

Gas booster systems in conformity with DVGW Code of Practice G620 – interpretation for use of a frequency-controlled booster

Burners in industrial thermoprocessing equipment or in combined heating and power plants require a minimum supply pressure. If the burner does not have adequate gas pressure available, owing to high pressure losses in the pipework for instance, this may necessitate use of a gas booster system. Use of such a system is the obvious choice particularly in the case of biogas plants, in which the process means that the gas pressure is very low, if a gas-consumption device – such as a CHP – is operated directly. Using a frequency converter in this case allows efficient operation and a broad control range. A compact design and delivery ready for connection mean that the operator receives a system that is matched perfectly to the individual operating conditions and that is ready for operation quickly.

Gas booster systems (hereinafter also abbreviated to GBSs) with an operating pressure of up to 1 bar (**Fig. 1**) and an operating power of max. 50 kW are designed and installed in conformity with DVGW Code of Practice G620. Code of Practice G497 applies in the case of higher pressures. Furthermore, all relevant Directives and Standards must be complied with. This includes, in particular, the Machinery Directive 2006/42/EC and the German Ordinance on Industrial Safety and Health (BetrSichV). The immission values of the German Technical Instructions on Noise Control (TA Lärm) and VDI Directive 2058, Sheets 2 and 3, apply in respect of reasonable noise pollution in the neighbourhood. On a general basis, GBSs may be connected, operated and modified only with the consent of the responsible gas utility company. They must be designed and operated so that they cannot cause any disruption to other consumers or public supply facilities (e.g. as the result of triggering of safety devices which lead to interruption of gas supply).

Fig. 1:

GBS packaged gas booster system, ready for connection



When planning, it is necessary, on a general basis, to differentiate between systems with a positive operating pressure up to 100 mbar and systems with a positive operating pressure exceeding 100 mbar (up to 1 bar):

Positive operating pressure up to 100 mbar

Booster systems with a positive operating pressure ≤ 100 mbar which are described in Point 2.1.1 of DVGW Code of Practice G620 may be installed in enclosed spaces, in the open air or in mines. They may also be installed in factory workshops, boiler rooms and similar rooms and spaces in which heating furnaces, annealing furnaces, smelting furnaces or continuous furnaces, for instance, are operated.

The room or space in which the booster system is installed must be adequately ventilated. This is guaranteed if, for instance, the unobstructed area of the non-closable intake and extract ventilation openings is at least 0.3% of the floor area.



Jens Kümper
Elster GmbH, Lotte (Büren)
Abt: Kromschröder
Systemtechnik

Tel. 05 41/12 14-310
E-Mail:
jens.kuemper@elster.com



Andreas Büscher
Elster GmbH, Lotte (Büren)
Abt: Kromschröder
Systemtechnik

Tel. 05 41/12 14-471
E-Mail:
andreas.buescher@elster.com

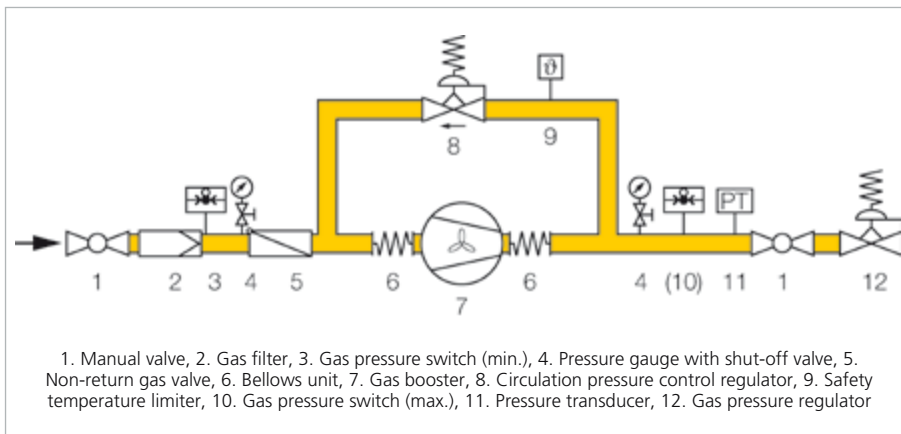


Fig. 2: Schematic view

The electric motors used to drive the gas boosters must comply with the DIN VDE regulations – in particular DIN EN 60034. The regulations of DIN EN 60439 must be complied with for the switchgear used.

Positive operating pressure exceeding 100 mbar (and up to 1 bar)

Gas booster systems with a positive operating pressure exceeding 100 mbar are described in Point 2.1.2 of DVGW Code of Practice G620. The following additional regulations apply in this case if it is not possible to install these gas boosters in the open air or in adequately ventilated factory workshops:

- The Explosion Protection Directive 2014/34/EC and the corresponding conformity assessment procedure must be applied.
- The gas booster system must be installed in separate, single-storey buildings, whereby solid ceilings are not permitted and a light-weight roofing must be provided.



Fig. 3: Circulation pressure control regulator VAR (KROMSCHRÖDER)

- If the gas booster system is installed in existing buildings or by constructing an annexe to existing buildings, open connections (e.g. doors or openings) to these buildings are not permitted. The room or space in which the gas booster system is installed must be directly accessible from the open air only.
- Doors may not open to the inside and must be blocked when open. Moreover, it must be possible to use routes leading to the open air at all times.
- Intake ventilation openings must be located at the lowest point and extract ventilation openings must be located at ceiling height. The unobstructed area of the non-closable intake and extract ventilation opening must be at least 0.3% of the floor area in each case. Transverse ventilation will generally be required.

The operator and the responsible monitoring authority, e.g. the Industrial Safety and Health authorities, are responsible for assessing whether an area in the open air or in an enclosed space must be considered as a potentially explosive atmosphere within the meaning of the Directives. In this case, the operator of the booster system must issue an Explosion Protection Document. We refer the reader to the "Guidelines on the Application of Directive 2014/34/EC", published by the European Commission, to supplement the wording of the Directive. Electrical devices in explosion-hazard rooms and spaces must be inspected annually by a qualified expert recognized by the employers' liability insurance association to ensure that they are in proper working order. The result of the inspection must be documented.

Gas booster systems Design

Two important points can be achieved if gas booster systems are planned professionally: running costs are reduced and environmental pollution is cut.

Since the booster is designed for maximum delivery, the gas volume must be controlled in response to demand. In the past when energy costs and energy consumption played a subordinate role, flow control was achieved by simple feedback of the excess amount of gas into the circuit – what is called circulation pressure control. In this case, the booster always runs at full capacity.

By contrast, using a speed-controlled booster allows flow control in response to demand by adapting the motor speed. This solution, which is technically optimal, is state-of-the-art and this is why it is to be the focus of what is said below.

Mechanical equipment

One of the aspects stipulated in the DVGW Code of Practice is the mechanical design of gas booster systems. It stipulates that the mechanical design of a booster system must meet the following minimum requirements (Fig. 2):

- Safety device which automatically prevents transgression of the permitted positive operating pressure (e.g. circulation pressure control regulator – Fig. 3).
- Shut-off valves at the inlet and outlet for separating the booster system from the rest of the installation.
- Safety device for shutting the system down if the pressure in the system drops below the minimum pressure stipulated by the gas utility company (e.g. pressure switch).
- A device which prevents abrupt release of the compressed gas volume towards the feeding network (e.g. a non-return gas valve – Fig. 4) must be fitted in the intake line.
- Pressure gauges must be fitted at the intake and delivery ends for checking.

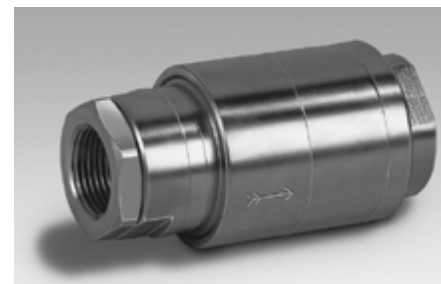


Fig. 4: Non-return gas valve GRS (KROMSCHRÖDER)

This design has basically not changed owing to the use of speed-controlled boosters. However, using mechanical safety devices may be re-interpreted. It has also proven expedient in practice to fit a gas pressure regulator at the delivery end (i.e. at the outlet end).

Gas pressure regulator

If a speed-controlled booster is used, the volume of gas pumped is adapted to the relevant amount consumed by the connected consumers by varying the speed. Due to the system design, this type of closed-loop control is subject to a certain degree of inertia. A sudden load change, e.g. as the result of connecting a further consumer, briefly causes a pressure drop. However, since the system pressure of the gas booster system lies above the required outlet pressure, the pressure regulator fitted at the outlet end can compensate for these fluctuations (Fig. 5). Consequently, the consumer has a constant gas pressure available over the entire capacity range.

Circulation pressure control regulator

In the reverse case, if the consumption is reduced by shutting down one or more consumers, this results in a pressure peak. This brief pressure surge is limited to a maximum permitted value (Fig. 5) by the circulation pressure control regulator until the closed-loop electronic control system responds by changing the speed. Even in this case, the connected consumers are supplied with constant gas pressure.

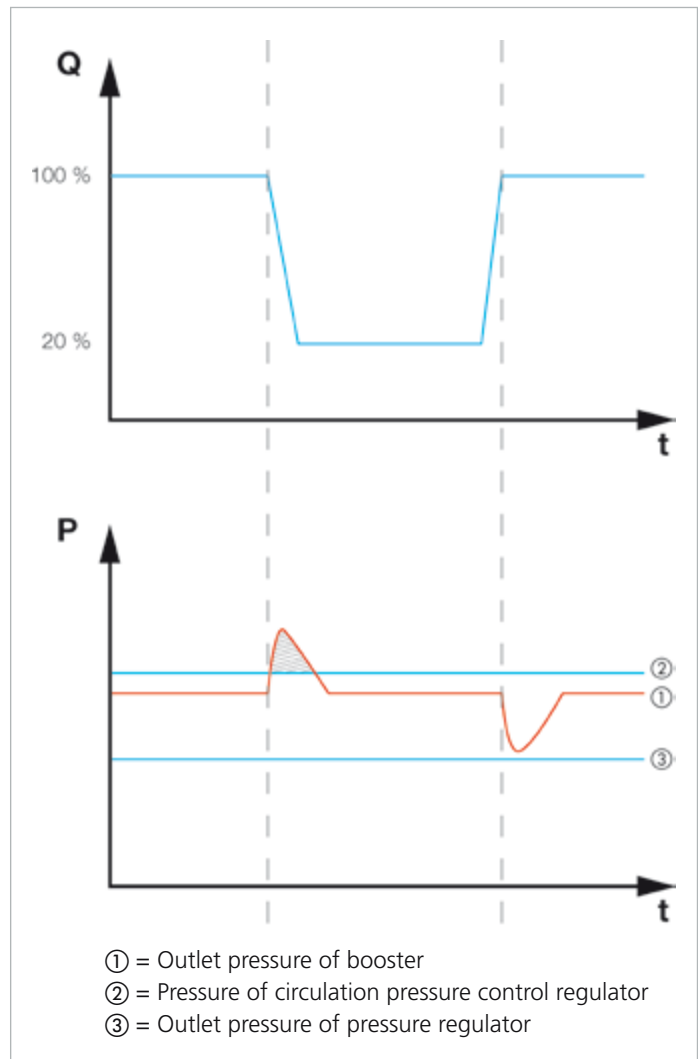
Non-return gas valve

As a general principal, it must be ensured that the gas pressure in the outlet of the GBS and thus also in the downstream pipework lies above the inlet pressure. When the system is shut down, this compressed



Fig. 6: MAPRO CL lateral duct booster

Fig. 5: Response behaviour in the case of sudden load change



gas must be prevented from being abruptly released towards the feeding network. Check valves or non-return gas valves (Fig. 4) are generally used for this.

Lateral duct booster

The booster itself is an essential part of the gas booster system. The obvious choice is to use lateral duct boosters (Fig. 6). They cover a broad capacity and pressure range. The pressure of the intake gas is boosted constantly and free of pulsations by a number of swirl sections and the utilization of centrifugal forces.

There is no friction since the rotating blades do not touch the housing, and this is why no lubrication is required either. So compression (boosting) occurs without contaminating the gas. Further advantages of a lateral duct booster are the low sound pressure level, vibration-free operation and, not least, the low maintenance effort required.

The manufacturer must guarantee "technical tightness" of the unit and certify it accordingly. This is achieved, among other things, by a double shaft seal and further design measures. Of course, the devices must be certified in conformity with Directive 2006/42/EC (Machinery Directive) and must comply with Directive 2014/34/EC (ATEX).

Control unit

The control unit is the central component of a gas booster system. It controls operation of the system and shuts it down in the event of a fault. The actual process of controlling the gas volume is performed by a frequency converter. The PI(D) controller integrated in the frequency converter receives its actual gas pressure value from a pressure transducer installed in the pipe. The control range is increased by adapting the electrical power to the volumetric gas flow rate currently required. One important advantage worthy of note at this point is the possible energy savings achieved by speed control.



Fig. 7: Status display of the control system

Fig. 1 shows the design of a gas booster system housing all control components required for safe operation of the system in a compact control cabinet, mounted on the system. The full-graphics, backlit multi-function display with its function keys is used for virtually all visualization and interactive operator-control functions. All operator-control actions and the system status are displayed graphically and in text form in corresponding menus. The user is provided with information on pressure setpoint and actual pressure, the current motor frequency and hours of operation of the unit (Fig. 7). The control unit performs monitoring and evaluation of signals relevant to safe operation (gas pressure, gas temperature, etc.). If the control unit detects a fault such as low gas pressure, an inadmissibly high gas temperature or a sensor error, the system shuts down automatically. The corresponding fault message is then displayed in plain text on the display.

The conceptual design of the control unit allows a high level of operational reliability and safety to be achieved. Downtimes are reduced to a minimum thanks to plain-text display of faults and the resultant fast fault clearance.

Commissioning, operation and maintenance

Commissioning, operation and decommissioning of a GBS must be carried out in conformity with the Operating Instructions enclosed by the manufacturer. These contain further information important for maintenance of the system. They also describe operation of the system and what to do in the event of faults in addition to fault-clearance procedures.

The system must generally be serviced once per year and as specified by the manufacturer. The shaft seals on the compressor in particular are subject to wear and must be replaced after max. 8,000 to 10,000 hours of operation – depending on manufacturer. The systems may be serviced only by the manufacturer himself or by qualified persons. All maintenance interventions must be documented in writing.

Summary

Gas booster systems are always used if the gas pressure applied to the consumer is not adequate. Individual planning and the use of a frequency-controlled compressor allow a large control range. Control ranges in the overall system of 1:20 are possible, depending on compressor type. Planning and installation work must conform to DVGW Code of Practice G620, allowing for other relevant Directives and Standards. Using optimally selected components such as gas compressor, circulation pressure control regulator and outlet pressure regulator in conjunction with a control unit which can be operated intuitively means that the operator has a system which fully meets his requirements and expectations as regards availability and efficiency.

Relevant Standards and Directives

- DVGW Code of Practice G 620: Installation of gas boosters with an operating overpressure up to 1 bar and power output up to 100 kW for gas-using equipment
- DVGW Code of Practice G 497: Booster systems – Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast) / replacing 98/37/EC (1998-06-22)
- Low Voltage Directive 2014/35/EC: Council Directive relating to electrical equipment designed for use within certain voltage limits.
- EMC Directive 2014/30/EC: Council Directive on the approximation of the laws of the Member States relating to electromagnetic compatibility
- Directive 2014/34/EC concerning equipment and protective systems intended for use in potentially explosive atmospheres (ATEX)

- VDI 2058, page 2: Assessment of noise in relation to hazard to hearing
- VDI 2058, page 3: Assessment of noise at the workplace taking various activities into account
- Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies (IEC 60439-1:1999 + A1:2004)
- DIN EN 60204-1:2005: Safety of machinery – Electrical equipment of machines – Part 1: General requirements
- DIN EN 730-2: Gas welding equipment – Safety devices – Part 2: Not incorporating a flame (flashback) arrester
- DIN EN 60034-1:2006: Rotating electrical machines – Part 1: Rating and performance