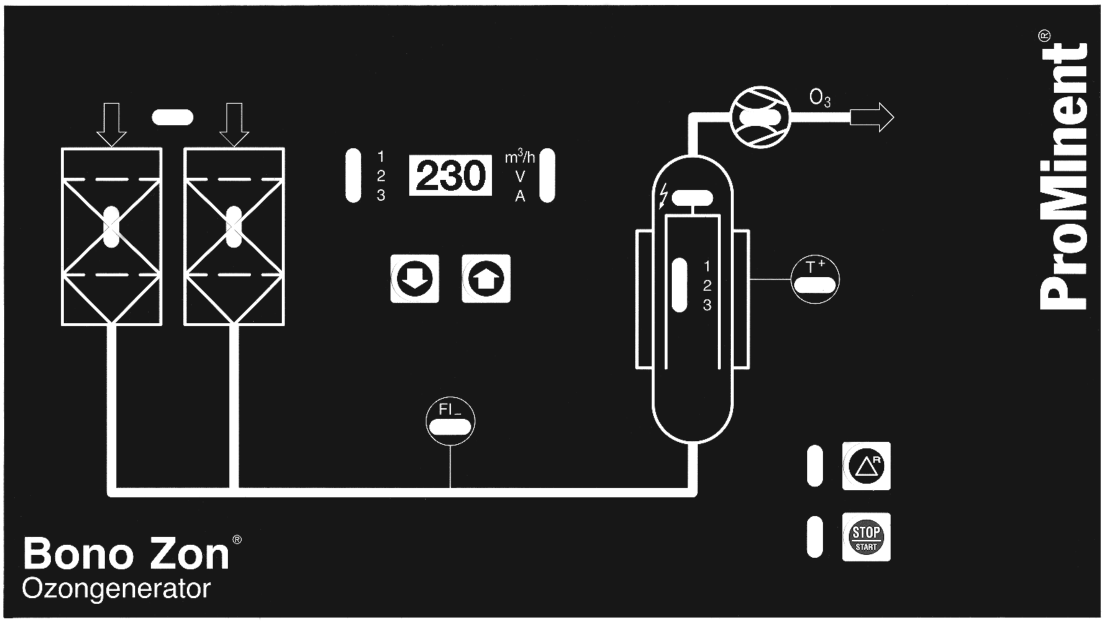
Operating Instructions
for Ozone Generating System
Bono Zon® Type BONa



BONa	___	___	A	___	1	___	___	T	___	___

Please enter identitycode of the device here.

Please read through these operating instructions in full before use. Do not discard!
Damage caused by incorrect operation will invalidate the guarantee.
The manufacturer is not liable for any damage caused by failure to follow operating instructions.

Legal notice:
Operating Instructions for Ozone Generating System
Bono Zon® Type BONa

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General user guidelines

Please read through the following user guidelines! They will help you to gain the maximum use from this manual.

The following are highlighted in the text:

- Numbered points

▶ Instructions

Operating instructions:

NOTE
Notes are intended to make your work easier.

and safety instructions:

DANGER

Describes an imminent danger. If not avoided could lead to death or extremely serious injury.

WARNING

Describes a potentially dangerous situation. If not avoided could lead to death or extremely serious injury.

CAUTION

Describes a potentially dangerous situation. If not avoided, could result in slight or minor injury to persons or property.

A Instructions for regulation use

A.a Regulation Use

Ozone generating systems are made only for the disinfection of water and may not be used for any other purpose.

NOTE

Ozone (O_3) decomposes during and after use to ordinary oxygen.

As a gas, ozone has a half-life of between 30-40 min., depending on the temperature. Dissolved in water, ozone's half-life is reduced to a few minutes.

The maximum allowable concentration at a place of work (according to German regulations) is 0.2 mg/m³.

A.b Non-regulation use

WARNING

Under no circumstances should ozone generating systems be used for the treatment of gaseous substances, liquids other than water, or for treating any solid material.

B Obligations of the user

This operating manual should be available to all supervisors and operating personnel and kept readily accessible near the ozone generating system.

The user must ensure that ozone generating systems are only used and operated by specially trained, expert persons. It is recommended to have operators confirm that they have been trained and introduced to the system.

The manufacturer should be notified immediately in the event of technical problems that could effect the health of persons having contact with water treated by the system.

After installation of the system by trained personnel, the system must be tested and approved for use by an expert authorised by ProMinent.

NOTE

The operator has the duty to create a working directive (including instructions for avoiding danger, and an alarm plan) taking into account the local conditions on site.

As further sources of information apart from the operating instructions manual, the following German directives of the main league of the trade associations and of the trade association of the chemical industry can be taken into consideration too:
a) ZH 1/474 "Directives for the use of Ozone in water processing"
b) ZH 1/262 "Specification leaflet 052 Ozone"

C Instructions for introducing operators to ozone generating system

It is mandatory that all chapters of this operating manual, especially those describing the ozone generating system and their commissioning be carefully read.

An expert from ProMinent must give operators a detailed introduction as part of the commissioning of the system.

This manual will provide enough information to answer almost all questions arising from malfunctioning. In addition, the user is responsible that extensions of the system, such as ozone transfer system, reactor tank, exhaust, etc., are properly maintained, and that environmental conditions are satisfactory for usage of an ozone generating system. Questions necessitating more detailed information should be addressed to the manufacturer of the system.

D Information on general safety

CAUTION

This operating manual is to be made available to all operating personnel and kept readily accessible near the ozone generating system (see section B).

D.a Relevant guidelines and regulations

Bono Zon® Systems are manufactured in compliance with the following regulations effective in Germany: "Ozon in der Wasseraufbereitung" (ozone in treatment of water) and the "Unfallverhütungsvorschriften" (accident prevention regulations) BGZ; ZH/471, 1994 edition.

CAUTION

When installing and using ozone generating systems, the following German regulations and ordinances or similar national regulations must be observed and the systems operated in accordance there of:

a) the "Unfallverhütungsvorschriften" (accident prevention regulations) – GUV 18.13 in the version of Oct. 1986.

CAUTION

§12 (1-5) prescribes personal protective gear that the user must provide.

b) the "Verordnung über gefährliche Arbeitsstoffe" (ordinance on dangerous working materials) (Arb-StoffV), in the version of 11 Feb. 1982 BGBl/p. 145.

D.b Requirements for starting components in the production of ozone gas in Bono Zon® BONa Systems

For process safety reasons, the dewpoint of the initial gas, the cooling water temperature and pressure must remain within the prescribed limits (see sections 8.1 and 8.2).

CAUTION

After finishing treatment of water for drinking purposes there may not be any impurities left in concentrations dangerous to human health. In this respect see “Gesetz über den Verkehr mit Lebensmitteln und Bedarfsständen” (act governing contact with food and public sale thereof) (Lebensmittelgesetz/Food Act).

Production within specifications other than those in Ch. 8 is permissible only with the expressed consent of the manufacturer.

D.c Additional information on safety

CAUTION

Any rooms in which the ozone generating system and the mixing station are placed must be locked when not in use. No persons may be allowed to remain in these rooms over longer periods of time. It must be adequately ventilated and protected against frost.

Rooms containing ozone generating systems must be separated by fire walls from all other rooms.

In case of accident:

Should ozone be emitted from the system, observe relevant safety regulations (see ZH1/474) when taking necessary action.

DANGER

The system must be installed in such a manner that ozone cannot be emitted into any rooms under any circumstances.

WARNING

In the event that water to be treated should fail to flow, it must be ensured that the feeding of ozone will be automatically stop.

The maximum allowable pressure for the system (see section 8.2) may not be exceeded under any operational conditions.

Disconnect all electric power when mounting system.

CAUTION

The complete system, including pipes, must be free of leaks at maximum operating pressure (see section 8.2).

Mount signs informing of danger according to GUV 8.15 Annex 2 and 3 (see also section D.d "Warning signs").

NOTE

The system may be operated only within environmental conditions specified herein (see Ch. 8).

The ozone system's reaction tank is covered by the pressure vessel directive. The operator is responsible for upholding the relevant directives.

D.d Warning signs

CAUTION

The following warning signs must be hung up during installation (see Ch. 3).

Warning signs

The following two signs must be placed together at the place of entrance to rooms used for Bono Zon® ozone generating systems..

Warning sign "Toxic Substances" Part no.: 607324

Warning sign "Ozone System. Access for Authorized Persons Only" Part no.: 740921

Warning sign "No Fire, Flame or Smoking" Part no.: 607323

E Emissions

During normal usage there are no emissions from ozone generating systems Bono Zon®
Type BONa. For further information on possible emission dangers, see section D "Information on general safety" and Ch. 8 "Technical speci-fications".

F Terms and abbreviations used

acc	according
approx.	approximately
BONa	ozone generating system
Ch	chapter
°C	degree celsius
fig	figure
g/m^3	grams per cubic metre
h	hour
Hz	Hertz (cycles per second)
kg	kilogram
l	litre
LED	light emitting diode
mA	milliampere
max	maximum
mg	milligram
mg/m^3	milligrams per cubic metre
min	minute
ml	millilitre
PLC	program logic control
PN	part number
PN 16	nominal pressure (DIN 8062, PVC pipes)
sec	second
tab	table
V	volt

1 Introduction

The use of ozone has undergone a history of ups and downs since its discovery (by Schönbein in 1840). In 1857 the ozone tube was invented by W. von Siemens. In 1873 Fox detected the germ-killing effect of ozone, necessary for the use of this substance in the treatment of water. At the turn of the century ozone was first introduced in waterworks for disinfection (at waterworks in Schierstein, Wiesbaden, Paderborn). The ozone process was slowly becoming accepted; the first large waterworks using ozone were constructed (Nizza in 1906, St. Maur, Paris in 1909, St. Petersburg in 1910).

In the 1920s, use of ozone was replaced by the more economical and technically simpler indirect chlorination. Although understood by then, the technological advantages of the ozone process were slowly forgotten.

It was only in the 1950s that the “old” procedure was rediscovered. It came back into use not only as a disinfectant, but also as an oxidation agent inside of treatment plants. At first it was used in drinking water treatment, then it spread to the production of mineral water, and in the 1960s it became part of swimming pool technology.

Today ozone is used in many areas of water treatment, in processing exhaust and sewage and as an oxidation agent in chemical reactions.

ProMinent recognised the significance of ozone technology very early and has been for years one of the leading manufacturers of small and mid-sized ozone systems. Above all, new standards have been set in the area of control technology and in the manufacturing of compact systems. The systems in the Bono Zon® and OZONFILT® product lines stand for modern ozone technology.

1.1 Ozone

1.1.1 Properties of ozone

Ozone is an energy-rich modification of oxygen. In concentrated form it is a noticeably blue gas that is about 1.5 times heavier than air. In the event of leakage, it can accumulate for this reason in rooms located at a lower level.

Characteristic is the smell of ozone (Greek: “ozein” - to smell), which is perceptible even in concentrations as small as 1 to 500,000. One notices the typical ozone smell often after powerful flashes of lightening or near frequently used copying machines.

Ozone can be used to oxidise many chemical compounds, and this can be utilised in the treatment and disinfection of drinking water, water for industrial use, swimming pool water and sewage.

A significant advantage of ozone as a disinfectant and oxidant is that it decomposes into oxygen, which is already present in water.

Ozone in a gaseous state has a half-life of between 30 to 40 min., depending on the temperature. When ozone is dissolved in water, its half-life is reduced to a few minutes.

DANGER

Ozone is poisonous! Concentrations of 10 g/m³ are life-endangering and lead to difficulties in breathing, irritation of the throat, unconsciousness within a short period of time.

The maximum concentration at place of work allowed by German regulations is 0.2 mg/m³.

1.1.2. Generation

Ozone is generated by silent electrical discharge. Using the ozonisator technique developed by Siemens, air is lead between the two poles of a high voltage field. The oxygen in the air is transformed into ozone in the presence of blue-violet light. Using common air as the input gas mixture, it is possible to reach concentrations of approx. 20-35 g ozone/m³.

Necessary conditions for the faultless generation of ozone are dry air free of dust and a satisfactory means of eliminating heat.

See fig. 1a: Principle of ozone generation and fig. 4: Mixing equipment.

The generation of ozone is influenced by the following factors:

- Volume flow of gas used (this also affects the concentration of ozone)
- high-voltage applied
- temperature of cooling water
- dewpoint of gas used

1.2 Definition of terms

1.2.1 Ozone system

Ozone system designates the entire system, including: ozone generating system (example: Bono Zon® Type BONa), mixing apparatus, reactor case and removal system for residual ozone.

1.2.2 Ozone generating system

The ozone generating system is that part of the system which actually serves to generate ozone. This includes air treatment, ozone generator and electricity control.

1.2.2.1 Ozone generator

That part of the system in which the ozone generating elements are built (in the case of BONa-systems, 14 or 19 glass tubes with internal high-voltage electrodes). The ozone generator is kept at operating temperature by the cooling water.

1.2.2.2 Ozone generating element

Glass tube in which air is subjected to silent electrical discharge. Inside the glass tube is the high-voltage electrode; ozone forms between the side of the tube and the electrode.

1.2.3 Mixing station

The mixing station is that part of the system in which gas coming out of the ozone generating system is mixed with water. In standard models, the mixing station consists of mixer housing, injector, booster pump and necessary accessories.

Note that use of the oxidising power of ozone depends on how much of the ozone goes into solution. The mixing is accomplished in Bono Zon® Systems by way of an injector utilising the principle of partial currents (approx. 90 % efficiency). Basis for a correct estimation is, among other things, the total volume flow of water, the size of the ozone dosage and the pressure at the point of dosage (mixer housing).

1.2.4 Reaction tank

The reaction with material in the water takes place in the reaction tank. The tank is situated at the end of the mixing process, provided that the introduction of ozone and its reaction does not take place in the same part of the system. Furthermore, air enriched with ozone is separated again in the reaction tank from the flow of water and emitted as exhaust.

1.2.5 Removal system for residual ozone

This is the part of the system where ozone not used in the reaction decomposes.

1.2.6 Partial-vacuum system

In the case of partial-vacuum systems (e.g., Bono Zon® Systems Type BONa), ozone generators and lines directing the flow of gas with ozone are subjected to a partial vacuum up to the place of mixing. In this way the discharge of ozone through possible leakage is prevented.

1.3 Functional description of ozone generation

Bono Zon® Ozone Generating Systems, Type BONa, generate ozone in a partial vacuum, using oxygen taken from the ambient air. The input gas (ambient air) is drawn through the ozone transfer system, dried and purified in the air treatment system. It then passes through an air flowmeter and reaches the ozone generator. Here ozone is generated by silent electrical discharge and passes on to the mixing station.

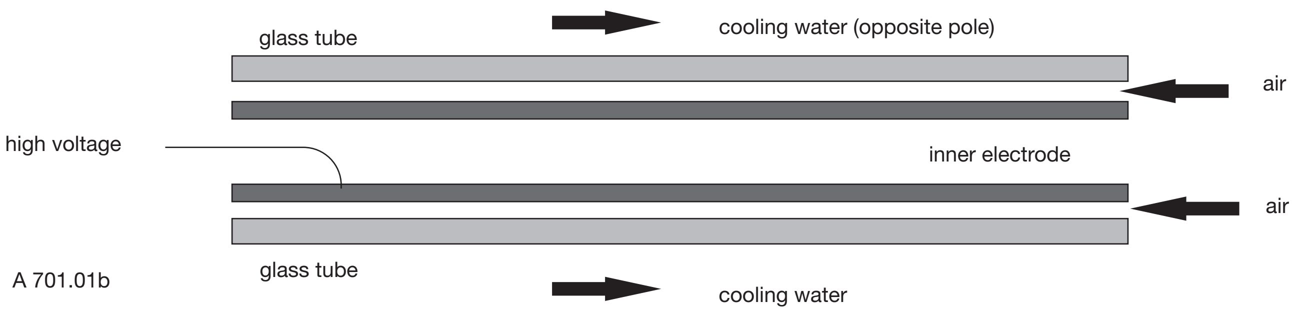


Fig. 1a Principle of ozone generation in the BONa XA (X = 1, 2, 3, ... 9) systems with PVC generator

2 Construction of a Bono Zon® ozone generating system

NOTE

All Bono Zon® ozone generating systems are built conforming to current German regulations. We strongly recommend reading the corresponding regulations which govern operation in your country.

Bono Zon® ozone generating systems consist of three components:

- air treatment system
- ozone generation
- electricity control

In the case of small systems, all components are housed in a standard control cabinet. Larger systems are distributed into several cabinets. The construction principle is the same for all systems.

See also fig. 2b: Construction of a Bono Zon® ozone generating system (appendix).

These systems are listed as partial-vacuum systems and conform to the highest safety standards. By way of electronic control (SPS), all processes can be monitored. This makes early error detection possible, protecting the user against expensive repairs and lengthening the lifetime of the system considerably. By way of built-in automatic adjustment of ozone production, certain models make continuous adaptation to particular needs possible.

2.1 General series structure

The product line BONa begins with 40 g/h ozone output. Maximum level per ozone generator is 80 g/h. This results in the following product line:

BONa 1 B	40 g ozone per hour
BONa 1 A/D	80 g ozone per hour
BONa 2 C/E	120 g ozone per hour
BONa 2 A/D	160 g ozone per hour
BONa 3 A/D	240 g ozone per hour
BONa 4 A/D	320 g ozone per hour
BONa 5 A/D	400 g ozone per hour
BONa 6 A/D	480 g ozone per hour
BONa 7 A/D	560 g ozone per hour
BONa 8 A/D	640 g ozone per hour
BONa 9 A/D	720 g ozone per hour

Apart from ozone output, other system features may vary, depending on the model:

- setting the ozone output is carried out continuously by way of the adjusting knob of the regulating transformer, or automatically by way of a motor-driven variable-voltage transformer. The latter is triggered by an ozone online sensor (or redox detector) connected to a controller.
- Power and power protection of booster pump integrated in the control cabinet.
- Supply voltage: 230/400 V
- Power frequency: 50 or 60 Hz

An identcode (identification code) has been introduced to clearly define the system characteristics.

See identcode for BONa systems, fig. 6 (appendix).

2.2 The air drying system

The ozone system is designed with a two-stream adsorber drier and hot air regeneration, which enables continuous ozone generation.

The adsorber drier system is designed for a rel. humidity of 60 % at 30 °C. Short-term overload of the drier system caused by weather conditions poses no problems. Higher temperatures and / or higher humidity over a longer term are to be avoided. The air intake must be pre-treated or taken from another room in this case.

Care should be taken to ensure that the warm, humid exhaust regeneration air does not cause any change to the specified ambient climatic conditions. Otherwise air must be diverted out of the installation room via special valves.

The air-drying system is designed as a two-stream adsorber drier system (Fig. 1-3). The process air is passed through a desiccant. The desiccant adsorbs the moisture from the air and the resulting dry air can then be used for ozone generation. The heat produced by the adsorption is driven off by convection. From adsorber size I 250 K) (BONa 2), cooling is fan-assisted. Generally, one adsorber drier is in operation while the second is regenerated. A light on the adsorber is lit green when that adsorber is in operation Fig. 3-3.

The operating and regenerating times are fully automated and controlled by the control. The regeneration time depends on the amount of moisture stored in the adsorber.

After the operating period has finished (maximum 16 hours) the system automatically switches to the second adsorber while the first is regenerated. Regeneration is achieved by blowing hot air back through the desiccant. The regeneration fan (Fig. 2 b-22) forces the air into the lower section of the adsorber where it is heated before reaching the desiccant. The temperature of the regeneration air is controlled by a thermostat and the heater is switched on and off accordingly. The LED, Fig. 3-1, is lit green during the heating phase of the regeneration.

Regeneration ends when the temperature reaches the upper thermostat switching limit in the top section of the desiccant. The duration of the heating phase is limited. If the upper thermostat switching limit is not reached within the specified time (maximum: 7 hours) the system registers a fault, LED Fig. 3-1 lights up red.

Once complete, regeneration is followed by the cooling phase. This lasts 9 hours. The LED Fig. 3-1 flashes green throughout this period. Once the cooling phase is over the control switches to the just-regenerated adsorber.

2.2.1 Starting regeneration - manual

Regeneration can be started manually using the yellow pushbutton in the open door of the control cabinet. To start the regeneration process, press the yellow button, close the door of the control cabinet once more and then press the “Reset error” button, Fig. 3-13.

2.2.2 Pausing regeneration

Press the yellow push button to pause regeneration. The LED Fig. 3-1 then lights up red.

In case regeneration is interrupted before reaching the breakthrough temperature, the adsorber cannot be placed in operation again.

2.2.3 Starting regeneration after manual interruption

After regeneration has been interrupted, it can be started again by repeatedly pushing the yellow button. After push-ing the yellow button, close the door to the control cabinet and push the “failure re-set” button (fig. 2-13). The regeneration process will continue until the heating phase is finished.

In case the breakthrough temperature has not been reached, the heating phase can be repeated by pressing the yellow button.

2.3 Ozone generation

The ozone is produced in the ozone generator (Fig. 2b-1). The ozone generator comprises individual ozone generating elements with external glass tubes containing high voltage electrodes. The air required to produce the ozone is fed between the glass tubes and the metal electrodes (see Fig. 1a). A high voltage alternating current is applied to create a corona, by which means part of the oxygen in the air is transformed into ozone. The discharge voltage can be altered by the regulating transformer to adjust the performance of the ozone system.

2.3.1 Cooling water

The cooling water flows through the ozone generator from the bottom to the top (Fig. 2 b-13, 14). The specified flow is monitored by a float and orifice-type flow monitor with a latching contact. A thermostat monitors the temperature of the cooling water. Water used as cooling water should be clean (in accordance with specification) and have a max. temperature of 25 °C . A higher temperature will lead to a reduction in the ozone generation. In this case, the operator should contact the manufacturer.

Cooling water should be available at a minimum pressure of 1.5 bar. Special cooling water pipework is necessary for lower pressures. The flow of cooling water is regulated by way of the corner valve (fig. 2b-11). If several ozone generators are present in the system, then each generator has its own corner valve. The same amount of cooling water must flow through each generator.

The stop valve and the pressure regulator are to be added upstream from the cooling water connection. A filter should be fitted upstream if cooling water is contaminated.

A solenoid valve is located upstream from the corner valve (fig 2b-12). As soon as ozone generation shuts down, this valve closes automatically.

2.3.2 Air flow meter

A temperature-compensated mass flow meter in the bypass serves as an air flow meter. It is connected to a perforated disk in the main airflow line between the adsorber drying facility and the ozone generator (fig. 2b-16, 17). The flow of air is measured electronically and shown in m^3/h in the display. Calibration of the sensor and setting of the minimum contact are made in the factory.

Should the flow of air fall below the minimal setting, then the system switches to the failure-mode (LED fig. 3-6, red).

2.4 Electrical part of system

The electrical components (regulating transformer, high voltage transformer and the power section with the motor safety switch) are housed in the control cabinet. The power section (see fig. 2b-2, mounting plate assembled) varies according to the size of the system. This section contains the main protection, the safety switches for the regulating transformer and the high voltage transformer and also for the heating, rotary current motor and the control transformer.

2.4.1 Control

On the inside of the door are the following: the control, auxiliary relays and operating panel with controls and display reading.

2.5 Setting of ozone generation

Before using the start/stop button (fig. 3-14), the interlocking contact (see 2.9.1) must be closed and the main switch turned on. Press the Start/Stop button (Fig. 3-14) to switch on the booster pump and the ozone generator after a delay period has elapsed.

2.5.1 Manual setting of ozone generation (for Type BONa xx xSx-...)

Set the ozone generation using the adjusting knob of the regulating transformer (fig. 2b-5). Ozone generation begins after the ionising voltage is reached. This can be observed by way of the varying readings of the current and voltage indicators.

The regulating transformer (Fig. 2 b-5) is used to adjust the high voltage and alter the system's ozone output.

2.5.2 Automatic setting (for Type BONa xx xRx-...)

In this model, a controller built into the door operates the variable-voltage transformer.

The variable-voltage transformer is set via a motor actuator.

The electronic circuit is designed so that the system runs down when stroke control motor is switched off by the controller.

The operation of the controller is described in the operating instructions DULCOMETER® D1C, part 2, measuring value ozone. However, only some functions are available. A new feature is the simplified manual operation described in 'manual settings'.

The defaults were specified such that in condition as delivered the ozone generation may be set manually without necessitating any modifications. For all other modes, the D1C is to be programmed correspondingly. This requires, however, that the operating menu of D1C is switched from "restricted" to "complete".

Operating functions available:

2.5.2.1 Manual setting (condition as delivered)

Set display at controller to PERMANENT DISPLAY 2 using the button "change display". Set desired value pressing buttons ↑↓ (e.g. 60 %) and acknowledge using "ENTER". The value will then be accepted as regulated value and the variable transformer adjusts to this value when the system is switched on. Note that the percentage of the regulated value in the range of approx. 30-100 % refers to the ozone performance and not to the position of the variable-voltage transformer.

When the system is switched off, the variable-voltage transformer adjusts to zero; when the system is switched on again, the preset value is again adjusted.

2.5.2.2 Ozone metering proportional to the input signal (e.g. flow-proportional ozone metering)

a) Input signal 0...20 mA (condition as delivered):

This function is realised as follows: In manual operation, the input signal is added to the regulated value set to zero as feed forward control. This requires the following operation steps:

Connect signal to terminal feed forward control nominal signal (on the terminal strip “ozone control”: x 0.1). Set display at controller to PERMANENT DISPLAY 2 using the button “change display”. Set the manual setting value “M” to 0 % by pressing the buttons ↑↓ and acknowledge by pressing “ENTER”. The value will be accepted as regulated value and the variable transformer adjusts to zero. A base load may also be set. The signal line is applied to the feed forward control nominal signal (on the terminal strip “ozone control”: x 0.1). An incoming signal will be added to the manual setting value (=0); the incoming value is equal to the regulated value. An evaluation of the input signal may be performed in the menu ‘servo motor’ through modifying the parameter ‘control range’ (only possible in the complete operating menu).

b) Input signal 4...20 mA:

Set the operating menu in the menu “general settings” to ‘complete’ and then “4...20 mA” in the menu ‘feed forward control’. Connect signal cable to terminals “standard signal disturbance value”. For further steps see a).

c) Input signal frequency 0...10 Hz or 0...500 Hz:

Set the operating menu in the menu “general settings” to “complete” and then to “10 Hz” or “500 Hz” in the menu “feed forward control”. Connect signal cable to terminals “disturbance frequency”. (For further steps see a).

2.5.2.3 Controlled ozone metering

Connect DULCOTEST® ozone measuring cell or other sensors to terminals “measuring value input”. Set the operating menu in menu “general settings” to “complete”, then set the measuring range in the menu “measuring value” to the corresponding signal transmitter. If a DULCOTEST® measuring cell is used, this cell is to be calibrated. Set menu “control” to “control normal” and modify the control parameters, if necessary. With regard to controlled metering, base load metering and feed forward control (addition and multiplication) are possible.

2.5.2.4 Interval function

A remote contact is to be connected to the terminals “input pause”. By opening the contact, the variable transformer can be ramped down remotely. This function is available with all described operating functions.

Basic settings of the controller built into the ozone generating system in condition as delivered:

Calibration:	not calibrated
Measuring value range assignment:	0 mA = 0 ppm 20 mA = 2 ppm
Measuring value control time:	OFF
Limit 1:	lower: 0.1 ppm
Limit 2:	upper: 1.0 ppm
Hysteresis limits:	0.04 ppm
Control time limits:	OFF
Servo motor:	OK
Metering:	O_3
Range of regulatet value:	0-100 % of operating range
Control:	regulatet value positive O_3
Control:	manual
Manual metering:	0 % of range of regulatet value
Feed forward control:	0...20 mA
Feed forward control nominal value:	20 mA
Feed forward control, disturbance effect:	additive
Feed forward control, max. additive d.:	100 %
Standard signal output:	measuring value, 0...20 mA 0 mA = 0 ppm 20 mA = 2 ppm
Identcode:	D1CAD0Z10111Z020D
Alarm relay:	active
Operating menu:	language according to customer, limited version

2.6 High voltage transformer

Reactive power compensated, multiple-immersed dry transformers with separate windings are used to generate high voltage (fig. 2b-7).

NOTE

High voltage transformers for the type of use required by Bono Zon® Systems are sensitive to moisture condensation. For this reason, a dry room should be set aside for the operation room. This problem area is less significant as long as the system is in continuous operation. Re-starting after an interruption is critical.

2.7 Indicators during operation

LEDs used are one-coloured or two-coloured (green/red). They can light up continuously, blink slowly or rapidly, depending or operational conditions or malfunction. LEDs come in pairs to prevent possible failure of an indicator.

During normal operation the following LEDs light up:

- LED system in operation (fig. 3-15), green
- Adsorber in operation (fig. 3-3), green
- Adsorber in regeneration (fig. 3-1); if the LED in fig. 3-1 is lit up, then the adsorber whose LED is not lit up (fig. 3-3) is in regeneration
- Adsorber in cooling-off phase: LED in fig. 3-1 blinks slowly green
- Display reading: can be switched back and forth to show different readings (green LED), air flow, primary voltage, or current (primary of high voltage transformer)
- Booster pump under voltage, LED in Fig. 3-8, green
- LED (fig. 3-17), green; operation indicator of electric circuits
- LED in fig. 3-16, green; indicates from which electric circuit the current and voltage values are shown; for BONa 1-3 always LED 1.
- LED in fig. 3-18 off

2.8 Monitoring systems

The following functions are monitored by the control:

- switch cabinet doors closed
- operational condition of regeneration blower, booster pump and high-voltage transformer
- operational air flow
- adsorber switching (after expiry of cooling phase)
- cooling water temperature, max.
- cooling water flow, min.
- mains power failure
- interlocking contact open
- current consumption of ozone generating system
- temperature of high-voltage transformer

In the case of error recognition by the control, the system shifts automatically into the failure mode, and the LED (fig. 3-12) lights up yellow. The cooling water is shut off, the power supply to the regulating transformer and the high voltage for the ozone generator are shut down.

If the function “Autoreset after mains power failure” is activated, the control will only register the mains power failure as a fault (LED in Figure 3-18, flashing yellow); it will not shut down the plant. Activation of the fault indicating relay will not take place.

A corresponding red signal lamp in the operational panel indicates the source of the error. At the same time the contact at the collective error message unit opens, so that the failure can be reported further.

After the error indicated is found and corrected, the system can be set back in operation by pressing the button (fig. 3-13).

2.8.1 Interlocking contact for ozone generation

The ozone system has an external interlocking contact. This contact interlocks the system with the current of water. If, for example, there is no flow of water to be treated with ozone, then the ozone system must be shut down by way of the interlocking contact.

Ozone generation shuts off when the interlocking contact is opened; the power supply to the booster pump stops and the solenoid valve in the cooling water line closes.

A regeneration cycle which has just finished is not interrupted.

This contact can also be used in connection with a gas detector or an emergency cut-off switch.

2.8.2 Door contact switch

If cabinet doors are opened while the main switch is on, then the system turns off automatically and goes into the failure mode; the LED (fig. 3-12) blinks rapidly (main protection open). After closing the door, the system can be placed back into operation by pressing the button “reset after failure” (fig. 3-13).

2.8.3 Emergency switch

In accordance with German safety regulations, it must be able to shut down ozone generation using an emergency command device (emergency cut-off switch). The emergency command device must be located in an easily accessible place near the door to the ozone system room and clearly designated.

Connection of an external emergency cut-off switch is already provided for all Bono Zon® Systems (see flow diagram for connection; remove jumper in the terminal strip).

The main protection opens when the emergency cut-off switch is used; at the same time the ozone system is closed down:

- cooling water solenoid valve closes
- solenoid valve air treatment closes
- LED fig. 3-12 (yellow) blinks rapidly.

CAUTION

Opening the door while the system is running, or turning off the main switch or the emergency cut-off switch can lead to excessively low pressure since the injector water flow does not break off immediately. None of these steps should be taken (except in emergency) before the system has been stopped using the start/stop button.

2.9 Stainless steel ozone generator

2.9.1 Definition

Systems with PVC generators are identified as type de-scription BONa x**A** (x=1-9, 80 g/h generator), BONa x**B** (x=1, 40 g/h system) or BONa x**C** (x=2, 120 g/h system).

Systems with stainless steel generators are identified as type description BONa x**D** (x=1-9) or BONa 2**E** (120 g/h system).

Versions A and C of the ozone generator are identical, as are types D and E. In the 120 g/h systems these generators operate at reduced high voltage.

2.9.2 Structure and function

The stainless steel generators (type D and E) have a nominal capacity of 80 g/h. The mounting and connections are designed to allow retrofitting into a BONa xA type system.

Stainless steel generators (types D and E) are made up of 19 ozone generating elements. The cooling water flows into a closed, pressure-tight stainless steel sleeve and has no direct contact with the dielectric. The air is fed into the dual sleeve system from above. The ozone outlets from the bottom.

2.9.3 Cooling water

Water used as cooling water must be clean and free from suspended solids (in accordance with specification). To minimise the risk of corrosion the chloride content must not exceed 250 mg/l.

The ideal temperature is between 10 and 15 °C. A cooling water flow of approx. 100 l/h is required per stainless steel generator. If the cooling water temperature increases it may be necessary to increase the flow up to 300 l/h.

If temperatures exceed 20 °C the generator's current consumption can also increase.

If cooling water temperatures are very high it is necessary to limit the max. current consumption of the ozone generator at the control transformer (automatic BONas, RS types, by reducing the setting range at the controller).

To adjust the cooling water for several generators, open all corner valves and set the flow by adjusting the priming pressure at the pressure release valve.

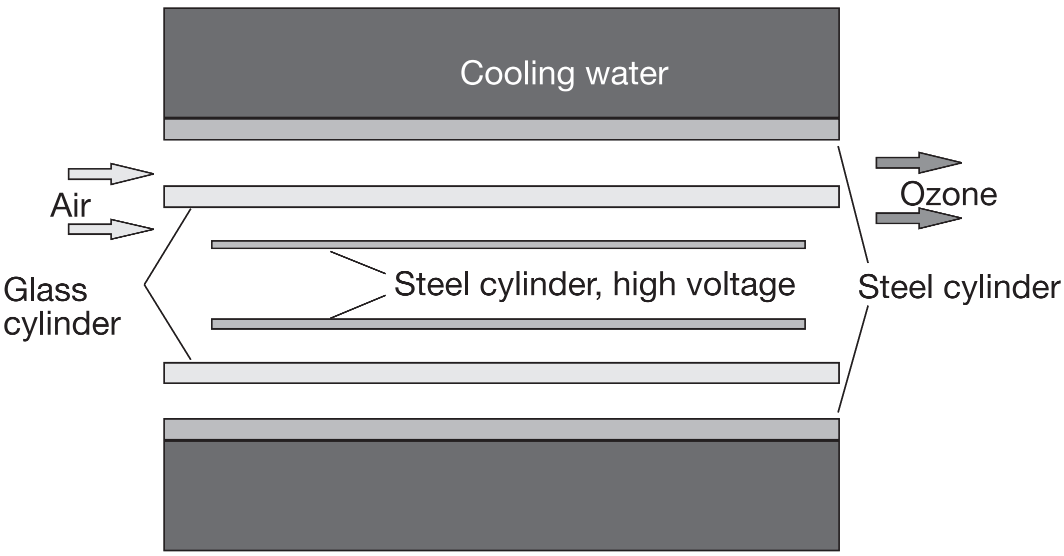


Fig. 1b Stainless steel ozone generator: Principle of ozone generation

3 Assembly and installation

NOTE

Please also read through the comprehensive instructions in the separate document: "Instructions for the installation of ProMinent BONa Ozone System"

3.1 Operation room requirements

Ozone systems must be set up in closed, lockable rooms. Machine rooms and operation corridors around swimming pools, for example, are possible locations. Rooms used for ozone systems should not be permanent places of work for any personnel. In case persons must nonetheless work in these rooms, ozone concentration in room air may not exceed a MAK-level of 0.2 mg/m^3.

A number of electrical devices are used in ozone generation systems that place minimal requirements on the operation room. The room must correspond to the protection mode of the system. The lifetime of electrical working equipment is increased by temperatures under 30 °C and by a relative humidity of less than 60 %. The air in the operation room should be free of dust. Aggressive types of gas in the environmental air must be avoided. Effective ventilation and exhaust must be provided.

The ozone generating system has to be installed vibration-free.

Concerning safety regulations, these are dealt with in the current "Regulations for the Use of Ozone for Water Treatment" (GUV 18.13 and ZH1/474), which at this point must be particularly emphasised.

An information sign is included with the system: "Ozone System. Access for Authorized Persons Only". This sign must be attached to the entrance to the room in which the BONa System is installed.

Observe local regulations if installing outside Germany.

3.2 Setting up the system

Set up the control cabinets of the ozone system and the air treatment system on a flat and horizontal surface. A sensible place for the system is on a separate base (protection against water). If the system consists of several cabinets, these should be bolted together with the connecting elements included, and the pre-assembled electrical cabinet elements joined together (see flow diagrams, terminal strip and cable designation).

3.3 Cooling water connection

Now connect the feeding pipe for the cooling water, as well as the stop valve and pressure regulator included (fig. 2b-8, 2b-9, 2b-10).

The minimum pressure should be 1.5 bar. Pressure surges must be avoided. The pressure reducer must be set between 0.5 and 1.0 bar.

The float and orifice flow monitor (supplied) is installed in the cooling water line.

NOTE

The cooling water outlet must be earthed in situ.

3.4 Waste water connection

The connection for waste water can be found on top of the generator cabinet (fig. 2b-21). The waste water line should be laid in such a way that excess pressure cannot develop. The water should be led openly without pressure to a container or into the sewer. If the water is directed upwards, then the vertical distance may not exceed 5 m. Choose the nominal diameter of the lines in accordance with the nominal diameter of the connecting pipe. Lay a line one size larger, if the length of the line exceeds 20 m.

NOTE

No armatures may be built into the waste water (cooling water) line. Lay the waste water line as shown in fig. 5.

3.5 Ozone line connection

Thick-walled and high-quality material is to be used for the ozone line, e.g. PVC hard (Specification Georg Fischer) of pressure stage PN 16.

CAUTION

An effective means of preventing a water return-flow must be installed in the ozone gas line (see Fig. 4). The ozone feed system is supplied as standard with two non-return valves for this purpose. These are installed inside the gas line near the injector before and after the stop tap (Fig. 4-10). The diameter of these valves can be either DN 10 or DN 40 depending upon the system type.

The system is also supplied as standard with a third non-return valve, which is installed in the hydraulic seal (Fig. 4-6). The diameter of this valve is DN 20 for all system sizes. Before installation, the grey non-return valve ball contained inside the valve (not floating) should be replaced with the green or white valve ball (floating, also supplied). The valve should be installed with the arrow on the valve pointing downwards.

Gaskets in system parts that convey gas containing ozone must be built out of material able to withstand ozone. Natural rubber (India-rubber) is destroyed by ozone. EPDM has proven itself in practice; these seals, however, must be inspected regularly as part of the year's maintenance and replaced if necessary.

The ozone gas lines must be free from tension and vibration-compensated as PVC perishes over time and loses its inherent elasticity.

3.6 Electrical connections

CAUTION

Assembly of electrical connections to the ozone generation system may only be made by a qualified electrician.

The following connections must be carried out according to the flow diagrams:

- power supply connection
- booster pump connection
- water treatment lock
- control lines for automatic operation (if used) of the system
- connection of error message lines to outside (if foreseen)
- assemble and connect emergency cut-off switch
- gas detector if foreseen (see sec. 2.9.1)

NOTE

Secure the power supply in accordance with the flow diagram.

4 Commissioning

WARNING

The system uses high voltage to produce ozone, a gas. Security requires that the system only be operated or serviced by a qualified expert. Manipulation of the system may cause extremely danger-ous high voltage arc-over or cause poison-ous gas to escape.

Qualified experts are persons who as a result of expert training and of experience are sufficiently knowledgeable in the area of ozone generation and familiar enough with relevant government regulations for protection of labour, for prevention of accidents; with regulations and generally accepted technical prescriptions (e.g., DIN standards, VDE instructions), so that they are in a position to judge the working safety condition of ozone systems.

Only persons trained and authorised by ProMinent qualify as experts for BONa Systems.

NOTE

Any interference by unauthorised persons invalidates the guaranty claim in its entirety.

4.1 Inspection before commissioning

4.1.1 Inspection by expert

CAUTION

Before the commissioning the ozone system, an expert must inspect the system to ensure that it is in proper condition. This inspection is to be repeated yearly; for this reason a maintenance contract is recommended. Work on the ozone system should only be carried out by qualified persons on the instruction of the employer.

4.1.2 Checks to be carried out before commissioning

- Have pipe connections been correctly laid and checked for leakage
- Ozone gas line
- Cooling water connection
- Pressure regulator installed in cooling water line
- Cooling water outlet properly laid (see fig. 5)
- Water backflow check installed in ozone gas line and able to function (see fig. 4)
- Residual ozone gas eliminator correctly installed
- Fill hydraulic seal (fig. 4-6) with water
- Fill syphon in front of active charcoal filter with water (see fig. 4-H)

CAUTION

Disconnect main switch (fig. 2b-4) before leadthrough and inspection of electrical connections.

- Have all electrical connections been made correctly (see flow diagram)
- 380 V 4-pole power supply:
  - Retain built-in bridge between ground (green/yellow) and neutral wire
- 380 V 5-pole power supply:
  - Remove built-in bridge, otherwise FI-safety switch may be activated, should one be connected
- Connect booster pump in control cabinet

- Is the system earth connected to each ozone generator
- Check motor safety switch for booster pump and set rated current of booster pump accordingly
- Has the interlocking contact been connected so that ozone generation can only take place with water flow available (water treated by ozone)? See flow diagram: "external locking, e.g., circulating pump"
- Set control on regulating transformer (fig. 2b-5) to zero
- Turn on main switch (fig. 2b-4)

4.1.3 Work on open ozone cabinet

NOTE

In order to work on open ozone cabinet, the door contact switches must be bridged over. This work may only be carried out by a qualified expert. After this work is finished, the door contact switches must be set back without exception into a functioning position.

- Is the connection on the primary side of the control transformer correct? The input may have to be adjusted to the local power supply. The voltage can be corrected by changing the connections of the primary on the transformer.
- Do the fan and the booster pump turn in the right direction? (press briefly the corresponding protection). The fan must turn in the direction shown by the arrow on the housing.

4.1.4 Regeneration of the adsorber

Both driers (fig. 2b-3) were regenerated during the inspection of the system in the factory. Regeneration must be carried out again, however, before commissioning the system.

Because of the inspection made at the factory, the control is usually already in the time program (see section 2.2).

To start regeneration, press the yellow button (inside the control cabinet door).

- Set door switch to function
- Close ozone cabinet

By operating the grey button inside the door of the plant control cabinet it is possible to change adsorbers independent of the status of the plant at the time.

ATTENTION

This function is exclusively for service purposes and must be applied in response to a specific instruction. Once the function has been activated, ozone generation will be suppressed until an adsorber is completely regenerated. Thereafter, ozone generation will commence again (after about 11 hours or a maximum of 16 hours). Once the function has been activated, ozone generation will be suppressed for about 11 hours, up to a maximum of 16 hours.

The lamps (fig. 3-1 and fig. 3-3) light up. With the help of the fan (fig. 2b-22), ambient air is blown upwards through the adsorber. The lamps (fig. 3-1) light up only when an adsorber is in regeneration and blink at the moment this adsorber is in a cooling-off phase.
The following checks can now be carried out:

- Is the regeneration exhaust being blown away? Air escape is in the cover to the cabinet (fig. 2b-15)
- Is the heating functioning, does the drier warm up, and is hot air blown away at the end of the heating phase (approx. 100-120 °C)? To check this function, attach a thermometer with data saving capacity to the regeneration air escape.

The end of the heating-up phase is determined when the upper end of the adsorber reaches the breakthrough temperature. The cooling-off phase follows. If the breakthrough temperature is not reached by the end of the heating-up phase, the system switches to the failure mode (LED 3-1 lights up red, see Ch. 6 "Operational failures, Causes of failures", section 1). A shifting to the other adsorber is only possible towards the end of the cooling-off phase (see also section 2.2 "Air treatment system"). Further commissioning can only be continued after completing the process of regenerating the first adsorber, including the cooling-off phase. Then the system will switch automatically to the regeneration of the second adsorber, and further commissioning will be carried out with the adsorber just dried.

NOTE

If commissioning is carried out with a damp adsorber there is a danger that the glass in the ozone generator may break.

4.2 Commissioning

4.2.1 Setting the cooling water

Make sure that all ozone generators are supplied with equal amounts of the specified cooling water.

- Open main cooling water line
- Set pressure regulator (fig. 2b-10) to approx. 0.5-0.8 bar (for flowing water)
- For systems with several ozone generators, use the corner valves (fig. 2b-11) to set a steady flow of cooling water for each ozone generator
- Fill ozone generator columns completely

4.2.2 Starting the ozone system

- Set the control for the amount of ozone generated (fig. 2b-5) to zero
- Press reset button (fig. 3-13)
- Press "start/stop" button (fig. 3-14)

When the latching contact is closed the booster pump switches on after a delay period, the injector draws in the requisite process air and the cooling water solenoid valve opens immediately.

If at this point the sensor detects no air flow, or if the specified air flow is less than the minimum value, the ozone system switches off automatically after a few seconds and LEDs 3-6 light up (see section 6 of the operating errors and troubleshooting chapter).

- Check booster pump, injector and ozone gas line

If the interlocking contact is open, the LED (fig. 3-12) blinks yellow, and the booster pump does not start running.

4.2.2.1 Setting air flow

- Set the ball valve at the suction end of the ball valve (fig. 4-9) for the right amount of air to be sucked in (see technical specifications and inspection protocol)

A 10-20 % lower amount can also be set, especially if the highest level of ozone production is not necessary at all times. If the production level set is too low, the mini-contact in the airflow monitor turns off the ozone system automatically.

If a low amount of air is set, the concentration of ozone is somewhat higher and the load on the adsorber at the same time less. This then improves the solubility of ozone in the mixing station, reducing, however, the total amount of ozone. Make sure that the flow meter (fig. 2b-16) is calibrated for standard conditions. The maximum amount of air for the rated concentration of 20 g ozone/m^3 is noted in the inspection protocol.

4.2.2.2 Checks before turning on high-voltage

- Check the high-voltage transformer for penetration of moisture

NOTE

Penetration of moisture into the windings can be caused by longer storage periods, stoppage periods, damp surroundings, sea transport and, above all, changes in temperature. In this case, dry the high voltage transformer before start up to avoid any damage being caused by high voltage surges.

The drying process can be carried out as follows:

- turn off ozone system
- set primary transformer to zero
- disconnect high-voltage transformer from ozone system (secondary side)
- short-circuit secondary on high-voltage transformer
- turn on ozone system
- turn primary transformer up until rated current flows (see inspection protocol)
- let system run for 24 hours
- reconnect secondary of high-voltage transformer to the ozone generator

4.2.2.3 Starting ozone generation

- activate door switch
- close door to ozone generating system
- set control of regulating transformer (fig. 2-5) to zero
- press reset button (fig. 3-13)
- press start/stop button (fig. 3-14)
- set control of regulating transformer (fig. 2-5) to desired amount of ozone production

4.2.3 Check of circuit and voltage readings

Now the voltage and circuit readings can be compared to the inspection protocol.

- start up ozone generation
- Set up system to display that the minimum test log voltage

The system is now running at the lowest level of ozone production.

- compare circuit reading with protocol
- Set system to maximum value

The system is now running at the highest level of ozone production.

- compare circuit reading with protocol

The circuit and voltage display readings should agree with those in the protocol within a tolerance of 10 %.

If the mains voltage is greater than the voltage ratings specified in the identcode the power consumption of the ozone generators may rise to inadmissibly high levels. In such cases, reduce the maximum power consumption by limiting the primary voltage at the control transformer.

4.2.4 Operations clock

An operating hours counter located on the back of the door in the control cabinet counts the operating hours.

4.2.5 Cabinet thermostat

There is a cabinet thermostat in the upper left section of the control cabinet. As long as ozone generation is turned off, the thermostat only activates the cooling fan in the control cabinet when the temperature in the cabinet exceeds 45 °C. As soon as ozone generation is turned on, the cooling fan starts up automatically.

5 Operation

WARNING

Ozone systems may only be operated by persons trained by the manufacturer and from whom it can be expected that they fulfill their work reliably.

5.1 Starting up ozone generation

- turn on main switch (fig. 2b-4)
- press reset button (fig. 3-13)
- press start/stop button (fig. 3-14)

NOTE

When starting the ozone generator by means of the start/stop button or by closing the locking contact, the ozone generator and the pressure booster pump start up after a delay of 30 s.

- set regulating transformer at desired capacity

The following LEDs light up during normal operation:

- start/stop (fig. 3-15), green
- adsorber in operation (fig. 3-3)
- adsorber in regeneration (fig. 3-1); if the LED in fig. 3-1 lights up, then the adsorber whose LED is not lit up (fig. 3-3) is in regeneration
- adsorber in cooling-off phase, LED in fig. 3-1 blinks slowly

Display reading (green LED), either air flow, primary voltage, or current (primary of high voltage transformer).

Booster pump under voltage, LED in fig. 3-8, green

The control cabinet ventilating fan runs during operation (on the left side of the power cabinet) and, from BONa 2 on, the ventilating fan for adsorber cooling (during the cooling phase).

From BONa 2 on, ambient air is used during the cooling-off phase to support the heat elimination process. There are two cooling fans on the right side of the door to the adsorber cabinet for this purpose. This air is directed upwards between the outer surface of the adsorber and the insulation.

5.2 Turning off ozone generation

- press start/stop button (fig. 3-14)
- or external latching contact open (see system circuit diagram)

5.3 Operational checks

Basic data such as current and voltage values, operating hours and, where applicable, errors and their remedying should be entered in an operating log.

5.4 Restarting after standstill

If the system has been idle for several weeks it will be necessary to regenerate the adsorber manually before the start of ozone production (see chapter 2.2.1). Dry air should also be taken in for approx. 60 min. before activating ozone production to remove any moisture that may be present. While the system is running for this reason, the regulating transformer should be set to 0.

5.5 Restarting after error message

If the controller detects an error, ozone generation is switched off and the LED Fig. 3-12 lights up yellow. After correcting the cause of failure (see Chapter 6), the system can be placed back in operation by pressing the reset button fig. 3-13. If the cause of failure cannot be corrected, notify ProMinent Service.

WARNING

BONa Ozone Generation Systems run on high voltage of up to 12000 V. Only a qualified electrician may carry out manipulations inside the cabinet. In addition, ozone generation must be shut off before opening the ozone cabinet. Opening the cabinet while keeping the main switch on and shorting out the door switch is life-endangering.

5.6 Autoreset after mains power failure (option)

Autoreset after mains power failure can be activated by means of a jumper. The terminal position for the jumper can be read off the appropriate wiring diagram (option: Autoreset).
Note the following:

- ▶ Jumper fitted: autoreset function activated
- ▶ Jumper not fitted: the plant must be manually reset by the operator after a mains power failure

If the jumper is fitted, the plant will automatically restart after a mains power failure. Once the supply voltage returns, the sequence is as follows:

- ▶ Controller start up (about 5 seconds)
- ▶ Check on status of permanent faults
- ▶ Cooling water solenoid valve opens and commencement of start delay period (about 30 seconds)
- ▶ Start of plant in selected operating status, provided no permanent faults are present.

Once the supply voltage returns, mains power failure is signalled by the yellow flashing warning light in Figure 3-18. The warning can be cancelled at any time using the reset button in Figure 3-13. Activation of the fault indicating relay will not take place.

ATTENTION

BONa plants are not released for despatch with the automatic reset function activated (the jumper is not fitted). It can only be activated during commissioning in response to an express instruction from the client.

6 Troubleshooting

6.1 LED in fig. 3-1 lights up red

Regeneration failure

- The breakthrough temperature was not reached within the 7-hour heating-up phase.

  Cause: - Ambient air too damp and/or too warm; adsorber was overloaded

  Help: - Find source of dry air; if necessary, connect air from another room to the ozone system.
  - install pre-cooling device.
  - install air conditioner in machine room.

- Start regeneration manually (see chap. 2.2); ozone production continues with the other adsorber. The LED flashes red until the adsorber is fully regenerated. The warning can then be cancelled using the reset button in Figure 3-13.
- Check whether regeneration exhaust is being emitted (see fig. 2b-15), measure temperature of exhaust during the heating phase. In case the breakthrough temperature was not reached by the end of the heating phase, call ProMinent Service.

6.2 LED in fig. 3-3 blinks green

Adsorber shift blocked

- Regeneration of the adsorber that is not blinking was interrupted, or the heating phase (max. seven hours) or cooling-off phase (nine hours) is not yet finished.

6.3 LED in fig. 3-6 lights up red

- Air flow is less than set minimum.

  Cause: - Injector not drawing in air.

  Help: - Check functioning of injector and booster pump.
  - Injector sucks wrong air into pipe system due to leak.
  - Injector possibly stopped up.
  - Check position of ball valve in ozone gas line before injector.
  - Check water level in reject vessel. Check ozone gas line for leakage (secondary air).
  - Check counter-pressure of injector output; injector possibly stopped up.

  Cause: - Solenoid valve in air treatment did not open.

  Help: - Call ProMinent Service.

6.4 LED in fig. 3-8 lights up red

- Excess current in booster pump motor.

  Cause: - Defective booster pump, motor safety switch thrown open.

  Help: - Check booster pump; if this does not solve problem, call ProMinent Service.
  - Motor safety switch improperly set.

6.5 LED in fig. 3-9 blinks red

- Temperature in high voltage transformer is too high. Ozone generation automatically shuts down.

  Cause: - ambient air temperature too high
  - high voltage transformer drawing too much current

  Help: - Call ProMinent Service. Under no circumstances place the system back into operation!

- Excess current by ozone generation.

  Cause: - Input current on the primary side of the high voltage transformer is too high.

  Help: - Call ProMinent Service. Under no circumstances place the system back into operation!

NOTE

In case the system is placed back into operation without qualified help in correcting failures, this invalidates the guaranty claim in its entirety.

6.6 LED in fig. 3-10 lights up red

- Temperature of cooling water is too high.
- Inadequate flow of cooling water.

  Cause: - Amount of cooling water flow is too small; cooling water temperature is too high.

  Help: - Check the source of cooling water (figs. 2b-8, 2b-9), setting of booster pump (fig. 2b-10) and setting of the corner valve (fig. 2b-11). In case this does not solve problem: check cooling water line inside and outside of the cabinet, check input and output of ozone generator for obstruction. Check solenoid valve, clean if necessary; check sediment screen filter in booster pump, clean if necessary.

6.7 LED in fig. 3-12 blinks yellow

- External ozone generator latching contact is open.

  Cause: - Start/stop button pressed while interlocking contact open
  - Interlocking contact opened while ozone generating turned on.

6.8 LED in fig. 3-12 lights up yellow

- Collective malfunction

7 Maintenance

WARNING

Only qualified experts are allowed to carry out maintenance work.

Qualified experts are persons who as a result of expert training and of experience are sufficiently knowledgeable in the area of ozone generation and familiar enough with relevant government regulations for protection of labour, for prevention of accidents; with regulations and generally accepted technical prescriptions, so that they are in a position to judge the working safety condition of ozone systems. ProMinent Service Technicians are experts of this kind who are adequately familiar with ozone systems and have participated in specialized training programmes.

Ozone generating systems are to be regularly, **at least** once a year and prior to re-commissioning after modification or repair checked for proper functioning by an expert commissioned by the operator.

To make long lifetime and faultless operation possible, ozone systems should be inspected and serviced every 6 months (lesser maintenance), or every 12 months at the latest. The following instructions are intended only as a summary and presuppose certain expert understanding.

WARNING

Carbon dust must be regularly cleaned off the coils of control transformers on ozone systems (every 12 months). The carbon rollers must also be checked every 3 months for deposits on the cross ridges (visual check) and replaced if necessary. In addition the filter mats from the control cabinet must be checked (fig. 2b-23) and replaced after 6 to 12 months.

Misuse can increase the risk of fire.

NOTE

Repairs on the ozone generator may only be made by persons authorized by ProMinent. Only original spare parts may be used for these repairs. Failure to observe these restrictions invalidates any guaranty claim for the entire system.

The following points should be noted in the maintenance of an ozone system:

7.1 Testing BONa ozone generating system

- note hours of operation
- check air intake rate, current consumption and voltage, and compare to protocol
- check rate of flow for cooling water, eliminate any blockage in pipelines or at intake to generator
- regenerate adsorbers, check exhaust temperature: T = 100 °C just before completion of heating phase; use thermometer with memory save of maximum temperature
- check functioning of heating system and of regeneration ventilator
- check functioning of thermostats for adsorber drying
- check safety elements of Bono Zon® System, e.g., door switches
- clean or replace filter inserts in the control cabinet vents (Fig. 2b-23)
- check and clean solenoid valves (air treatment and cooling water)
- check that the safety cut-out switches are working correctly

7.2 Testing supplementary devices of ozone generating system

7.2.1 Injector

- Check injector and clean, if necessary
- Check injector seals and seals in check valve; replace after 12 months.
- Check booster pump, pressure before and after pump; check intake of current.
- Check hydraulic seal (reject vessel), water level, check-valve.

In case air flow rate less than at commissioning:

- Possible causes: booster pump is older, injector defective, leakage in ozone gas line, wrong supply of air.
- Check by measuring pressure in ozone gas line (measuring device necessary).
- Force out line using operating pressure
  - unscrew ozone gas line from ozone cabinet, unseal gas line, unseal line to hydraulic seal (reject vessel), remove check valve balls from injector (grey balls) and, using system water pressure, force out line.

NOTE

For the ozone gas line use only hard PVC of the highest quality and pipe of substantial thickness. The material should correspond to the German standards for PVC pipes in DIN 8062: “PVC hart, serial 5, nominal pressure PN 16”.

If any part of the line has perished, replace the entire ozone gas line.

7.2.2 Exhaust valve

- Check exhaust of reaction tank and of active charcoal filter; is there water in the flow of gas? Does the exhaust valve release on a regular basis? For this check, set ozone generation to zero, leave booster pump and injector running, loosen screws behind the exhaust valve.

In case the exhaust is not optimally functioning:

- Replace the gasket in the exhaust valve if necessary.
- Check dimensions of exhaust valve.
- Is the gas line correctly laid?
  - **downward** slope necessary
  - Pockets of water can form which cause intermittent flow surges, which in turn can cause damage to the unused ozone destructor

7.2.3 Residual ozone eliminator

- Check level, clean, remove burned up carbon, re-fill, if necessary, control after max. 6 months necessary (activated charcoal-based unused ozone destructors only).
- Check for moisture in residual ozone eliminator, check pipes in gas line (see pipework details, fig. 4).
- Exhaust line of residual ozone eliminator must lead to outdoors.

7.2.4 Other checks

- Check room temperature, max. 30 °C.
- Check humidity, max. 60 %.
- Place of installation: closed room with lock, clearly identified with adequate ventilation.
- Emergency shut-off switch installed at entrance.

7.2.5 User obligations

- Set up operating instructions.
- Only authorized persons may use ozone system.
- Repairs only by qualified experts.
- Each user must have his own protective gas mask with respective filter.

8 Technical specifications for BONa systems

8.1 Input gas

- atmospheric air (dehumidified by way of adsorber drying)
- all models of Bono Zon® systems are partial-pressure systems

8.2 Cooling agent

- Water: minimum pressure 1.5 bar (upstream from relief valve)
- Guideline values for cooling water quality:
- Suspended solids < 0.1 ml/l
- Iron < 0.2 mg/l
- Manganese < 0.05 mg/l
- Chloride < 250 mg/l (BONa D and E)
- No tendency towards calcium precipitation
- No corrosive components
- The pressure reducer is to be set to a pressure between 0.5 and 1.0 bar.
- cooling water temperature: max. 25 °C
- Maximum operating pressure 0.5 bar in flowing water; therefore no pressure surges permitted.

8.3 Rated ozone concentration

20 g/m^3 (related to standard environmental conditions, p = 1.013x10^5 Pa, T = 273 K), measured with a cooling water temperature of max. 15 °C, at a environmental temperature of max. 20 °C.

8.4 Operating frequency and connected load

- frequency 50 or 60 Hz
- voltage: 230 V/400 V (other voltages possible)

8.5 Setting range for ozone generation

- ~20-100 % of rated capacity

8.6 Conditions for surroundings

- minimum air temperature: 4 °C
- maximum air temperature: 30 °C
- maximum humidity: 60 %, non-condensing

8.7 Phases for adsorber regeneration

- Heating phase: ≤ 7 hours
- Cooling-off phase: 9 hours

Technical data

Bono Zon® BONa ozone generator system series - PVC

List of models with performance data

Model: BONa ...		**1B**	**1A**	**2C**	**2A**	**3A**	**4A**	**5A**	**6A**	**7A**	**8A**	**9A**

Environmental parameters

Max. humidity of ambient air 60 % non condensing, Max. ambient temperature: 30 °C

Ozone generation module

Ozone generator operating pressure: -0.08 to 0 bar

PVC generator modules, corrosion-resistant, with directly cooled dielectric

		1B	1A	2C	2A	3A	4A	5A	6A	7A	8A	9A
Number of generator modules		1	1	2	2	3	4	5	6	7	8	9
Ozone performance, measured according to DIN,with air 20 °C, cooling water 15 °C	g/h	40	80	120	160	240	320	400	480	560	640	720
Airflow for ozone generation max.	m^3/h	2	4	6	8	12	16	20	24	28	32	36
Ozone concentration	g/m^3	20	20	20	20	20	20	20	20	20	20	20
Power consumption of ozone generator (without air drying)	kW	0.7	1.5	2.2	3.0	4.5	6.0	7.5	9.0	10.5	12.0	13.5
Ozone connection	DN	15	15	20	20	25	32	32	40	40	40	50

Cooling water

		1B	1A	2C	2A	3A	4A	5A	6A	7A	8A	9A
Cooling water consumption	(m^3/h)	0.06	0.08	0.12	0.16	0.24	0.32	0.4	0.48	0.56	0.64	0.72
Cooling water intake pressure, upstream from relief valve	bar	1.5-6	1.5-6	1.5-6	1.5-6	1.5-6	1.5-6	1.5-6	1.5-6	1.5-6	1.5-6	1.5-6
Cooling water intake	G..i	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Cooling water outlet, atmospheric pressure	DN	15	15	20	20	20	20	20	20	20	20	20
Cooling water temperature	°C	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25

Cooling water quality: potable water, not totally desalinated water

Electrical power supply

		1B	1A	2C	2A	3A	4A	5A	6A	7A	8A	9A
Mains power supply including booster pump	kVA	4	5.5	7	10	14.5	20	22.5	27.5	34	36	38
Amperage	3x A	16	25	50	50	63	50	63	80	80	80	80
Enclosure rating	IP	23	23	23	23	23	23	23	23	23	23	23

Ozone feed system interface

		1B	1A	2C	2A	3A	4A	5A	6A	7A	8A	9A
Connector for booster pump integrated into control cabinet	A	1.6-2.5	2.5-4	4-6.3	4-6.3	6-10	6-10	6-10	9-14	13-18	13-18	13-18
Motor safety cut-out switch (standard value)	kW	0.75	1.1	2.2	2.2	3	4	4	5.5	7.5	7.5	7.5

Overall dimensions

		1B	1A	2C	2A	3A	4A	5A	6A	7A	8A	9A
Width	mm	800	800	1600	1600	2000	2400	2400	2800	3200	3400	3400
Height	mm	1950	1950	1950	1950	1950	2200	2200	2200	2200	2200	2200
Depth	mm	500	500	500	500	500	600	600	600	600	600	600

Weight

		1B	1A	2C	2A	3A	4A	5A	6A	7A	8A	9A
Weight (PVC ozone generator)	kg	310	340	660	680	760	1110	1170	1240	1770	1820	1870

NOTE: The wastewater line and the ozone gas line are connected to the top of the cabinet in all systems, the cooling water intake line is connected from the right-hand side (leave approx. 30 cm space).

Technical data

Bono Zon® BONa ozone generator system series - stainless steel

List of models with performance data

Model: BONa ...		1D	2E	2D	3D	4D	5D	6D	7D	8D	9D

Environmental parameters

Max. humidity of ambient air 60 % non condensing, Max. ambient temperature: 30 °C

Ozone generation module

Ozone generator operating pressure: -0.08 to 0 bar

Stainless steel generator module with indirectly cooled dielectric

		1D	2E	2D	3D	4D	5D	6D	7D	8D	9D
Number of generator modules		1	2	2	3	4	5	6	7	8	9
Ozone performance, measured according to DIN with air 20 °C, cooling water 15 °C	g/h	80	120	160	240	320	400	480	560	640	720
Airflow for ozone generation max.	m^3/h	4	6	8	12	16	20	24	28	32	36
Ozone concentration	g/m^3	20	20	20	20	20	20	20	20	20	20
Ozone generator power consumption (without air drying)	kW	1.5	2.2	3.0	4.5	6.0	7.5	9.0	10.5	12.0	13.5
Ozone connection	DN	15	20	20	25	32	32	40	40	40	50

Cooling water consumption

		1D	2E	2D	3D	4D	5D	6D	7D	8D	9D
Cooling water temperature 15 °C and air temperature < 25 °C	(m^3/h)	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Cooling water temperature 25 °C and air temperature < 30 °C	(m^3/h)	0.3	0.6	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7
Cooling water intake pressure, upstream from relief valve	bar	1.5-6	1.5-6	1.5-6	1.5-6	1.5-6	1.5-6	1.5-6	1.5-6	1.5-6	1.5-6
Cooling water intake	G..i	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
Cooling water outlet, atmospheric pressure	DN	15	20	20	20	20	20	20	20	20	20
Cooling water temperature, max.	°C	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25

Cooling water quality: potable water, not totally desalinated water, chloride content max. 250 ppm

Electrical power supply

		1D	2E	2D	3D	4D	5D	6D	7D	8D	9D
Mains power supply including booster pump	kVA	5.5	7	10	14.5	20	22.5	27.5	34	36	38
Amperage	3x A	25	50	50	63	50	63	80	80	80	80
Enclosure rating	IP	23	23	23	23	23	23	23	23	23	23

Ozone feed system interface

		1D	2E	2D	3D	4D	5D	6D	7D	8D	9D
Connector for booster pump integrated into control cabinet	A	2.5-4	4-6.3	4-6.3	6-10	6-10	6-10	9-14	13-18	13-18	13-18
Motor safety cut-out switch (standard value)	kW	1.1	2.2	2.2	3	4	4	5.5	7.5	7.5	7.5

Overall dimensions

		1D	2E	2D	3D	4D	5D	6D	7D	8D	9D
Width	mm	800	1650	1600	2000	2400	2400	2800	3200	3400	3400
Height	mm	1950	1950	1950	1950	2200	2200	2200	2200	2200	2200
Depth	mm	500	500	500	500	600	600	600	600	600	600

Weight

		1D	2E	2D	3D	4D	5D	6D	7D	8D	9D
Weight	kg	360	700	720	820	1200	1280	1360	1920	1980	2000

9 Illustrations

Fig. 2a Diagram for ozone generating system (e.g. swimming pool)

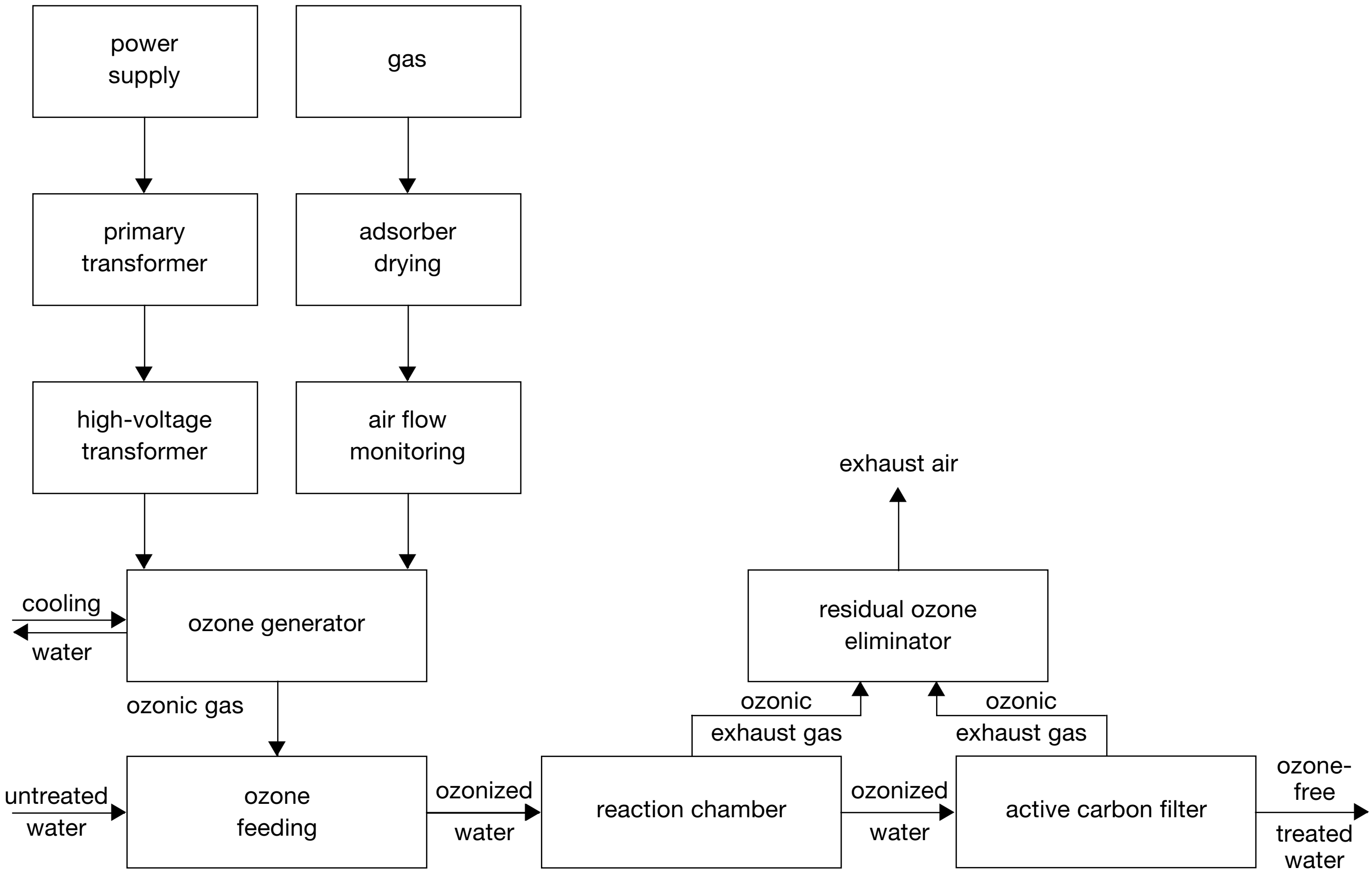
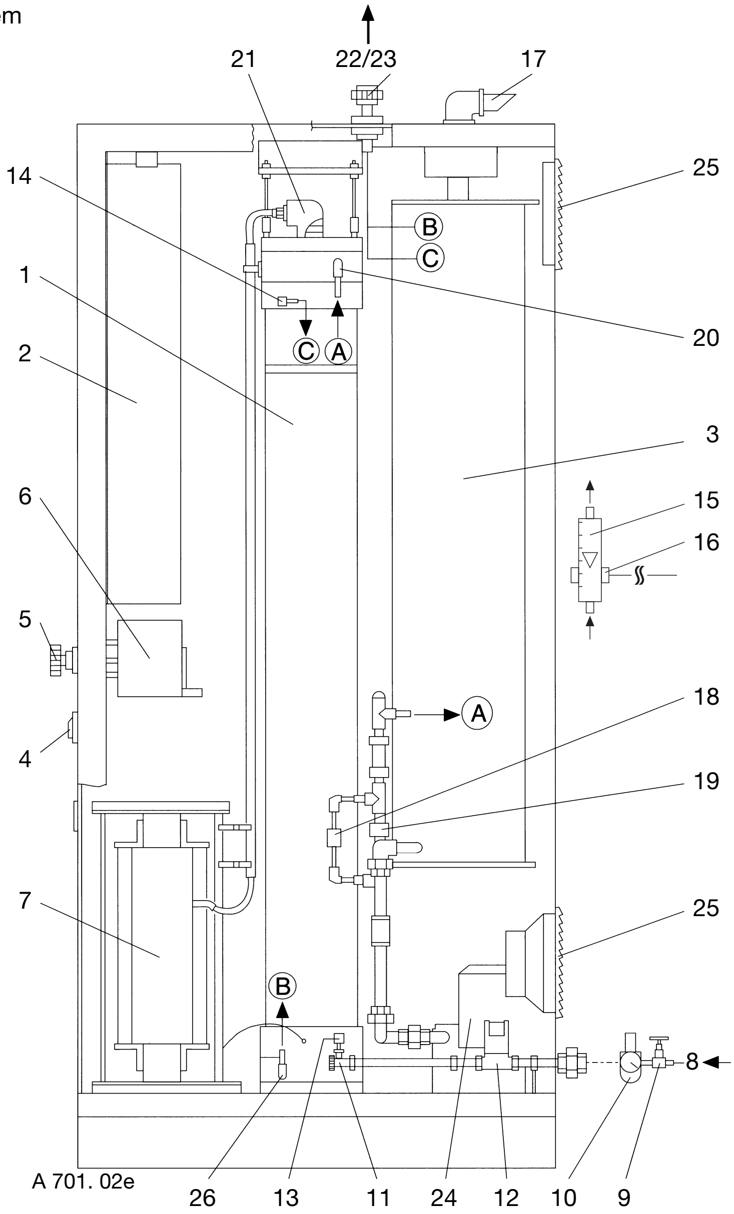


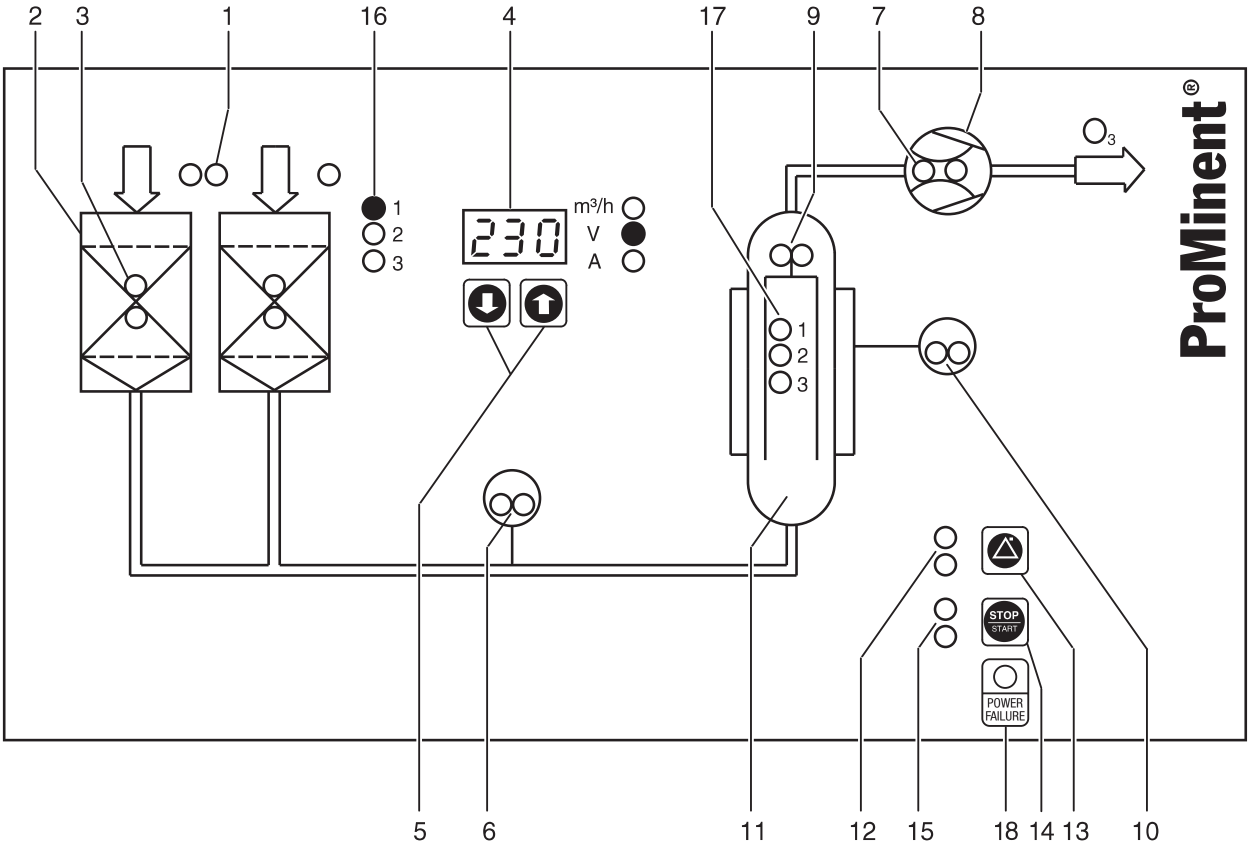
Fig. 2b Design of BONa 1 Ozone generating system



Pos.	Component
1	ozone generator
2	electrical section of system (mounting plate assembled)
3	adsorber drying (two columns one behind other)
4	main switch
5	control of regulating transformer for setting ozone generation
6	regulating transformer
7	high-voltage transformer
8	cooling water supply
9	stop valve, cooling water
10	pressure regulator, cooling water
11	corner valve for setting amount of cooling water flow
12	solenoid valve, cooling water
13	cooling water inlet to ozone generator
14	cooling water outlet from ozone generator

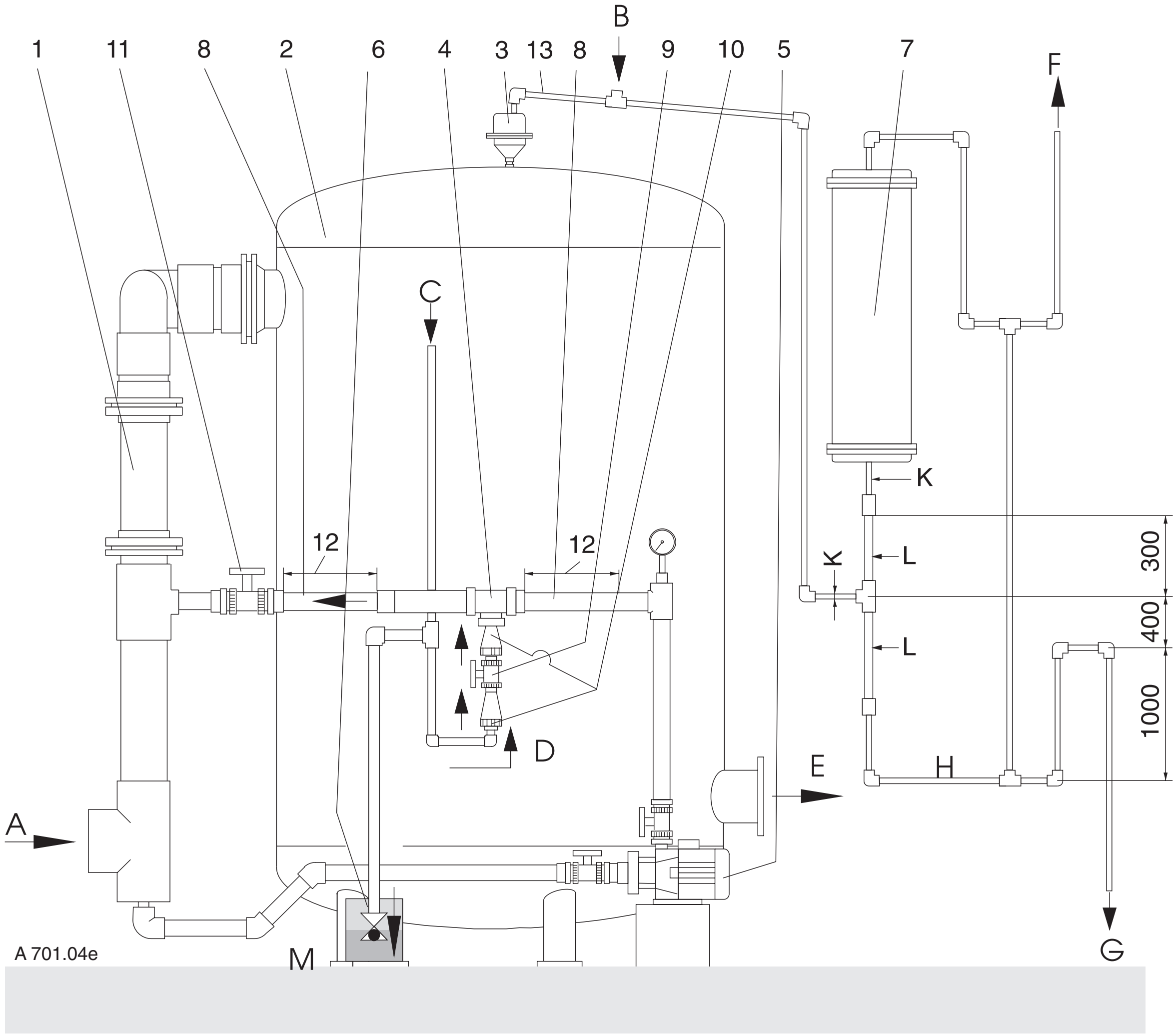
Pos.	Component
15	cooling water flow meter
16	limit contact of cooling water flow meter
17	air intake / regeneration exhaust
18	airflow sensor
19	perforated disk
20	air intake to ozone generator
21	high-voltage source
22	ozone gas line connection
23	waste water line connection
24	fan for regeneration air
25	filter mat
26	ozone gas outlet from ozone generator
A	air feed line to ozone generator
B	ozone gas line
C	cooling water drain

Fig. 3 Operating panel of BONa System



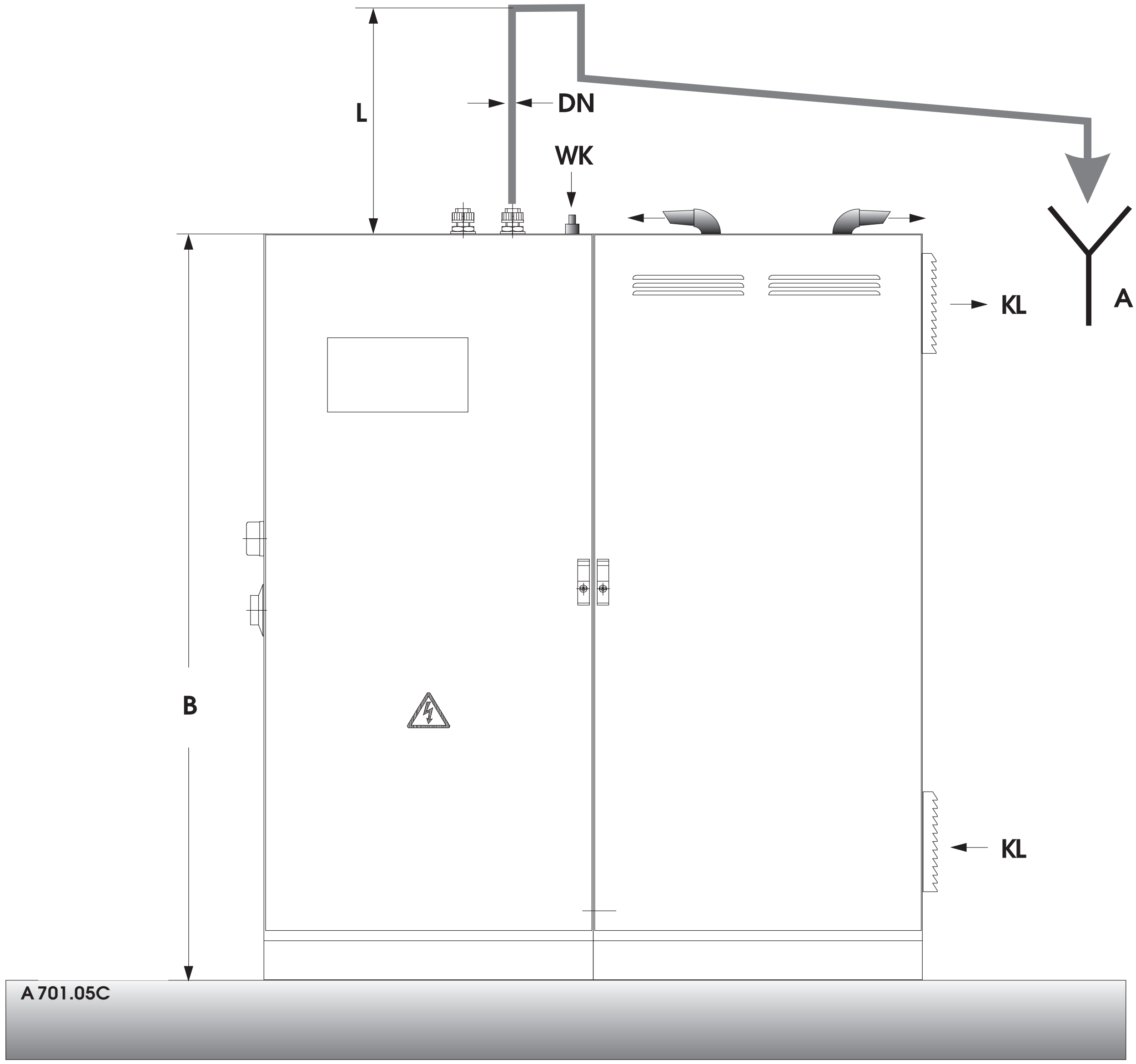
Pos.	Component
1	LED regeneration ON
2	adsorber (air treatment)
3	LED adsorber in operation
4	display readings
5	switching buttons for display
6	air circulation/flow monitor
7	injector
8	LED booster pump in operation
9	LED safety switch, ozone
10	cooling water error LED
11	ozone generator
12	LED collective malfunction
13	reset button after failure
14	start/stop button
15	LED system in operation
16	LED circuit display indicator
17	LED circuit operation indicator
18	LED mains power failure

Fig. 4 Mixing station (basic structure)



Pos.	Component	Pos.	Component
1	mixer housing	A	intake for untreated water
2	reaction container	B	exhaust from active charcoal filter
3	exhaust valve	C	gas line, ozone (from ozone generator)
4	injector (liquid jet compressor)	D	direction of flow (ozone)
5	booster pump	E	ozonised water
6	hydraulic seal (green or white ball, see chapter 3.5)	F	air discharge to atmosphere
7	residual ozone eliminator	G	water discharge (drainage)
8	intake and discharge segment	H	syphon, water-filled
9	control fixture for gas flow	K	diameter, for BONa 1B DN 25
10	ball check valve (grey ball)		for BONa 1A-3E DN 32
11	control fixture		for BONa 4A-9D DN 40
12	pipe length (minimum 500 mm)	L	diameter two nominal widths greater than for K
		M	water drop/damage block: valve installation direction: arrow downwards

Fig. 5 Installation scheme for extended waste water lines



Pos.		Meaning
A	=	cooling water runoff
DN	=	nominal diameter of cooling water runoff line same as of connecting line in system; for lengths of more than 20 m, use nominal diameter one size larger
KL	=	cooling air
L	=	maximum height above exit of cooling water from system
WK	=	cooling water (located top or side depending on BONa model)

NOTE: if cooling water runoff is below the top edge of ozone cabinet, then install anti-vacuum device in line

Fig. 6 Identcode for BONa Systems

Bono Zon® Systems of the BONa construction series are completely assembled installations ready for connection. The system configuration is determined by the identcode used for configuring Bono Zon® Systems.

Nr.	1	2	3	4	5	6	7	8	9	10
BONa	**x**	**X**	**X**	**X**	**1**	**X**	**x**	**T**	**x**	**x**

NB:
X is place marker for a letter and
x is place marker for a number

Enter identcode here:

BONa 1 A A S 1 N 0 T 0 0

Bono Zon® ozone generating system (BON), product line version a — **BONa**

Number of ozone generators: **1**
1 = 1 unit
9 = 9 units

Generator type: **2**
A = 80 g -generator, PVC
B = 40 g -generator, PVC (only BONa 1)
C = 60 g -generator, PVC (only BONa 2)
D = 80 g -generator Stainless Steel
E = 60 g -generator Stainless Steel

Drying: **3**
A = twin operation adsorber drying with hot air regeneration

Setting amount of ozone production: **4**
S = manual
R = automatic, with servomotor

System control: **5**
1 = control of booster pump

Supply voltage [V]: **6**
alternating/rotary current, according to connection
-N = 230/400
-U = 220/380
-P = 115/200
-V = 240/420

Power frequency: **7**
0 = 50 Hz
1 = 60 Hz

Electrical connection: **8**
T = L1 + L2 + N3 + N + PE

Custom models: **9**
0 = standard model

Drier size in multi-circuit systems: **10**
0 = standard
M = modified

EC Declaration of Conformity

We, **ProMinent Dosiertechnik GmbH**
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hereby declare that, on the basis of its functional concept and design and in the version brought into circulation by us, the product specified in the following complies with the relevant, fundamental safety and health stipulations laid down by EC regulations.
Any modification to the product not approved by us will invalidate this declaration.

Product description:	***Ozone generator***
Product type:	***BONa 1A - EA/...***
Serial number:	***see type identification plate on device***
Relevant EC regulations:	***EC - low voltage regulation (73/23/EEC)*** ***EC - EMC - regulation 89/336/EEC***
Harmonised standards used, in particular:	***EN 60204-1***
National standards and technical specifications used, in particular:	***E DIN 19627*** ***VDE 0110 T1 und T2*** ***VDE 0101*** ***VDE 0160*** ***ZH1 / 474*** ***VBG 4***
Date/manufacturer's signature:	***28.2.1997*** ppa.
The undersigned:	(T. Koetzing, Exportmanager)

Subject to technical modifications.

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