that pumping and dosing also represent parasitic operating costs. The general trend is: the lower the system temperature, the more expensive it is to operate. The reason for this is because lower fluid temperatures cause an increase in density, loss in specific heat and increase in viscosity for the majority of fluids. It goes without saying that this will increase pumping power, but another consideration that is often overlooked is the compound effect this has by way of additional heat load on the system. For example, a low temperature methanol circuit with 10kW rated pumps will need to cater for an additional circa 10kW heat load in the heat transfer medium and the refrigeration plant must be sized accordingly to cater for this, often at additional expense – 10kW of cooling capacity at -25°C costs a lot more to implement than 10kW at +7°C!

Moving on to regulations, the European Ecodesign Directive (2009/125/EC) dictates the Minimum Energy Performance Standards (MEPS) for chillers and all new systems brought on to market must meet these minimum criteria as a baseline The metric used to define this standard is Seasonal Energy Performance

Ratio (SEPR) which is a weighted average of chiller efficiencies across a range of capacities and ambient conditions (or in the case of water-cooled systems, cooling water supply temperatures). SEPR gives a baseline figure for comparison between standard chillers and is a figure buyers and end-users can use to conduct a rough, high level evaluation of the expected performance of a system they are looking to purchase. From an environmental standpoint, it is also worth mentioning there is a 10% relaxation of the SEPR requirements for systems which adopt low GWP refrigerants less than 150 kgCO2 equivalent in order to make the efficiency criteria more accessible for manufacturers of environmentally conscious systems.

If you require guidance or assistance with any of the topics discussed above, Star Refrigeration would be pleased to offer further information and support and are contactable at: star@star-ref.co.uk

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