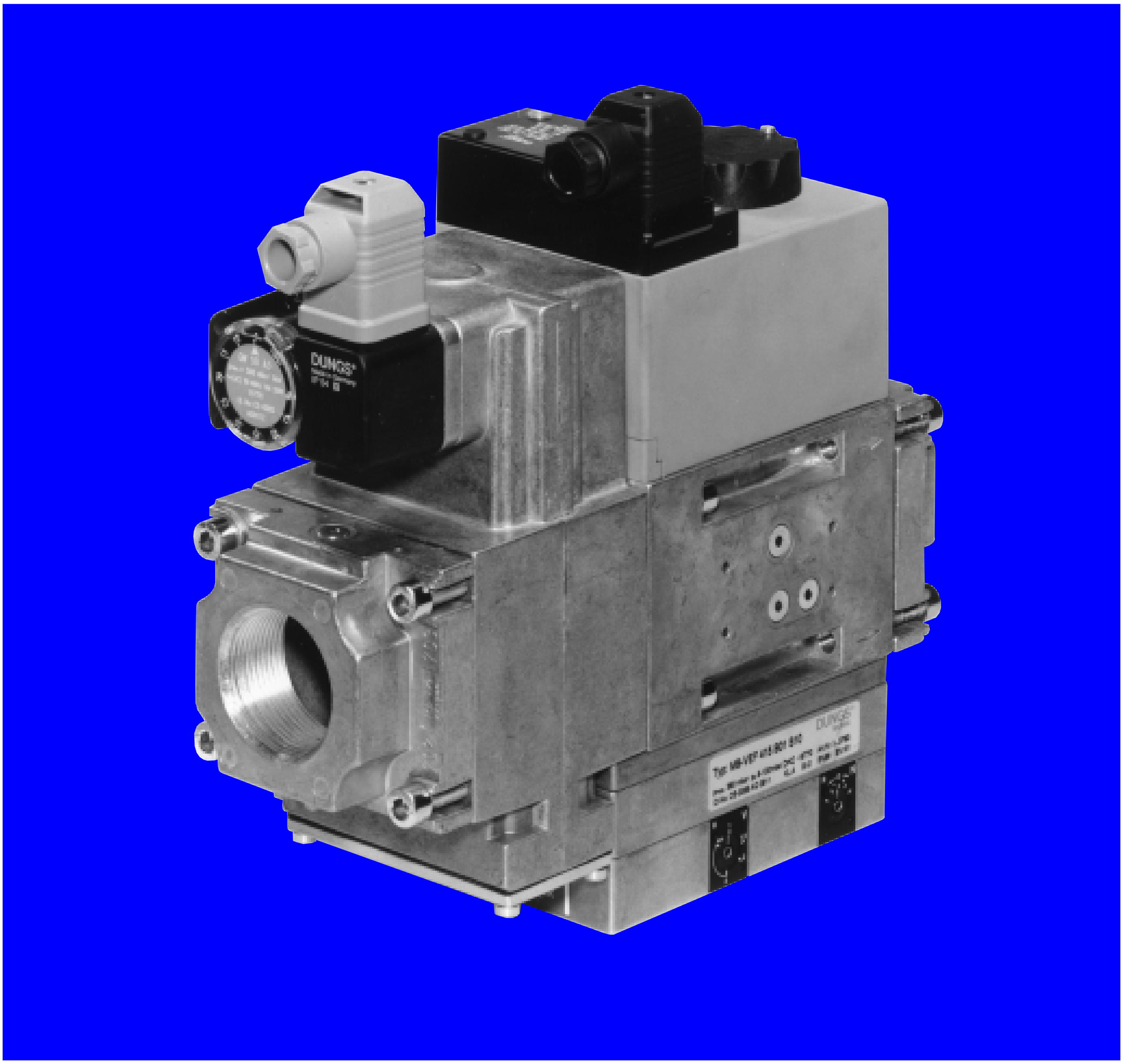
Gas/Air Ratio Control

MB-VEF
DMV-VEF



Kompaktarmatur mit 2 Magnetventilen, Regler, Druckwächter und Feinfilter

Compact unit with 2 solenoid valves, regulator, pressure switch and filter

Armature compacte avec 2 électrovannes, régulateur, pressostat et filtre

Unica struttura compatta con 2 valvole elettromagnetiche, regolatore, pressostato e filtro

MB-VEF

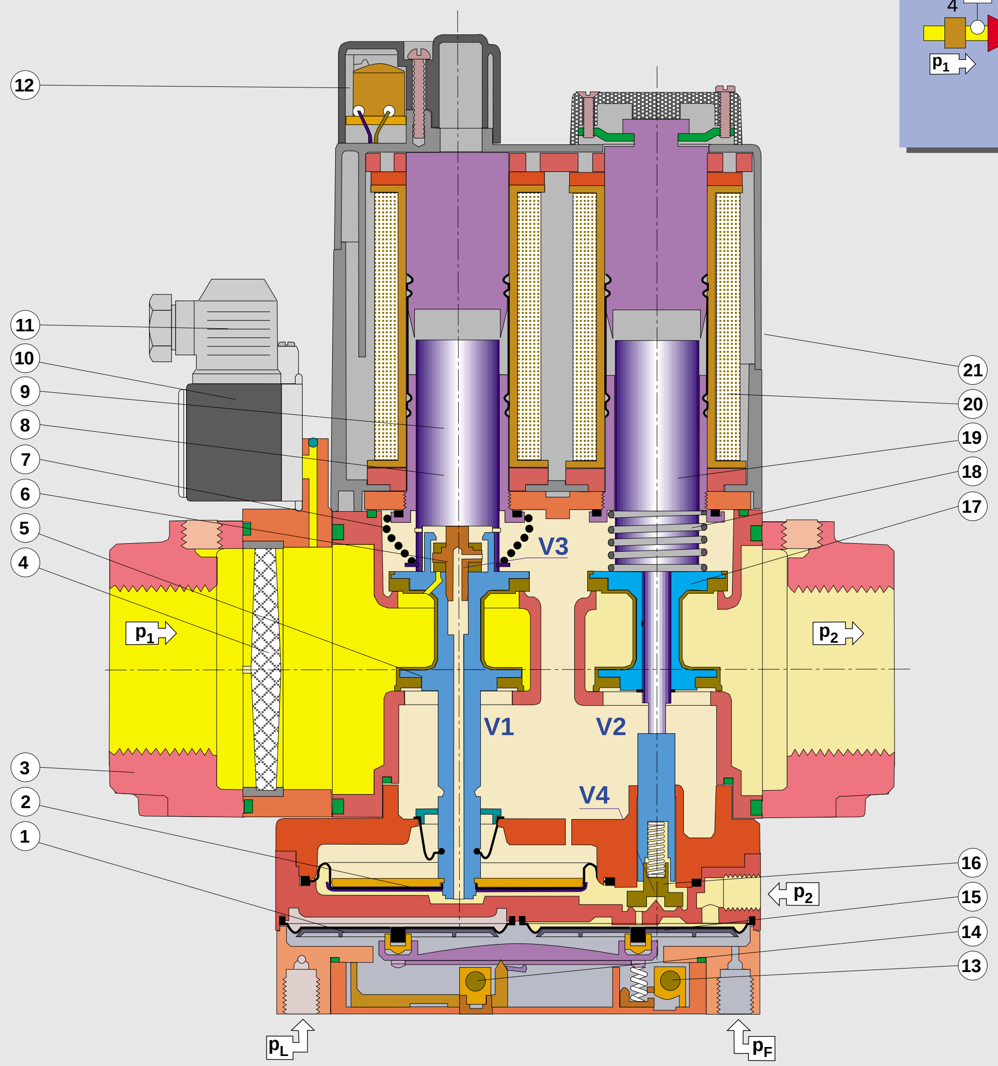
GasMultiBloc mit Gas-Luftverbundregelung

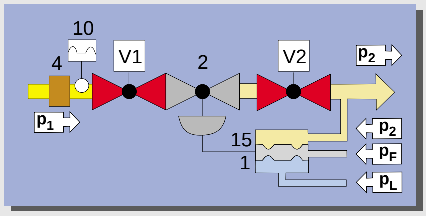
GasMultiBloc with air/gas-ratio control mode

GazMultiBloc avec régulation par rapport air/gaz

GasMultiBloc con regolazione della miscela gas-aria

DUNGS®





1 Luftdruck-Membrane
2 Regler-Membrane
3 Anschlussflansch
4 Feinfilter
5 Ventil V1
6 Steuerventil V3
7 Schliessfeder V1
8 Anker V1
9 Magnet V 1
10 Gasdruckwächter
11 GW-Elektroanschluss
12 MB-Elektroanschluss
13 Nullpunkt-Korrektur
14 Verhältnis-Einstellung
15 Gasdruck-Membrane
16 Steuerventil V4
17 Ventil V2
18 Schliessfeder V2
19 Anker V2
20 Magnet V2
21 Magnetgehäuse

1 Air pressure diaphragm
2 Regulator diaphragm
3 Flange
4 Microfilter
5 Valve V1
6 Control valve V3
7 Closing spring V1
8 Plunger V1
9 Solenoid V1
10 Gas pressure switch
11 GW plug
12 MB plug
13 Zero-point correction
14 Ratio setting
15 Gas pressure diaphragm
16 Control valve V4
17 Valve V2
18 Closing spring V2
19 Plunger V2
20 Solenoid V2
21 Solenoid housing

1 Membrane pour la pression d´air
2 Membrane de régulation
3 Bride
4 Filtre
5 Clapet vanne V1
6 Vanne de commande V3
7 Ressort de fermeture V1
8 Induit V1
9 Bobine V1
10 Pressostat gaz
11 Connecteur du GW
12 Connecteur du MB
13 Correction du point zéro
14 Réglage du rapport
15 Membrane pour la pression gaz
16 Vanne de commande V4
17 Clapet vanne V2
18 Ressort de fermeture V2
19 Induit V2
20 Bobine V2
21 Boîtier de bobine

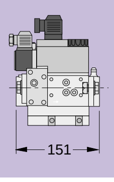
1 Membrana lavoro aria
2 Regolatore
3 Flangia
4 Filtro fine
5 Otturatore V1
6 Valvola controllo V3
7 Molla regolatore
8 Indotto V1
9 Magnete V1
10 Pressostato gas
11 GW-connettore
12 MB-connettore
13 Correzione punto zero
14 Regolazione rapporto
15 Membrana lavoro gas
16 Valvola controllo V4
17 Otturatore V2
18 Molla chiusura V2
19 Indotto V2
20 Magnete V2
21 Corpo magnete

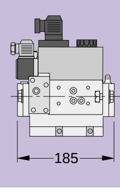
MB-VEF…-S10 p_1 **S10 5…100 mbar**
MB-VEF…-S30 **S30 100…360 mbar**

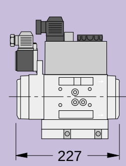
p_2 **0,5…100 mbar**

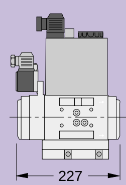
p_L **0,4…100 mbar**

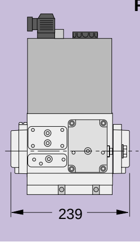
MB-…407 B01	MB-…412 B01	MB-…415 B01	MB-…420 B01	MB-…425 B01	Sieb
Rp 1/2	Rp 3/4	Rp 1	Rp 1	Rp 2	Sieve
Rp 3/4	Rp 1	Rp 1 1/4	Rp 1 1/4		Filtre
	Rp 1 1/4	Rp 1 1/2	Rp 1 1/2		Filtro
		Rp 2	Rp 2		











06.2000 KST

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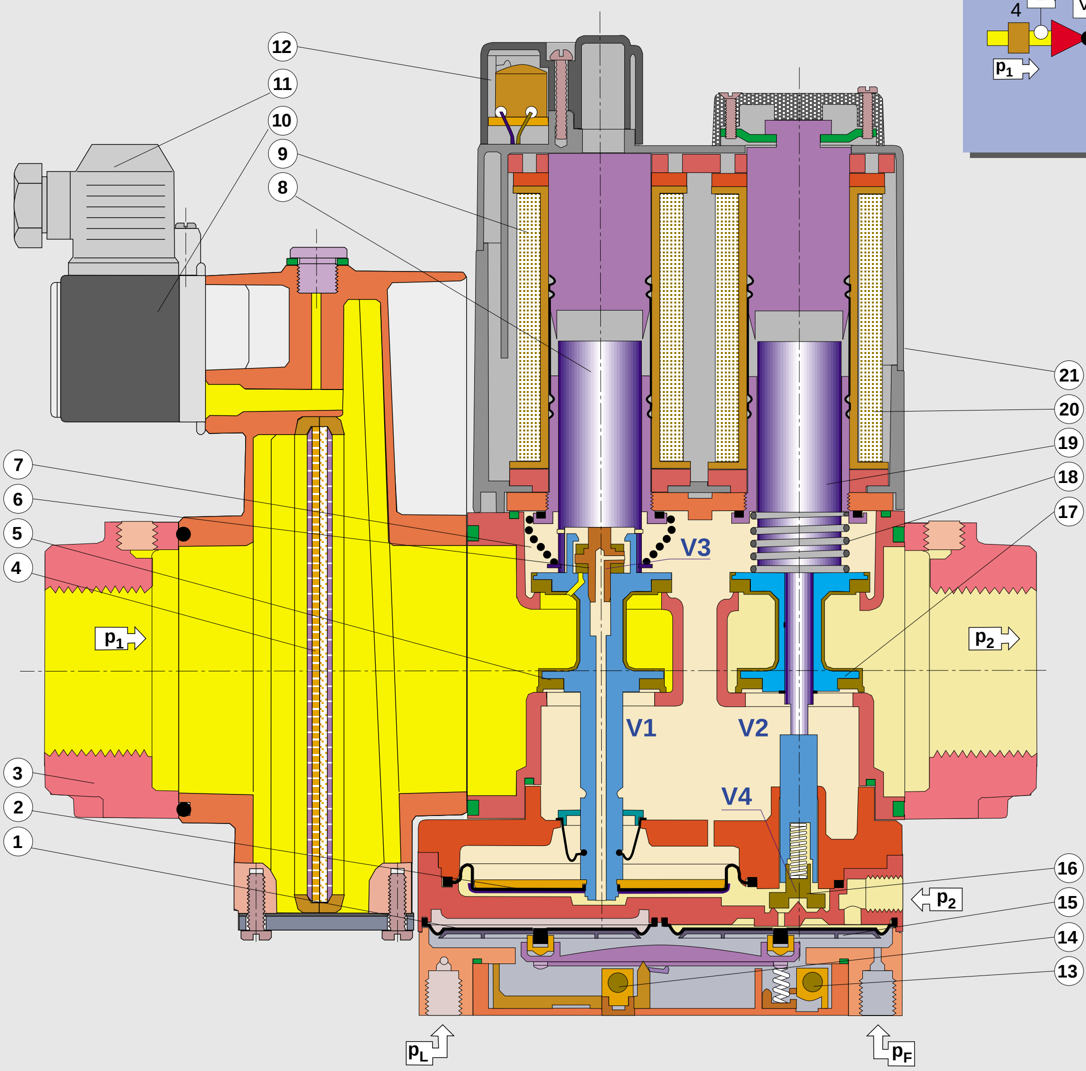
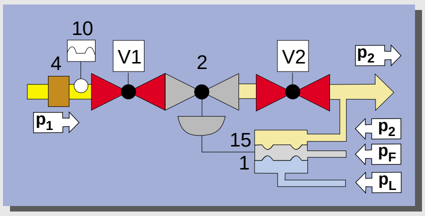
régulation par rapport air/gaz

GasMultiBloc con
regolazione della miscela gas-aria

DUNGS®

MB-VEF 415/420





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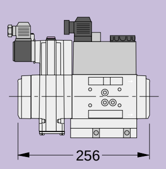
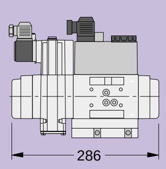
MB-…415 B01
Rp 1
Rp 1 1/4



MB-…415 B01
Rp 1 1/2
Rp 2



MB-…420 B01
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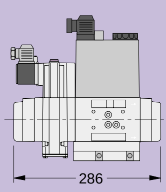
Rp 2



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Analysis Report on

Gas/Air Ratio Controls MB –VEF / DMV – VEF

Fitted to Forced Draught Burners

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Head of Burner Test Laboratory
Karl Dungs GmbH & Co.

Urbach, 22.02 2000

Contents

1. Introduction

Due to the increasing demand of gas burners for modulating operation, the demand for suitable gas/ air ratio control systems is more and more the focus of discussions.
In this context, a high modulation range for burners is required.
For many years, DUNGS has been supplying compact controlss (MB – VEF and DMV – VEF) which are equipped with gas/air ratio control units.
The DUNGS gas/air ratio control system requires no additional power for the control function.
The forced air pressure P_{air} is the key parameter to control the gas/air ratio control system.
The control controls a gas pressure which is proportional to the forced air pressure via an adjustable ratio V so that the gas volume corresponds to the current combustion air volume.
The controls can also be used for a two-stage floating operation.

These controls have a compact design comprising the following functional elements:

- 2 solenoid valves (Class A)
- Pressure controller in double-seat technology, located on the axis of the first solenoid valve (inlet side)
- Servo pressure control unit controlling the pressure controller without any additional power
- Ratio setting $V = P_{burner} / P_{air}$, 0.75 : 1 to 3 : 1
- Zero point correction
- Dirt trap or premount filter
- Pressure limiter
- Pulse flange (for threaded versions)

Additionally, DUNGS provides microprocessors equipped with controlled automatic burner controls comprising integrated fuel/air ratio control systems of types MPA or BCS. They can also be combined with a pneumatic ratio control system.

The controls can be supplied in nominal widths of DN 15 to DN 100 (DN 15 to DN 65 with threaded flange and DN 65 to DN 100 in flanged versions).

For technical details (e.g. gas flow rates depending on inlet and outlet pressures, equipment and options, dimensions and functional descriptions), refer to datasheets and equipment specifications as well as operating and mounting instructions. They are also available on our homepage: http://www.dungs.com.

Below we will specify the key items resulting from various tests on the VEF controls.
In the DUNGS burner test laboratory, we have tested burners of different types and manufacturers (150, 330 and 770 kW) with VEF controls.
From the results we gained, the following special instructions have been issued to ensure proper functioning of the VEF controls.

- **Definition of pulse connections**
- **Setup and settings**
- **Impacts in operation**

2. Definition of pulse connections

Please refer to the operating and mounting instructions for line dimensioning and for routing pulse lines between control and burner.

Please note the following when connecting VEF controls to marked pulse connections, e.g:
P_{buner}: Gas outlet pressure (variable)
P_{air}: Combustion air pressure (leading parameter)
P_{cc} : Combustion chamber pressure (interference variable)

2.1 Burner pressure P_{burner}

Define the measuring location (measuring point) at a distance of 5 x d in the gas line between control and gas burner.
Please note that the bore hole diameter at the measuring point is at least 4 mm and that the pulse bore hole is drilled in such a way that it cannot be blocked by any condensate occurring.
Instead of the 5 x d measuring point, you can use a pulse flange for controls with a threaded connection flange.

2.2 Combustion air pressure P_{air}

The P_{air} pulse is the key parameter for the pneumatic gas/air ratio control system and defines the function of the ratio control.

The pulse is decisive for the following items listed below:
- selection of ratio V
- ignition response of the burner
- modulation range of the burner
- gas/air mixture response and combustion quality

Route the measuring point for the pulse tap within a range of the combustion air route in which the air flow is smooth and cannot be influenced by deviations or flow stops.

Experience shows that the most favourable solution is when the measuring tube with an inner diameter of 4 mm is attached in parallel to the burner tube directly at the mixing point of the combustion gas.

For gas-forced air burners with a gas outlet downstream of the splash plate, route the measuring up to just upstream of splash plate. Consider the adjustability of the nozzle bar.

For gas-forced air burners with premixture, the measuring tube must be installed sufficiently far away from the gas outlet slots.

On some burners, we obtained positive results by installing the measuring tube at right-angles to the air flow direction in the burner tube to measure the dynamic pressure.
We provided the measuring tube with 2 mm through-holes along its complete length.

A check of the correct measuring point is possible by recording an air flow characteristic (refer to 3.1).

2.3 Combustion chamber pressure P_{CC}

The best point for measuring the pulse of the combustion chamber pressure is the burner outlet inside the burner.
Route a measuring tube with an inner diameter of 4mm in parallel to the burner tube which ends just upstream of the burner tube.

For proper functioning of the gas/air ratio control system, it is not necessary to connect the P_{CC} pulse, in case ratio V is equal to 1.

The P_{CC} pulse, however, is a key correction factor which ensures a constant selected ratio in case the gas/air ratios are not equal to 1.

3. Coarse setting for setup

To make a first coarse setting of ratio V and zero point correction N for setting up the VEF, the combustion air pressure P_{air} and the required gas pressure upstream of burner P_{burner} must be known roughly or calculated.

3.1 Combustion air pressure P_{air}

Determine the combustion air pressure by determining an air flow characteristic.

Measure the combustion air pressure P_{air} at different air valve position angles and display it in a curve by using the pre-ventilation time of the burner at maximum air valve position.
The air valve positions in steps of 5 angle degrees are obtained by manually adjusting the actuator motor of the air valve.
Measure the air flow characteristic at different nozzle bar positions.

The determined characteristic shows the achievable pressure values P_{air} and the characteristic of the curve sequence.
Based on this curve, define the effective modulation range (working range).

Fig. 2

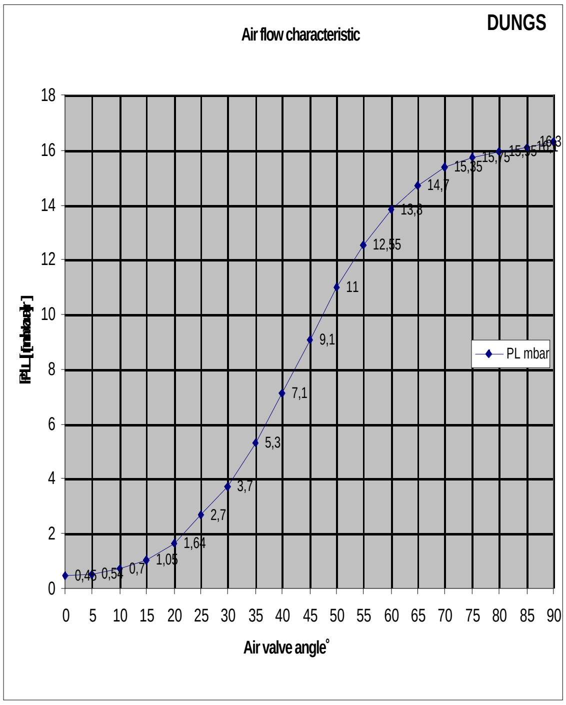
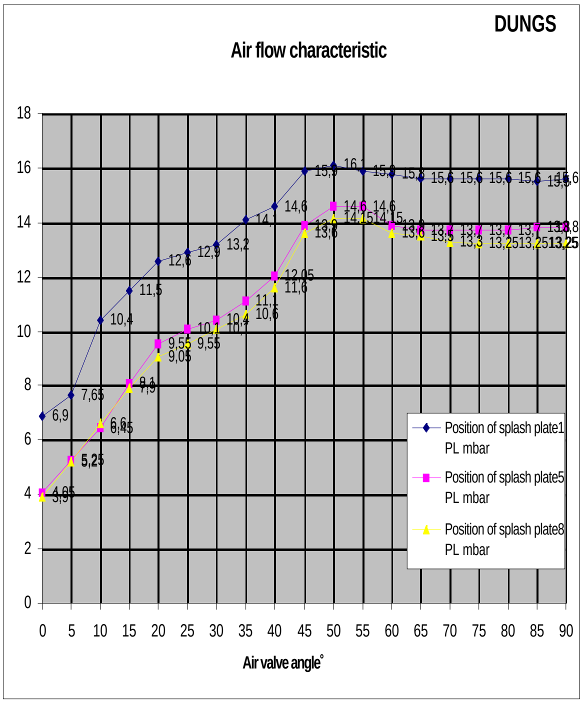


Fig. 3



An ideal curve of the air flow characteristic is shown in Fig. 2. The effective working range results from an air valve position of 0° to 80°.
The initial pressure for P_{air} is almost 0 and provides good conditions for a large burner modulation range. The curve characteristic is steady rising.

The air flow characteristic in Fig. 3 shows an effective working range of 0° to 50°.
The curve rises unevenly and therefore the burner modulation range is not constant.
The initial pressure for P_{air} is too high. The minimum load of the burner will therefore be too high.
In this case, DUNGS recommends a correction of the air valve.

3.2 Gas pressure P_{burner}

The gas pressure required for the necessary gas flow volume (burner capacity) is known due to the geometry of the gas outlet cross-sections in the gas-forced air burner and is specified in the technical descriptions of the respective burners.

3.3 Ratio V

The settable ratio V can first be calculated roughly using the following equation:

$V = P_{burner} - P_{CC} / P_{air} - P_{CC}$

On pre-mixture burners, P_{burner} is subtracted by P_{air}.
e.g.: P_{burner} = 10 mbar, P_{air} = 8 mbar, P_{CC} = 1 mbar (estimated)

V = 10 – 1 / 8 – 1 = 1.28

Set ratio V to 1.3.

If V < 0.75 results, increase P_{burner} by changing the nozzle geometry or it is necessary to adjust the control at DUNGS.

3.4 Zero point correction N

The gas volume is influenced by an offset in the zero point correction, e.g. a selectable default for the ignition gas volume.

The zero point correction can also be determined by calculation. Experience shows, however, that this is not practical; it is better to perform adjustment tests.

Set zero point to 0.
Perform a correction if no ignition occurs or ignition is too hard.
If the gas volume need not be increased due to ignition failure, adjust N in + direction (increase gas volume).

Experience shows that gas pressure must be measured during ignition. If it is below P_{burner} = 0.4 mbar increase the gas volume for ignition.

Since ratio characteristic V has a parallel offset, it is not a zero-point straight line. This means that different ratios will be set at individual measuring points. If necessary, the V setting must be corrected. This applies in general (refer to Item 4. Setup).

4. Setup

4.1 Burner ignition

Ignition settings are described in general in Item 3.

It is possible to place an orifice in the pulse inlet P_{air} at the VEF to attenuate an ignition which is too hard.
The orifice is adjusted by a screw-in nozzle for the first use. Then it is integrated as standard in the control by agreement with DUNGS.

4.2 Maximum load adjustment

After successful burner ignition, first set the maximum burner capacity (maximum load).

Compare the selected maximum load values P_{burner} and P_{air} with the
- set ratio V and the
- measured combustion values (flue gas analysis)

to calculate ratio V.

If it is necessary to correct the gas/air ratio if maximum gas volume is not obtained or of bad analysis values (O_2 > 2.5 vol.%) are achieved, first change the air valve setting if possible.
If the gas volume cannot be increased by changing the air valve position, adjust ratio V in a positive direction (apply more gas).
The combustion values then change.
The following estimation values shall apply:

- Max. load O_2 = 2.0 – 2.5 vol.%   (better values are possible)
- Min. load O_2 = 2.5 – 3.0 vol.%

4.3 Minimum load adjustment

After you have set the maximum load, set the minimum load.

To achieve the largest possible modulation range of the burner, set the minimal possible low load.

Make sure that the values P_{burner} = 0.5 mbar and P_{air} = 0.4 mbar are not undershot by far.

If the values are undershot, perform a test for drift (refer to Item 6.1).
Set the minimum load by adjusting N taking into consideration the above-mentioned O_2 values.
- N in minus = smaller gas volume
- N in plus = higher gas volume

In addition, make sure that the N adjustment requires a correction of the V setting.

Move to maximum load after specifying the minimum load adjustment and correct if necessary.

4.4 Adjustment of intermediate steps

Even in modulating mode, we recommend you check 2 to 3 load stages within the burner working range by performing combustion-specific measurements.

Perform any necessary corrections by adjusting minimum and maximum loads.

4.5 Notes on setup

- After setting V and N, always re-ignite the burner and check the combustion values.

- Without suitable measuring media for:
  . pressure measurements P_{burner}, P_{air}, P_{CC}
  . gas volume measurements, and
  . flue gas analysis

it is not possible to adjust the ratio control exactly.

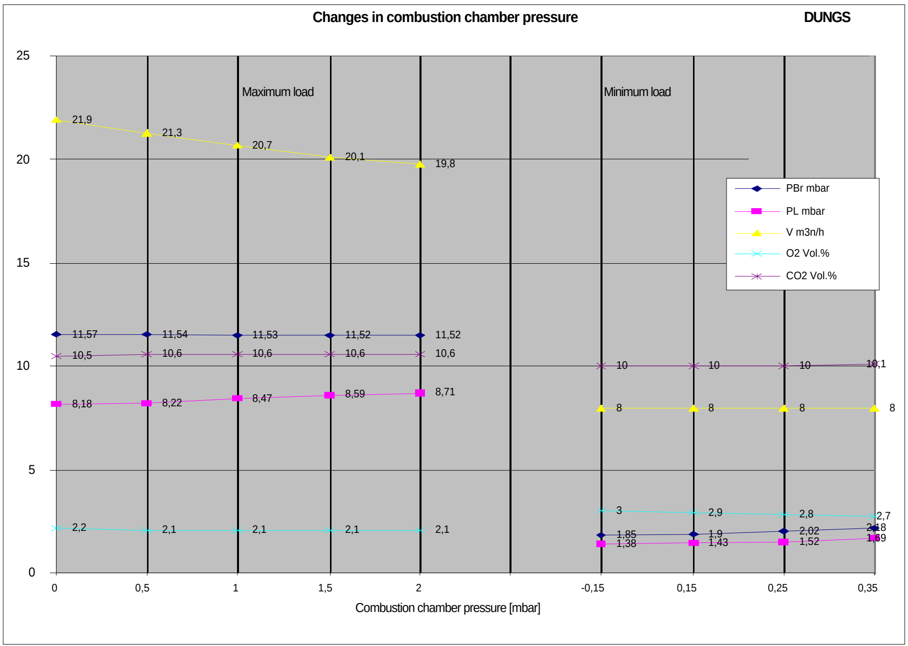
To reduce time required to perform system setup, we recommend you use pre-adjusted controls.

The adjustment values can first be determined at the burner manufacturer on the burner test stand or during an initial setup. Burner-specific estimation values are provided for further systems. In this context, orifices for P_{air} and P_{CC} can be determined for attenuating the pulses.

5.0 Impacts on operation

5.1 Changes in combustion air pressure P_{CC}

Fig. 4



Changes in pressure ratios in the stack (e.g. due to weather conditions) lead to pressure changes in the combustion chamber of the heat generator.
A change in gas volume due to gas and combustion air pressure changes will result. The combustion values however remain almost constant.

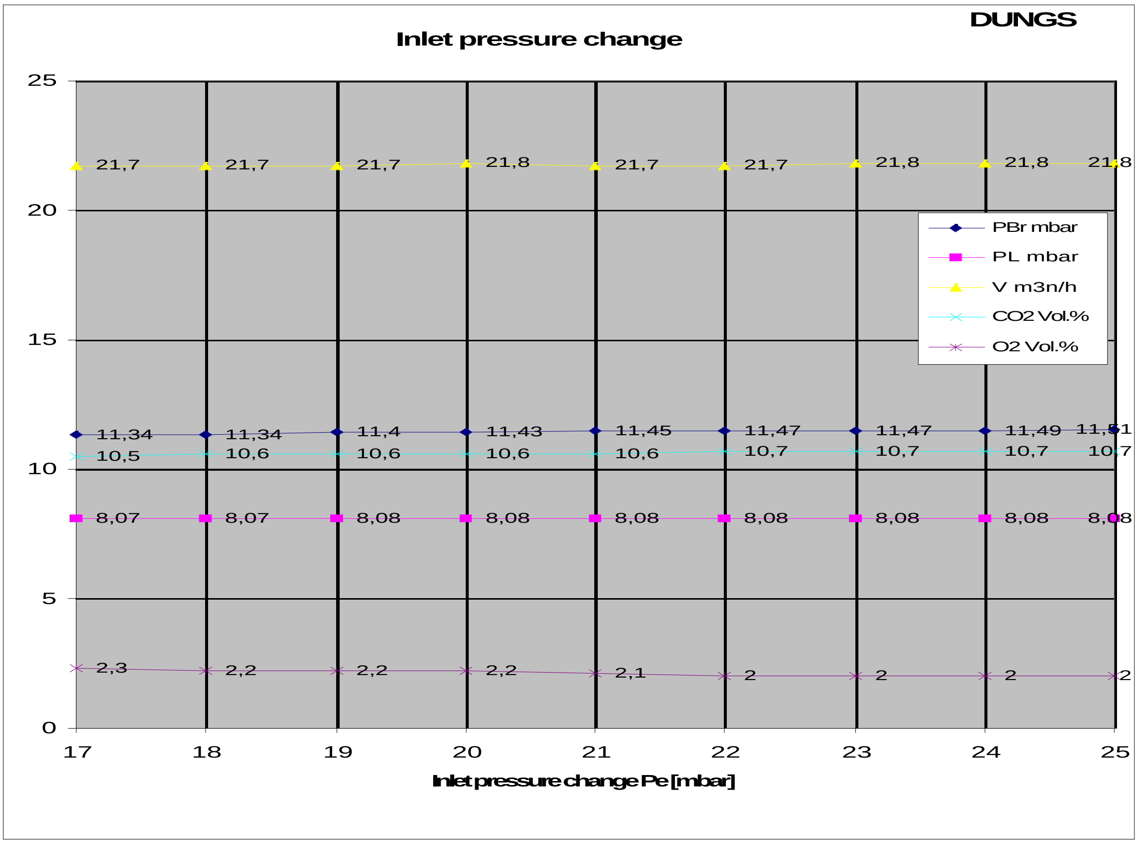
As can be seen from Fig. 4, pressure value P_{air} increases at an increase of P_{CC}.
The gas volume diminishes.
The combustion values O_2 and CO_2 remain constant.

5.2 Change in inlet pressure P_e

Gas pressure deviations in the gas supply network within the framework of values specified in DIN EN 88 (e.g. normal pressure = 20 mbar, minimum pressure = 18 mbar, maximum pressure = 25 mbar) result in constant values if the minimum pressure is within the control range of the VEF.

Fig. 5

Fig. 5 shows constant values, especially of combustion values O_2 and CO_2.



5.3 Changes of combustion air pressure P_{air}

Changes in combustion air pressure influence the leading parameter P_{air} which corrects the gas pressure P_{burner} via the ratio setting.

6. Experiments to determine operating response

6.1 Drift response

In the case of very large burner modulation ranges and small combustion air pressures, pressures of P_{air} < 0.4 mbar and P_{burner} < 0.5 mbar may become necessary. This may lead to a drift in long-term mode.
Already small pressure changes may lead to a change in the O_2 content of flue gases.

To avoid these effects, the following initial conditions specified by DUNGS must be fulfilled:
- P_{air} = 0.4 – 100 mbar
- P_{burner} = 0.5 – 100 mbar

The effective pressures of $P_{air} – P_{CC}$ and $P_{burner} – P_{CC}$ must be taken into account.
If the above mentioned values are undershot, it may become necessary to perform tests for drift response.

Fig. 6

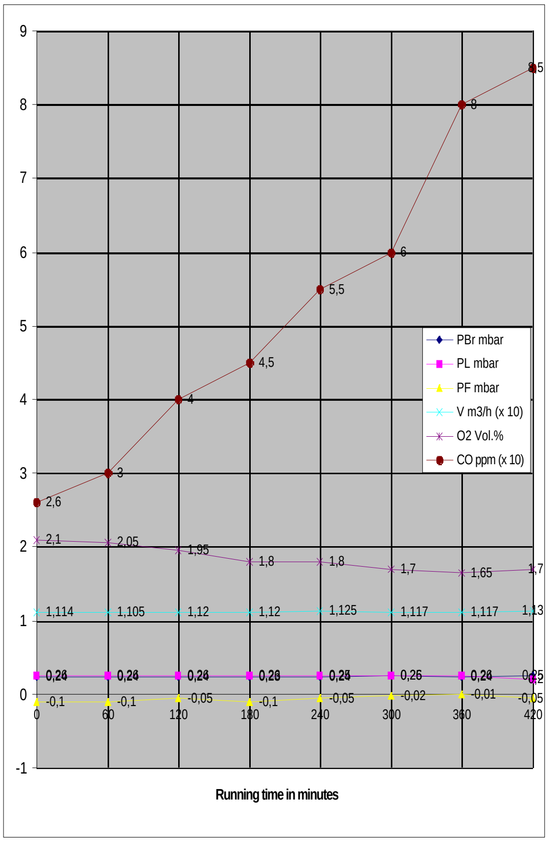


Fig. 7

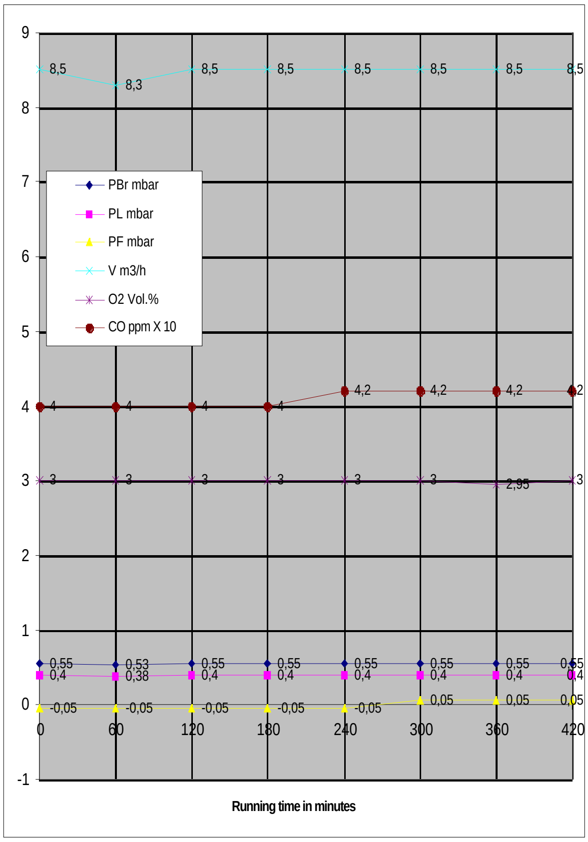
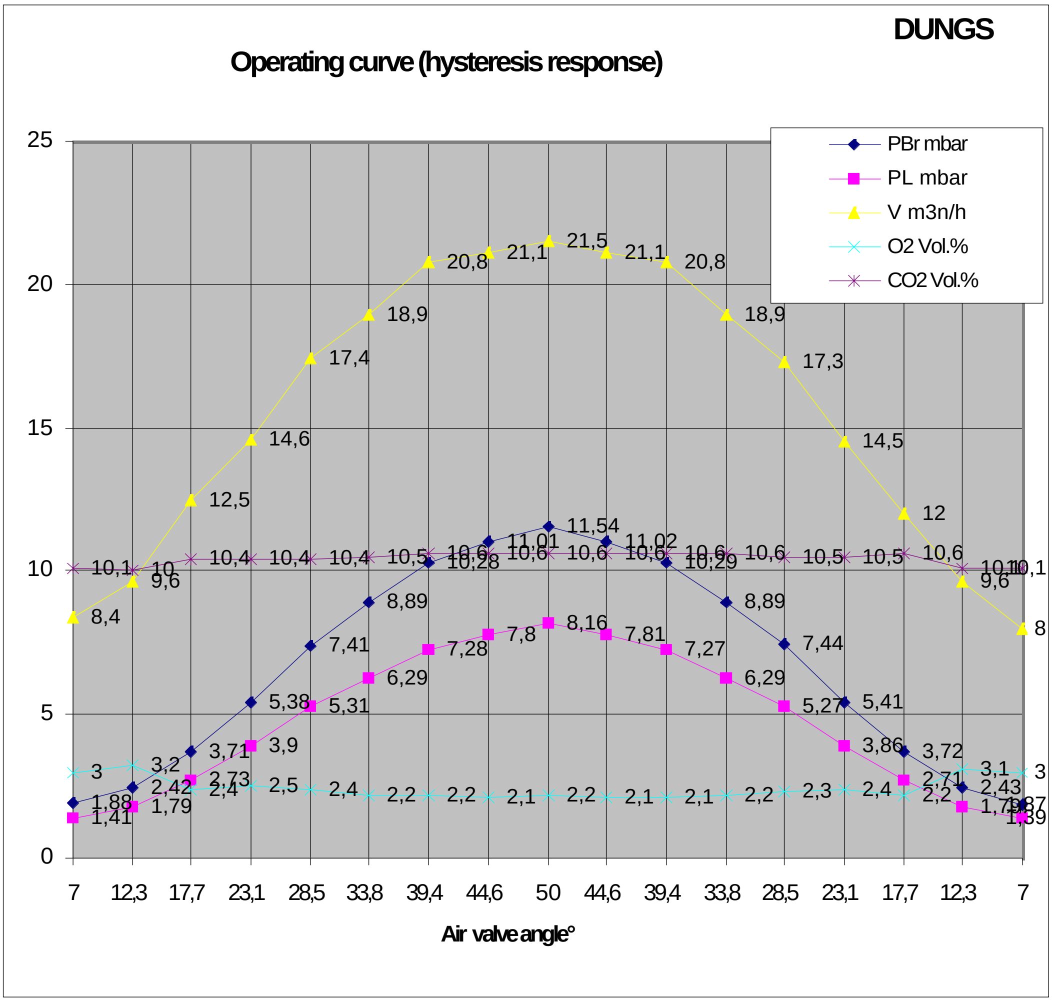


Fig. 6 shows a drop in O_2 from 2.1 to 1.7 vol.% within 420 minutes for a small P_{air} = 0.26 mbar. The gas volume increases from 11.14 m^3/h to 11,3 m^3/h.

As shown in Fig. 7, O_2 is not reduced at P_{air} = 0.4 mbar. The gas volume remains constant. This supports the specified minimum pressure of 0.4 mbar.



The question still remains whether a long-term minimum load mode with minimum gas volume is relevant in practice at all or if its only occurs in exceptional cases. Practice tests regarding such measurements must still be made.

6.2 Hysteresis response

To prove hysteresis response in increased and reduced burner mode, operating values are determined step-by-step (air value angle) over the complete modulation range.
It is important that comparable values, e.g. P_{burner}, P_{air}, O_2, gas volume, are present at the same air valve position in increased and reduced operating modes.

Fig. 8 shows that the operating values are properly met in increased and reduced operating modes. A stable guidance parameter P_{air} is displayed. It controls analogously assigned gas pressure values P_{burner} via the set ratio V. Combustion values (CO_2 and O_2) and gas volumes in the modulation range of the burner in the selected load stages conform in increased and reduced operating modes(see Fig. 8).

Hysteresis occurs, for example, when mechanical influences change ratio V in increased and reduced operating modes. Deviating combustion values and gas volumes would then result.

Fig. 8

6.3 Reproducibility

The reproducibility of the set values have been tested after several ignitions of the burner and in long-term tests.
Deviations from the settings do normally not occur.

7. **Summary**

The experience we gained from in-company analyses and application cases have shown that the gas/air ratio control s MB - VEF and DMV-VEF fully comply with the specified requirements.

In especially critical applications, we were able to adjust the controls in co-operation with the burner manufacturers to special requirements and thus achieve optimum results.

To set up the controls properly, you require special knowledge. If these specifications are fulfilled, you can set up a burner in a very short period of time.