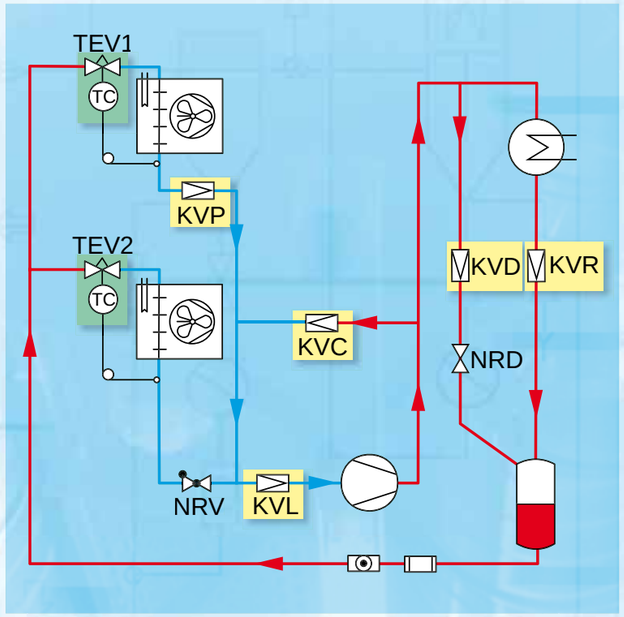
BASIC KNOWLEDGE

PRIMARY AND SECONDARY CONTROLLERS

Primary and secondary controllers control the refrigerant flow in the refrigeration circuit. The refrigerant flow must match the capacity demand. I.e. if a higher refrigeration capacity is required because e.g. goods to be cooled are added to the refrigeration chamber, more refrigerant must be evaporated. In addition, controllers are required to ensure that all components of the refrigeration circuit, such as evaporator, condenser and compressor, are operated in their optimum pressure and temperature range. Only this guarantees that a refrigeration system is operated safely and economic.



Refrigeration circuit with primary and secondary controllers
primary controller *secondary controller*
***KVP** evaporation pressure controller,*
***KVR** condensation pressure controller,*
***KVL** start-up controller,*
***KVC** capacity controller,*
***KVD** collector pressure controller,*
***NRD, NRV** non-return valve,*
***SGN** sight glass,*
***DN** filter / drier,*
***AEV** pressure-controlled expansion valve,*
***TEV** thermostatic expansion valve*

Primary controllers

In technical language primary controllers are also called expansion elements. They control the capacity of the evaporator directly via the injected refrigerant flow.

Four different types are differentiated:
- Capillary tube
- Pressure-controlled expansion valve
- Thermostatic expansion valve
- Electronic expansion valve

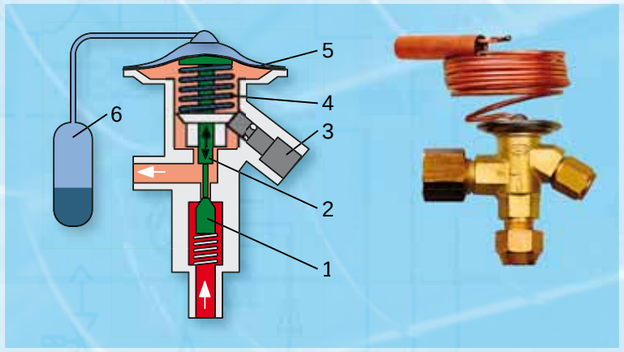
Capillary tube

In small systems, such as refrigerators, the capillary tube is favoured. It is a non-adjustable expansion element without control properties. As capillary tube a copper tube with very small inner diameter is used. The expansion element effect is set experimentally via the length of the capillary tube.

Capillary tube systems do not contain a collector and the refrigerant volume is matched exactly to the system.

Thermostatic expansion valve

The thermostatic expansion valve (TEV) is used most frequently. The TEV compares the temperature of the refrigerant at the evaporator outlet with the inlet temperature. Here the TEV tries to maintain a slight overheating of the refrigerant of a few degrees at the outlet. This ensures that the maximum possible refrigerant volume is supplied to the evaporator to be safely evaporated in full. It is important that no liquid refrigerant exits the evaporator, because this could cause major damage to the compressor. The degree of superheating can be adjusted by the pretension of the diaphragm spring.



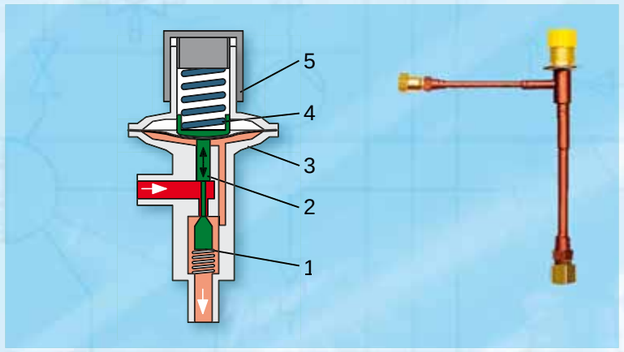
***1** nozzle insert with valve cone, **2** tappet,*
***3** adjustment screw, **4** diaphragm spring,*
***5** diaphragm, **6** temperature sensor*

Pressure-controlled expansion valve

With the pressure-controlled expansion valve (AEV) the pressure in the evaporator and thus the evaporation temperature is kept constant via the refrigerant supply. This is e.g. important if the goods to be cooled come into direct contact with the evaporator surface.

A disadvantage of the pressure-controlled expansion valve is that liquid refrigerant might exit the evaporator. Therefore, it is only used in special applications.

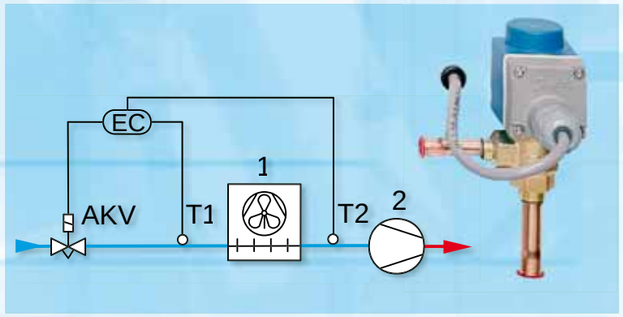
The evaporation pressure is set via the pretension of the diaphragm spring.



***1** nozzle insert with valve cone, **2** tappet,*
***3** diaphragm, **4** diaphragm spring,*
***5** adjustment cap*

Electronic expansion valve

The electronic expansion valve is the most flexible one. Here several effects can control the refrigerant flow simultaneously. However, the electronic expansion valve must be controlled via a complex digital control unit and is due to its high cost only economic for larger systems. In the drive of the valve cone a difference is made between a motorised and electromagnetic drive.



*Electronic expansion valve (**AKV**) with control unit **(EC)** and two temperature sensors:*
***T1** determination of the evaporation pressure and*
***T2** to measure the superheating*

Secondary controllers

Secondary controllers guarantee the optimum operating conditions for different components of the refrigeration circuit. They are mainly pressure controllers which, dependent on the tasks, keep the inlet, outlet or differential pressure at a desired value. Temperature controllers and electronic capacity controllers are also amongst the secondary controllers.

The following types of pressure controllers are differentiated:

- Evaporation pressure controller KVP
- Condensation pressure controller KVR
- Start-up controller KVL
- Capacity controller KVC
- Collector pressure controller KVD

(KVP, KVR, KVL, KVC, KVD, NRV were originally type designations by Danfoss which have become common terms in refrigeration language.)

Evaporation pressure controller

Via the evaporation pressure controller KVP the pressure and thus the temperature of the refrigerant in the evaporator is set. The KVP is often used to set different temperature levels (refrigeration and freezing stage) in a refrigeration system.

Capacity controller

The capacity controller KVC reduces the delivery volume of the compressor at low refrigeration capacity. The KVC prevents too low an intake pressure and therefore the unnecessary cycling of the compressor.

If the intake pressure is too low the KVC returns some of the delivery volume via a bypass to the intake side.

Condenser pressure controller

The condensation pressure controller KVR maintains a minimum pressure in the condenser. The KVR is used in air-cooled outdoor condensers. Using accumulated liquid refrigerant, the effective heat transfer area is reduced at low ambient temperatures. This reduces the condenser capacity.

Collector pressure controller

The collector pressure controller KVD prevents in conjunction with a condensation pressure controller KVR too low a collector pressure which results in a partial evaporation in the liquid pipes of the refrigeration system. For this purpose the KVD directs a small quantity of vaporous refrigerant directly from the compressor outlet to the collector.