

Safety When Handling CO2-Systems

Content

Results of the working group with members M.Lorenz (Visteon), R.Knorr (BMW), H.Mittelstrass (Behr), D.Schroeder (Audi), J.Schug (Porsche), C.Walter (Behr)

- ➡ Working sequences and safety aspects when servicing
- ➡ Tasks and first results
- ➡ General rules and regulations for an AC repair facility

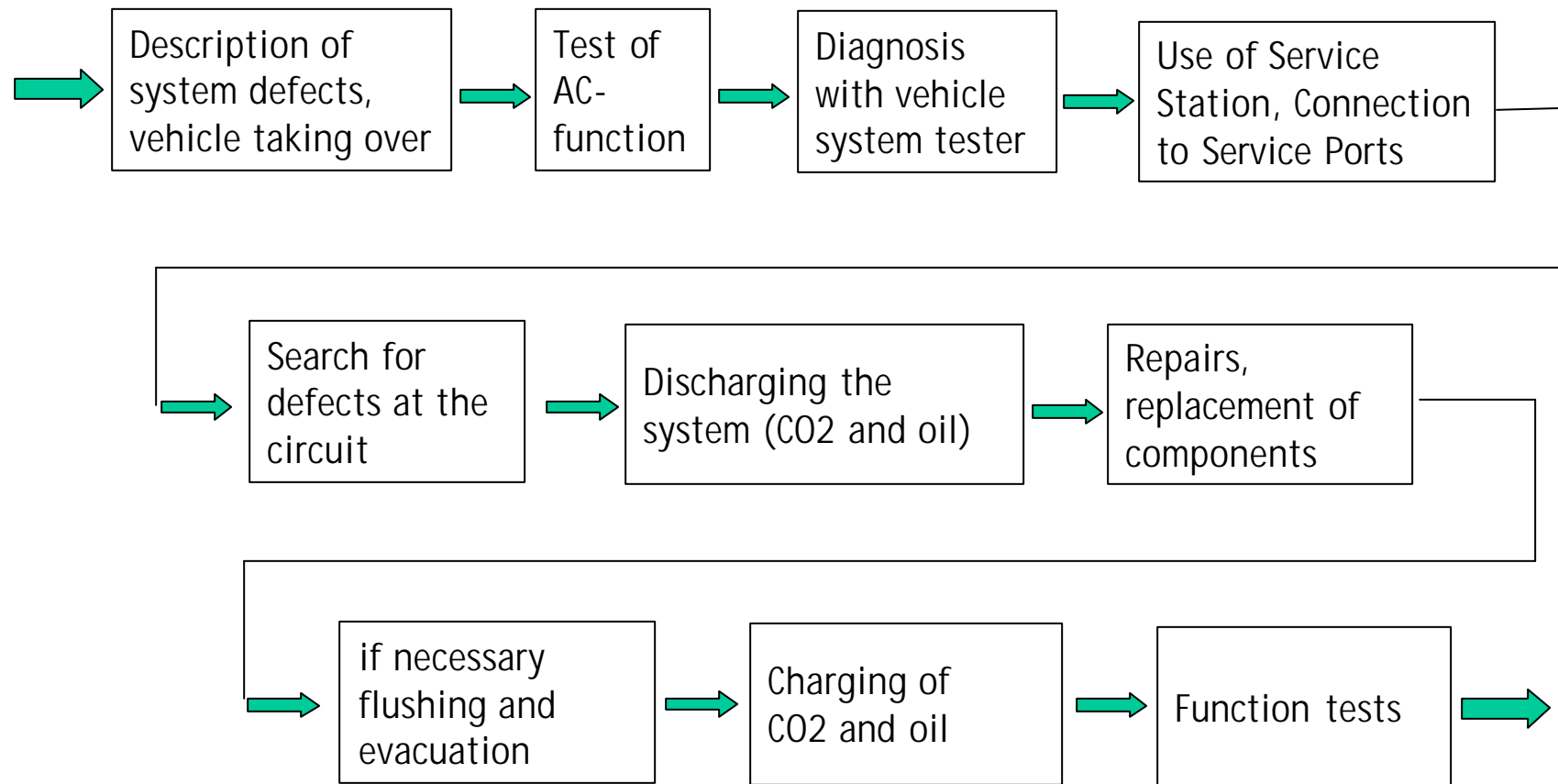
Service Station SeCO2 from BEHR

- ➡ Functions and safety demands
 - ➡ Safety strategy at the CO2 bottle
 - ➡ Outlook
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Differences in comparison to R134a and outlook

Service of the AC System in the Workshop

Working Sequences



Safety Aspects of the Working Sequences

Excerpts of the Most Important Points (1)

Activity	Potential Errors	Potential Effects	Measures	Necessary Regulations, Remarks	Action n°
1. First vehicle check					
1.2 mechanical check	leakage	high leakage rate of CO2 / oil, potential injury	minimization of errors through suitable component design, reparations at the pressurized system not allowed	regular training, question: is a CO2-sensor in the shop necessary?	(1, 7, 14)
6. Discharge of the system (CO2 / oil)					
6.1 through service port	system is not completely empty, parts of the system are still under pressure	sudden leakage possible when working at the system → potential injury	discharge of the whole system must be ensured, 2 service ports necessary (lp / hp)	first step: ensure that system is completely discharged	(4, 5, 6)
7. Replacement of components					
7.2	dirt in the system	blockation of small cross sections possible	flushing possible, under operation: destroke of the compressor / pressure relief valve	common working rules	(8, 14)

Safety Aspects of the Working Sequences

Excerpts of the Most Important Points (2)

Activity	Potential Errors	Potential Effects	Measures	Necessary Regulations, Remarks	Action n°
9. Charging					
9.2 charging with CO2 bottle	Overcharging of system → max. allowed soak pressure can be exceeded; under subcritical conditions overcharging is not detectable!	under operation on the road the whole amount of CO2 / oil can escape to the atmosphere → potential injury; possible damage of the compressor	at soak conditions: relief valve under operation: controlled destroke of the compressor	common working rules	(5, 9, 14)
11. Work like welding, brazing etc. close to the pressurized system					
11. 1	leakage, damage possible	high leakage rate of CO ₂ / oil, potential injury	working at or close to the pressurized system is not allowed	common working rules	(11, 14)

Actions of the Group

Safety Rules, Working Rules, Specifications

Nr	Action Point
2	Safety aspects when using external pressure sensors when serviceing
4	Specification for charging valves
5	Specification for service equipment
7	Specification for connections
10	Specification for relief valves
12	Detection of overcharged systems - definition of test function - definition of charging procedure
13	Safety rules for prototype phase
3	Definition of an AC repair facility
11	Working in neighborhood of pressurized AC-system
6	Consequences of powerless closed valves
8	Flushing of the system or components (fluids, tools...)
9	Definition of maximum tolerable moisture in the system
1	Definiton of leak detection for CO2
14	Working rules and training for service

→ Results and report of the working group

→ further discussion and elaboration of rules and training material by experts

First Results

Safety Design Rules for Service Components

Connections	
1	Complete opening of a connection under pressure must be prevented
2	System can not be pressurized, if connection is not correctly sealed
Charging port / valve	
Comparable to R134a	
1	When connecting the charging hose, leakage of CO2 and oil must be avoided
2	Sealing surfaces must be protected against damage, additional protection cap
3	Standardized ports for CO2 (no mix-up with R134a equipment)
4	Charging valve must be closed / tight before disconnecting is possible
5	Opening of the valve only with tools or charging hose possible
6	Specific standardized cross-section
Pressure relief valve	
Comparable to R134a	
1	Specific volume flow must be guaranteed > see available standards
2	Closing of the valve through icing must be prevented
3	Upon opening, an uncontrolled CO2 stream is not allowed
4	Definition of reuse versus replacement

Definiton of an AC Repair Facility

Common Safety Regulations and Standards (UVV / TRG 280)

Main results of the working group

- ➡ only hydraulic ramps are allowed (no assembling pit)
- ➡ good ventilation
- ➡ defined discharging > specification of charging valve
- ➡ defined charging > service station
- ➡ Definition of pressure relief valve > specification

Excerpts of common standards and regulations for gases in Germany

TRG 280 (Technical Rules for Gases)

- loosening of connections under pressure not allowed, tightning by experts allowed
- heat up of CO2 bottle up to 50 °C (122 °F) allowed
- common regulations for CO2 bottles (suppliers)

UVV 61 Gases (Accident Prevention)

- technical equipment to prevent danger from gases or use of CO2 warning system
- training of technicians every year

BEHR - Service Station CO₂

SeCO₂

Technique and Safety Functions

Technique

Remarks

Defined discharge of CO₂ and oil and separation of the oil



Defined relief cross-section and relief velocity at the service station

Evacuation of the circuit



same as R134a

Defined charging of the circuit with a weight scale



tolerance of +/- 10 g, bottle stands freely on the scale, prevented from falling

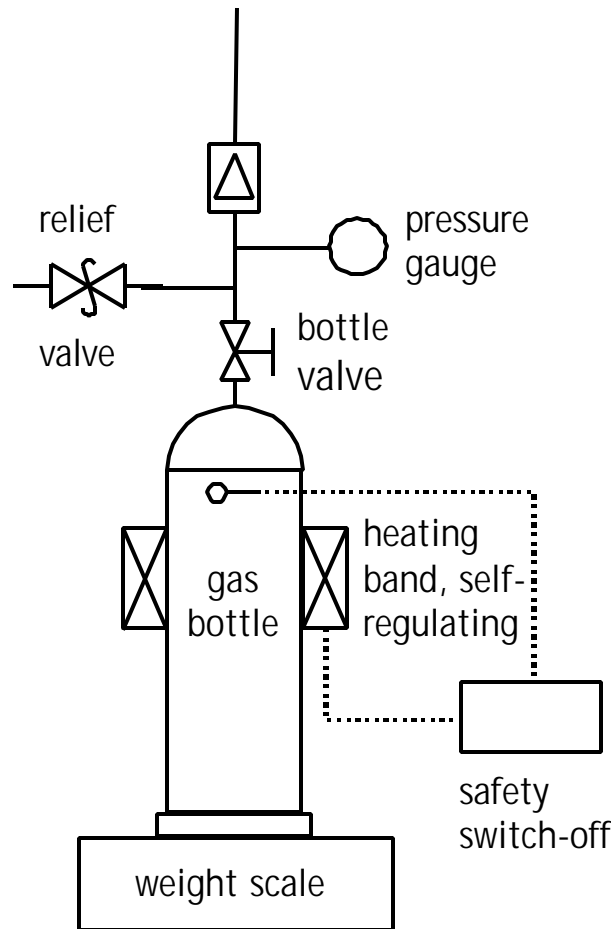
Safety Functions

- 1 Regulated heating device, self controlled switch-off at 50°C (122°F)
- 2 Relief valve between bottle valve and pressure gauge opens at 9 MPa
- 3 Optional: CO₂-sensor with acoustic signal (not demanded from technical authority)
- 4 Operation instruction

BEHR - Service Station CO₂

Safety Strategy at the CO₂-Bottle

SeCO₂



Generating of the charging pressure level through heating of the CO₂-bottle

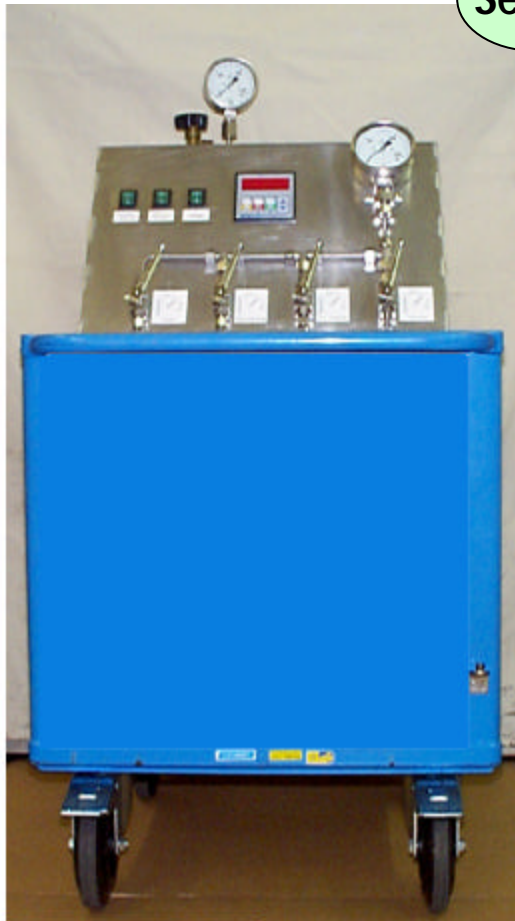
Safety levels

- 1 regulated heater max. 50°C (122°F), heating band covers less than 1/3 of the surface
- 2 mech. temperature sensor switches off the power supply, when surface temp. > 40°C
- 3 pressure relief valve opens at > 9 MPa and closes again below 9 MPa

Safety standard at the bottle through supplier:
burst disk at 19 MPa

BEHR - Service Station CO₂

Prototype Station - Outlook



SeCO₂

Prototype Station 2000



Bauart Geprüft

Further Possibilities

Automation with magnetic valves

- control of the system pressure of the AC-circuit
- forced evacuation before charging
- reading of bar-code for CO₂-charge level (car specific)
- exact automatic charging using the weight scale
- verify seals with vacuum
- measuring of CO₂ amount when discharging
- etc.

Outlook

Summary and Next Steps

Significant differences to R134a

- **under subcritical conditions overcharging is not detectable, exceeding of max. allowed soak pressure is possible! --> service station**
- **technical equipment must be installed, to prevent danger from gases --> service station**

Next steps

- **report and publication of the complete results by November 2000**
- **further work on specifications, rules and training material by expert teams**

Supported By Experience

The Results Of The Working Group Show:

Handling Of CO2-Systems Is Safe

When Proper Safety Procedures

Are Used