

highpreactor™

High-Pressure Laboratory Reactor

BR-100

V. 3.0

User Manual



*realizing
your
ideas.*

PRODUCTS + INSTRUMENTS

ZUNDEL Holding Enterprise

Copyright © 2004 BERGHOF Products + Instruments GmbH, All Rights Reserved

Copying, duplication or republication is prohibited without the express prior written permission of BERGHOF Products + Instruments GmbH

Liability Disclaimer

The contents of this publication have been checked for compliance with the described hardware and software. Nonetheless, differences cannot be ruled out so that we can assume no liability for any differences which may arise. The information in this publication is reviewed regularly and any revisions that may be required are included in subsequent versions. We welcome all comments regarding improvements to our products and publications.

We reserve the right to make technical changes.

Trademarks

highpreactor and BERGHOF are registered and unregistered trademarks and service marks of BERGHOF Products + Instruments GmbH.

Notes regarding this Handbook

Contents:

This handbook describes a high-pressure laboratory reactor of product family **highpreactor** from BERGHOF Products + Instruments GmbH. It contains product specific information, current as of the date of publication of this handbook. This technical documentation is a reference and instructional manual. Each chapter is complete in and of itself.

This handbook guides the user in the safe and proper use of the high-pressure laboratory reactor. Familiarity with the relevant chapters of this handbook is required for safe and intended use of the equipment

Read this instructional manual carefully prior to operating the equipment. After unpacking, carefully check the equipment for mechanical damage and missing parts. Should you find any damage incurred during shipment, contact the manufacturer immediately and do not operate the equipment.

This instructional manual does not include repair instructions. Should repairs be required, please contact your dealer or BERGHOF Products + Instruments GmbH.

Order no.: BR-100_53-0120-93-00-00-002

You can contact us at:

Germany:

BERGHOF Products + Instruments GmbH

Harretstr. 1

72800 Eningen

Telephone: +49 7121 / 894-202

Fax: +49 7121 / 894-300

e-mail: info@berghof-instruments.de

www.berghof-instruments.de

BERGHOF Products + Instruments GmbH are certified in accordance with DIN EN ISO 9001:2000.

Contents

1. GENERAL NOTES	5
1.1. Danger Categories and Signal Words.....	5
1.2. Qualified Users	5
1.3. Proper Use	6
1.4. General Safety Information	7
1.5. Legal Requirements	9
1.6. Other Applicable Documentation	12
1.7. Safety 12	
1.8. Informations on Disposal	13
1.9. Warranty / Limitation of Warranty	14
2. DEVICE DESCRIPTION	15
2.1. Basic Instrument	15
2.2. Technical Specifications	17
2.3. Accessories	19
2.3.1. Heating and Stirring (BLH-800 Heating Plate with Heater Block Mount)	19
2.4. Gas and Liquid Sampling (Option)	20
2.4.1. Liquid Injection Under Operating Pressure (Option).....	21
2.4.2. Overflow Valves (Option)	22
2.4.3. BTC-3000 Temperature Regulator	23
2.4.4. BDL-3000 Data Logger	23
3. SETUP AND COMMISSIONING.....	25
3.1. Standard Delivery.....	25
3.2. Setup and Commissioning.....	25
3.2.1. Transport and Storage	25
3.2.2. Ambient Conditions.....	25
3.2.3. Unpacking / Inspection.....	26
3.2.4. Installation	26
4. OPERATION.....	31
4.1. Opening and Closing	31
4.2. Filling the Reactor Vessel	32
4.3. Operation	33
4.4. Heating and Stirring with the Heating Plate and Heating Block Mount.....	34
4.5. Gas and Liquid Sampling (Option).....	35
4.6. Liquid Injection (Option).....	35

- 5. MAINTENANCE, TROUBLESHOOTING AND SERVICE37**
- 5.1. **Cleaning.....37**
- 5.2. **Maintenance.....39**
 - 5.2.1. Recurring Inspections41
 - 5.2.2. Inspection41
- 5.3. **Troubleshooting41**
- 5.4. **Repairs / Customer Service.....42**
- 5.5. **Nameplate42**

- 6. APPENDIX43**
- 6.1. **Conversion Table43**

1. General Notes

Please read this instruction manual carefully before operating your high-pressure reactor. Failure to follow these instructions could result in damage to the equipment as well as personal injury.

Safety instructions are printed in **boldface** throughout and shown as illustrated in section '*Danger Categories and Signal Words*'. These safety notes must be heeded in all cases!

1.1. Danger Categories and Signal Words

The signal words described below are used in connection with warnings throughout this manual. For your own safety and to avoid property damage, you must strictly heed these warnings!

The safety signals are printed in boldface or are otherwise marked throughout this manual and have the following meanings:



DANGER ! Means that failure to follow the safety instructions is likely to cause severe personal injury, death or severe property damage.



Warning ! Means that failure to follow the safety instructions may cause severe personal injury, death or severe property damage.



Caution Means that failure to follow the safety instructions may cause personal injury or some property damage.



Note:

This symbol indicates that this is important information regarding the product or refers to a part of the manual, which requires particular emphasis.

1.2. Qualified Users

Only Qualified Users should operate this equipment. Qualified Users with respect to this manual are relevantly schooled and trained specialists with a basic knowledge of chemistry and technology. They should be trained in the relevant legal regulations for handling pressure vessels and in the safe handling of chemicals.

1.3. Proper Use



DANGER ! Explosion hazard!

The unit is not designed for the use with substances decomposing exothermically or forming explosive vapors upon heating (e.g. perchloric acid, Alcohols, ether etc.).



Warning ! Observe all operating instructions!

Always exercise particular care when handling pressurized containers. Always comply with the operating instructions and all legal requirements as well as general safety regulations related to handling the individual chemical substances involved.

The operator may only permit knowledgeable and properly trained personnel to operate the high-pressure laboratory reactor and its accessory equipment and must ensure that other employees or third parties are not endangered.

The operator must prepare appropriate operating instructions in order to ensure that personnel operating the high-pressure laboratory reactor or equipment receive proper instruction.

All locally applicable regulations governing the operation of the pressure reactor must be complied with.

The **highpreactor** high-pressure laboratory reactor is employed as a reaction vessel for chemical reactions and material tests which are performed under excess pressure. Increased pressure can be produced by the addition of gases or by heating the reaction solution in the sealed vessel.

Prerequisites for the proper and safe operation of the **highpreactor** high-pressure laboratory reactor include qualified handling as well as proper transport, storage, setup, and application, together with careful maintenance.

The system may only be used within the context of data and applications specified in this documentation and the associated user manuals.

The high-pressure laboratory reactor may only be used:

- Properly;
- In a technically flawless condition;
- Without unauthorized alterations or modifications;
- By qualified users.

Please also observe all regulations published by professional/trade associations, the TÜV, VDE regulations, or corresponding national regulations.

1.4. General Safety Information

Using the high-pressure laboratory reactor involves taking into account various safety precautions which go beyond those for general laboratory practices. The following general safety information should therefore be read carefully prior to using the system, and should be observed at all times.

We can assume no liability for damages resulting from improper handling of a failure to comply with this information.



Warning ! Always wear eye protection and protective gloves!

Always wear safety glasses/goggles and protective gloves during work which may involve contact with chemicals, that is, when working with acids, pressure vessels, during cleaning, etc.!



DANGER ! Explosion hazard!

The unit may never be employed without proper over-pressure protection. Rupture discs are the sole, admitted over-pressure protection. Therefore rupture discs may never be removed and the reactor may never be operated with pressure release valves as sole over-pressure protection.

The unit is not designed for use with compounds and solutions which may generate explosive vapors when heated (e.g., perchloric acid, alcohols, ether, etc.).

Special, grease-free valves must be employed if oxygen is used. Under no circumstances may any grease be subsequently applied to these valves.

Adequate explosion protection must be provided in the immediate vicinity of the high-pressure laboratory reactor whenever flammable substances are employed. Any vapors generated by the flammable liquids which may escape from the over-pressure protection (e.g., rupture disc or pressure release valve) must be safely extracted in accordance with local requirements. This also applies should the rupture disc be activated. If the high-pressure laboratory reactor is set up under an extractor, the latter must be equipped with adequate explosion protection.



Caution Emissions!

Should the over-pressure protection (e.g., rupture disc or pressure release valve) activate, gases which may be hazardous to individuals will be suddenly released into the atmosphere. Always make sure the opening of the over-pressure protection is never directed towards individuals. Preferably, a high-pressure hose should be connected to the over-pressure protection to safely discharge the gases.

Secure the reactor against possible recoil should the rupture disc break by, for example, screwing the heating jacket onto the base.



DANGER ! Pressure Vessels

Use only pressure vessels and spare parts authorized by BERGHOF Products + Instruments GmbH for use with the high-pressure laboratory reactor. These can be obtained either from your local dealer or directly from BERGHOF Products + Instruments GmbH (Refer to the "Repairs / Customer Service" section for contact addresses).

Never open the high-pressure laboratory reactor while it is under pressure. Never use force to open the vessel. Never use tools to open the vessel!

Hot gases and vapors can escape from the pressure vessel when it is opened! Always wait until the vessel has cooled to room temperature before opening it.

Always exercise extreme caution when working with toxic substances. Always comply with all relevant spec sheets and safety precautions!

The reactor may not be operated without its PTFE insert when working with strong acids (e.g., nitric acid, hydrochloric acid, sulfuric acid, phosphoric acid, hydrofluoric acid). A C4 Hastelloy reactor must always be used where the fittings also require protection against corrosion as is the case, for example, when these types of acids are heated or if gaseous acids are employed.

Perform regular visual inspections of all the high-pressure laboratory reactor's components to detect any damage (corrosion, cracking, etc.).

All applicable legal regulations governing the use of high-pressure reactors must be observed.



DANGER ! Improper use!

Should a directly hazardous situation develop while the high-pressure laboratory reactor is in operation, e.g., as the result of an unexpected reaction or dangerous effects from the outside, all requisite countermeasures must be immediately initiated and, if necessary, the reactor must be taken out of service.

A complete and detailed inspection of the high-pressure laboratory reactor must be performed if the operational fault resulted in the permissible pressure being exceeded by more than 10%, or if the permissible operating temperature was significantly exceeded, or if the high-pressure laboratory reactor or its fittings were damaged.



Warning ! Max. operating temperature and operating pressure!

The maximum interior temperature and maximum operating pressure may not be exceeded (refer to the *Technical Specifications* section). Exceeding the maximum temperature will result both in a reduction of the high-pressure laboratory reactor's pressure resistance as well as possibly damaging the seals.



Warning ! Accessories!

The **high reactor** high-pressure laboratory reactor may only be used in conjunction with the specified heating and stirring systems.

Never allow liquids, particularly toxic compounds, to spill on hot parts.



Warning ! The unit employs low voltage 230V!

Unit must always be carefully connected to a grounded conductor. Provided the wall outlet used is equipped with a ground connection, the supplied power cord will ensure proper connection. If it is necessary to use an extension cord to connect the system to the power supply, only a three-wire cord with a ground connection may be employed.

Repair and servicing of the equipment may only be performed by trained personnel.

1.5. Legal Requirements

Within the European Union, 97/23/EG (pressure equipment guideline) and 87/404/EG (guideline for simple pressure vessels) bring the various national technical requirements into line. In the German Code, these have been included in the 6th and 14th Equipment Safety Laws. This enacted harmonized characteristics requirements. However, harmonized technical rules or adapted national construction requirements (e.g., AD-2000 in the FRG) may also apply.

Manufacturers of pressure equipment are free to select among these regulations based on their countries!

If the pressure vessel was manufactured in accordance with the German AD-2000 body of rules, recurring inspection is only required every 5 years. If the pressure vessel was manufactured in accordance with the national regulations of the countries listed below, the following inspection periods apply.

	D	F	B	I	L	NL	GB	S
Recurring inspections, in years	5	1.5-3	1-3	1-2	5	4	2.17	3

Operation of pressure equipment is regulated by the European Union's individual member states. In Germany, this is regulated by the industrial safety code, supplemented by a secondary body of technical rules.

The operator must comply with all locally applicable operating regulations. With regard to the recurring inspections, operators within the European Union may choose to abide by either their national requirements or by the German requirements. This is possible because the reactor has been manufactured in accordance with the AD-2000 body of rules and these rules are recognized throughout the EU. Therefore, an inspection period of 5 years applies to all BERGHOF high-pressure laboratory reactors employed within the European Union.

Operating Regulations and Characteristics Requirements			
EU	Characteristics of Pressure Equipment	Operation of Pressure Equipment	
	EC Guideline 97/23/EG (Pressure Device Guideline)	EC Guidelines 89/655/EG, 95/63/EG, 2001/45/EG (Employment of Work Equipment)	
FRG	§3, Para. 1, Equipment and Product Safety Code (GPSG)	§§18, 19 Occupational Safety Code	§§2(7), 14 GPSG (Equipment Requiring Inspection)
	14. GPSGV, Pressure Equipment V	Occupational Safety Code	

Due to the particular hazards related to pressure vessels and their use, they have been classified as "equipment requiring inspection" under the German equipment and occupational safety code (GPSG, January 6, 2004).

Categories

The reason for this classification lies in the energy stored in the pressure vessel. This energy can be expressed as the pressure content product. Pressure equipment is subdivided into the following categories on the basis of this pressure content product and the charging media (fluid):

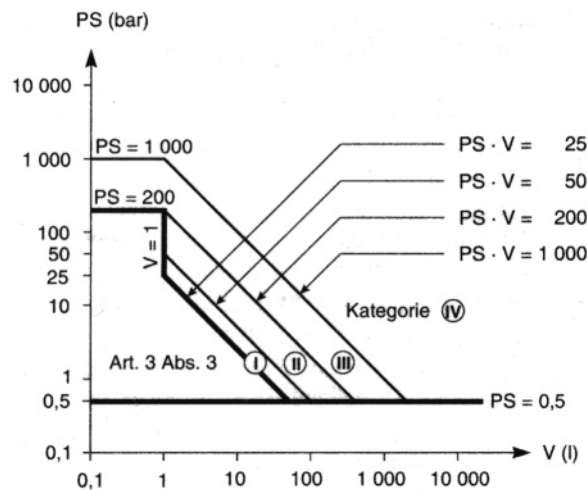
1. Pressure content product: $P \cdot V = [\text{bar} \cdot \text{l}]$; (1 bar \cdot l for gases, this corresponds to approx. 100 Joules);
2. Charging medium (fluid): Gases store a greater amount of energy than liquids. However, liquids heated beyond their boiling point store additional energy in the form of heat.

Fluids are divided into two groups: Group 1, hazardous fluids (potentially explosive, flammable, oxidizing, and toxic materials); Group 2 (all other fluids).

Because the high-pressure laboratory reactors described in this manual are intended for use in chemical laboratories, they generally fall under Group 1 – Hazardous Fluids!

As the following diagram illustrates, BERGHOF high-pressure laboratory reactors with a volume of up to 1,000ml and a max. operating pressure of 200bar cannot be assigned to any specific category. These must be designed, manufactured, and tested in accordance with Art. 3, Para. 3 (DGRL 97/23/EG). Such reactors do not require CE certification and may not carry a CE symbol.

As the diagram further illustrates, high-pressure laboratory reactors with a content of 1,000ml (max. operating pressure: 150 or 200bar) are classified as Category III units. These must bear the CE symbol and be designed, manufactured, and tested accordingly.



TÜV/CE symbols

The minimum requirements for the conformity evaluation procedure can be deduced from this category. BERGHOF Products + Instruments applies the following process for this purpose:

- | | |
|--------------------------|--|
| EC type examination test | By the TÜV as an authorized testing center; |
| Conformity with design | Pressure test of every reactor by the TÜV as an authorized testing center; |

This methodology ensures that all reactors are designed, manufactured, and tested in accordance with the 97/23/EG pressure equipment guideline and the AD body of rules. This is confirmed by the TÜV seal, the conformity declaration and, to the extent that the reactors may be so designated, by the CE symbol.

Reactor operation

Based on the classification into the above-cited categories, the following obligations arise for the operator (§17 and Appendix 5 (19), of the operational safety code of January, 2004; §12 and Appendix II (38) of the pressure vessel code of July, 1999):

1. The recurring inspections of high-pressure laboratory reactors must be performed by a certified monitoring center if the product of the maximum permissible pressure, P, and the relevant volume, V, is greater than 100 bar*liter.
2. The recurring inspections must be performed at least every 5 years.

Aside from this and in accordance with the technical regulations related to the pressure vessel ordinance, TRB 801, No. 38, the following applies to test autoclaves:

3. An inspection by a competent individual must be performed after every use.
4. Inspection prior to commissioning and the recurring, external inspections need not be performed.

Test autoclaves within the context of TRB 801, No. 38 are pressure vessels employed for testing purposes whose anticipated pressures and temperatures are not known for certain.

In other words, BERGHOF high-pressure laboratory reactors with a pressure/content product > 100 bar * l must undergo a new pressure test at least every five years. This test may only be performed by a certified testing center (TÜV). The test comprises:

- An examination of the documentation (manufacturing documents, inspection log);
- An interior inspection (as a rule, a visual inspection of the condition of the pressure-bearing components);
- An examination of functional capability;
- A pressure test.

If the anticipated pressures and temperatures are not known for certain, the high-pressure laboratory reactor is to be viewed as a test autoclave and the operator must perform an inspection of the unit after each use. This inspection comprises:

- An interior inspection (as a rule, a visual inspection of the condition of the pressure-bearing components);
- An examination of functional capability;
- A pressure test.

Setup and operation of pressure vessels is regulated by TRB 700 and TRB 701 and, for test autoclaves, by TRB 801 Nr. 38.

1.6. Other Applicable Documentation

EC	Pressure equipment guideline Body of rules	97/23/EG AD-2000
Germany:	Pressure vessel code, DruckbehV, of July, 1999 Operational safety code, BetrSichV, of January, 2004 Technical regulations governing pressure vessels (TRB)	
Other nations	Corresponding national requirements.	

1.7. Safety

Every BERGHOF high-pressure laboratory reactor has been tested at 1.6 times the maximum operating pressure, with a corresponding certificate included in the delivery.

In the following situations, the unit must be disconnected from the mains power supply and be locked out to prevent accidental use:

- If the unit evidences visible signs of damage;
- If unit parts or components are found to be loose;
- If the unit fails to operate;
- If the unit is to be stored for extended periods of time under unfavorable conditions (e.g., outdoors, in very moist or humid environments).

European Community

The high-pressure laboratory reactor has been designed, manufactured, and tested in accordance with the 97/23/EG equipment guideline and the AD body of rules.

Conformity declaration

Due to the small volume BR-100 cannot be CE tested and certified.

1.8. Informations on Disposal

European Union

Electrical and electronic products should not be mixed with general household waste. BERGHOF Products and Instruments GmbH accepts its electrical and electronic instruments from on a free of charge basis for proper treatment, recovery and recycling from their business users. If you wish to discard electrical and electronic products, please contact your local dealer or BERGHOF Products and Instruments GmbH (info@berghof-instruments.de). They will provide further information.

Disposing of this product correctly will help to protect our environment..

Countries outside the European Union

This regulation is only valid in the European Union



Note:

BERGHOF-Products are not used in private households.

1.9. Warranty / Limitation of Warranty

Limited Warranty

Each product manufactured by BERGHOF Products + Instruments GmbH is warranted to conform to BERGHOF Products + Instruments GmbH's applicable specifications on the date on shipment. The warranty period is twelve (12) months after the date of delivery, unless another period is specified. The warranty does not extend to damages due to improper installation, improper maintenance, abuse, accident, negligence, alteration, misuse, ordinary wear and tear, or the like. Claims for replacement of parts caused by ordinary wear and tear are excluded, as are claims for replacement of parts meant to be expended during the operation of the equipment.

Remedies

Under the limited warranty, BERGHOF Products + Instruments GmbH repairs or replaces any products which BERGHOF Products + Instruments GmbH determines to be defective and covered by this limited warranty. This is the sole and exclusive remedy. If BERGHOF Products + Instruments GmbH determines that repair or replacement fails its essential purpose, the purchaser will, at its option, be entitled to a refund of the purchase price for the products in question or a credit therefore.

All warranty claims must be accompanied by a description of the claim, which description must be attached to the equipment claimed to be defective. Claim descriptions must include the claimants name, address, department (if applicable) and telephone number.

The equipment should be returned in its original packaging, to the extent possible. We regret that BERGHOF Products + Instruments GmbH cannot be held responsible for damage caused during shipping due to improper packaging.

LIMITATION OF WARRANTY

EXCEPT AS EXPRESSLY SET FORTH ABOVE, THERE ARE NO OTHER WARRANTIES HEREUNDER, WHETHER EXPRESSED OR IMPLIED, ARISING BY OPERATION OF LAW OR OTHERWISE, INCLUDING WITHOUT LIMITATION, THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND ANY WARRANTIES ARISING UNDER COURSE OF PERFORMANCE, COURSE OF DEALING OR USAGE OF TRADE.

UNDER NO CIRCUMSTANCES WILL BERGHOF PRODUCTS + INSTRUMENTS GMBH BE LIABLE FOR ANY CONSEQUENTIAL, EXEMPLARY, INCIDENTAL, INDIRECT OR SPECIAL DAMAGES, OR LOST PROFITS, EXPENSES OR LOSSES ARISING OUT OF OR RELATED TO THE SALE OR USE OF ANY OF ITS PRODUCTS REGARDLESS OF WHETHER THE LIABILITY RESULTED FROM ANY GENERAL OR PARTICULAR REQUIREMENT OR NEED WHICH BERGHOF PRODUCTS + INSTRUMENTS GMBH KNEW OR SHOULD HAVE KNOWN OF.

2. Device Description

2.1. Basic Instrument

The **high**reactor high-pressure laboratory reactor is employed as a reaction vessel for chemical reactions and material tests which are performed under excess pressure. Increased pressure can be produced by the addition of gases or by heating the reaction solution in the sealed vessel.

Depending on the individual reactor design, materials used in its construction include CrNiMo stainless steel (material no. 1.4571, in accordance with DIN, or 316Ti, in accordance with AISI), C-4 Hastelloy, and/or isostatically molded PTFE or PFA. This provides the complete apparatus with a very long service life, even where aggressive acids are employed or under extreme laboratory conditions. The precise design and construction of your particular high-pressure laboratory reactor can be found in the device documentation provided with the unit.

At minimum, each high-pressure reactor comprises:

- The actual pressure reactor, possibly equipped with a PTFE insert and lid cladding;
- The installed fittings which, for safety reasons, always include at least one rupture disc as overpressure protection device and a vent valve;
- A manometer or electric pressure meter;
- An immersion tube for measuring the interior temperature, e.g., with the aid of a PT-100 sensor, as well as;
- Accessories (heater with temperature control, stirrer, etc.).

The high-pressure laboratory reactor is sealed by means of a conical flange lock with a fitted O-ring.

Pressure and temperature sensors are available to track the progression of temperature and pressure in the unit and, when employed in conjunction with an electronic analysis device, these also permit the progression of these values to be recorded by a PC as well as displaying them on a digital temperature and pressure monitor.

Accessories

The BTC-3000 regulator is available to regulate the heating jacket and thus the temperature of the high-pressure laboratory reactor. Connections for NiCr/Ni thermal elements type k are provided as the standard sensor input. Heating power (up to a maximum of 1,000 Watts) is controlled by means of a wear-resistant semiconductor relay. Heating power is automatically switched off in case of sensor breakage or an interruption in the compensation line.

The high-pressure laboratory reactor has been designed, constructed, and tested in accordance with the 97/23/EG device guideline according to the AD-2000 body of rules.

Options

Liquid sampler with immersion tube; nominal diameter = 4.0 mm (BR-100)

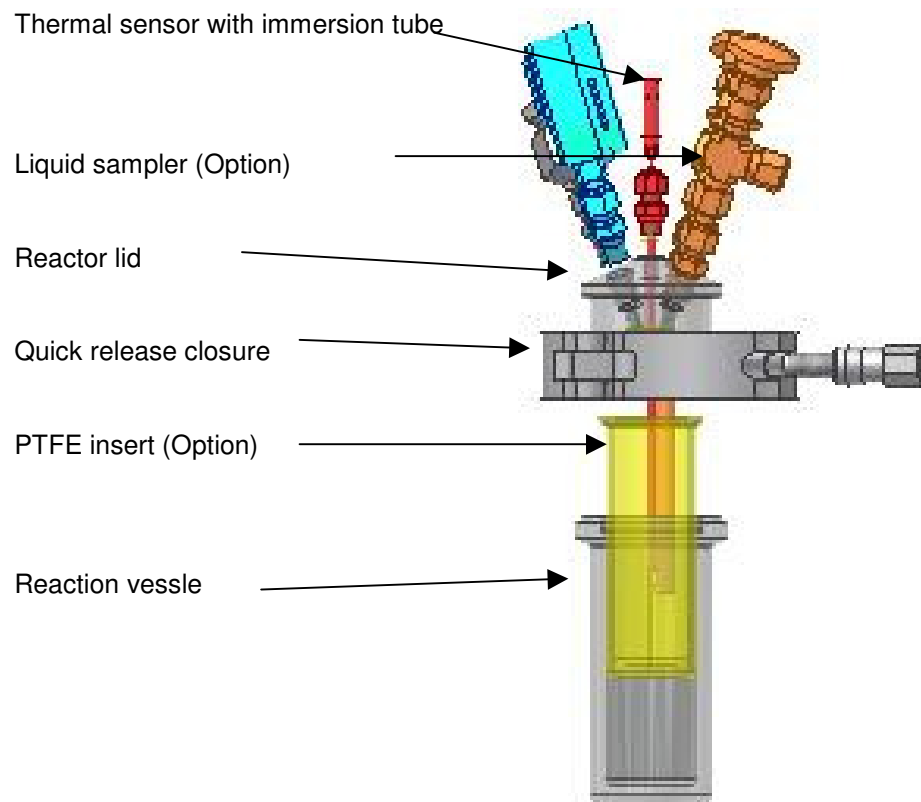
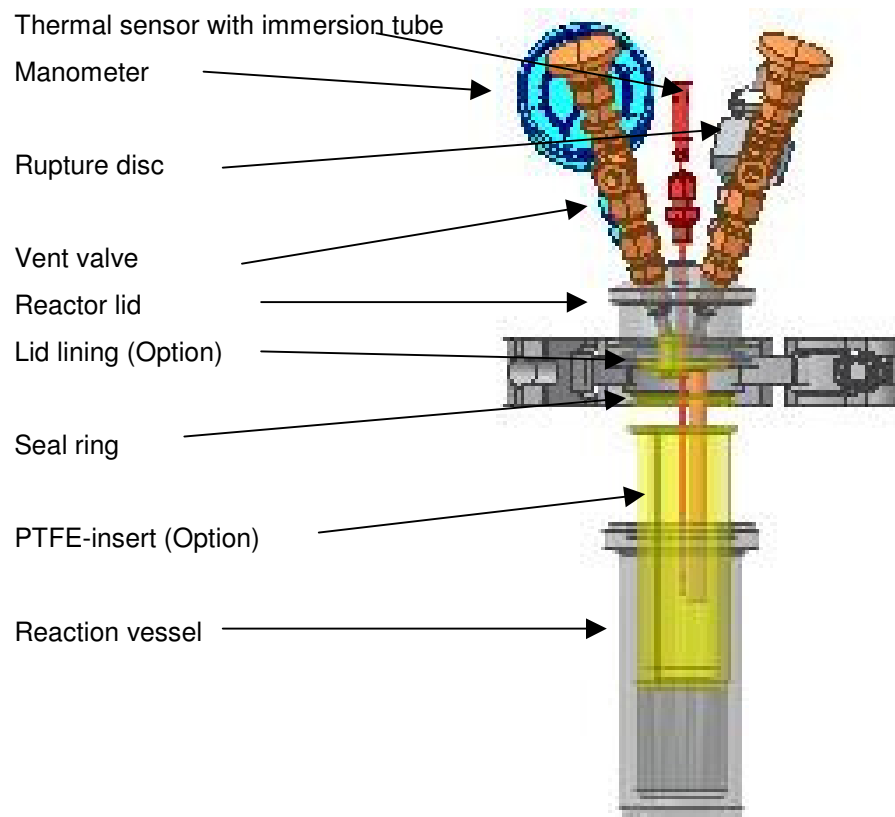
Gas sampler

Electric pressure recorder and measurement data acquisition (0- 250bar; accuracy: +/- 0,5%; output signal 4-20mA)



Note:

The PTFE lining ends inside the high-pressure reactor lid (standard design). On request, the manometer can also be lined with PTFE, and the rupture disc retainer, distributor, and the valve can all be made of C4 Hastelloy.



2.2. Technical Specifications

Base	SS316TI	SS316TI	SS316TI	SS316TI	SS316TI or HC-4	SS316TI or HC-4
Insert	PTFE	PTFE	PTFE	PTFE	-	-
Lid	SS316TI	SS316TI	SS316TI	SS316TI	SS316TI or HC-4	SS316TI or HC-4
Lid lining	PTFE	PTFE	PTFE	PTFE	-	-
Fittings	SS316TI	SS316TI	SS316TI	SS316TI	SS316TI or HC-4	SS316TI or HC-4
Connections (clamping-ring unions)	1/4"	1/4"	1/4"	1/4"	1/4"	1/4"
Lock	Chain	Chain	Chain	Chain	Chain	Chain
Rupture disc	Monel / PFA	Monel / PFA	Monel / PFA	Monel / PFA	Monel / PFA	Monel / PFA
Rupture pres- sure	200 bar	200 bar	200 bar	200 bar	200 bar	200 bar
Volumes	75ml	100ml	150ml	200ml	170ml	225ml
Max. fill volume	Max. 90% of volume					
Max. operating pressure	200 bar	200 bar	200 bar	200 bar	200 bar	200 bar
Max. operating temperature	230° C	230° C	230° C	230° C	230° C	230° C
Exterior dia- meter	43.8 mm (1.7 in)	43.8 mm (1.7 in)	43.8 mm (1.7 in)	43.8 mm (1.7 in)	58 mm (2.3 in)	58 mm (2.3 in)
Interior diame- ter	29 mm (1.1 in)	34 mm (1.3 in)	40 mm (1.6 in)	40 mm (1.6 in)	42 mm (1.7 in)	42 mm (1.7 in)
Depth (interior)	121 mm (4.8 in)	118 mm (4.6 in)	121 mm (4.8 in)	159 mm (6.3 in)	124 mm (4.9 in)	162 mm (6.4 in)
DGRL 97/23/EG cate- gory	Not assignable to any category					
CE required?	No					
Liquid group	1					
Corrosion sup- plement	>1mm (>0,04in)					
Cited participat- ing body	TÜV					

Seals

O-rings made of PTFE, Viton, or Kalrez for all reactors

Connections

All valves are equipped with 1/4" clamping-ring unions for connection to appropriate pipe or tube systems.



Note:

Every BERGHOF high-pressure laboratory reactor has been pressure and leak tested, evidence of which is provided by a corresponding manufacturer's certificate.

2.3. Accessories

2.3.1. Heating and Stirring (BLH-800 Heating Plate with Heater Block Mount)

Thermo-insulated heater block mount made of aluminum with stainless steel safety hood.

The heater block mount is intended for use in conjunction with the BLH-800 laboratory heating plate. The temperature can be controlled either by means of the thermal regulator integrated in the heating plate (external temperature regulation), or by measurement of the interior temperature in conjunction with the BTC-3000 temperature regulator. A special connecting cable is provided to allow the BTC-3000 to control the laboratory heating plate.

A magnetic stirrer has also been integrated into the laboratory heating plate to permit the reactor contents to be stirred using a conventional magnetic stirring rod.



Note:

The rotational speed may only be adjusted on BLH-800. An external control is neither possible with BTC-3000 nor BDL-3000.

Technical specifications:

Heater block mount		BR-100
Dimensions W x L x H	(mm)	180 x 180 x 140
	(inches)	7.1 x 7.1 x 5.5
Bore hole diameter		58 mm / 2.3"
Appropriate heating plate diameter		145 mm / 5.7"
Appropriate magnetic stirrer rod (L x Ø)		20 x 8 mm 0.8 x 0.3 "
Heating plates		BLH-800
Dimensions W x L x H	(mm)	160 x 250 x 125 mm
	(inches)	6.3 x 9.8 x 4.9
Power supply		230 V / 50 Hz
Heating power		850 W
Max. speed		1250 rpm
Temperature sensor		NiCrNi DIN 43710 type k
Total weight, approx.		4 kg / 8.8 lb

2.4. Gas and Liquid Sampling (Option)

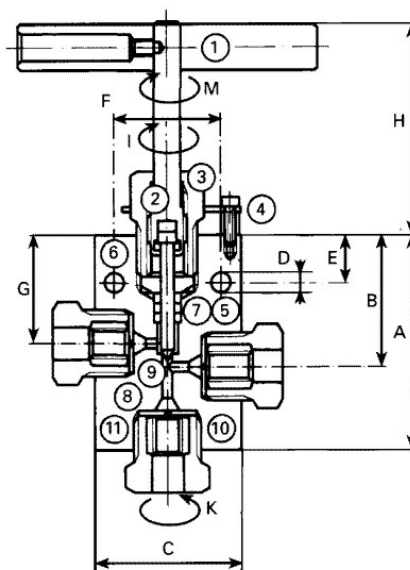
The valves for gas and liquid sampling are appropriately marked and may be used to extract gases or liquids from the reactor under operating pressure. The opening of the gas valve opens into the autoclave lid, while the one for liquid sampling ends in a dip-tube reaching to the base of the reactor.

It is advisable to connect appropriate collecting systems or tubings. (see Assembly of ring clamp screw-on connectors `Maintenance and Service`)

Technical specifications

Material	SS 316TI	Hastelloy C-4
Operating temperature	<300 °C	<300 °C
Operating pressure	<200bar	<200bar
Nominal width	4mm	2mm
Material dip tube	PTFE or SS 316TI	PTFE or Hastelloy C-4

- 1. Handle
- 2. Stem
- 3. Packing nut
- 4. Locking device
- 5. Panel mounting
- 7. PTFE-seal
- 8. Valve body
- 10. High-pressure tube connections



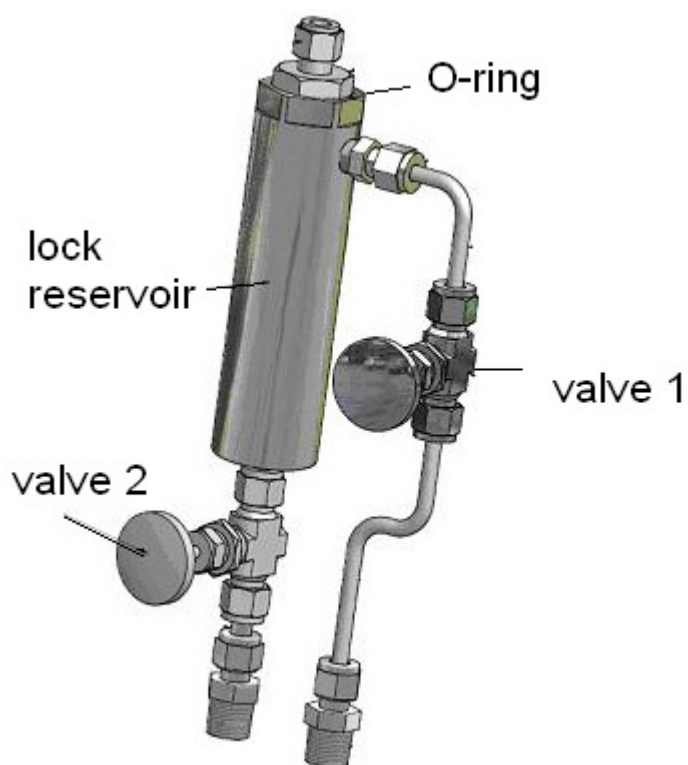
Sitec High pressure valve made of Hastelloy C-4

2.4.1. Liquid Injection Under Operating Pressure (Option)

This optional combination of fittings permits liquids to be added to the reaction solution while the reactor is under operating pressure. The complete system comprises the following components:

- Reservoir;
- Ball valve for the addition of the liquid to the reactor from the reservoir (Valve 1);
- Ball valve for pressure equalization (Valve 2).

To add liquid, the reservoir is opened by unscrewing its lid. The vessel's lid is equipped with a pressure release valve which vents the reservoir before it is opened. A Viton O-ring provides a secure seal.



Technical specifications:	Nominal volume:	5 ml
	Material:	1.4571 stainless steel
	Max. temperature:	200° C (392 °F; Viton O-ring)
	Max. pressure:	150 bar (2,176 psi)
	Nominal width, valves:	4 mm (0,16 inch)

2.4.2. Overflow Valves (Option)

In parallel to rupture disc a proportional overflow valve may be assembled to regulate the maximum operating pressure. The valve plug is relieved and media blown-off if the internal pressure of the reactor exceeds the pre-adjusted relief pressure of the spring. Mass flow increases proportional to the internal pressure. As soon as the internal pressure is below the relief pressure again, the valve closes automatically.



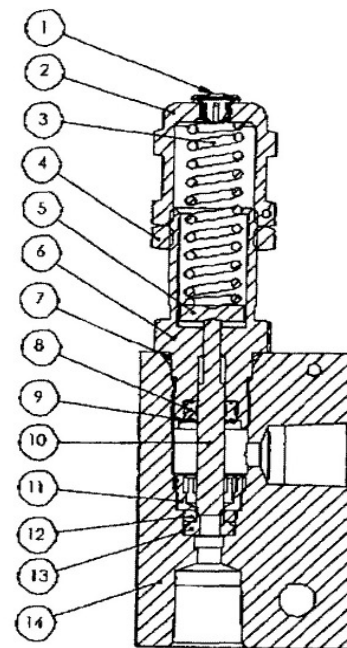
DANGER ! Explosion hazard!

The unit may never be employed without proper over-pressure protection. Rupture discs are the sole, admitted over-pressure protection. Therefore rupture discs may never be removed and the reactor may never be operated with pressure release valves as sole over-pressure protection.

Technical specifications:

Material	SS 316 TI	Hastelloy C-276
Operating temperature	<120 °C	<300 °C
Relief pressure according colour indication		
Blue	3,4 - 24 bar	3,4 - 24 bar
Yellow	24 - 51,5 bar	24 - 51,5 bar
Violet	51,5 – 103 bar	51,5 – 103 bar
Orange	103 – 155 bar	103 – 155 bar
Brown	155 – 206 bar	155 – 206 bar
Max. operating pressure	413 bar	413 bar
Max. back pressure	103 bar (back pressure shall not exceed internal pressure)	
Nominal width	3,6 mm	3,6 mm
Material for sealing	Viton	Kalrez

1. Cap plug
2. Adjustment cap
3. Sprng
4. Lock nut
5. Spring support disc
6. Bonnel
7. O-ring
8. Quad ring
9. Retaining ring
10. Poppel
11. Nut
12. O-ring
13. Insert
14. Valve body



2.4.3. BTC-3000 Temperature Regulator

Refer to the BTC-3000 manual.

2.4.4. BDL-3000 Data Logger

Refer to the BDL-3000 manual.

This page intentionally blank

3. Setup and Commissioning

3.1. Standard Delivery

Because of the modular nature of the **highpreactor** high-pressure laboratory reactor, there is no generally applicable standard delivery. Therefore, please check the shipping documentation with regard to the completeness of your specific unit.

3.2. Setup and Commissioning

3.2.1. Transport and Storage

The high-pressure laboratory reactor may only be moved once all pressure has been released. Please observe the ambient conditions described below.

3.2.2. Ambient Conditions

Pressure equipment must be set up in such way that neither operators nor others are endangered. All safety zones mandated by national ordinances in the country of use must be complied with.

The high-pressure laboratory reactor must be set up in such a way that:

- It is accessible and can be viewed from all sides for any required visual inspections;
- The seal (nameplate) is clearly visible;
- The pressure reactor and its accessories can be operated from a safe and secure position;
- It is protected against mechanical influences from the outside and that damage to the unit cannot be anticipated;
- Access by unauthorized individuals is not possible.



Note:

If the reaction progression is not precisely known or if unanticipated pressure increases or exothermic reactions may occur (test autoclave), the unit must be set up in a special reactor chamber.

The setup location must meet the following requirements:

Ambient temperature:	+10 °C (50 °F) and +40 °C (104 °F) In addition, the temperature should lie between 40 °C (-40 °F) and +70 °C (158 °F) during shipping and storage
Max. rel. humidity:	85%
Space requirements: (DxWxH)	BR-100 40 x 40 x 90cm 15,7x15,7x35,4inch
Load bearing capacity:	At least 18 kg (39,7 lb)
Electrical connection:	230V; 50/ 60Hz (to the extent that corresponding accessories are to be employed)

3.2.3. Unpacking / Inspection

Open the shipping packaging and carefully remove it. Please save all packaging in order to be able to return the unit to the manufacturer in its original packaging, should service be required.

Also remove all other components and accessories and inspect the delivery to make sure it is complete.

Inspect the system for shipping damage such as cracks, scratches, dents, etc.



Warning !

Visible damage!

For safety reasons, never operate the unit if it exhibits visible signs of damage. Contact your local, authorized dealer or BERGHOF Products + Instruments GmbH to obtain the required service (Refer to the "Repairs / Customer Service" section for contact addresses).



Note:

Should any components be missing or damages be detected, contact your local, authorized dealer or BERGHOF Products + Instruments GmbH directly (Refer to the "Repairs / Customer Service" section for contact addresses).

3.2.4. Installation



Warning !

The unit employs low voltage 230V!

Unit must always be carefully connected to a grounded conductor. Provided the wall outlet used is equipped with a ground connection, the supplied power cord will ensure proper connection. If it is necessary to use an extension cord to connect the system to the power supply, only a three-wire cord with a ground connection may be employed.

Repair and servicing of the equipment may only be performed by trained personnel.

Positioning

First, position the accessories, particularly the heating system, if these items were part of your delivery. Install the high-pressure laboratory reactor in the heater and position the complete system on the intended work surface. The work surface must be adequately, statically dimensioned for the weight of the reactor system (refer to the `Ambient Conditions` section).

Installation

The high-pressure laboratory reactor is fully assembled at delivery. All PTFE linings and specified fittings and options have already been installed and mounted. However, you should check them to make sure they have not been jarred loose during shipping. If necessary, retighten any loose fittings.

Connections

The valves can be connected to the required media supply lines (e.g., pressurized gas lines) with ring clamp screw-on connectors. When doing this, first hand-tighten the ring clamp screw-on connection union nut. Then, using the wrench provided, tighten the union nut an additional 1/4-turn. Never tighten these connections by more than 1/4-turn!

A high-pressure hose can be connected to the over-pressure protection (e.g., rupture disc or pressure release valve) to safely dissipate any gases which may be released should the rupture disc be activated.

**Caution****Emissions!**

Should the over-pressure protection (e.g., rupture disc or pressure release valve) activate, gases which may be hazardous to individuals will be suddenly released into the atmosphere. Always make sure the opening of the over-pressure protection is never directed towards individuals. Preferably, a high-pressure hose should be connected to the over-pressure protection to safely discharge the gases.

Secure the reactor against possible recoil should the rupture disc break by, for example, screwing the heating jacket onto the base.

Using the connecting cables provided, connect the accessories as illustrated in Fig. 1. Naturally, this step is not necessary if your delivery does not include accessories or if you have only ordered individual components.

**Note:**

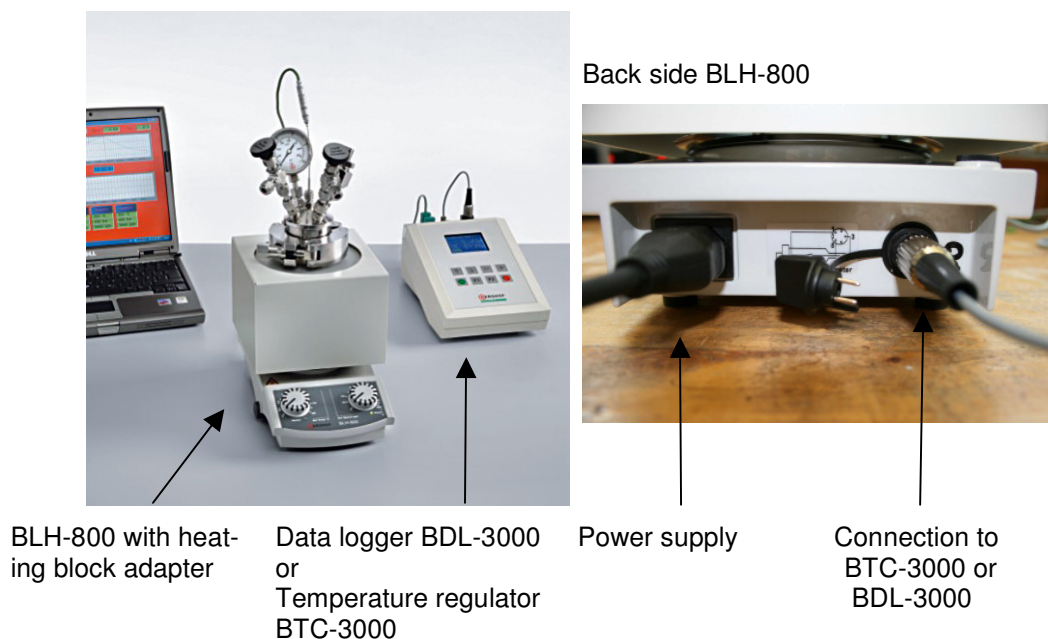
In accordance with §14 of the operational safety ordinance, the operator must perform an inspection prior to commissioning. In other countries in which the unit is set up, corresponding local ordinances regarding such inspections prior to commissioning must be observed.

**Note:**

Users are responsible for assuring that appropriate ventilation of toxic gases is assured. Make sure that all ventilation procedures conform to applicable laws.

The system is now ready for use.

Fig. 1. Reactor heating with Laboratory Hot plate BLH-800

**Caution****Connection BLH-800!**

Power supply of BLH-800 must always be connected to mains. Never connect the power supply of BLH-800 with power outlet of BTC-3000 to prevent any damages on BLH-800.

**Note:**

In case that BLH-800 is controlled by BDL-3000 or BTC-3000 the temperature switch setting of BLH-800 functions as overtemperature protection. Therefore this temperature switch should not be set to higher values than necessary to achieve additional safety. Please select temperature settings on BLH-800 which are approx. 50 °C above requested operational temperature..

Fig. 2a. Connection Temperature controller BTC-3000

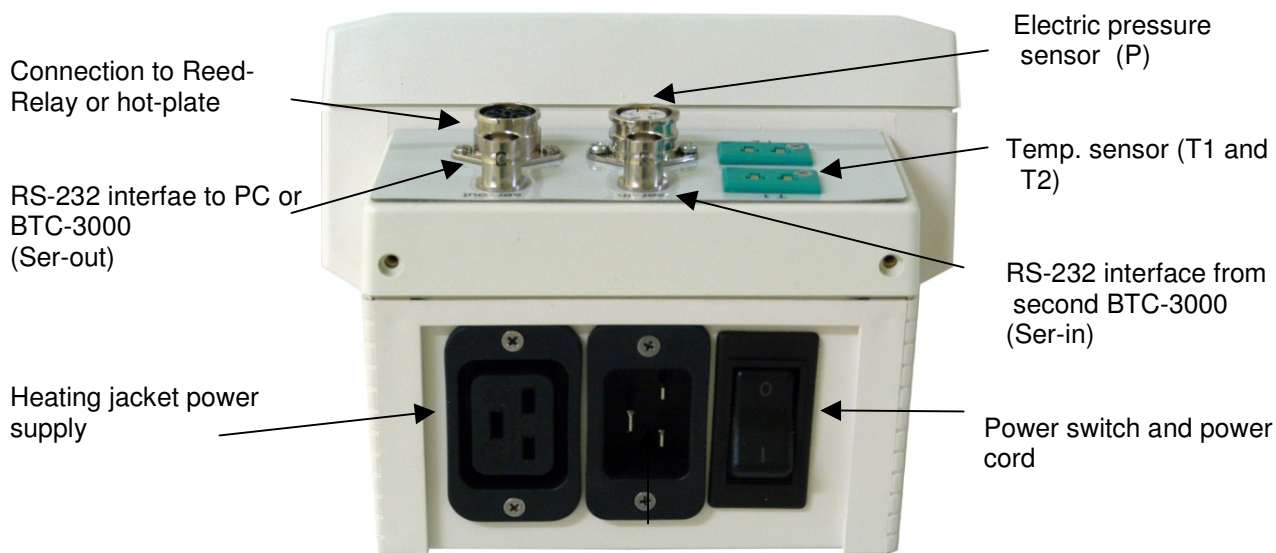
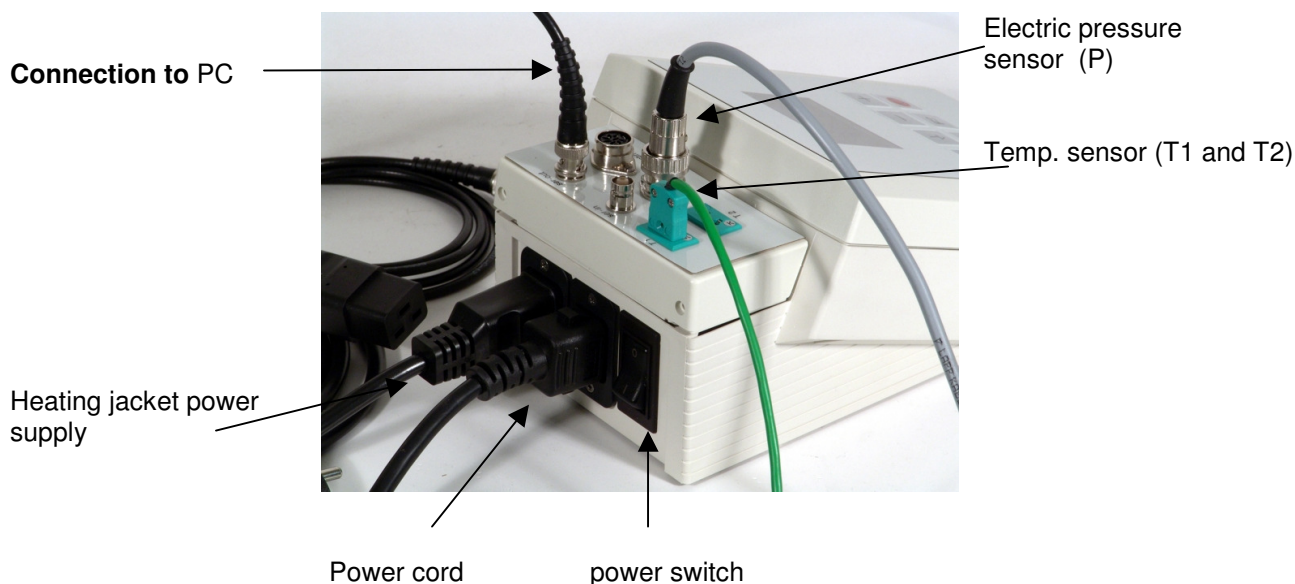


Fig. 2b. Connection Temperature controller BTC-3000 (Standard contact configuration)



Note:

If T2 is not connected to a Temp. sensor, T2 must be short-circuited with the supplied short circuiting-plud (see picture).

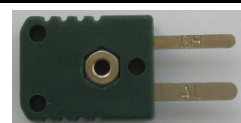
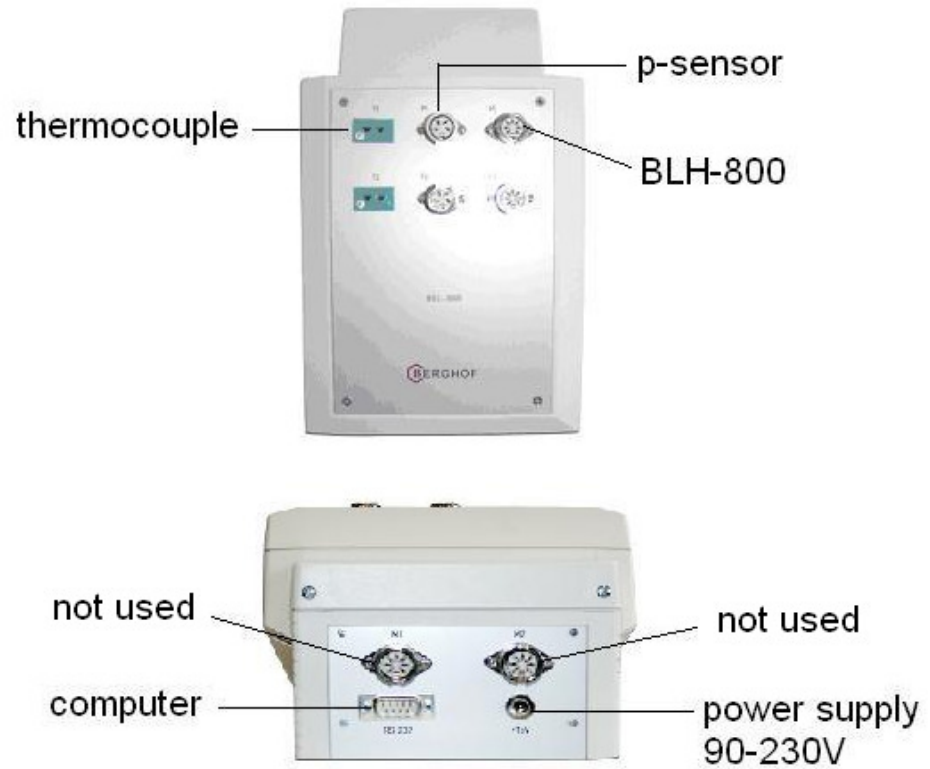


Fig. 3. Connection Temperature controller BDL-3000



4. Operation

4.1. Opening and Closing



DANGER ! Pressure vessel!

Never open the high-pressure laboratory reactor while it is under pressure. Never use force to open the vessel. Never use tools to open the vessel!

Hot gases and vapors can escape from the pressure vessel when it is opened! Always wait until the vessel has cooled to room temperature before opening it.

Always exercise extreme caution when working with toxic substances. Always comply with all relevant spec sheets and safety precautions!



Warning ! General operating instructions!

Pressure vessels must be closed in such a way that all components intended in their design can be properly employed. Sealing surfaces must be clean and undamaged.

Locking screws must be tightened carefully and uniformly and only to the extent required to create a seal. All indicated torque values must be observed.

Locking screws may not be tightened or loosened while the high-pressure laboratory reactor is under pressure.

Wait until the reactor has cooled to room temperature.

Venting

Carefully open the gas sampling valve and allow the excess pressure to slowly vent. Once all gas has escaped and the pressure indicator shows no residual pressure, the high-pressure laboratory reactor is pressure-free. For your own safety, leave the valve open in order to prevent a renewed build-up of pressure.



Note:

A gas blanket between the reactor vessel and the PTFE insert can result in a deformation of the PTFE insert when the reactor is vented too fast. Should such a deformation occur, it can be rectified by filling the autoclave with water and heating it to approx. 180 °C (356 °F), then slowly cooling it down.

Opening (chain clamp) To open the high-pressure laboratory reactor, loosen the screw on the clamping chain, then remove the chain.

Opening (reactor) Should the lock be jammed, gently tap it with a rubber or plastic mallet. The lid can then be removed and the O-ring carefully taken out. Be sure not to damage any components when doing this. Using splayed fingers, slowly lift the PTFE insert out of the reactor.

PTFE insertion If a PTFE insert is employed, it must be inserted into the reactor vessel before the reactor lid is installed. Make sure the insert has been carefully dried in order to prevent the formation of a gas blanket between the reactor vessel and the PTFE insert when the reactor is heated.

**Note:**

A gas blanket between the reactor vessel and the PTFE insert can result in a deformation of the PTFE insert when the reactor is heated. Should such a deformation occur, it can be rectified by filling the autoclave with water and heating it to approx. 180 °C (356 °F), then slowly cooling it down.

Closing (reactor)

Carefully position the O-ring seal on the sealing shoulder before installing the reactor lid.

Locking (chain)

The reactor lid, centered by the guide shoulder, is locked in place by installing the clamping chain and tightening the locking screw with the SW18 wrench provided. Hand tightening this locking screw is completely adequate.

The high-pressure laboratory reactor is now tightly and securely sealed. It should be remembered that during subsequent heating the PTFE in the seal area will also expand and that this increasing pressure will serve to strengthen the seal.

**Note:**

Visually inspect the O-ring before installing it. Deformed O-rings can be returned to their original shape by heating (refer to the `Maintenance and Service` section).

4.2. Filling the Reactor Vessel

**Warning !****Always wear eye protection and protective gloves!**

Always wear safety glasses/goggles and protective gloves during work which may involve contact with chemicals, that is, when working with acids, pressure vessels, during cleaning, etc.!

Reaction material can be added to the PTFE insert either outside the reactor vessel or once it has been placed in the reactor vessel. Note the maximum fill volume (refer to the `Technical Specifications`). Make sure the external walls and seal surfaces stay clean during filling.

Gas addition

If gases are also to be added to the reactor, this is done after the reactor vessel has been sealed, using the appropriate gas injection valves on the reactor fittings. Add gas slowly and carefully in order to avoid a sudden pressure increase in the reactor.

Do not exceed the high-pressure laboratory reactor's maximum permissible operating pressure.

**Note:**

Bear in mind that, in cases of gas generation and exothermic reactions or while heating up the high-pressure laboratory reactor during operation, there will be a resulting pressure increase.

4.3. Operation



Warning ! **Always wear eye protection and protective gloves!**

Always wear safety glasses/goggles and protective gloves during work which may involve contact with chemicals, that is, when working with acids, pressure vessels, during cleaning, etc.!



DANGER ! **Explosion hazard!**

The unit may never be employed without proper over-pressure protection (e.g., rupture disc or pressure release valve).

The unit is not designed for use with compounds and solutions which may generate explosive vapors when heated (e.g., perchloric acid, alcohols, ether, etc.).

Special, grease-free valves must be employed if oxygen is used. Under no circumstances may any grease be subsequently applied to these valves.

Adequate explosion protection must be provided in the immediate vicinity of the high-pressure laboratory reactor whenever flammable substances are employed. Any vapors generated by the flammable liquids which may escape from the over-pressure protection (e.g., rupture disc or pressure release valve) must be safely extracted in accordance with local requirements. This also applies should the rupture disc be activated. If the high-pressure laboratory reactor is set up under an extractor, the latter must be equipped with adequate explosion protection.



Caution **Emissions!**

Should the over-pressure protection (e.g., rupture disc or pressure release valve) activate, gases which may be hazardous to individuals will be suddenly released into the atmosphere. Always make sure the opening of the over-pressure protection is never directed towards individuals. Preferably, a high-pressure hose should be connected to the over-pressure protection to safely discharge the gases.

Secure the reactor against possible recoil should the rupture disc break by, for example, screwing the heating jacket onto the base.

The max. operating pressure up to 150° C (302°F) should lie approx. 10% below the rupture disc's nominal bursting pressure. At temperatures above 150° C (302°F), the max. operating pressure should lie approx. 20% below the rupture disc's nominal bursting pressure.

4.4. Heating and Stirring with the Heating Plate and Heating Block Mount

The high-pressure laboratory reactor is heated and its contents are stirred in the heating block mount designed specifically for this purpose and used in conjunction with a suitable laboratory heating plate. Temperature regulation can take place using either the regulator built into the heating plate or via a PID controller connected externally which can also display the autoclave's interior temperature.

If heat is merely regulated by the heating plate, it must be remembered that the reactor's interior temperature is approx. 15° - 30° (59 - 86 °F) lower than the heating plate temperature. In such cases, we recommend monitoring the interior temperature with the aid of an additional temperature indicator (NiCrNi, type K).

If a Teflon insert is employed, special consideration must be given to the large time lag inherent in the control path when a PID controller is used. The regulator should therefore operated as a purely proportional regulator, that is, the both the lead time as well as the follow-on time must be set to zero (refer also to the manual provided by the manufacturer of the regulator being used). The proportional range (Pb) as well as the maximum heating power must be adjusted based on the set temperature range. The following parameters can be used as guideline values.

T range	Pb (p band)	Y1 (power)
Less than 75°	10°	5 %
75 - 125°	10°	10 %
125 - 175°	10°	20 %
175 - 210°	3°	30 %
Greater than 210°	1°	40 %

If large temperature excesses (>5° – 10°) occur, either the p band must be increased or the power must be decreased. If the continuing setpoint deviation is too large (> 5°), proceed in the reverse manner.

In principle, the autoclave should only be heated when it is under pressure (at least 2 bar) and should remain under pressure until it has cooled off, otherwise the high level of heat expansion to which the PTFE material is prone will result in a deformation of the PTFE insert.

4.5. Gas and Liquid Sampling (Option)



Warning ! Always wear eye protection and protective gloves!

Always wear safety glasses/goggles and protective gloves during work which may involve contact with chemicals, that is, when working with acids, pressure vessels, during cleaning, etc.!

The valves for gas and liquid sampling are appropriately marked. The gas sampling opening opens into the autoclave lid, while the PTFE tube for liquids sampling reaches to the base of the PTFE vessel insert. Connection to the valve is by means of a ring clamp screw-on fitting. An 8 x 1 PTFE tube can be used for sampling at slight excess pressure (max. 5 bar max.). A stainless steel tube must be used at higher pressures. The liquids sampling valve can also be used to transfer the reaction materials to another pressure vessel under pressure.

The sampling valves should always be opened slowly because any attached sampling line should remain as pressure-free as possible.

4.6. Liquid Injection (Option)



Warning ! Always wear eye protection and protective gloves!

Always wear safety glasses/goggles and protective gloves during work which may involve contact with chemicals, that is, when working with acids, pressure vessels, during cleaning, etc.!



Warning ! Pressure Vessel!

Never open the reservoir while Valve 1 or 2 are open. Always vent the reservoir with the vent screw before opening it and always leave the vent screw open!

Once either Valve 1 or 2 is opened, the reservoir may become hot!

Always be careful when adding cold solution to a hot reservoir!

solution (refer to the *'Device Description'*). To do this, proceed as follows:

1. Make sure Valves 1 and 2 are closed.
2. Carefully open the vent screw and allow the excess pressure in the reservoir to vent.
3. Unscrew the reservoir lid, if necessary holding the reservoir with the supplied holder to prevent it from being unscrewed from its base.
4. Add the desired solution, making sure to observe the nominal reactor vessel volume (refer to the *'Device Description'*).
5. Close the reservoir and the vent screw.
6. Open Valve 2 to equalize the pressure between the reactor and the reservoir.
7. Open Valve 1 to allow the liquid to flow into the reactor. Wait several seconds for the transfer to be completed.
8. To check whether the entire solution was correctly injected you can open the

reservoir again by repeating steps 1-4 above. Check whether any solution remains in the reservoir.

There are several reasons why not all the solution in the reservoir was transferred:

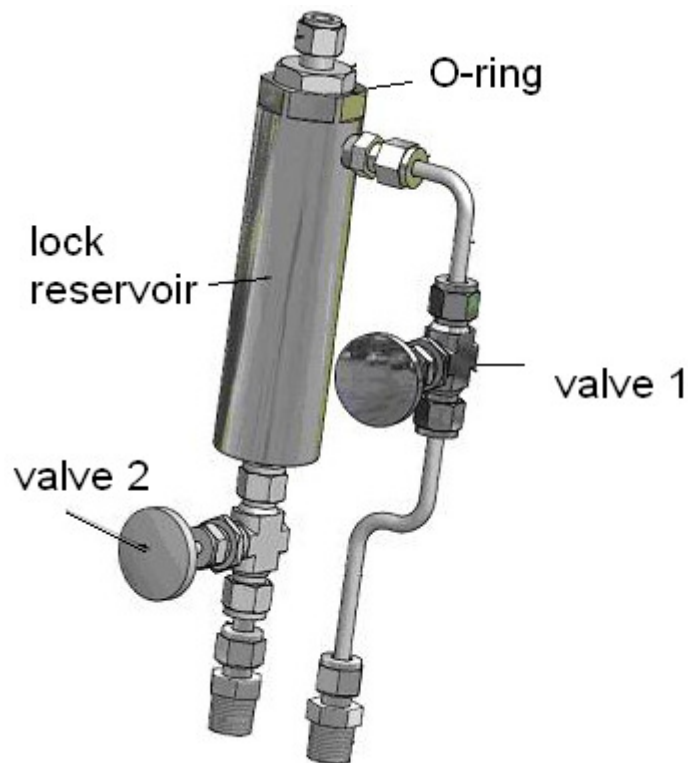
The solution's viscosity is too high. Try again, but increase the waiting time in Step 7.

The pressure could not be correctly equalized. This may be due to a blockage in the pressure equalization line, e.g., as a result of condensation from liquids vaporized in the reactor. Try again, but increase the waiting time between Steps 6. and 7. You can also gently tap against the pressure equalization line and attempt to force the droplets to flow out.



Note:

Please note that simply opening Valve 2 to the cold reservoir can cool the reactor contents by as much as 50°C (122°F).



5. Maintenance, Troubleshooting and Service

All required inspection, maintenance, and repair work must be performed in compliance with the local ordinances.

No damaged components such as stripped, cracked, or broken screws, bent or broken nuts, bent clips or straps, damaged seals, etc. may be reused and must be replaced.

Any repair work which might compromise the safety of the pressure vessel such as welding, hot or cold forming that alter the reactor material properties may only be carried out in compliance with local ordinances.

5.1. Cleaning



DANGER ! Pressure Vessel!

Use only pressure vessels and spare parts authorized by BERGHOF Products + Instruments GmbH for use with the high-pressure laboratory reactor. These can be obtained either from your local dealer or directly from BERGHOF Products + Instruments GmbH (Refer to the *"Repairs / Customer Service"* section for contact addresses).

Never open the high-pressure laboratory reactor while it is under pressure. Never use force to open the vessel. Never use tools to open the vessel!

Hot gases and vapors can escape from the pressure vessel when it is opened! Always wait until the vessel has cooled to room temperature before opening it.

Always exercise extreme caution when working with toxic substances. Always comply with all relevant spec sheets and safety precautions!

The reactor may not be operated without its PTFE insert when working with strong acids (e.g., nitric acid, hydrochloric acid, sulfuric acid, phosphoric acid, hydrofluoric acid). A C4 Hastelloy reactor must always be used where the fittings also require protection against corrosion as is the case, for example, when these types of acids are heated or if gaseous acids are employed.

Perform regular visual inspections of all the high-pressure laboratory reactor's components to detect any damage (corrosion, cracking, etc.).

All applicable legal regulations governing the use of high-pressure reactors must be observed.



Warning ! Always wear eye protection and protective gloves!

Always wear safety glasses/goggles and protective gloves during work which may involve contact with chemicals, that is, when working with acids, pressure vessels, during cleaning, etc.!

In order to ensure the long-term, faultless operation of the reactor and its accessories, various maintenance and inspection tasks should be performed at regular intervals.



Note:

Despite the fact that all the high-pressure laboratory reactor components are manufactured from high-grade stainless steel and the vessel and lid may be lined with PTFE, indications or wear and corrosion resulting from aggressive reaction materials and their vapors cannot be ruled out.

It is therefore essential that the PTFE vessel be cleaned after each use and, if necessary, boiled in a solvent solution. The exterior of the PTFE vessel insert should also be carefully cleaned because, for example, the chloride content of oils and sweat from user's hands promote corrosion on stainless steel (1.4571). The pressure vessel and fittings should also be rinsed off from time-to-time. After rinsing, make sure all components are completely dry before reinstalling them. In particular, there must be no moisture between the PTFE vessel insert and the pressure vessel in order to prevent the formation of gas blankets during subsequent operation.

In order to ensure a proper reactor seal, the seal surfaces in the locking area must be kept clean and smooth. The O-ring should be replaced regularly after several uses. After several thermal load cycles, the fittings should be checked to make sure they are firmly seated and, if necessary, they should be retightened. After being placed under extreme pressure loads several time, the rupture disc may become fatigued, thus altering its activation pressure. This component should then also be replaced. When replacing the rupture disc, do not forget the PTFE foil protecting the disc. The valve threads should also be lightly lubricated from time-to-time.



DANGER ! Explosion hazard!

Special, grease-free valves must be employed if oxygen is used. Under no circumstances may any grease be subsequently applied to these valves.

5.2. Maintenance



Warning ! General operating instructions!

Locking screws must be tightened carefully and uniformly and only to the extent required to create a seal. All indicated torque values must be observed.

Locking screws may not be tightened or loosened while the high-pressure laboratory reactor is under pressure.

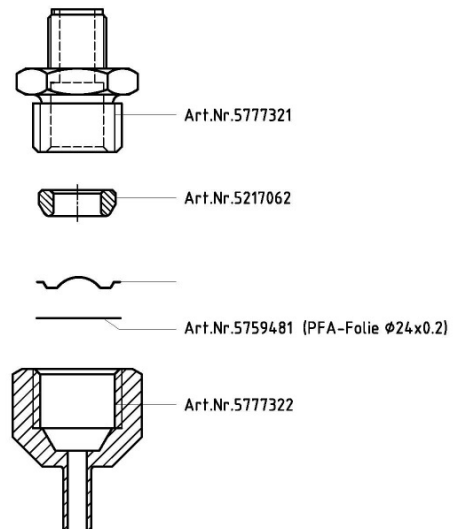
The high-pressure laboratory reactor is to be regularly serviced by competent personnel in order to ensure that it remains hermetically sealed in the long-term under the intended operating conditions and anticipated mechanical, chemical, and thermal loads. Based on the operating instructions and experience, the operator should note the required maintenance and inspection measures in the operating instructions themselves.

In particular, monitoring and ensuring the following are an essential part of the required inspection and maintenance tasks:

- Pressure tightness;
- Ambient conditions and safety zones;
- Identification and other labels;
- Proper operation of all safety and alarm equipment;
- Wall thickness where the unit is subject to corrosion.

Rupture disc replacement

Install a new rupture disc as shown in the illustration on the right. The PFA foil on the inside of the rupture disc serves both as a seal as well as to protect the rupture disc from aggressive media.





Warning ! Use only specified spare parts!

Only rupture discs with a bursting pressure equal to or less than the high-pressure laboratory reactor's maximum operating pressure may be installed in the holder.

Only OEM rupture discs specified by BERGHOF Products + Instruments GmbH for your specific reactor may be used. These can be obtained from your local representative or directly from BERGHOF Products + Instruments GmbH (refer to the "Repair / Customer Service" section for the contact address).

**Component re-
placement**

All components are connected together with ring clamp screw-on connectors. Only the fittings in the reactor lid are screwed in with NPT threads. These fittings are sealed by wrapping them with two or three turns of Teflon strip.

**Assembly of ring
clamp screw-on
connectors**

Ring clamp screw-on connectors consist of a front and a back-ferrule as well as a nut.

Installation:

Insert tubing into the tube fitting till it rests firmly on the shoulder of the tube fitting body.

Tighten the nut finger-tight.

While holding the fitting body steady, tighten the nut 1 ¼ turns with a wrench. (Note: For tube fittings with 2, 3 or 4 respectively 1/16, 1/8 or 3/16 inch tighten the nut ¾ turns only.)

Reassembly:

Insert tubing with pre-swaged ferrules into the fitting body until the front ferrule seats.

Rotate the nut with a wrench to the previously pulled-up position.

Tighten slightly with a wrench (1/4 turns).

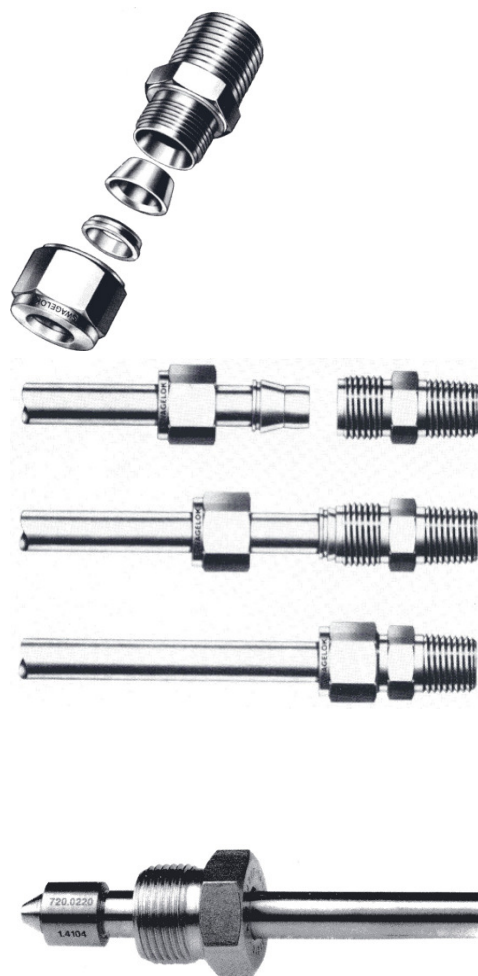
**Assembly of Sitec
high-pressure con-
nectors**

Sitec High-Pressure Tube connectors consist of a gland nut and a threaded collar.

First slide the gland nut on the tubing end and thread the collar fully on the tubing end. Insert this assembly in the connection and handtighten. Tighten the gland nut firmly with a wrench.

**PTFE O-ring
regeneration**

PTFE O-rings will deform after multiple exposures to increased pressure and temperature. They can, however, be returned to their original shape by allowing them to sit in a heating cabinet for 3-4 hours at 300-320 °C (572- 608 °F).



5.2.1. Recurring Inspections

When set up in Germany, the operator of the high-pressure laboratory reactor must have the unit regularly inspected for proper operation in accordance with §15 of the operational safety code. This inspection must be performed at least every 5 years and may only be carried out by certified test centers (TÜV). Within the European Union, operators of BERGHOF high-pressure laboratory reactors can assume this procedure (refer to 'Legal Requirements')

In other nations, all corresponding, applicable, local requirements must be complied with.

5.2.2. Inspection

After each use, the a visual inspection of the reactor's exterior and interior should be performed. No damaged components such as stripped, cracked, or broken screws, bent or broken nuts, bent clips or straps, damaged seals, etc. may be re-used and must be replaced.

If, due to its purpose, the reactor in question falls under the category of a "test autoclave" (refer to the 'Legal Requirements' section for a definition of this term), a pressure test is also required.

To test the pressure tightness of the high-pressure laboratory reactor and its fittings, the reactor system may be filled with pressurized nitrogen and inspected. A leak detecting agent may also be applied to the threads on fittings, but this material must be subsequently carefully removed.

5.3. Troubleshooting

Fault	Possible cause	Corrective action
Pressure loss	Damaged O-rings	Replace the O-rings.
	Deformed PTFE O-ring	Regenerate the PTFE O-ring (refer to the 'Maintenance' section).
	Leaking screw-on connections	Tighten the connection ¼-turn.
-	-	-

You can obtain technical support from your regional BERGHOF dealer or directly from BERGHOF Products + Instruments GmbH by contacting:

BERGHOF Products + Instruments GmbH
 Harretstr. 1
 72800 Eningen / Germany
 Tel: +49/(0)7121/894-202
 Fax: +49/(0)7121/894-300
 e-mail: service@berghof-instruments.de

Please provide your unit's serial number with all repair questions or repair orders. The serial number is located on the nameplate.

5.4. Repairs / Customer Service



Warning ! The unit employs low voltage 230V!

Unit must always be carefully connected to a grounded conductor. Provided the wall outlet used is equipped with a ground connection, the supplied power cord will ensure proper connection. If it is necessary to use an extension cord to connect the system to the power supply, only a three-wire cord with a ground connection may be employed.

Repair and servicing of the equipment may only be performed by trained personnel.

You can obtain technical support from your regional BERGHOF dealer or directly from BERGHOF Products + Instruments GmbH by contacting:

BERGHOF Products + Instruments GmbH
Harretstr. 1
72800 Eningen / Germany

Tel: +49/(0)7121/894-202
Fax: +49/(0)7121/894-300
e-mail: service@berghof-instruments.de

Please provide your unit's serial number with all repair questions or repair orders. The serial number is located on the nameplate.

5.5. Nameplate

Manufacturer symbol



Manufacturer symbol

Material number (DIN)

Serial number

Volume / max. pressure

1.4571 / Serial-No
500ml / 200 bar / 250 °C
BJ. 2003 / PR 330bar

max. pressure / Temperature

Year of construction

test pressure

6. Appendix

6.1. Conversion Table

Temperature	°C =	$(^{\circ}\text{F} - 32^{\circ}) / 1.8$	
	°F =	$1.8 * ^{\circ}\text{C} + 32^{\circ}$	
Length	1 cm =	0.3937 inch	
	1 inch =	2.540 cm	
Volume	1 ml =	0.06102 inch ³	= 2.642*10 ⁻⁴ gallon
	1 inch ³ =	16.387 ml	= 43.29*10 ⁻⁴ gallon
	1 gallon =	3785 ml	= 231 inch ³
Pressure	1 bar =	14.504 psi	= 0.1 Mpa
	1 psi =	0.06895 bar	= 0.0068948 Mpa
	1 Mpa =	10 bar	= 145.04 psi
Weight	1 kg =	2.2046 lb.	
	1 lb. =	0.4536 kg	