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Future Technology

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Future Technology

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OBJECTIVES

After completion of this module you will be able to:

- Familiarize yourself with the new CO_2 technology proposed to replace R134a.
- Understand the need for the change to CO_2 systems.
- Describe the difference in both systems.

Future Technology - CO_2 Refrigerant

Air Conditioning System with CO_2 (R744) as the Refrigerant

The greenhouse potential of carbon dioxide is lower by a factor of 1300 than that of R134a, or one kilogram of R134a escaping into the atmosphere has the same greenhouse effect as 1300 kg of CO_2. Since CO_2 for motor vehicle air conditioning systems will with certainty be produced from natural sources or as a waste product from industrial processes, it even has a neutral environmental effect when used as a refrigerant. The CO_2 (R744) air conditioning system also has a higher degree of efficiency than today's R134a system. It therefore requires less fuel to achieve the same refrigerating capacity (outside temperatures up to < 35 °C) thus reducing exhaust emissions. On an annual *European* average, this means higher efficiency is achieved in combination with lower fuel consumption.

Note: An important advantage of the CO_2 air conditioning system is that in reverse operating mode it works as a heat pump and is used very effectively as a heater.

The CO_2 Refrigerant Circuit

The CO_2 refrigerant circuit is made up of the evaporator, expansion element, collector/separator, internal heat exchanger, compressor and gas cooler.
In the compressor, the gaseous CO_2 is compressed from 35 bar intake pressure to up to 133 bar. and it is heated to a max. 165°C.

The gas cooler gives off a part of the absorbed heat to the outside air. The refrigerant can become liquid only if its temperature can drop below 31°C (the critical temperature for CO_2). However, due to its technical efficiency of < 1 (an "ideal" gas cooler would have an efficiency of 1) this occurs in the gas cooler only at outside temperatures below 27°C (therefore the term gas cooler is used instead of condenser).

In the heat exchanger, the CO_2 coming from the gas cooler is cooled further by the CO_2 coming from the evaporator at a temperature of about 0°C. It is then injected through an expansion element into the evaporator where the pressure is relieved from 120 bar to 35 bar allowing it to evaporate.

The refrigerant takes the heat required for evaporation from the supplied air or with the air conditioning system in circulating mode from the air in the passenger compartment that is routed through the fins of the evaporator and cooled. The lower the temperature of the liquid refrigerant after the gas cooler, the more heat it can take from the ambient air in the evaporator.

Following evaporation, the refrigerant initially passes through a collector where the liquid CO_2 components are separated and then the inner heat exchanger. The now pure gaseous CO_2 is fed to the compressor and the process starts again from the beginning.

Due to the higher density of CO_2 compared to R134a, lower volumetric flow rates can be used to achieve the same refrigerating capacity as with today's R134a air conditioning systems.

System description:

- The CO_2 refrigerant has the designation R744.
- The refrigerant filling capacity is about 10- 15% lower than in today's systems filled with R134a.
- With only a few exceptions, the components in the air conditioning system are similar to the components used for R134a.
- Depending on the ambient temperature, the pressure level is considerably higher at up to 95 bar when stationary (high-pressure and low-pressure) and up to 133 bar on the high-pressure side during operation.

New A/C components:

- An accumulator with integrated inner heat exchanger. It has 4 connections.
- The condenser in the CO_2 system is referred to as the gas cooler.
- In addition to the pressure, the sensor at the inlet to the gas cooler also measures the hot gas refrigerant temperature.
- A rupture disc between the evaporator and expansion valve (low-pressure side) trips at a pressure of 120 +/-10 bar .
- A rupture disc at the compressor outlet (high-pressure side) trips at 160 +/-10 bar .

The temperatures and pressures in the R744 refrigerant circuit are considerably higher than those in an R134a system. The air conditioning system uses a combined pressure-temperature sensor on the refrigerant side for control purposes. This sensor is positioned in the high-pressure section before the inlet to the gas cooler.

The system controls operation such that a maximum pressure of 133 bar is reached in the high-pressure section. If this pressure level cannot be maintained by corresponding control interventions, the compressor is set to zero stroke as of a pressure of 140 bar.

Besides the control, the air conditioning system can respond by mechanical means to high pressures. If control intervention is not possible the system pressure is relieved via the discharge elements called rupture discs. The rupture or bursting disc in the low pressure section (combined accumulator and internal heat exchanger) responds at a pressure of 130 bar at the latest. The rupture disc in the high-pressure section (at the outlet of the compressor) responds at a pressure of 170 bar at the latest.

Switch-on Pressure

The air conditioning system is switched on only if the system pressure is within the range from 25bar to 95bar. There is a distinct undercharge in the system at pressures less than 25bar- At more than 95bar the system is overfilled or the ambient temperature is distinctly higher than 54°C.

A different refrigerant oil is used. Instead of PAG oil for the R134a system, POE oil is used for R744.

Under no circumstances must PAG oil be used in the system. The aim is to use a standardized PAG oil by the time the system is introduced in series production.

New service devices with filler adapters as well as new leak detectors will be necessary. The system cannot be filled with the R134a service devices.

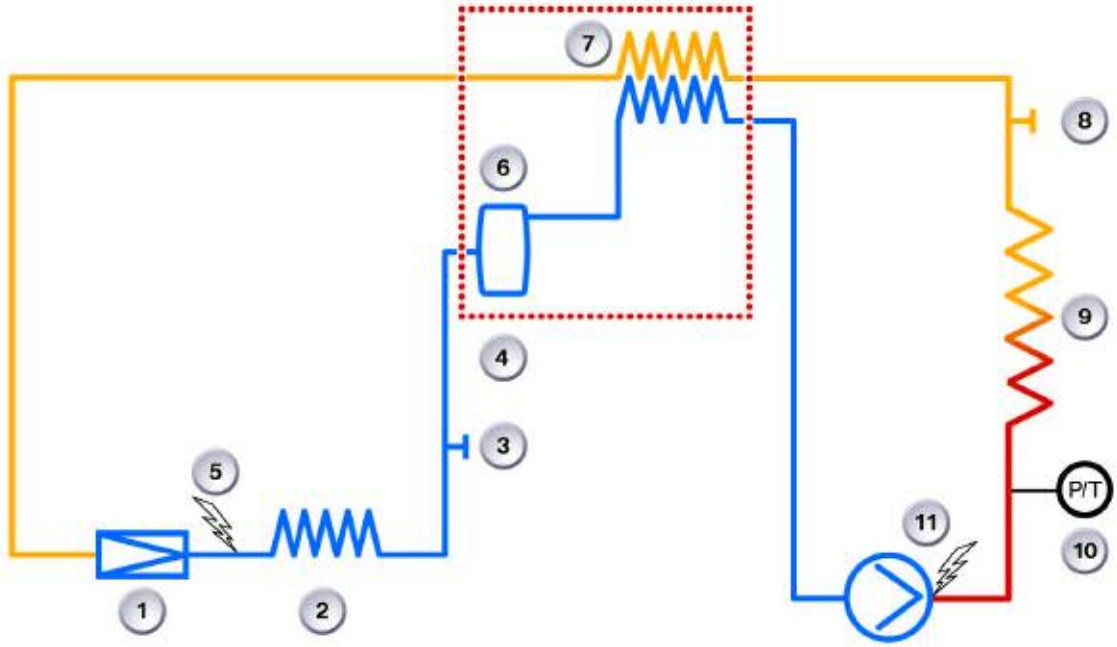
Refrigerant

The refrigerant is carbon dioxide (R744) and can be disposed of directly into the ambient air in well ventilated rooms.

Legal Situation

The current legal situation in Europe stipulates changeover to the R744 as from 2011 for new vehicle types and as from 2017 for all new vehicles. The introduction at BMW will therefore take place slowly and in stages.

R744 Refrigerant Circuit



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The refrigerant circuit is subdivided into three areas corresponding to temperature:

- The low-pressure area (ND) is blue.
- The high-pressure area (HD) is red and orange.
- The red area is the hot gas zone of the system with refrigerant temperatures up to 165°C (short-term max. 180°C).