INSTALLATION AND OPERATING INSTRUCTIONS

General operating instructions for sample gas conditioner
Model: MAK 6

List of contents

INSTALLATION AND OPERATING INSTRUCTIONS

General operating instructions for sample gas conditioner
Model: MAK 6

1.0 Uses

The electric sample gas conditioner MAK 6 is used in the measuring gas preparation of an analysis system to cool moist measuring gas so that at no subsequent point in the analysis system does the temperature drop below the dew point.

During certain measuring work the dew point of the measuring gas must be kept constant to eliminate the effect of water steam on the measurement result. In such cases the water steam share which is kept constant be the sample gas conditioner is taken into consideration during calibration.

The electric sample gas conditioner MAK 6 may not be used in hazardous areas.

The reciprocal heat exchangers may only be replaced by identical models. When changing over to other materials (PVDF/stainless steel/glass) please consult the manufacturer's service department.

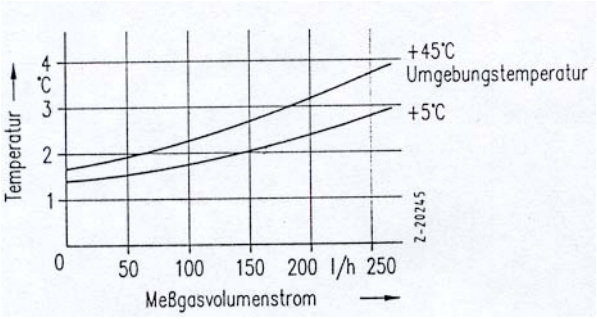
2.0 Technical data

2.1 Operating data

No. of gas channels	1,2 or 3 reciprocal heat exchangers
Material of heat exchanger	- PVDF (standard) - Stainless steel (1.4571) (option) - Glass (option)
Operating pressure (absolute pressure) with (standard) PVDF: with (option) glass with (option) Stainless steel (1.4571)	 0.5 ... +3.5 bar at $t_{\in}$ = 100°C 0.5 ... +2.5 bar at $t_{\in}$ = 140°C 0.5 ... +2.5 bar at $t_{\in}$ = 140°C 0.5 ... +100 bar at $t_{\in}$ = 140°C
Max. measuring gas flow Volume flow rate relative to 1 bar, 25°C PVDF-HE Glass-HE Stainless steel-HE PVDF-duo HE	 250 l/h at $T_{surrounding}$ = +5°c ... 45°C 300 l/h at $T_{surrounding}$ = +5°c ... 45°C 500 l/h at $T_{surrounding}$ = +5°c ... 45°C 2x100 l/h at $T_{surrounding}$ = +5°c ... 45°C
Measuring gas inlet temperature:	≤ 140°C PVDF ≤ 180°C glass, Stainless steel
Measuring gas inlet dew point:	≤ 65°C
Measuring gas outlet temperature:	+2°C ... +12°C Works setting +3°C
Dead volume per cooling system:	approx. 137 cm^3, without condensate collector
Pressure loss per cooling system:	approx. 25 mbar at V = 250 l/h
Refrigerating capacity *):	180 watts
Run-up time:	approx. 35 min.
Performance monitor: Standard: Option:	 S6(Tendency indicator) S6DIGI (digital display)

*) At an ambient temperature of 40°C

Dew point diagram as a function of the measuring gas flow and ambient temperature (mean valves) at a measuring gas inlet dew point of 65°C and measuring gas inlet temperature of 140°C.



2.2 Construction and installation

Design:	Modular unit housing
Housing material:	Sheet steel; colour RAL 7035
Type of installation:	Wall installation or installation in analysis cabinet with mounting lugs
Housing type of protection:	IP22 acc. to DIN 40 050
Protection class:	I acc. to DIN 57 700 Part 1A1 / VDE 0700 Part 1A1/6.83
Material of parts carrying gas:	PVDF, glass, Stainless steel 1.4571 (option)
Refrigerant:	R 134a
Measuring gas connection:	Pipe; d_a= 6 mm, d_i = 4 mm
Condensate drain:	Pipe; d_a= 12 mm, d_i = 10 mm
Auxiliary energy connection:	3 m connecting cable, 3 x 1.5 mm^2
Colour:	RAL 7035
Status signal:	On thermostat with S6(Tendency indicator) or on rear of performance monitor
Dimensions (H x W x D): **MAK 6-1, MAK 6-2** **MAK 6-3**	 290 x 366 x 355 290 x 422 x 341
Weight:	approx. 19 kg 1 Gaspath approx. 21 kg 2 Gaspath approx. 25 kg 3 Gaspath

2.3 Climatic load

Climatic group:	LZE acc. to DIN 40040
Ambient temperature:	+5°C ... +45°C
Transportation and storage temperature:	-25°C ... +65°C
Relative air humidity:	Annual mean of ≤ 75%, rare and slight condensation possible

2.4 Power supply

Power supply:	230V (198-264V), 50 Hz, 1 Ph 230V (207-253V), 60 Hz, 1 Ph 115V (100-135V), 50 Hz, 1 Ph 115V (100-135V), 60 Hz, 1 Ph
Power consumption: with 1 gas channel	272W; 1,56A at 230V, 50 Hz 315W; 1,75A at 230V, 60 Hz 288W; 3,18A at 115V, 50/60 Hz
Device fusing:	10A

3.0 Function and design

3.1 General comments

The sample gas conditioner cools, dries and cleans combustible and non-combustible measuring and analysis gases.

The measuring gas is cooled to approx. +3°C in a heat exchanger inside the electric sample gas conditioner MAK 6. The measuring gas condensate produced is collected in the condensate trap and has to be drained via a condensate drain. (Not included with the MAK 6.)

3.2 Design

The compressor (1) compresses the gaseous refrigerant to approx. 7 bar depending on the operating conditions. In the subsequent condenser (2), a tubular lamellar heat exchanger, the refrigerant is liquefied. The fan ensures the dispersion of heat. The capillary tube (4) reduces the refrigerant pressure to approx. 2.2 bar.

The pressure-reduced refrigerant is injected into the evaporator (6) in which it absorbs the thermal energy from the measuring gas through evaporation. The evaporator (6) and cooling spiral through which the measuring gas flows with subsequent condensate trap (7) are located in the cooling brine-filled heat exchanger unit (5). The measuring gas is cooled through a transfer of heat to the cooling brine and the cooling brine through a transfer of heat to the refrigerant. The measuring gas, cooling brine and refrigerant are hermetically separated from one another.

The measuring gas outlet temperature is controlled by the pressure of the refrigerant. The hot gas bypass valve (9) takes more or less refrigerant from the refrigerant system directly before the inlet to the condenser (2) depending on the refrigerant pressure in the evaporator outlet and returns this to the compressor (1) via a bypass. Since the pressure and temperature of the refrigerant are directly linked, the bypass control valve ensures a constant temperature of the measuring gas within the operative range of the sample gas conditioner at a pre-set evaporator pressure of 2.2 bar.

The cooling brine temperature (= measuring gas outlet temperature) is measured with a temperature probe and displayed on the performance monitor (12). (Function of the performance monitor see Chap. 3.3).

The condensate collected flows away from the measuring gas into a condensate collector to be installed beneath the sample gas conditioner.

3.3 Performance monitor

1. Standard S6 Tendency indicator

Analogue Tendency indication via a band of light-emmitting diodes (red/green/red) indicates the temperature of the cooling brine (=outlet temperature of the sample gas).

Deviation ± 0,5°C between 0... 10°C.

Status signal for a too high or a too low temperature of the cooling brine (fault-indication contact): If the temperature exceeds or falls below the limits of +8°C and 0°C respectively, the LED indicator changes from the green to either the right (>8°C) or the left (<0°C) red area. The status signal can be tapped off via two potential-free contacts. (NC or NO can be loaded with 250VAC / 1A). The circuit diagram can be found on the rear side of the performance monitor.

2. Option S6 DIGI

Digital temperature indication indicates the temperature of the cooling brine (=outlet temperature of the sample gas).

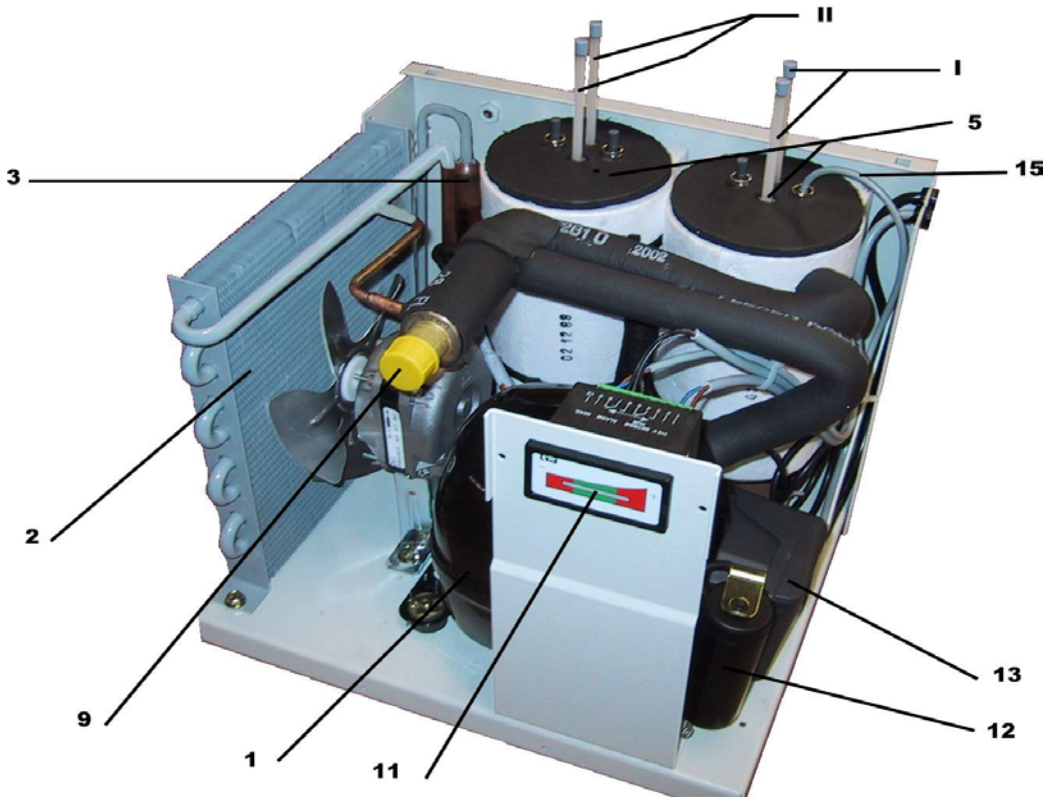
Deviation ± 0.5°C in the 10°C range. Status signal for a too high or a too low temperature of the cooling brine.

Flashing of an LED marked H (>8°C) or L (<0°C) respectively. The status signal can be tapped off via two potential-free contacts. (NC or NO can be loaded with 250 VAC / 1A). The circuit diagram can be found on the rear side of the performance monitor.

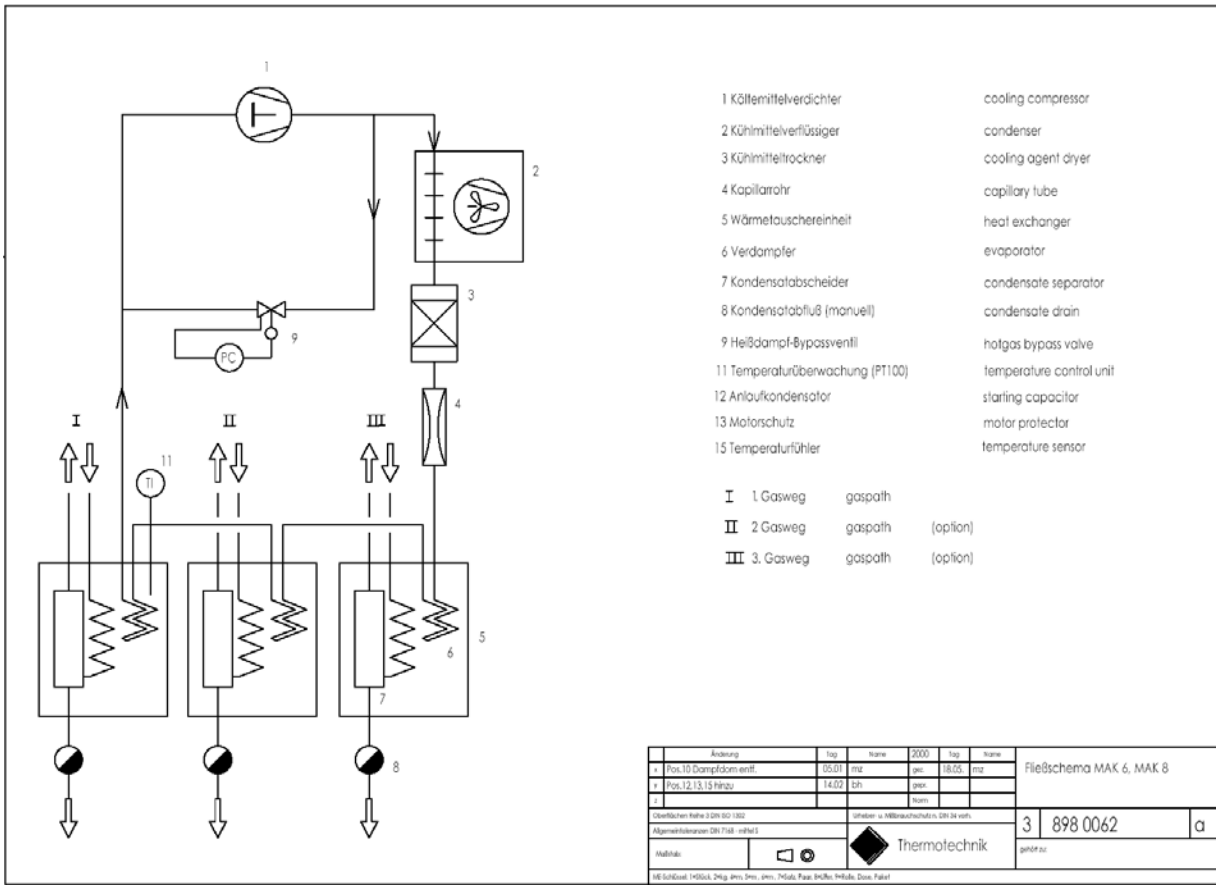
INSTALLATION AND OPERATING INSTRUCTIONS

General operating instructions for sample gas conditioner
Model: MAK 6

Electrical sample gas conditioner MAK 6-2, without tophousing



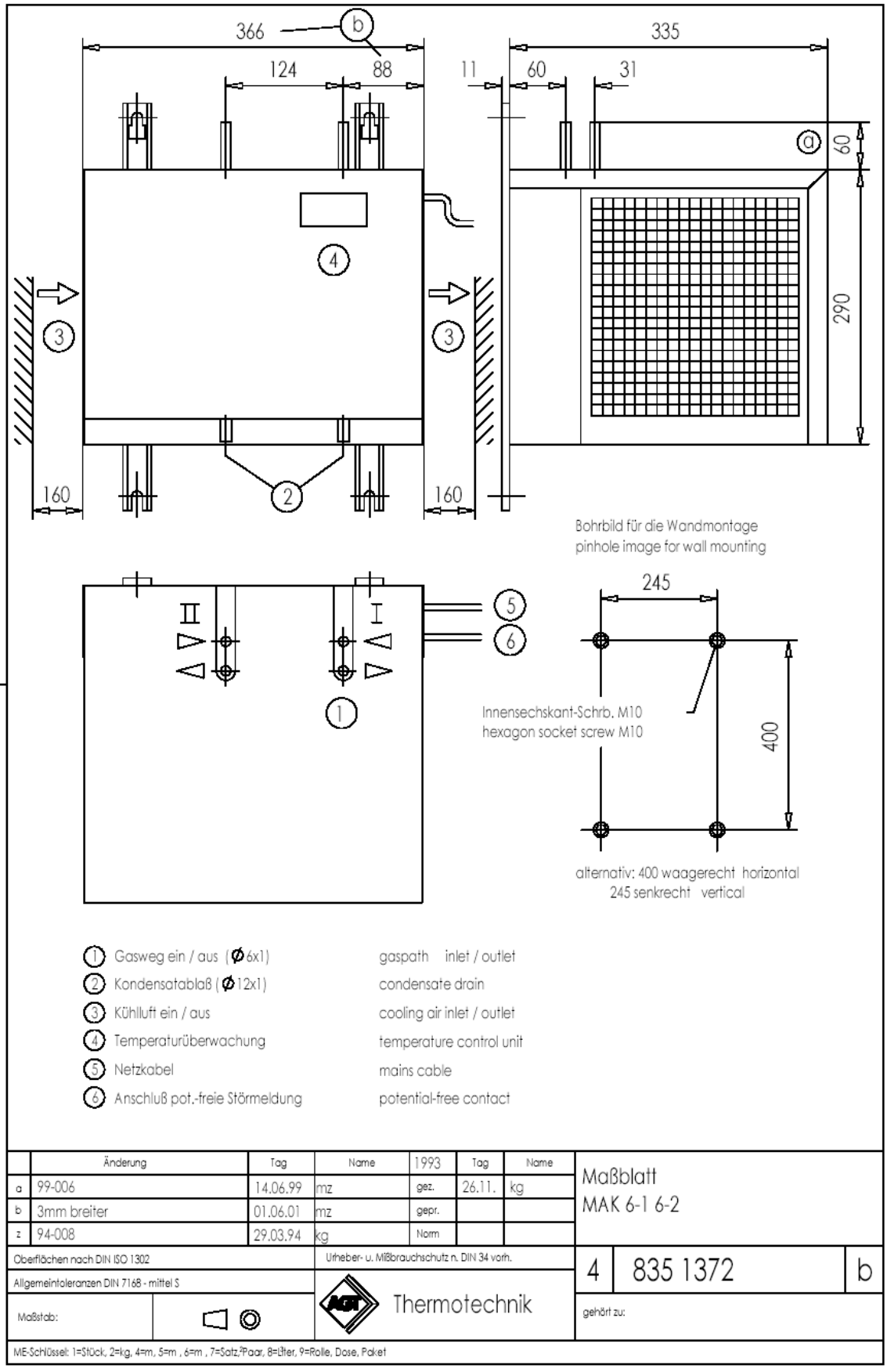
Flowsheme MAK6 (Part-No. 898 0062)



INSTALLATION AND OPERATING INSTRUCTIONS

General operating instructions for sample gas conditioner
Model: MAK 6

Dimension sheet MAK 6-1; 6-2 (Part-No. 835 1372)



	Änderung	Tag	Name	1993	Tag	Name
a	99-006	14.06.99	mz	gez.	26.11.	kg
b	3mm breiter	01.06.01	mz	gepr.		
z	94-008	29.03.94	kg	Norm		

Maßblatt
MAK 6-1 6-2

Oberflächen nach DIN ISO 1302 | Urheber- u. Mißbrauchschutz n. DIN 34 vorh.

Allgemeintoleranzen DIN 7168 - mittel S

Maßstab:

Thermotechnik

4 | 835 1372 | b

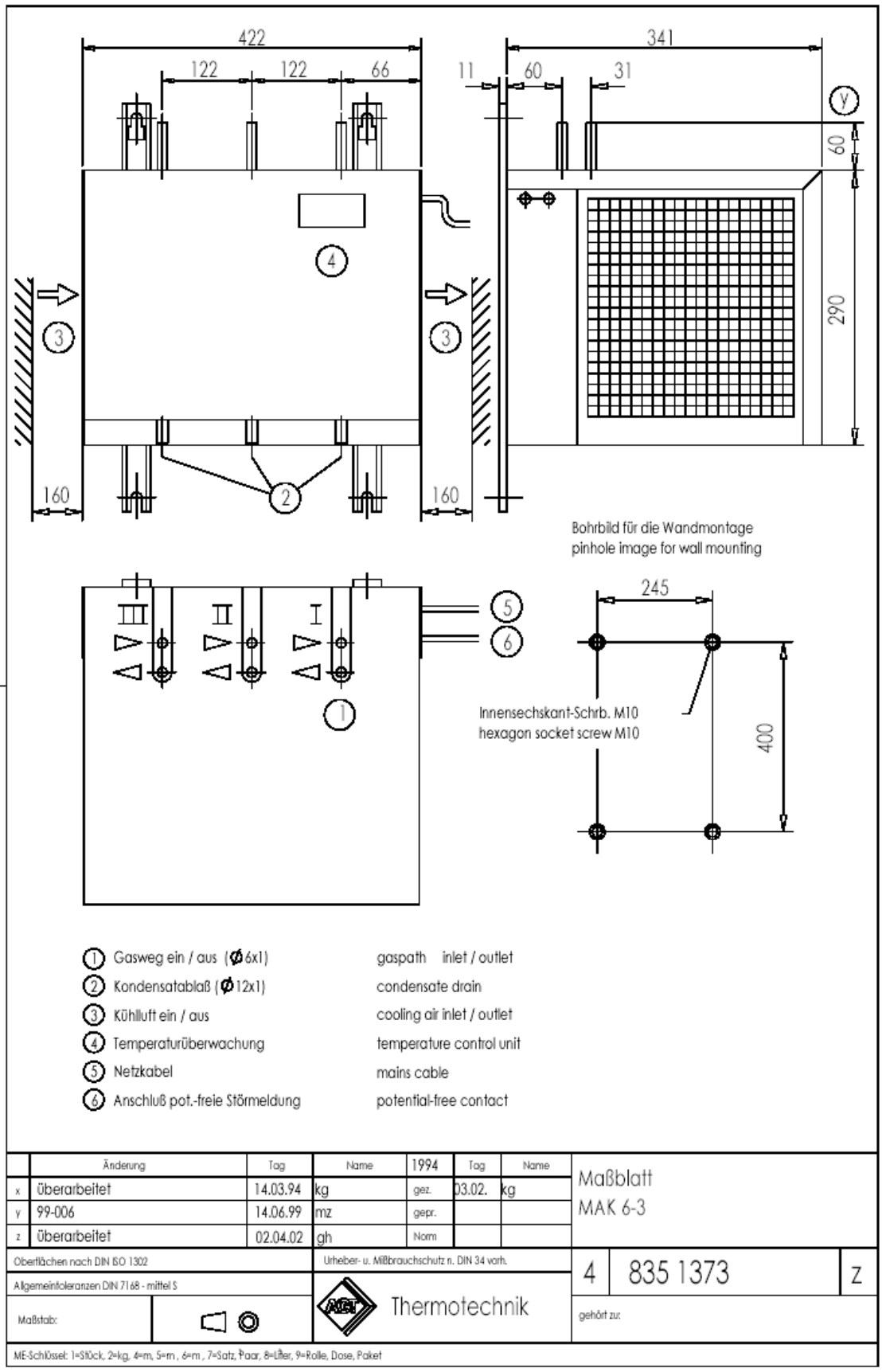
gehört zu:

ME-Schlüssel: 1=Stück, 2=kg, 4=m, 5=m , 6=m , 7=Satz,²Paar, 8=Liter, 9=Rolle, Dose, Paket

INSTALLATION AND OPERATING INSTRUCTIONS

General operating instructions for sample gas conditioner
Model: MAK 6

Dimension sheet MAK 6-3 (Part-No. 835 1373)



	Änderung	Tag	Name	1994	Tag	Name
x	überarbeitet	14.03.94	kg	gez.	03.02.	kg
y	99-006	14.06.99	mz	gepr.		
z	überarbeitet	02.04.02	gh	Norm		

Maßblatt
MAK 6-3

Oberflächen nach DIN ISO 1302 | Urheber- u. Mißbrauchschutz n. DIN 34 vorh.

Allgemeintoleranzen DIN 7168 - mittel S

Maßstab:

Thermotechnik

4 | 835 1373 | z

gehört zu:

ME-Schlüssel: 1=Stück, 2=kg, 4=m, 5=m , 6=m , 7=Satz, 8=Paar, 8=Liter, 9=Rolle, Dose, Paket

4.0 Installation and connection instructions

4.1 General comments

- Pay attention to ambient temperature: +5°C ...45°C
- Always transport the sample gas conditioner in an upright position.
- Install the sample gas conditioner as close as possible to the gas bleeder connection and protect against direct sunshine, rain and heavy soiling.
- Install the sample gas conditioner on a wall or in a cabinet using the enclosed mounting rails. Max. slope of 5°. Leave sufficient space beneath the unit for the condensate drain or condensate collector. Leave sufficient space to the left and right of the unit for the cooling air inlet and outlet.

4.2 Measuring gas connection and condensate drain

- The measuring gas path is shown by arrows; the arrows on the measuring gas inlet and outlet ports show the direction of flow for the measuring gas. (The measuring gas inlet is offset, the measuring gas outlet central in the reciprocal heat exchanger).
- Connect the measuring gas lines as hoses with an internal Ø of 4 mm and external Ø of 6 mm.
- When using screw fittings relieve the pipe inlets and outlets when tightening, e.g. with a spanner, so that they are not twisted.
- Pipe sockets with an external Ø of 12 mm and an internal Ø of 10 mm are to be used as condensate drains.

4.3 Electrical connection (see drawing 880 1579)

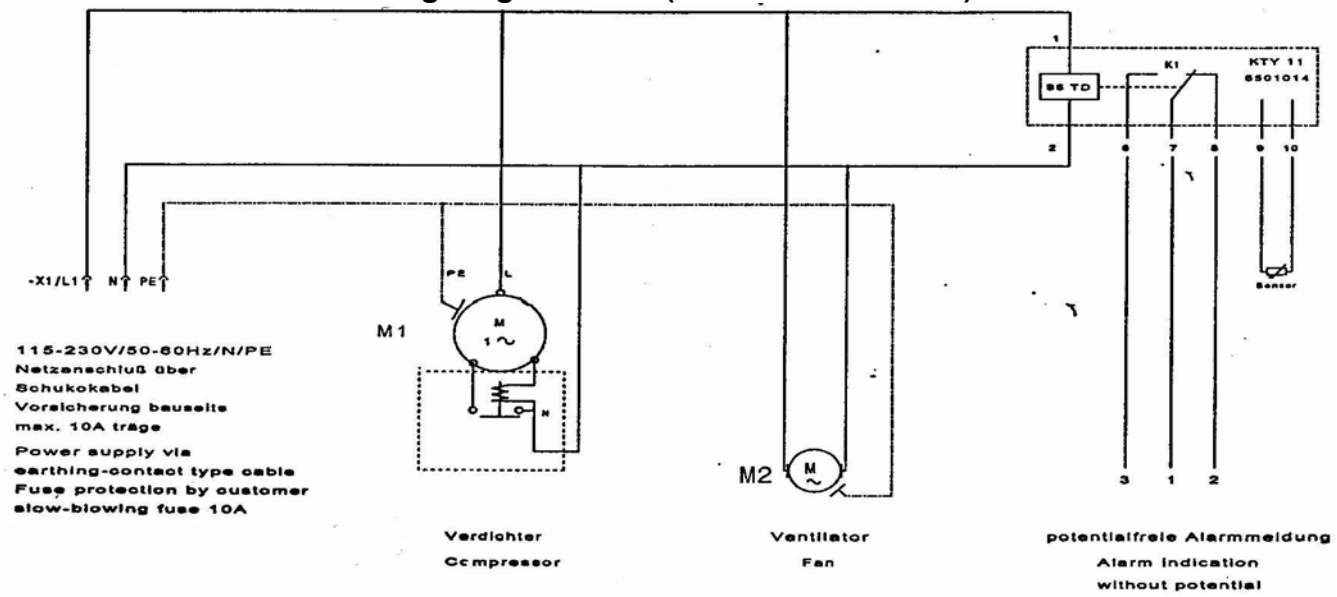
- Please refer to the ratings plate for the mains voltage, frequency and power consumption.
- Power supply by means of a mains cable and shock-proof plug.

Attention

The mains plug may only be plugged into a socket with an earthing contact. The protective effect may not be cancelled by a extension cable without ground lead.

Mount a 2-pole mains switch in the power supply line since the sample gas conditioner does not have its own mains switch.

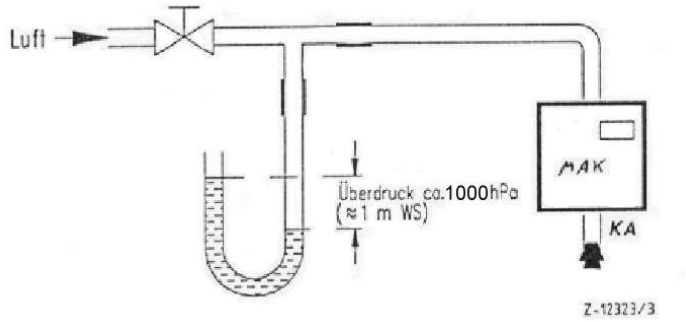
Wiring diagram MAK (Ident. No. 880 1579)



5.0 Starting

Carry out the instructions in Chapters 5.1 - 5.3 item for item

5.1 Leak test



*) Air
**) Excess pressure approx., 1000 hPa (≈ 1 m head of water)

1. Close measuring gas outlet port and condensate drain.
2. Connect a T-piece with stop cock to the measuring gas inlet port of the measuring gas channel via a hose. Connect the end of the T-piece to a U-tube manometer approx. half-filled with water.
3. Blow in air through the hose until the sample gas conditioner is under an excess pressure of approx. 1000 hPa (= 100 mbar = 1 m head of water).
4. Close the stop cock. The water level in the U-tube may not change by more than 1 mm in 1 minute. A greater pressure drop indicates a leak within the measuring gas channel.
5. Continue step 2. – 4. for the other Measurementgasways

5.2 Condensate drain check

1. Open condensate drain plug and connect with
- the condensate collector or
- the automatic condensate trap.
2. Check that the condensate drain cock is closed on the condensate collector where used.
3. Use the automatic condensate drain according to the separate operating instructions.

5.3 Starting the sample gas conditioner

Note
Leave the sample gas conditioner at least 2 hours after transportation and installation before starting!

Attention
Before switching on make sure that the operating voltage set for the device and the mains voltage are identical.

1. Switch on the power supply for the sample gas conditioner. The pre-set cooling brine temperature (= measuring gas outlet temperature) is reached after a run-up time of approx. 35 minutes: (performance monitor in green area). As long as the cooling brine temperature does not drop below the pre-set value of 8°C the display of the performance monitor (red area) or fault message contact signals the alarm status.
2. Fill sample gas conditioner with measuring gas.

6.0 Maintenance

Attention
When opening covers or removing parts, unless this is possible by hand, live parts may be exposed. Connections may also be live. Before starting any maintenance or repair work and before replacing spare parts the device must be disconnected from all sources of electricity if it has to be opened. If maintenance work or repairs on the opened device are then unavoidable under voltage, this work may only be performed by a qualified expert who is familiar with the associated risks.

Attention
The condensate produced is often acidic. Corresponding protective measures should thus be taken during draining and the pertinent waste disposal regulations observed.

6.1 Condenser cleaning

Dust which collects on the surfaces of the condenser fins can affect the refrigerating capacity of the aggregate: the condenser fins should thus be cleaned regularly.

1. Switch off the power supply to the sample gas conditioner (disconnect mains plug).
2. Loosen all twist locks on the front and top and remove the housing cover.
3. Remove dust from the fins of the condenser with a brush or compressed air.
4. Replace housing cover and fasten with the twist locks

6.2 Replacing the starter

1. Switch off the power supply to the sample gas conditioner (disconnect mains plug).
2. Loosen all twist locks on the front and top and remove the housing cover.
3. Release the screws which hold the cover for the compressor connection box with a screwdriver and remover cover from above.
4. Remove the starter from the pin contacts of the compressor and exchange. Fit and connect the new starter. Pay attention to its position.
5. Mount protective cover from above and fasten with the lateral screw using a screwdriver.
6. Replace housing cover and fasten with the twist locks.

6.3 Replacing the reciprocal heat exchanger

The reciprocal heat exchanger may only be replaced by identical models. When changing over to other materials (PVDF/Stainless steel/glass) please consult the manufacturer's service department.
Proceed as follows when replacing the reciprocal heat exchangers:

1. Release the connecting lines for gas inlet, gas outlet and condensate drain.
2. Remove the cover from the cooler.
3. Pull out the heat exchanger by turning slightly.
4. Lubricate the new reciprocal heat exchanger with cold conducting paste.
5. Insert the new reciprocal heat exchanger into the correct position by turning slightly (pay attention to position of inlet and outlet lines; the gas outlet comes centrally out of the heat exchanger.)
6. Fasten the temperature probe (Attention: insert far enough into the submersion sleeve of the heat exchanger.)
7. Fasten the cooler's cover.
8. Check the reciprocal heat exchanger for leaks; (see 5.1).
9. Start the unit; (see 5.3)

6.4 Spare parts

Spare parts for the electric sample gas conditioner MAK 6 are listed in the following spare parts list. Please quote the name and Ident. no. of the spare part when ordering. Please quote the complete serial number of the sample gas conditioner too. This can be found in the ratings plate.

Spare part	Ident. No.
Fan	
115 V, 50/60 Hz	660 0145
230 V, 50/60 Hz	660 0116
Start Capacitor of Compressor	
115 V, 50/60 Hz	5801055
230 V, 50/60 Hz	5801041
Overload Protector of Compressor	
115 V, 50/60 Hz	5802031
230 V, 50 Hz	5802002
230 V, 60 Hz	5802032
Relais of Compressor	
115 V, 50/60 Hz	5801006
230 V, 50 Hz	5801043
230 V, 60 Hz	5801044
Performance monitor S6 (tendency)	
115 V, 50/60 Hz	881 6025
230 V, 50/60 Hz	881 6023
Performance monitor S6 DIGI, display °C	
230 V, 50/60 Hz	881 6005
Performance monitor S6 DIGI, display °F	
115 V, 50/60 Hz	881 6011
Temperature probe for MAK 6	650 1013
Reciprocal hat exchanger	
PVDF design	841 0731
Stainless steel design	841 0733
Glass design	841 0732
PVDF-duo design	841 0788

The names in the spare parts list, the order confirmation, the delivery note and the invoice may differ from those functional names used in the present operating instructions. The Ident. No. alone is decisive.

7.0 Faults: causes and remedies

Tips on troubleshooting for the sample gas conditioner MAK 6 can be found in the error analysis diagram. The following information should facilitate the discovery and remedy of faults. Wherever the faults cannot be remedied please consult the device manufacturer service or send the electric sample gas conditioner MAK 6 back to the supplier for repairs.

When returning the device for repairs please specify the probable cause of the fault and any other observations which may help. Moreover, name the device number on the ratings plate (possibly order number) and the dispatch address in any complaints.

8.0 Packaging regulation

Before dismantling and transporting the electric sample gas conditioner MAK 6 the measuring gas connections and condensate connections are to be sealed with plugs or protective caps as a protection against dust. If the original packaging is no longer available, wrap the electric sample gas conditioner in paper and pack in a large enough dustproof crate lined with cushioning material (wood shavings, rubber hair or the like). When using wood shavings the packed layer on each side should be at least 15 cm thick. The cooler must always be transported upright.

For overseas dispatch the sample gas conditioner must also be sealed airtight in 0.2 mm thick polyethylene film enclosing a desiccant (e.g. silica gel). Moreover, during this type of transportation the transport container should be lined on the inside with one layer of union paper.

This packaging regulation also applies for returns to the device supplier (e.g. repairs).

Fault analysis

Fault	Cause	Remedy
Water condensation in measuring gas outlet	Condensate collector overflow	Empty condensate collector, clean and dry subsequent assemblies as necessary
	Ambient temperature < 5°C	Heat subsequent assemblies
	Sample gas conditioner overloaded	Pay attention to operating data (see technical data)
	Refrigerating capacity too low although sample gas conditioner not overloaded	Ensure a good circulation of cooling air. Fan must be in operation Pay attention to min. distance to adjacent assemblies or walls (see Fig. 1) Clean condenser (see Section 6.1)
	Protective motor switch on compressor triggered	Eliminate thermal load from measuring gas flow or excessive ambient temperature. Clean condenser (see Section 6.1) Pay attention to operating data (see technical data) Let compressor cool down before restarting
Measuring gas flow blocked	Condensate frozen	Heat the operational premises of the sample gas conditioner at ambient temps. < 5°C If the sample gas conditioner is overloaded the operating temp. initially drops
	Measuring gas channels dirty	Dirt can be caused by dust which has not be precipitated beforehand or sublimate. Ensure dust precipitation before entry of the measuring gas into the sample gas conditioner; separate sublimate beforehand Clean measuring gas lines and cooling systems; if using chemical cleaning agents pay attention to the corrosive effects or resistances.
Wrong temperature display	Performance monitor defective	Replace performance monitor
	Refrigerant escapes	Return sample gas conditioner to manufacturer's service dept. for repairs
Sample gas conditioner fails	Power supply interrupted	Restore power supply
	Starter not working properly (compressor motor starts in cycles of approx. 1 min, each for 10 s)	Switch off sample gas conditioner for at least 5 min. Wait for pressure equalisation. If the cyclic starting of the compressor motor still occurs, replace starter (see Section 6.2)
	Protective motor switch or motor winding defective (compressor motor does no run)	Measure electrical resistance of motor winding, reference value approx. 20 Ω. In the event of considerable deviation (measuring circuit open or short-circuited), replace starter (see Section 6.2). In the event of a defective motor winding, send sample gas conditioner to manufacturer's service dept. for repairs.