Condensing units

Fitters Notes (Part 4)

Preassembled modules
The compressor is often described as the heart of a refrigeration system. However, for systems up to a certain capacity, refrigeration specialists often like to use a compressor integrated into a condensing unit. Air-cooled condensing units – which are the exclusive subject of this article – generally consist of a compressor (or sometimes two compressors), a condenser with one or two fans, an electrical terminal box, and optionally high-pressure and low-pressure switches and a receiver. There are also water-cooled condensing units, in which the air-cooled condenser with fans is replaced by a water-cooled condenser. Coaxial condensers are the preferred choice for relatively small condensing units, but they gradually give way to shell-and-tube condensers and plate heat exchangers as the capacity increases. The entire module is pre-configured with the tubing necessary for the refrigeration circuit, and the electrical connections are fed to a separate terminal box. This means that part of the refrigeration system is pre-assembled and does not have to be put together on site. This yields distinct time and cost savings without reducing flexibility, since it is still possible to use a wide variety of evaporators and regulators.

Useful practical tips for the everyday work of fitters are provided in the “Fitters Notes” series. In the last section, we covered the subject “reciprocating compressors”. This fourth section deals with a related component containing reciprocating compressors – the condensing units.

Fans
The size of the condenser depends primarily on whether it is fitted with one or two fans. If there are two fans, which are normally arranged next to each other, the condensing unit is somewhat wider. If there is one fan, the base plate of the condensing unit is usually very compact. As a result, the complete unit is somewhat higher. Fan motors are available in single-phase and three-phase versions, with the vast majority of devices being fitted with 230-V, single-phase fan motors in actual practice. There are two main reasons for this. As single-phase compressors are used in relatively small condensing units, a corresponding type of fan motor is also used. However, a 230-V fan motor is often used even with three-phase compressors operating from a 400-V supply voltage, since variable-speed control can be implemented less expensively for a single-phase motor. Pressure-led variable speed controls with phase-angle control are very widely used in refrigeration systems, and they can usually be retrofitted in standard condensing units as an option. However, it is necessary to pay attention to suitability for phase-angle control operation (or the insulation class of the fan motor), since fan motors become warmer with phase-angle control than without, which can lead to problems – especially during summer operation. The direction of air flow in a condensing unit is always suction through the condenser coil, and thus from the fan toward the compressor.

This ensures better air contact with the air-cooled condenser. If the fan does not rotate in the desired direction, this can be corrected with a 400-V fan motor by swapping two of the phases. With a single-phase fan motor with a capacitor, the direction of rotation can also be changed by swapping those two leads from the motor where also the two leads of the capacitor are connected. In case of doubt, consult the wiring diagram in the terminal box of the condensing unit.

Receiver
A receiver is always present in the condensing unit when the system uses an expansion valve as a throttling device. If a capillary tube is used for injection in the evaporator – which is usually the case with very simple and small systems – a receiver is not included in the condensing unit. Receivers in condensing units for expansion valve operation are usually mounted upright. This is better for ensuring a reliable liquid reserve, especially if the outlet to the liquid line is taken from the top of the receiver via a dip tube and only a small residual volume of liquid is left in the receiver as a reserve. In condensing units with relatively large capacity, the receiver outlet can usually be shut off. This simplifies repairs to the refrigeration system that require opening the refrigeration circuit substantially. If the receiver outlet valve is closed, the refrigerant of the system can be pumped into the receiver. This makes it possible to carry out service work between the receiver outlet and closed suction side of the compressor without having to remove the refrigerant charge from the system.

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**Pressure switches**

Whether or not a condensing unit is fitted with high-pressure and low-pressure switches is primarily a question of price. However, at least a high-pressure switch must always be retrofitted. It is also not advisable to do without the low-pressure switch for cost reasons, because if it is not present when it is really needed – for example, in case of a loss of refrigerant – the result can easily be a defective compressor. From a business perspective, this is considerably more significant than the price of a low-pressure switch.

The high-pressure side of a dual pressure switch has divided refrigeration system builders into two camps for many years already. One camp always uses a pressure monitor (automatic reset after triggering) if this is allowed. The other camp always uses a high-pressure limiter (manual reset after triggering for restarting the system) to ensure that the high-pressure shutdown does not go unnoticed. For this reason, Danfoss condensing units with pressure switches have a special, pre-fitted version that allows the reset on the high-pressure side to be configured as individually desired. Either the automatic reset function or the manual reset function can be selected by shifting the position of a safety washer.

**Cooling capacity**

There is a special consideration with regard to specifying the cooling capacity of condensing units. The cooling capacity is always specified at a particular ambient temperature (usually 32 °C). This may appear somewhat unusual, since a specific condensing temperature is normally taking as the basis. For example, the cooling capacity of a compressor is specified for a fixed condensing temperature of 50 °C or 54.4 °C, depending on the standard conditions. However, if the same approach were used with condensing units, the size of the condenser would not be taken into account. For this reason, the capacity of a condensing unit is measured at a specific ambient temperature (under laboratory conditions). This means that a condensing unit with a larger condenser has a lower condensing temperature, which means it has a higher cooling capacity even though the same compressor is fitted. This also reduces the difference in cooling capacity resulting from using different refrigerants, as compared to considering only the compressor.

In other words, if (for example) you compare the capacity of a condensing unit with R404A to the capacity of a condensing unit with R134a, you will see a smaller difference than if you compared the compressors fitted in the units. As R404A has a higher volumetric cooling capacity than R134a, a compressor operating with R404A has a higher capacity than the same model with R134a at the same evaporating temperature. However, the condenser of a multi-refrigerant condensing unit will appear larger if R134a is used instead of R404A, so that the condensing temperature is lower than for operation with R404A. This improves the cooling capacity of the condensing unit with R134a. In short, in case of doubt it is a good idea to check the performance figures of the compressor when examining the performance specifications of condensing units.

**Multi-refrigerant capability**

This leads to the question of whether these differences in the refrigerating capacity of a condensing unit due to the refrigerant that is used can be utilised commercially. The answer is ‘yes’. The first benefit is obvious: if the condensing unit is designed to be suitable for use with various refrigerants, such as R404A, R507, R407C and R134a, availability from the refrigeration wholesaler is better than if a different unit is used for each type of refrigerant. This benefit is especially important with relatively large condensing units, since they take up more space in the warehouse of the wholesaler (and space is expensive). The second benefit is increased customer flexibility. For example, if a new system is being built and the customer is not yet sure whether an expansion will be carried out in the coming years, it is advisable to install a condensing unit with multi-refrigerant capability and operate it with R134a. If the system is installed in a petrol-station shop, for example, and the shop is enlarged five years later, it is possible to extract more cooling capacity by simply changing the refrigerant to R404A without having to replace the condensing unit.
This is by no means detrimental to the customer, since R134a refrigerant has a very good energy rating and only rates second to R404A (or R507) in terms of general-purpose use.

**Fully equipped condensing units**
Beside conventional condensing units with a basic configuration, fully equipped condensing units are presently very popular. With conventional units, features such as fan speed control, a weatherproof housing, compressor protection, an emergency stop switch, a dryer and a sight glass can only be retrofitted as options, they are already included in a fully equipped condensing unit outdoor module.

These units are usually more compact than standard condensing units in terms of the required installation area. A standard unit provides time savings during installation, and the time savings with such a ready-to-install unit are of course even greater. The growing popularity of these complete units also has a positive effect on pricing. As a result, these units have become a genuine alternative, especially for demanding end customers. System builders especially appreciate features such as integrated, pressure-controlled fan speed regulation and a built-in electrical cabinet with an emergency stop switch.

Subject of the next issue:
**Pressure regulators**
Now that we have examined compressors and condensing units in detail, in the next instalment of ‘Fitters Notes’ we will look at how you can use regulator valves to govern the pressure in condensers, evaporators, and ahead of the compressor. Read more about the pressure regulators product group in the next issue at the same place.

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Information
The “Fitters Notes” series is based on the handbook of the same name produced by Danfoss, which discusses the basic principles of commercial refrigeration systems and the associated basic components.

You can view the Fitters Notes handbook from here:
http://www.danfoss.com/BusinessAreas/RefrigerationAndAirConditioning/EducationAndTraining/Fitters+Notes.htm

This “Fitters Notes” series is aimed at refrigeration fitters in servicing, system construction, people entering refrigeration engineering from other disciplines, trainee refrigeration fitters and anyone who would like to gain a basic practical knowledge of refrigeration in a series of articles.

The discussion avoids formulae as far as possible and only a small amount of prior technical knowledge is necessary. Fitters like using rules of thumb and so we will provide plenty of them, even if this sometimes makes it necessary to accept generalisations that are not always entirely accurate from an academic viewpoint. Unless otherwise stated, this series always refers to refrigeration systems using fluorinated hydrocarbons, such as R134a, R404A/R507 and R407C (i.e. not ammonia refrigeration systems).