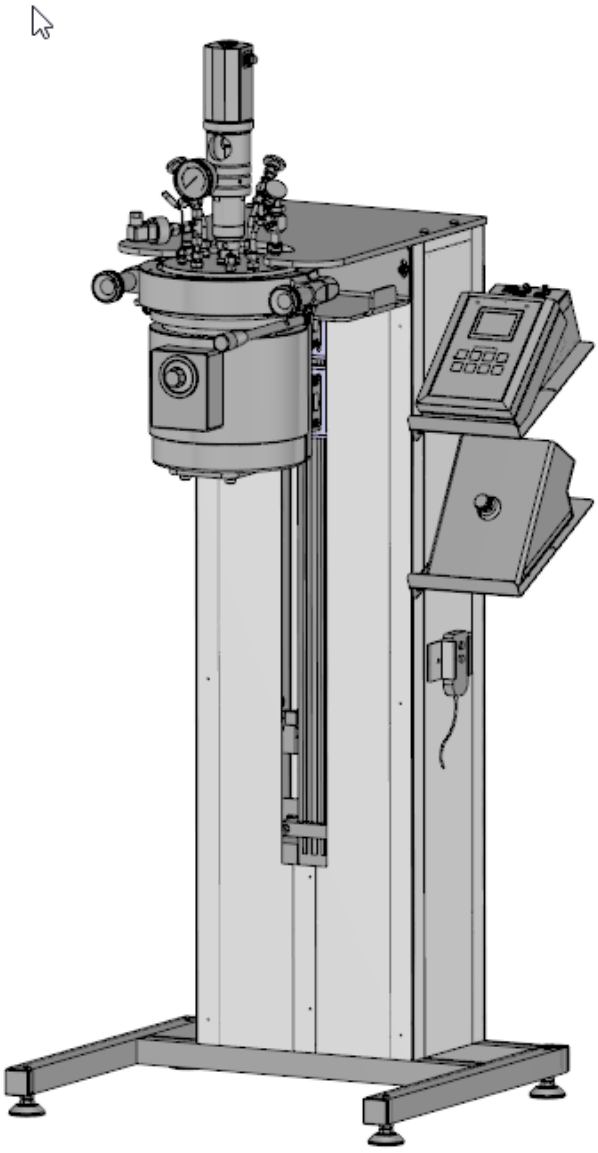
USER MANUAL | VERSION 2.1

# NR-1500, NR-3000, NR-6000, NR-10l NR-20l

s Low pressure reactor



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**Disclaimer**

The content of this publication was checked for compliance with the hardware and software described. However, discrepancies may arise; therefore, no liability is assumed regarding complete compliance. The information in this document will be checked regularly and all necessary corrections will be included in subsequent editions. Suggestions for improvements are always welcome.
Subject to technical changes.

**General Information on this Manual**

- → This user manual describes the microwave pressure digestion system Speedwave4 from Berghof Products +Instruments GmbH. It contains product specific information, current as of the date of publication of this manual.
- → This manual guides the user in the safe and proper use of the Speedwave4 system. 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 representative or Berghof Products + Instruments GmbH.

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.

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Berghof Products + Instruments GmbH works in accordance with DIN EN ISO 9001:2015.

# Document history

| Version | Release date | Author | Changes |
|---|---|---|---|
| 2.1 | 19.12.2023 | M. Edele | WEEE; new service address and telephone number; cleaning recommendation for stainless steel; BRL-1: Update Declaration of Conformity |
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| | | | |

# Contents

# 1. General Notes

Please read this instruction manual carefully before operating your high pressure digestion system. Failure to follow these instructions could result in damage to the equipment as well as personal injury.
Safety instructions are described 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** | DANGER means that failure to follow the safety instructions **is likely to cause** severe personal injury, death or severe property damage. |
| **WARNING** | WARNING means that failure to follow the safety instructions **may cause** severe personal injury, death or severe property damage. |
| **CAUTION** | CAUTION means that failure to follow the safety instructions **may cause** personal injury or some property damage. |
| **NOTICE** | NOTICE indicates a potential situation which, if not avoided may result in property damage. |

## 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 of chemicals.

## 1.3. Proper Use

**DANGER**

**Explosion hazard!**

The unit is not designed for the use with substances / solutions, gas- / liquid mixtures or similar, which can form explosive mixtures and substances under operating conditions. (E.g., perchloric acid, solvent / air mixtures in certain concentrations, 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 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 pressure laboratory reactor or equipment receive proper instruction.

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

The 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 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.

→ Application area

**The 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 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.

**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 the use with substances / solutions, gas- / liquid mixtures or similar, which can form explosive mixtures and substances under operating conditions. (E.g., perchloric acid, solvent / air mixtures in certain concentrations, etc.)

The reactor may not be operated with strong acids (e.g., nitric acid, hydrochloric acid, sulfuric acid, phosphoric acid, hydrofluoric acid).

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 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 pressure laboratory reactor is set up under an extractor, the latter must be equipped with adequate explosion protection.

**DANGER**

**Improper use!**

Should a directly hazardous situation develop while the 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 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 pressure laboratory reactor or its fittings were damaged.

**DANGER**

**Pressure Vessels**

Use only spare parts authorized by Berghof Products + Instruments GmbH for use with the pressure laboratory reactor. These can be obtained either from your local representative or directly from Berghof Products + Instruments GmbH (Refer to the “Repairs / Customer Service” section for contact addresses).

**Never open the pressure laboratory reactor while it is under pressure. Never use force 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). If necessary a Hastelloy reactor is to 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 pressure laboratory reactor’s components to detect any damage (corrosion, cracking, etc.).

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

**WARNING**

**Always wear personal protective equipment!**

Always wear your personal protective equipment during work which may involve contact with chemicals, that is, when working with acids, pressure vessels, during cleaning, etc.!

**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 pressure laboratory reactor’s pressure resistance as well as possibly damaging the seals.

**WARNING**

**Accessories!**

The 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**

**Quenching**

Quenching the container with water or oil, especially under internal pressure, must be strictly avoided!

**WARNING**

**Accessories use low voltage 230V!**

The heating and stirring systems must always be connected to a ground conductor. This is ensured by the included power supply unit, provided that the wall outlet employed is connected to a corresponding ground circuit. 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.

**Repairs and service may only be performed by properly trained and qualified personnel.**

**WARNING**

**Only use approved supply cords!**

Do not exchange the detachable mains supply cord with a cord of inadequate rating. Use only approved and undamaged supply cords.

**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 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.

**Ventilation**

Users are responsible for assuring that appropriate ventilation of toxic gases is assured.

Make sure that all ventilation procedures conform to applicable laws.

# 1.5. Legal Requirements

**DANGER**

The user is responsible for ensuring that the current regulations are complied. The compilation in this chapter is only an overview.

Within the European Union, 2014/68/EU (pressure equipment guideline) and 2014/29/EU (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 Germany) may also apply.

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

## 1.5.1. Recurring inspection, Responsibility for technical inspection, maximum inspection periods according BetrSichV 2015

The laboratory reactor can be operated either as a pressure vessel or as an autoclave. The classification must be carried out by the operator.

**The following applies to pressure vessels:**

| No. | Vessel | Test-group | V, [Liter] | PS, [bar] | PS*V, [bar*Liter] | §15 Examinati-on for commision-ing | §16 Recurring inspections | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Examination of pressure unit | Examination of unit compo-nents | | |
| | | | | | | | | External Inspection | Internal Inpection | Strength Test |
| 1. | NR-1500 | I | 1,80 \| 1,86 | 25 | 45,0 \| 46,5 | | 10 years | 2 years | 10 years | 10 years |
| 2. | NR-3000 | II | 3,50 \| 3,60 | 25 | 87,5 \| 90,0 | | 10 years | 2 years | 10 years | 10 years |
| 3. | NR-6000 | II | 6,92 \| 7,06 | 25 | 173 \|176,5 | | 10 years | 2 years | 10 years | 10 years |
| 4. | NR-10000 | III | 11,4 \| 11,5 | 25 | 284 \| 288 | | 10 years | 2 years | 10 years | 10 years |
| 5. | NR-20000 | III | 20,2 | 25 | 505 | | 10 years | 2 years | 10 years | 10 years |

Table 1: Pressure vessels

Legend:

No test group according to BetrSichV
Person qualified for examination
Approved body according to §11 GPSG

**The following applies to experimental autoclaves:**

| No. | Vessel | Test group | V, [Liter] | PS, [bar] | PS*V, [bar*Liter] | §15 Examination for commisio-ning | §16 Recurring inspections | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Examination of pressure unit | Examination of unit compo-nents | | |
| | | | | | | | | External Inspection | Internal Inpection | Strength Test |
| 1. | NR-1500 | I | 1,80 \| 1,86 | 25 | 45,0 \| 46,5 | 2) | 1) | 2) | 10 years | 10 years |
| 2. | NR-3000 | II | 3,50 \| 3,60 | 25 | 87,5 \| 90,0 | 2) | 1) | 2) | 10 years | 10 years |
| 3. | NR-6000 | II | 6,92 \| 7,06 | 25 | 173 \|176,5 | 2) | | 2) | 5 years | 10 years |
| 4. | NR-10000 | III | 11,4 \| 11,5 | 25 | 284 \| 288 | 2) | | 2) | 5 years | 10 years |
| 5. | NR-20000 | III | 20,2 | 25 | 505 | 2) | | 2) | 5 years | 10 years |

Table 2: Autoclaves

Legend:

| | |
|---|---|
| | No test group according to BetrSichV. |
| 2) | The inspection before commissioning and the recurring inspections can be omitted. However, an inspection by a competent person must be carried out before each usage. |
| | Approved body according to §11 GPSG. |
| 1) | Not a part of the unit that requires monitoring, but examinations in accordance with §14 BetrSichV are required. |

Before **each** usage, the autoclave must be examined by a competent person.

The special risk involved with pressure vessels has led to them being classified in the German Equipment and Product Safety Act (ProdSG) under “systems requiring monitoring”.

Under Section 3 of the BetrSichV 2015, ‘Additional requirements for systems requiring monitoring’:
The operator is to ensure that the result of the inspection and testingare documented according to §§ 15 and 16. If the inspection and testing is done by an approved monitoring office, a certificate of inspection for the result of the inspection is to be requested. At minimum, records and inspection certificates must give information about:

- → System ID
- → Inspection and testing date
- → Type of inspection and testing
- → Basis of inspection and testing
- → Scope of inspection and testing
- → Effectiveness and functioning of the protective measures
- → Result of the inspection and testing
- → Date until next required inspection and testing according to§ 16 paragraph 2.

If the pressure vessel was manufactured in accordance with the national regulations of the countries listed below, the following inspection periods apply.

→ Country specific regulations

| Recurring inspection | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | D | F | B | I | L | NL | GB | S |
| In years | 5* | 1,5-3 | 1-3 | 1-2 | 5 | 4 | 2,17 | 3 |

See Table 1 and 2

Operation of pressure equipment is regulated by the European Union's individual member states. In Germany, this is regulated by the Ordinance on Industrial Safety and Health, 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 pressure laboratory reactors employed within the European Union.

**Regarding competent persons**
The technical regulations for operating safety, TRBS 1203, specify the requirements for the necessary expertise needed by a person qualified under § 2, Abs. 7 BetrSichV.

Vocational training:
For the purposes of this Ordinance, a competent person means a person who has the technical knowledge necessary for inspectioning the work equipment because of his/her vocational training, professional experience and current activity on the job.

Professional experience:
Professional experience requires that the qualified person has used the equipment to be tested and inspected in practice for a proven length of time in a professional environment and knows the functions and operation of it to the necessary extent. Furthermore, there were sufficient occasions to actually undertake the inspections and testing, e.g., as a result of a risk assessment and from daily observation.
Participation in inspections and testing of work equipment has led to an accumulation of experience concerning the performance of the inspections or similar tests, and the necessary knowledge for handling the testing instruments as well as evaluating the test results has been acquired.
Professional experience includes the ability to evaluate whether a recommended testing procedure is suitable for inspecting and testing the work equipment. This also includes detecting hazards involved through the testing activity and the work equipment to be tested.

Recent professional activity:
Recent professional activity in the sense of § 2 Abs. 7 BetrSichV includes activity in the context of the forthcoming inspection and testing as well as adequate training.
The execution of multiple inspections and testing per year (keeping testing skills up-to-date) belongs to recent professional activity.
In the event of lengthier interruptions of the inspection and testing activity, experience in inspection and testing should be renewed and necessary technical skills refreshed by participating in inspection and testing done by other parties.

The competent person must have knowledge about the state of the art regarding the work equipment to be tested and the hazards which might occur and keep this knowledge up-to-date. Familiarity with the operational safety regulations and their technical regulations and other statutory occupational safety regulations (e.g., ArbSchG, GefStoffV) and the associated technical regulations as well as regulations with requirements relating to the properties (e.g., ProdSG, relevant ProdSV), with provisions of the accident insurance carrier and other regulations (e.g., standards, recognized test principles) is required so that the safe state of the work equipment can be properly evaluated.

Additional qualifications for inspecting pressure systems that require monitoring according to Annex 2, Sec. 4, No. 3 BetrSichV:

- → Relevant technical vocational training.
- → At least one-year experience with manufacturing, assembling, operating or maintaining the equipment or system components to be inspected and tested.
- → Current state of knowledge about pressure hazards by participation in a training or instruction.

## 1.5.2. Categories (Test group)

**The pressure equipment referred to in Article 4 (1) of PED 2014/68/EU shall be classified by category in accordance with Annex II to the increasing risk potential.**

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 content product: P x V = [bar x l]; (1 bar x l for gases, this corresponds to approx. 100 Joules)
- → 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.

Pressure equipment is subdivided into the following categories on the basis of this pressure content product and the charging media (fluid):

**Application of the categories of danger according to the CLP regulation**

Assignment of the substance properties to fluid groups:

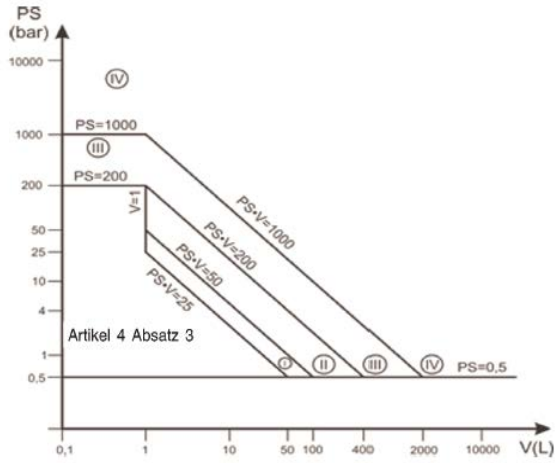
Fluid group 1:

- → explosive substances / mixtures according to Annex I, No. 2.1.
- → flammable gases according to Annex I, No. 2.2.
- → oxidizing gases according to Annex I, No. 2.4.
- → flammable fluids according to Annex I, No. 2.6 (category 3 fluids only if TB> TFl and TFl <55 ° C).
- → pyrophoric fluids according to Annex I, No. 2.9.
- → oxidizing fluids according to Annex I, No. 2.13.
- → Acute toxic substances according to Annex I, No. 3.1.2 Categories 1 and 2.

Fluid group 2: all substances which do not belong to fluid group 1.

**Because the 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, the Berghof pressure laboratory reactors with a volume smaller than 1000 ml 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. 4 Para. 3 (PED 2014/68/EU). Such reactors do not require CE certification and may not carry a CE symbol.




## 1.5.3. TÜV/CE Mark

The minimum requirements for the conformity evaluation procedure can be deduced from this category. Berghof Products + Instruments GmbH 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 directive 2014/68/EU and the AD 2000 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.

## 1.5.4. Operation

**DANGER**

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.

Based on the classification into the above-cited categories, the following obligations arise for the operator § 15 Inspection prior to putting into service, § 16 Recurrent inspections:

→ Operators Responsibilities

- → The recurring inspections of test autoclaves must be performed by an approved body if the product of the maximum permissible pressure, P, and the relevant volume, V, is greater than 100 bar x liter.
- → The recurring inspections must be performed at least every 5 years.

This test includes:

- → Check the documentation (manufacturing documents, test book)
- → Internal inspection (the determination of the actual state, the comparison of the actual state with the desired state, and the evaluation of the deviation of the actual state from the desired state)
- → Functionality
- → Pressure test

**Special test regulations according to BetrSichV Annex 2, Section 4, No. 6.19:**

In the case of pressure vessel and connected pipelines for flammable gases and gas mixtures in liquid state, which are applied to the walls of the vessels and pipelines

- → which have corrosive effect, external tests must be carried out every two years by an approved body
- → which have no corrosive effect, external tests must be carried out every two years by a competent person.

Experimental autoclaves for which the expected pressures and temperatures during experiments are not known with certainty are to be set up in specially protected chambers or behind safety walls so that they are protected from outside exposure and so that employees and others are safe in the event that the experimental autoclaves fail. There are safety precautions in this pressure equipment for experimental purposes which do not help in the event that pressure and temperature becomes excessive. Watching the safety and measurement equipment and operating the experimental autoclaves must be done in a safe place.

Measures for protecting persons have been undertaken to avoid extreme heating by the heat load which could result in failure of the pressure-loaded wall sections, equipment parts relevant for safety and/or supporting components of pressure equipment or its parts.

Protective measures are, e.g.,

- → Safety distance
- → Safety wall
- → Ground cover
- → Fire protection insulation
- → Fixed fire extinguishing systems
- → Sprinkler systems

The recurring inspections of test autoclaves must be performed by an approved body if the product of the maximum permissible pressure, P, and the relevant volume, V, is greater than 100 bar x liter.

# 1.6. Operating regulations and Characteristic Requirements

## 1.6.1. National Regulations, Laws, Ordinance, Technical Rules

- → Ordinance on Industrial Safety and Health concerning the protection of safety and health in the provision of work equipment and its use at work (Ordinance on Industrial Safety and Health - Betriebssicherheitsverordnung–BetrSichV)
- → Hazardous Substances Ordinance (Gefahrstoffverordnung – GefStoffV)
- → Act on making products available on the market (Product Safety Act - Produktsicherheitsgesetz – ProdSG)
- → Fourteenth Ordinance on the Produce Safety Act (Directive 2014/68/EU -Druckgeräteverodnung - 14. ProdSV)
- → TRBS 1201 Part 2: Tests for hazards caused by steam and pressure
- → TRBS 1203: Competent persons
- → TRBS 2141: Risk posed by steam and pressure - General requirements
- → TRBS 2141 Part 3: Risk posed by steam and pressure upon release of media

## 1.6.2. International regulations

- → Directive 2014/68/EU of the European Parliament and of the Council of 15 May 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment
- → Directive 2014/29/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of simple pressure vessels
- → Corresponding national provisions (e.g. ASME for the USA)

## 1.6.3. Applicable Documents

AD 2000 code, in particular:

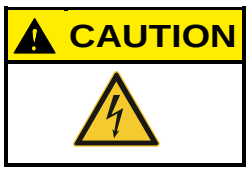
- → Datasheet HP 30: Execution of pressure test
- → Datasheet HP 512 R: Construction regulations - Design examination, final testing and pressure testing of piping

## 1.7. Safety

The Berghof Pressure Laboratory Reactors are tested with overpressure according to AD 2000 code and supplied with respective certificate.

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)




The housing cover may only be removed by authorized trained personnel!

The instrument must be disconnected from the power outlet before being serviced.

# 1.8. Information on Disposal

The product is made of high-quality, recyclable and reusable materials and components.
Correct disposal is essential for environmental protection.

→ Disposal within the EU

**European Union**

Electrical and electronic devices must not be disposed via domestic waste. Berghof Products + Instruments GmbH takes back its electrical and electronic products from business customers for free disposal, raw material recovery and recycling.

Affected products are marked on the type plate with: 

Contact your dealer or Berghof Products + Instruments GmbH directly, if you are intending to dispose of electrical and electronic devices.

The form "WEEE return of old devices" describes the return of old devices. Customers must fill this out and return it with the device. We will be happy to send you the form or you can download it from our website:
https://www.berghof-instruments.com/en/downloads/

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Important note!
Customers wishing to return instrumentation and/or associated materials to Berghof Products + Instruments GmbH or regional dealer are advised that all returned goods must be certified as clean and free from contamination. Therefore, clean and decontaminate your old device before returning it.

**Countries outside the European Union**

→ Disposal outside the EU

Outside the European Union, the relevant regional and local laws regarding proper disposal must be complied with.

**⚠ CAUTION**

**Environmental hazard in case of incorrect disposal!**

This can result in minor or moderate injuries.

1. The device must be disposed of in accordance with the requirements of the European Union.
2. The relevant regional and local laws regarding proper disposal must be complied with.
3. To ensure proper disposal, you can contact Berghof Products + Instruments GmbH.

# 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 loses 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.

## 1.9.1. Caveat emptor

Berghof Products + Instruments GmbH does not accept any warranty for wearing parts (e.g. seals, bearings, glas components on pH electrodes), for the improper usage, storage and handling.

# 2. Device Description

## 2.1. Basic Instrument

The 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), Hastelloy C-4, Hastelloy C-276, Hastelloy C-22 or/and isostatically compression-molded PTFE / 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 pressure laboratory reactor can be found in the device documentation provided with the unit.
At minimum, each 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 NiCrNi thermocouples or PT-100 sensor, as well as
- → Accessories (heater with temperature control, stirrer, etc.) possibly

The 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.

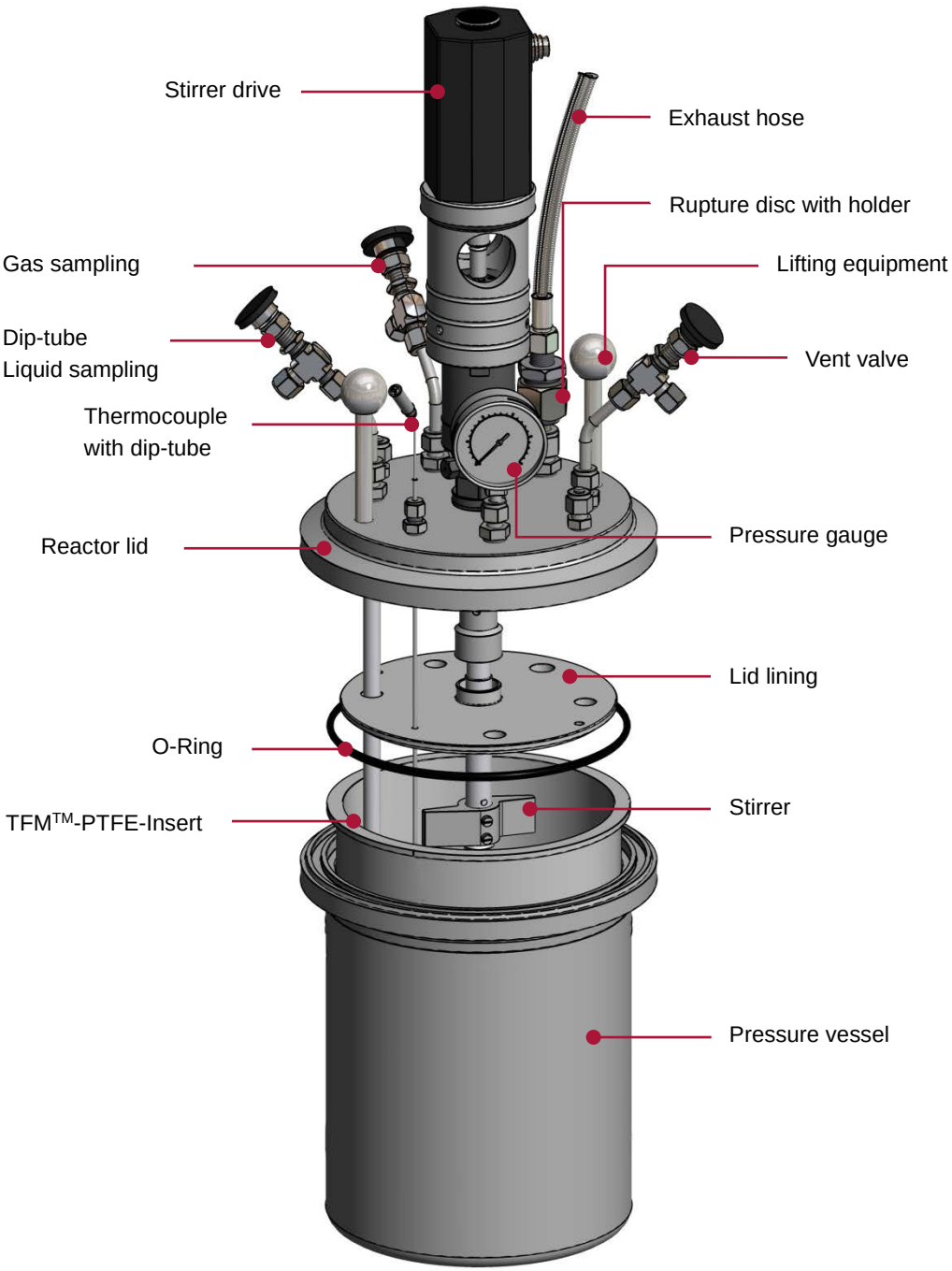
The pressure laboratory reactor has been designed, constructed, and tested in accordance with the 2014/68/EU device guideline according to the AD-2000 body of rules.

**Accessories**
The BTC-1000 or BTC-3000 Controllers are available to regulate the heating systems and thus the temperature of the laboratory reactor. Connections for Type K-thermal elements (NiCr-Ni) are provided as the standard sensor input. Heating power (up to a maximum of 3,000 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.

**Options**
Liquid sampler with immersion tube; nominal diameter = 5.0 mm

- → Gas sampler
- → Electric pressure recorder and measurement data acquisition (0- 250bar; detection accuracy: +/- 0.5%; output signal 4-20mA)
- → and far more in inquiry

# Reactor


Stirrer drive
Exhaust hose
Rupture disc with holder
Gas sampling
Lifting equipment
Dip-tube
Liquid sampling
Vent valve
Thermocouple
with dip-tube
Reactor lid
Pressure gauge
Lid lining
O-Ring
Stirrer
TFM™-PTFE-Insert
Pressure vessel

## 2.1.1. Technical Specification

**Low pressure reactor**

| Reactor | | | | | |
|---|---|---|---|---|---|
| **NR-Series** | **NR-1500** | **NR-3000** | **NR-6000** | **NR-10000** | **NR-20000** |
| **Pressure vessel** | | | | | |
| Material | Stainless steel: 1.4571 (AISI 316Ti)<br>Hastelloy®: 2.4602 (C-22)<br>optionally with PTFE-lining and PTFE-insert | | | Stainless steel: 1.4571 (AISI 316Ti)<br>Hastelloy®: 2.4602 (C-22) | |
| Height without bottom drain valve | 180mm | 320 mm | 261 mm | 412 mm | 412 mm |
| Height with bottom drain valve | 186,4 mm | 334,4 mm | 270,5 mm | 419,5 mm | 452 mm |
| Exterior dimensions (Ø) | 133 mm | 133 mm | 208 mm | 208 mm | 273 mm |
| Volume without bottom drain valve | 1800 ml | 3590 ml | 6930 ml | 11370 ml | 20019 ml |
| Volume with bottom drain valve | 1860 ml | 3620 ml | 7070 ml | 11510 ml | 20216 ml |
| Volume PTFE-Lining | 1500 ml | 3040 ml | 5890 ml | --- | --- |
| Max. fill volume | max. 80 % of volume | | | | |
| Max. permissible temperature*<br>(Operating temperature | -40 … +300 °C (-40 … +572°F) without PTFE-Insert<br>-40 … +230 °C (-40 … +446°F) with PTFE-Insert | | | -40 … +300 °C without PTFE-Insert | -40… +250°C without PTFE-Insert |
| Max. permissible pressure**<br>(Operating pressure) | max. 25 bar | | | | |
| **Seal** | | | | | |
| Material | TFM™-PTFE, Viton®, Kalrez® | | | | |
| **Lid** | | | | | |
| Material | Stainless steel (1.4571, SS 316Ti) optional with PTFE Lining | | | | |

* The operating temperature is limited by PTFE parts (e. g. vessel insert, dip tube), the fittings, the seals and the heating systems used

** The operating pressure is further limited by the inserted rupture disk, the tolerance of the rupture disk, as well as the used fittings such as e.g. pressure gauge.

Each laboratory reactor is subjected to a pressure- and leakage test and is delivered with a corresponding inspection certificate.
For more information, please refer to the accompanying documents, such as test and inspection certificates, declaration of conformity and material certificate.

**NOTICE**

**Maximum permissible temperature!**

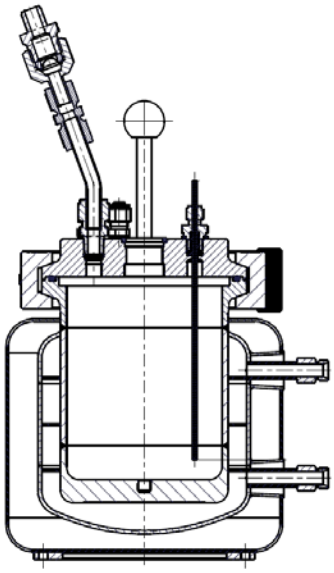
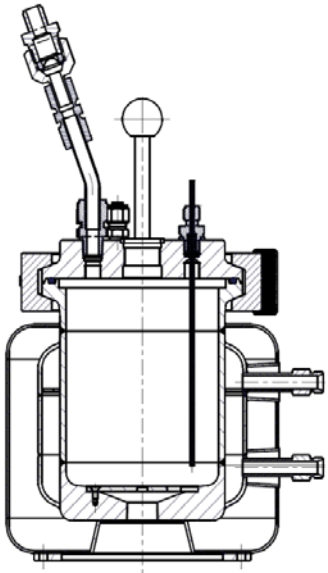
During operation of the laboratory reactor with PTFE-Lining, the maximum allowable temperature is reduced to 230 °C. The maximum permissible temperature is also reduced depending on the seal and fittings used.

The maximum allowable temperature is depending on the type of heating and the used fittings.

## 2.2. Heating

### 2.2.1. Reactor Set

The low pressure reactors NR-1500, NR-3000, NR-6000, NR-10000 and NR-20000 are optionally offered as a reactor set with welded-on and isolated jacket for heating or cooling with circulation thermostat.
All reactor sets are available with or without bottom drain valve.

| Technical Data | | |
|---|---|---|
| **Isolated jacket** | **SS J** | **SS J BV** |
| Bottom drain valve | without | with |
| |  |  |
| Material | 1.4301 (SS 304) | 1.4301 (SS 304) |
| Connection | M16 x 1 | M16 x 1 |

## 2.2.2. Electric Jacket Heater for NR-Reactors (NHM)

Suitable for all NR-Reactors without welded-on and isolated jacket.
For accurate temperature control the Berghof BTC-1000 or BTC-3000 is required.

| Technical Data | | | | |
|---|---|---|---|---|
| **Electric Jacket Heater** | **NHM-1500** | **NHM-3000** | **NHM-6000 NHM 10 l** | |
| Material | Stainless steel with powder coating | | | |
| Interior diameter | 133 mm | 133 mm | 208 mm | |
| Operating temperature | 50 – 320 °C | 50 – 320 °C | 50 – 320 °C |  |
| Heating power | 3 KW | | | |
| Current | 16 A | | | |
| Overtemp. protection | NiCr/Ni Temperature sensor | | | |
| Connection | C 20 | | | |

## 2.2.3. Safety information on the unit

**Electric Jacket Heater (NHM)**

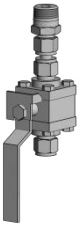
**Warning of hot surface, risk of burns!**
This safety information is located on the temperature regulator.


**Turn off the main switch before opening the housing!**
This safety information is located on the temperature regulator.

# 2.3. Valves

## 2.3.1. Bottom outlet valve

To drain the contents of the Berghof Laboratory reactors, between two variants of bottom outlet valves can be chosen.

| Bottom outlet valve | | |
|---|---|---|
| | **Ball valve** | **Zero-dead volume valve** |
| |  |  |
| Material | SS 1.4571 | SS 1.4408 / 1.4401 |
| Nennweite | 12 mm | G ½ " Internal thread |

## 2.3.2. Gas and Liquid Sampling

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 dib-tube reaching to the base of the reactor.
It is advisable to connect appropriate collecting systems or tubing's. (see Assembly of ring clamp screw-on connectors (`Maintenance and Service´)

| Technical Data | | | |
|---|---|---|---|
| **Gas- and liquid sampling** | **SS 1.4571** | **Hastelloy** | |
| Max. Temperature at the valve | 230 °C (446 °F) | |  |
| Max. pressure | 200 bar (2900 psi) | | |
| Nominal width | 6 mm | 2 mm | |
| Material dip tube | SS 1.4571 or PTFE | Hastelloy or PTFE | |

**NOTICE**

**Maximum allowable temperature!**

During operation of the laboratory reactor with PTFE-Lining, the maximum allowable temperature is reduced to 230°C (446 °F).

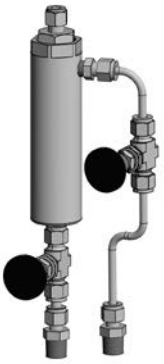
The maximum permissible temperature is also reduced depending on the seal and fittings used.

The maximum allowable temperature is depending on the type of heating and the used fittings.

## 2.3.3. Liquid Injection under Operating Pressure

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:

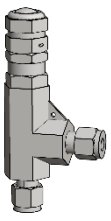
- → Reservoir
- → Plug valve for the addition of the liquid to the reactor from the reservoir (Valve 1)
- → Needle valve for creating pressure equalization with the reactor (valve 2). Alternatively, the pressure equalization or overpressure in the reservoir can also take place via inert gas (e.g. nitrogen). For this purpose, valve 2 is not connected to the reactor, but to the corresponding gas supply.
- → 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 Data | | |
|---|---|---|
| **Liquid Injection** | | |
| Nominal volume | ≤ 50 ml |  |
| Material | stainless steel (1.4571, SS 316Ti) | |
| Max. temperature | 204 °C (399 °F); Viton O-Ring | |
| Max. pressure | 245 bar (3553 psi) | |
| Nominal width | 4 mm (0,16 inch) | |

## 2.3.4. Overflow Valves

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!**<br>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 overpressure protection. |
| **CAUTION** | The media guide must not be impeded; this means there should be no back pressure. |
| **CAUTION** | **Exception**<br>In order to operate a reactor with an overflow valve as the sole overpressure protection, the setting and integrity of seals must be performed as e.g. TÜV by a notified body. |
| **DANGER** | The overflow valves must be checked regularly for their function; In the case of experimental reactors, before each experiment. |

| **Technical Data** | | |
|---|---|---|
| **Overflow valves** | **SS 1.4571** | |
| Max. Operating temperature | ≤ 120°C (248 °F) | |
| Relief pressure according colour indication (Swagelok)<br>Blue<br>Yellow<br>Violet<br>Orange<br>Brown | <br>3,4 - 24 bar (49,3 – 348 psi)<br>24 - 52 bar (348 - 754 psi)<br>52 – 103 bar (754 – 1494 psi)<br>103 – 155 bar (1494 – 2248 psi)<br>155 – 206 bar (2248 – 2988 psi) |  |
| Max. operating pressure | 413 bar (5990 psi) | |
| Nominal width | 3,6 mm | |
| Material for sealing | Viton® | |

Since the seals of the overflow valves tend to stick, the overflow valves must be checked regularly for their function. For test reactors, a test must be carried out **before each** test. (see chapter Maintenance)

## 2.4. Control units

### 2.4.1. Temperature Controller BTC-1000

The Berghof Temperature Controller BTC-1000 is operated via a touch screen. Capacity regulation takes place via a PID controller. The PID controller can be configured by the customer.
The built-in data logger allows the parameters to be documented on a PC.
For further information, see BTC-1000 user manual.

### 2.4.2. Temperature Controller BTC-3000

The easy-to-use Berghof temperature controller unites all control and regulating parameters in a single, compact unit. All process parameters are easily accessible. The built-in data logger allows the parameters to be documented on a PC.
For further information, see BTC-3000 user manual

### 2.4.3. Datalogger BDL-3000

The data logger BDL-3000 can also serve to document temperature and pressure progressions of 2 Berghof high pressure reactors. Optionally, the system is also available for up to 8 reactors.
For further information, see BDL-3000 user manual.

### 2.4.4. Stirring systems BRM

The Berghof BRM stirring systems consist of stirrer drive, magnetic clutch, their speed controllers and various stirrers.
For further information, see BRM user manual.

# 3. Setup and Commissioning

## 3.1. Standard Delivery

Because of the modular nature of the 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. Transport and Storage

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

## 3.3. Ambient Conditions

Pressure equipment must be set up in such a 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 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
- → Possible openings such as the overpressure protection or valves do not endanger persons.

| ⚠ DANGER | 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 conditions | |
|---|---|
| Ambient temperature | +10°C (50°F) to +40°C (104°F) during operation<br>-40°C (-40°F) and +70°C (158°F) during shipping and storage |
| Max. rel. humidity | 85% |
| Space requirements | Depending on reactor size and configuration |
| Load bearing capacity | * |
| Electrical connection | 230 V; 50/ 60 Hz |

*Due to the modular nature of the laboratory reactor, no general load bearing capacity can be given. Therefore, please refer to the shipping documents.

## 3.4. Unpacking and 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 representative or Berghof Products + Instruments GmbH to obtain the required service (Refer to the “Repairs / Customer Service” section for contact addresses).

**NOTICE**

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

## 3.5. Installation

The pressure laboratory reactor is fully assembled at delivery. All PTFE linings 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. See chapter 6.2.4 Quick Connects.

**WARNING**

**Accessories use low voltage 230V!**

The heating and stirring systems must always be carefully connected to a ground conductor. This is ensured by the included power supply unit, provided that the wall outlet employed is connected to a corresponding ground circuit. If an extension cord must be used to connect the system to the mains power supply, make sure it is a 3-wire cord with a ground wire.

**Repairs and service may only be performed by properly trained and qualified personnel.**

### 3.5.1. Connections on the reactor

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, tighten the union nut an additional ¼-turn. Never tighten these connections by more than ¼-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.

**NOTICE**

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

**NOTICE**

Users are responsible for assuring that appropriate ventilation of toxic gases is assured.

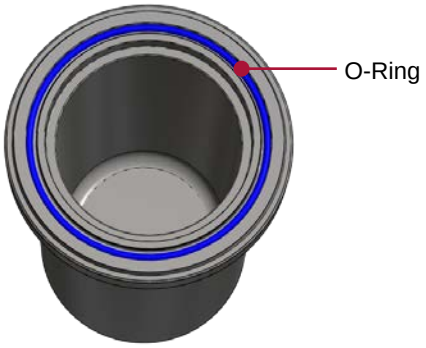
Make sure that all ventilation procedures conform to applicable laws.

## 3.5.2. O-Ring

Depending on the reactor configuration different sealing variants are used.

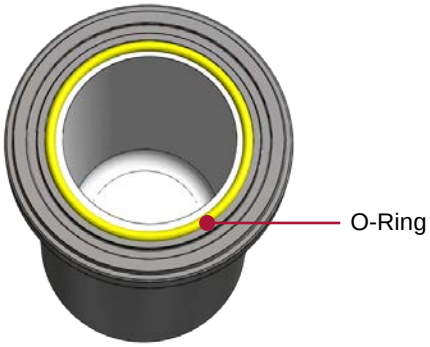
→ Seal variants

**Reactor without PTFE-Insert**




When operating the pressure reactor without PTFE Insert, the O-ring is inserted into the groove of the reactor flange.

**Reactor with PTFE-Insert**

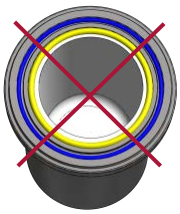



If the high-pressure reactor is operated **with** a PTFE-Insert, **only** the PTFE O-Ring may be used for sealing.
For this purpose the PTFE O-Ring is placed on the lid edge of the PTFE-Insert.

**HINWEIS**

**Insert O-Rings**

When using the reactor with a PTFE insert, both sealing variants must not be used simultaneously.



## 3.5.3. Heating systems

**WARNING**

**Accessories use low voltage 230V!**

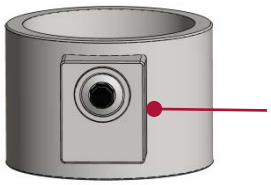
The heating and stirring systems must always be connected to a protective grounding conductor.

The enclosed power cable ensures the grounding, given that the socket outlet is equipped with a protective grounding conductor. 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.

**Repairs and service may only be performed by properly trained and qualified personnel.**

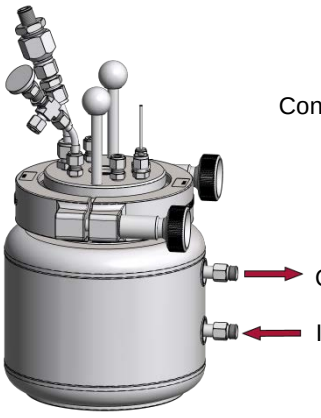
Using the connecting cables provided, connect the accessories as illustrated in BRM, BTC-1000, BTC-3000 or BDL-3000 manual. Naturally, this step is not necessary if your delivery does not include accessories or if you have only ordered individual components.

**Installation mit NR Heizmantel (NHM)**



Connection to BTC- 1000 or BTC-3000

**Installation des NR-Reactor Set**



Connection to heating and cooling

Outlet

Inlet

**NOTICE**

The thermostatic jacket must be flushed before commissioning in order to avoid contamination of the heating and cooling systems.

# 4. Operation

## 4.1. Opening and Closing the reactor

**DANGER**

**Pressure vessel!**

Never open the high-pressure laboratory reactor while it is under pressure. Never use force 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.

Use an exhaust system.

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.

Only open pressure vessels in vertical position.

The maximum filling volume must not be exceeded.

**WARNING**

**Always wear personal protective equipment!**

Always wear your personal protective equipment during work which may involve contact with chemicals, that is, when working with acids, pressure vessels, during cleaning, etc.!

**Cooling**

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.

## 4.1.1. Opening the Safety Lock

**DANGER**

**Mounting the LC-Key**

The correct mounting of the opening key to the provided media connection is safety-relevant. The Lock Clamp may only be opened with the LC-Key provided. The removal of the LC-Key from the media connection on the reactor lid ensures that the reactor is pressureless when the Lock Clamp is opened. The LC-Key must not be affected by other components, such as a combination fitting with valves.

**DANGER**

**Emissions**

When the opening key is unscrewed, if applicable hazardous gases can escape through the lateral bore or the thread!

**DANGER**

**Adhesions of dangerous substances**

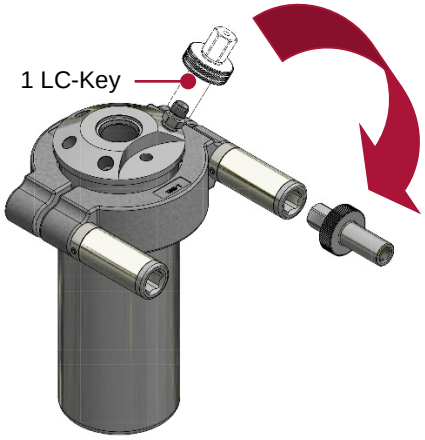
Dangerous substances may adhere to the media connection of the LC-Key! Clean the LC-Key after unscrewing. Wear personal protective equipment.

Before opening the safety lock, the opening key (LC-Key) has to be removed from the pressure system first. This guarantees that the container will be depressurized when it is opened. This LC-Key is mounted on the lid and integrated into the pressure system. The LC-Key is built into the tee part or a screw connector. To be able to open the left / right hand screw and therefore the entire Lock Clamp, this opening key (the forced depressurization mechanism) is needed to unlock them. The LC-Key is inserted into the hand screw to permit the hand screw to be removed.
The LC-Key ensures that the Lock Chain can only be opened when the pressure vessel is completely depressurized.

**Procedure remove LC-Key**
check by means of a pressure gauge (e.g. manometer) whether the reactor is pressureless
vent the reactor via vent valve
recheck the pressure

Only when the reactor is pressureless:
slowly unscrew the LC-opening key (1) by manually turning on the knurling. Should a gas leak be audible, vent the reactor first via the pressure relief valve. In such a case do not turn the (1) LC key further

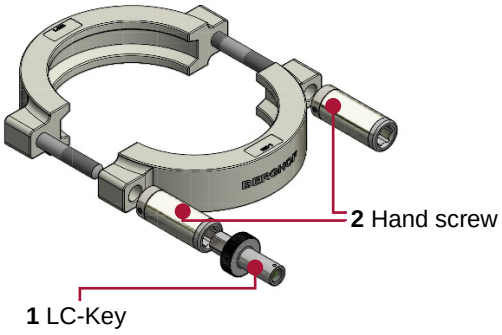
remove (1) LC-Key



**Procedure Open Lock Clamp:**

→ The pressure-free reactor is opened on the Lock Clamp, using the LC-Key (1) by evenly loosen both hand screws (2). (This means alternately and in small increments). In doing so, hold the back half tightly.

→ Pull out forward the front half of the Lock Clamp




## 4.1.2. Opening the Lock Chain

| | |
|---|---|
| DANGER | **Mounting the LC-Key**<br>The correct mounting of the opening key to the provided media connection is safety-relevant. The Lock Clamp may only be opened with the LC-Key provided. The removal of the LC-Key from the media connection on the reactor lid ensures that the reactor is pressureless when the Lock Clamp is opened. The LC-Key must not be affected by other components, such as a combination fitting with valves. |
| DANGER | **Emissions**<br>When the opening key (LC-Key) is unscrewed, if applicable hazardous gases can escape through the lateral bore or the thread! |
| DANGER | **Adhesions of dangerous substances**<br>Dangerous substances may adhere to the media connection of the LC-Key! Clean the LC-Key after unscrewing. Wear personal protective equipment. |
| GEFAHR | **Danger of crushing fingers when putting down the Lock Chain** |

Before opening the safety lock (1), the opening key (LC-Key 3) must first be removed from the pressure system. This guarantees that the container is depressurized when it is opened. This LC-Key is mounted on the lid and integrated in the pressure system. The LC-Key is built into the tee part or a screw connector (4). In order to be able to open the hand screw (2) and thus the entire Lock Chain by swiveling out the lock, this opening key (forced ventilation device) is required as an unlocking key. The LC-Key is inserted into the hand screw and so the hand screw can be loosened. Only after approx. 7 to 8 turns (unhooking protection) can the lock be swiveled outwards and the chain ends unhooked.
The LC-Key is sealed with a PTFE sealing washer and can be screwed on and off by hand without tools.

The LC-Key is provided with a cross hole Ø3 mm on the cylindrical surface as a relief hole.
The LC-Key ensures that the Lock Chain can only be opened when the pressure vessel is completely depressurized.

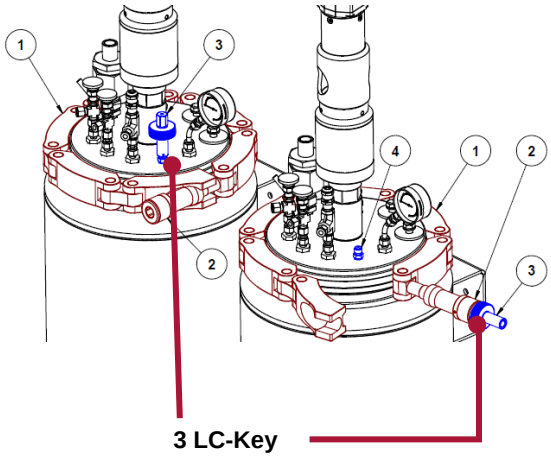
**Procedure remove LC-Key:**

→ check by means of a pressure gauge (e.g. manometer) whether the reactor is pressureless
→ vent the reactor via vent valve
→ recheck the pressure

Only when the reactor is **pressureless**:

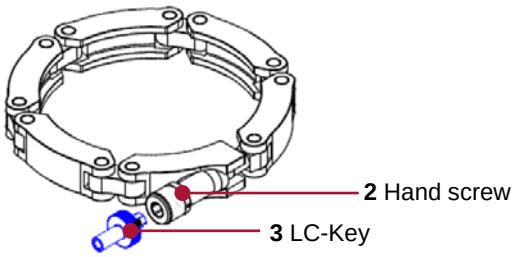
→ slowly unscrew the LC-Key (3) by manually turning on the knurling. Should a gas leak be audible, vent the reactor first via the pressure relief valve. In such a case do not turn the (3) LC-Key further

→ remove LC-Key (3)




**Procedure Open Lock Chain:**

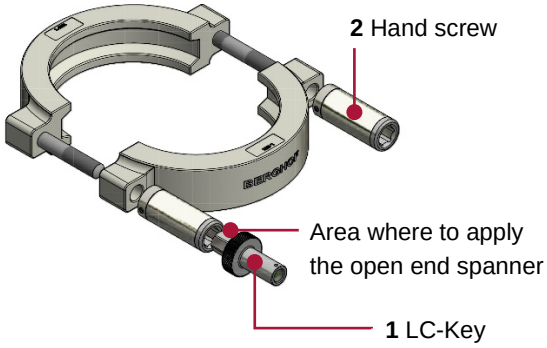
→ The pressureless reactor is opened with the LC-Key (3) by opening the hand screw (2) of the Lock Chain.
No tools other than the LC-Key may be used!
→ Unhook the chain lock and carefully put the chain down. Caution, risk of crushing!




## 4.1.3. Closing the Safety Lock

**Procedure Close Lock Clamp:**

→ place the back part of the Lock Clamp around the reactor and reactor lid
→ stick the front part of the Lock Clamp on the setscrew while holding back the rear Lock Clamp
→ screw in both hand screws (2) evenly with the LC-Key (1) alternating between the two gradually and tighten both hand screws hand-tight*
→ both Lock Clamps must be parallel. The gap between the two clamping rings left and right must be the same.
→ assemble the LC-Key (1) to the provided media connection

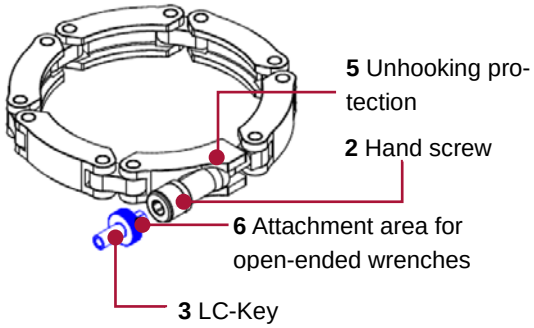


* Depending on the seal used, a higher tightening torque may be required. If necessary, use an open end spanner (SW 18) for assistance. This can be applied on the hexagon socket of the LC-Key.
For FKM and FFKM a tightening torque of appr. 2 Nm is required (= hand-tight)

## 4.1.4. Closing the Lock Chain

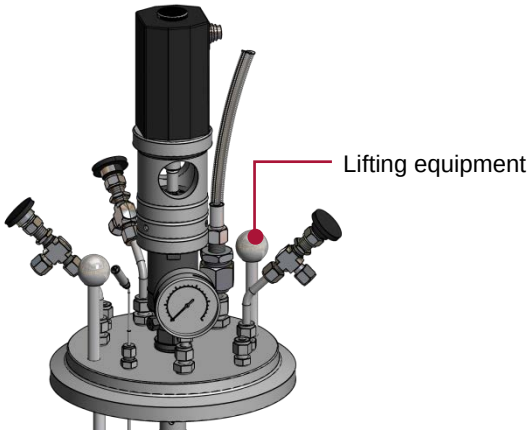
**Procedure Close Lock Chain:**

- → Place the Lock Chain around the reactor and reactor lid. The contact surfaces (link cheeks, screw thread and hand screw contact surface) must always be well lubricated, e.g. with graphite lubricant.
- → Hook the chain fastener into the unhooking protection (5) at the open end of the chain.
- → Screw the hand screw (2) into the unhooking protection (5) with the LC-Key (3). Make sure that the Lock Chain sits securely on the reactor flange all around (by shaking movements).
- → Use the LC-key (3) to screw the hand screw into the unhooking protection (5). Then hand-tighten. Check the correct fit by shaking the chain and then tighten it with the LC-Key. The hand screw must sit firmly in the unhooking protection, it must no longer be possible to unhook it.
- → Slightly remove the opening key and tighten the now visible wrench size (6) with a fork wrench (Width across flats 18) until a significant increase in force can be felt.
- → Mount the LC-Key on the media connection provided (4) (see “Opening the tension chain”).




## 4.1.5. Lifting equipment (NR-Type)

After the quick-lock chain is removed the lid can be lifted by means of the Lifting equipment.



### 4.1.6. PTFE-Insert

If a PTFE insert is employed, make sure the PTFE-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.

| NOTICE | A gas cushion between the PTFE-Insert and the pressure vessel can lead to a deformation of the PTFE-Insert during the heating process. Should such a deformation have occurred, this can be reversed by heating the reactor with the water-filled PTFE-Insert to about 180 ° C (356 ° F.) and subsequent slow cooling. |
|---|---|

### 4.1.7. O-Ring

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

Depending on the reactor configuration different sealing variants are used.
See chapter Installation, 3.5.2 O-Ring

## 4.2. Filling the Reactor Vessel


**Always wear personal protective equipment!**

Always wear your personal protective equipment during work which may involve contact with chemicals, that is, when working with acids, pressure vessels, during cleaning, etc.!

Pay attention to the maximum filling quantity (see **Fehler! Verweisquelle konnte nicht gefunden werden.**2.1.1 Technical Specifications).
An excessively high filling quantity in the case of liquids can produce a very high hydraulic pressure as a result of the thermal expansion, which leads to the rupture disk being triggered.

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.


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

**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 the use with substances / solutions, gas- / liquid mixtures or similar, which can form explosive mixtures and substances under operating conditions. (E.g., perchloric acid, solvent / air mixtures in certain concentrations, 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.

**WARNING**

**Always wear personal protective equipment!**

Always wear your personal protective equipment during work which may involve contact with chemicals, that is, when working with acids, pressure vessels, during cleaning, etc.!

**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 lay 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.
The rupture disc's nominal bursting pressure can be found in the supplied test reports.

## 4.4. Heating

| NOTICE | **Maintain maximum internal temperature!**<br>Do not exceed the maximum interior temperature of 230° C (446°F) when using a PTFE-Insert. |
|---|---|

The reactor is heated in the heating jacket designed for this purpose and into which the pressure vessel has been carefully inserted, without tilting. In general, the thermal sensor in the reactor provides the actual value signal for the temperature regulator.

| NOTICE | **PTFE-Insert**<br>In principle, the high-pressure laboratory reactor should only be heated when it is under pressure (at least 10 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. |
|---|---|

| NOTICE | **Overtemperature protection**<br>The heating jacket is equipped with an adjustable over-temperature protection which prevents a jacket temperature of 320° C (608°F) from being exceeded. |
|---|---|

**Temperature Control**

A special procedure is required to regulate the temperature of autoclaves with a PTFE insert due to the very slow reaction time of the regulating path. Recommended regulating PID parameters can be found in the corresponding manuals.

## 4.5. Stirring

The stirrer speed can be adjusted with the selector switch on the control unit. The selected stirrer speed must be based on the medium in the autoclave, in other words, a lower speed must be selected for viscous media. To check the system, the stirrer can be observed with the high-pressure laboratory reactor's lid open and the most appropriate speed can be noted. In general, too high a speed should not be selected in order to reduce shaft bearing wear.
Real stirrer speed may be observed with BTC-3000. If stirrer shaft has been decoupled, the selected speed is too high for the medium's viscosity and should therefore be reduced.

## 4.6. Gas and Liquid Sampling

**WARNING**

**Always wear personal protective equipment!**

Always wear your personal protective equipment 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.

## 4.7. Liquid Injection

**WARNING**

**Always wear personal protective equipment!**

Always wear your personal protective equipment during work which may involve contact with chemicals, that is, when working with acids, pressure vessels, during cleaning, etc.!

**WARNING**

**Pressure Vessel!**

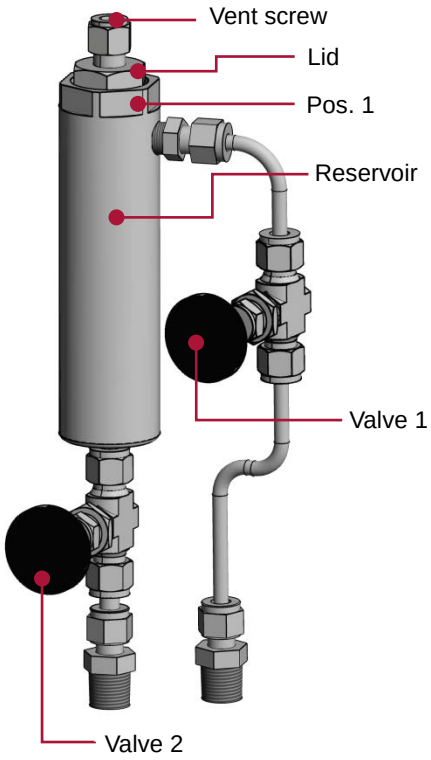
Never open the reservoir while Valve 1 or 2 are open. Always vent the reservoir with the vent screw before opening it and always leave the vent screw open!

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

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

Liquids up to max. working pressure (see Description) of the reaction solution is added.
For 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 hold the reservoir on position 1 with an open-end spanner 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.
   Hold on position 1.
6. Open Valve 1 slowly to equalize the pressure between the reactor and the reservoir.
7. Open Valve 2 to allow the liquid to flow into the reactor. Wait several seconds for the transfer to be completed.
8. Close Valve 1 and Valve 2.
9. 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.



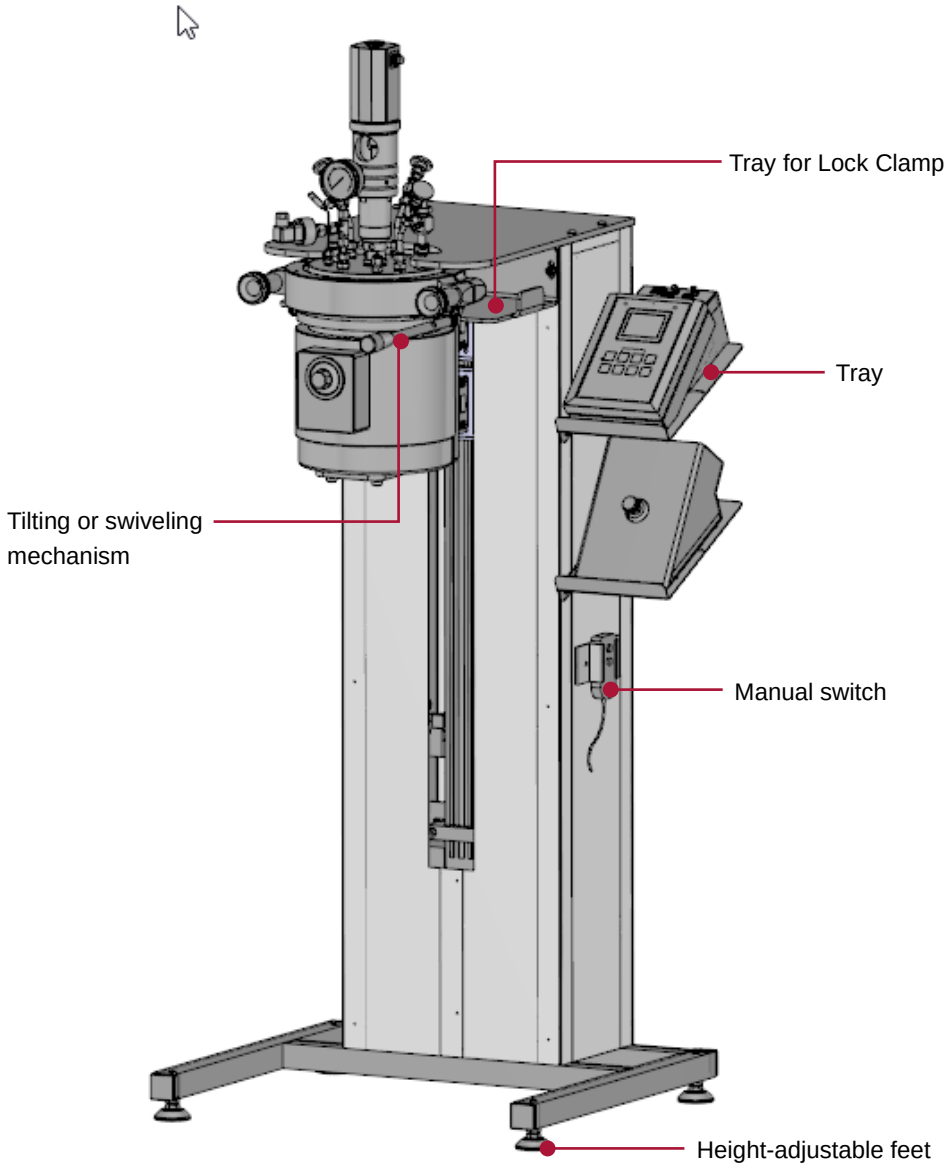

There are several reasons why not all the solution in the reservoir was transferred:
The solution's viscosity is too high. Try again, but increase the waiting time in Step 7.
The pressure could not be correctly equalized. This may be due to a blockage in the pressure equalization line, e.g., as a result 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.

# 5. Option Lift Systems

## 5.1. Device Description BRL-1

### 5.1.1. Basic device

The electrical Berghof Reactor Lift BRL-1 provides efficient, safe and ergonomic work aid when handling with Berghof laboratory reactors. Thanks to the modular design, the Berghof lift systems can be individually arranged according to specific requirements, such as electric drive, tilting or swiveling mechanism.



### 5.1.2. Technical Data

| Technical Data | |
|---|---|
| **BRL-1** | |
| Material | Stainless steel (1.4301) |
| Dimensions (W x H x D) | 740 x 1400 x 680 mm (without reactor) |
| Power supply | 230 V, 50/60Hz, 140W |

### 5.1.3. Safety information on the unit

**Warning - Pinch Point**

This label is located on the front side of the device.

**Warning - Entanglement hazard**

This safety information label is located on the front side of the device.

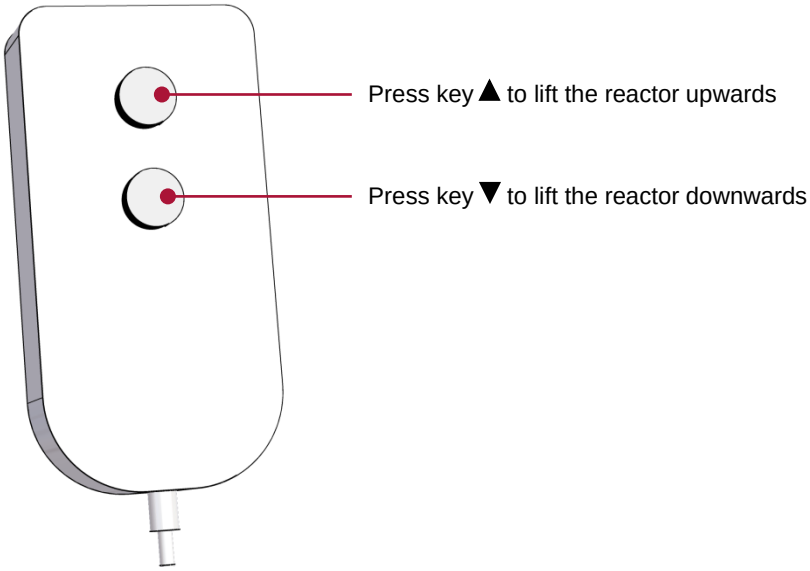

**DANGER!**

Before opening disconnect mains.

This safety information label is located on the back of the device.

## 5.1.4. Manual switch

With a manual switch the Berghof reactor lift BRL-1 can be moved continuously upwards and downwards. At the preset end positions the lift drive is automatically stopped and can then only be moved in the opposite direction.



# 5.2. Device Description BRL-2

## 5.2.1. Basic Device

The manual lifting unit allows loads of up to 200kg to be comfortably lifted and lowered using a hand crank. It is vital that the applicable accident prevention measures are observed during use.

## 5.2.2. Technical Data

| Technical Data | |
|---|---|
| **BRL-2** | |
| Material | Stainless steel (1.4301) |
| Dimensions (W x H x D) | 1000 x 1400 x 870 mm (without reactor) |

### 5.2.3. Safety information on the unit

**Warning - Pinch Point**

This label is located on the front side of the device.

**Warning - Entanglement hazard**

This safety information label is located on the front side of the device.

### 5.2.4. Manual Operation

The manual Berghof reactor lift BRL-2 can be continuously moved up and down using the hand crank.

### 5.2.5. Maintenance

The lift system is delivered ready for operation and is maintenance-free. The relevant accident prevention regulations must be observed.

## 5.3. Setup and Commissioning

### 5.3.1. Transportation and Storage

Transport is permitted only when the container is depressurized and empty. Before transport, remove or secure any loose devices on the support surface. Transport the lift system positioned vertically on a pallet and secured against falling or tipping. Remove the cables or secure them to protect against catching.
Lifting is permitted only below the floor frame between the adjustable feet.
The environmental conditions listed below must be observed.
Please note any necessary legal or operational safety regulations.

### 5.3.2. Ambient condition

See chapter 3.3

### 5.3.3. Positioning

Position the lift system on the appropriate work surface provided.
The floor space must be sufficiently dimensioned for the weight of the whole assembly.
(The total weight is given on the delivery documents)
Access to the lift system must be possible from all directions for its installation and operation.

It is recommended to provide enough space behind the manual lifting unit BRL-2 to easily operate the lifting system using the hand crank.

## 5.3.4. Alignment of the system

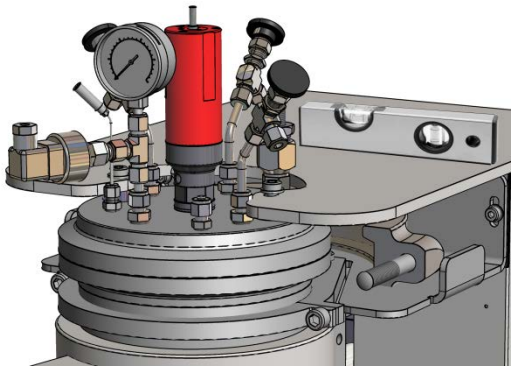
The Berghof Lifting Systems must be aligned before commissioning.

Needed tools:
- → Spirit level
- → 10 mm wrench

These tools are not part of the scope of delivery.

**Procedure**

→ Place the spirit level on the top plate of the Lifting System

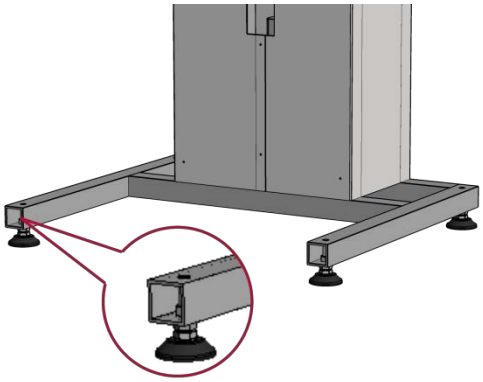


→ The Lifting-Systems are aligned by extending or retracting the height-adjustable feet

→ Release the lock nut before each adjustment and retighten it afterwards.

→ Check the alignment of the Lifting-System using the spirit level

→ Readjust if necessary

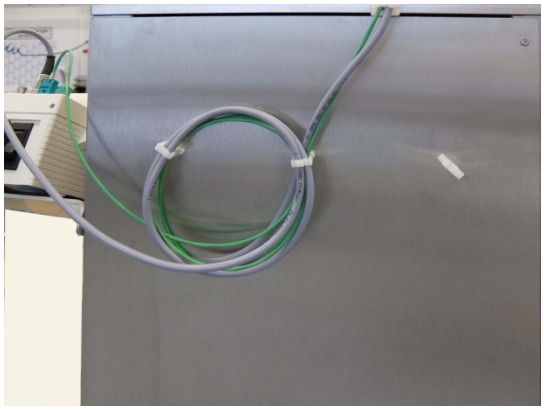


## 5.3.5. Installation

Connect the power cord to a suitable power supply (230 V; 50/60 Hz).

The installation instructions of the heating, control and stirring devices, which are included in the scope of delivery, are described in the corresponding manual.

To avoid contact with hot surface or tripping hazard, it is a good practice when connecting your equipment to use cable holders which are located on the rear side of the lift.



## 5.4. Operation

The procedure and the safety requirements for the operation of the reactors are described in detail in the main chapter "Operation", therefore only the modified work steps and the operation of the Lifting Systems are described here.

**CAUTION**

**Danger of pinching and risk of crushing**

There is increased risk of pinching or crushing in the area of the reactor and the metal tray.

When lifting the lift, make sure that no person can reach into the danger area.

### 5.4.1. Opening the reactor

The reactor must be opened for filling, draining or cleaning. The following procedure must be followed.

**DANGER**

**Pressure vessel!**

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

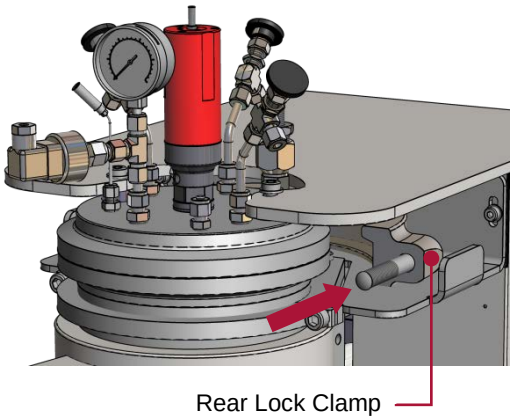
Hot gases and vapors can escape from the pressure vessel when it is opened! Always wait until the vessel has cooled to room temperature before opening it.

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

To open the Lock Clamp, see chapter 4.1.1

→ Place the rear part of the Lock Clamp at the very back of the storage area provided for this purpose

This prevents that Lock Clamp parts are getting jammed with the reactor lid.



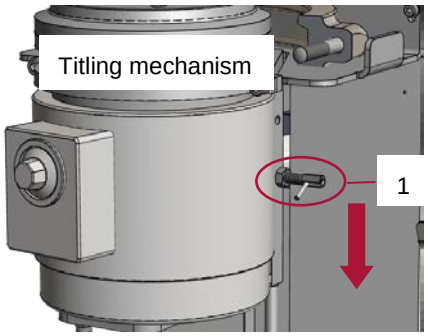
## 5.4.2. Lowering the reactor

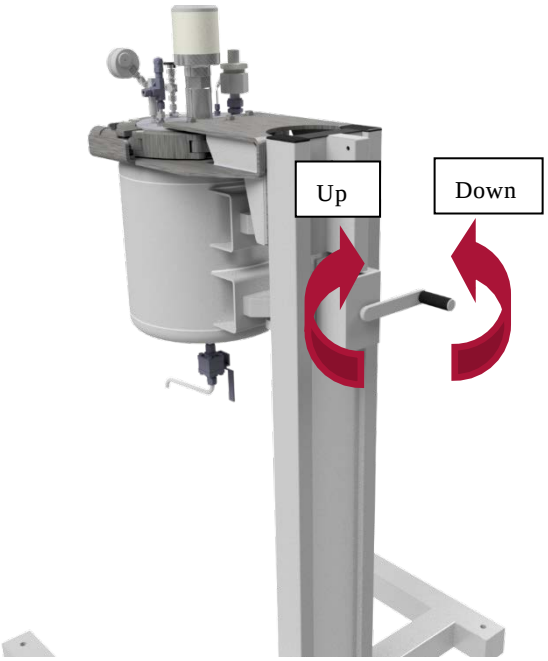
**Procedure:**

→ Check that the index bolt (1) is fixed and that the traverse range downwards is free of obstacles

→ The reactor can now be lowered by means of the hand control respectively the hand crank

→ The reactor is raised by turning it clockwise and lowered by turning it counterclock-wise. The hand crank can be removed at any time.

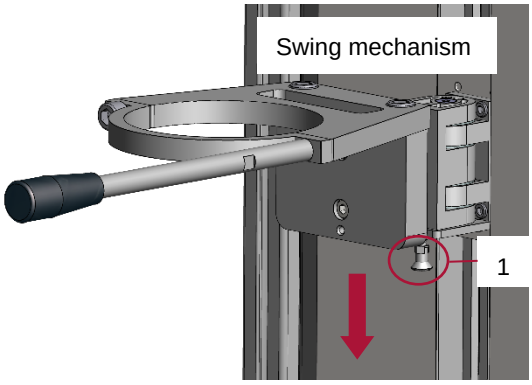


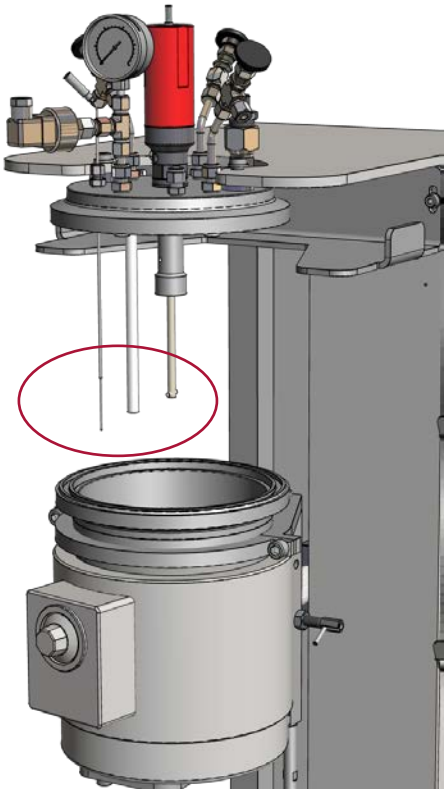

**NOTICE**

**Damage due to incorrect Operation**

If the crank is turned to lower the reactor when the reactor is completely low-ered, the brake and/or the housing of the winch may be damaged.




**Attention!**
Before swiveling or tilting the reactor, the rector must be lowered far enough downwards to prevent damage to the parts protruding into the reactor!



## 5.4.3. Tilting and draining the reactor

This application is only possible for lift system with titling mechanism.

| CAUTION | **Protecting the Heating Jacket during tilting**<br>If the reactor is tilt, liquids running down the reactor can damage the heating mantle.<br>Use the discharge cover and O-ring supplied. |
|---|---|

| NOTICE | **Heat damage to pouring cap**<br>The pouring cap is made of polypropylene (PP), so temperatures over 80 °C can cause deformation.<br>The pouring cap is used exclusively for emptying the reactor; the reactor may **not** be operated with the pouring cap in place. |
|---|---|

**Draining the reactor content**
Before emptying, the reactor must be closed with the pouring cap provided for this purpose.

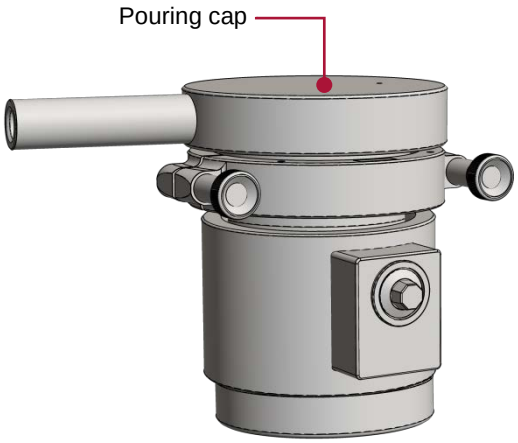
**Attention!**
Liquids must not be allowed to enter the heating jacket.

**Procedure:**

→ Place the pouring cap on the reactor flange

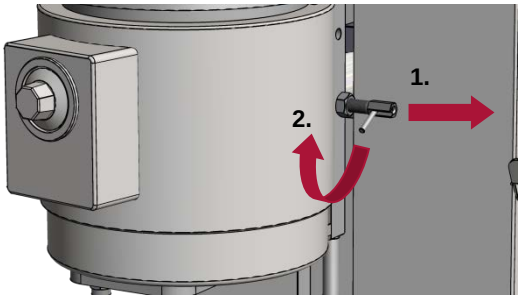
→ Close the reactor with the pouring cap and the Lock Clamp. For this purpose, the two Lock Clamp parts must be firmly held, so that the rear Lock Clamp is not pushed backwards by mistake during screwing in. (A further person may be needed)

→ Both Lock Clamps must be positioned in parallel. The gap between the two clamping rings left and right must be the same.



**Loosening the index bolt:**

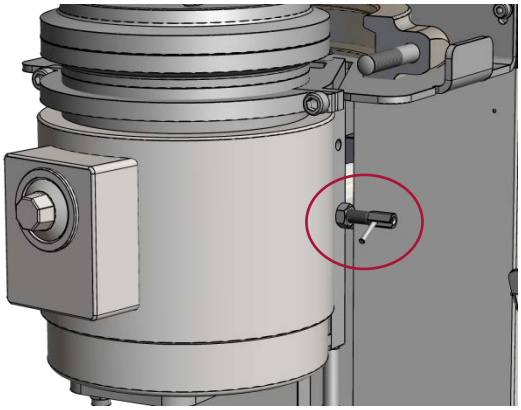
- → First, twist the index bolt out in a clockwise direction
- → then turn the lever back by 180°. The figure shows the index bolt in the closed position. Using the handle rod, the reactor can now be tilted to the side and stopped in 30-degree increments (with an engagement) by turning the lever forwards by 180° again and guiding it in through the groove (spring force).




**Raise the Reactor**

Before the reactor is brought up to its base position using the manual switch or the hand crank, please be sure of the following:

- → Place the reactor vertically
- → Secure it with the index bolt (lever must be pointing forward)
- → Check that the index bolt is engaged and that swiveling with the handle rod is no longer possible.
- → Check that the path of movement is free and that no person reaches into the danger zone.



## 5.4.4. Closing the reactor

See chapter 4.1 - Opening and Closing the reactor

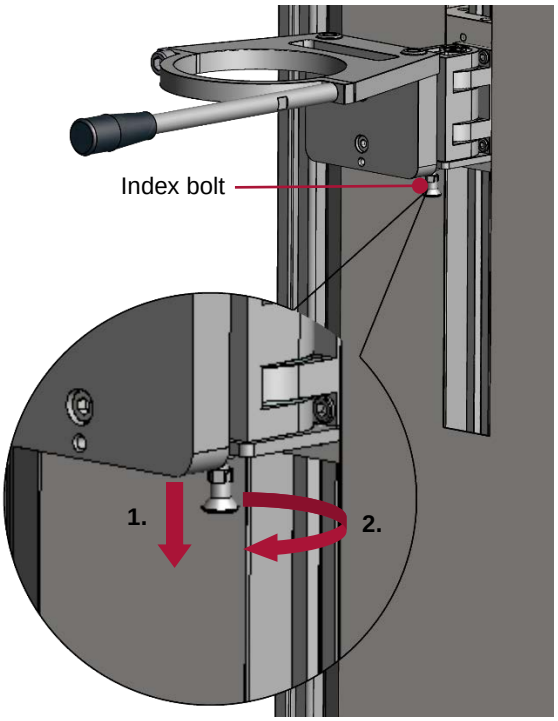
## 5.4.5. Swiveling the reactor

Application only possible for reactor lift with swivel mechanism

**Procedure:**

→ Pull the index bolt downwards

→ Turn the index bolt 90° C to the side




**Raise reactor**

Before the reactor is brought back into the basic position by means of a hand switch, attention must be paid to the following:

→ Engaging the swivel mechanism by turning the index bolt 90°, if it is permanently unlocked. The locking knob must be able to move freely in vertical position, so that it lock into place.

→ Check that the index bolt is engaged and that swiveling with the handle rod is no longer possible.

→ Check that the path of movement is free and that no person reaches into the danger zone.

# 6. 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.

## 6.1. Cleaning

**DANGER**

**Pressure vessel!**

Never open the high-pressure laboratory reactor while it is under pressure. Never use force 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**

**Always wear personal protective equipment!**

Always wear your personal protective equipment during work which may involve contact with chemicals, that is, when working with acids, pressure vessels, during cleaning, etc.!

**NOTICE**

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-Insert be cleaned after each use and, if necessary, boiled in a solvent solution. The exterior of the PTFE-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-Insert and the pressure vessel in order to prevent the formation of gas blankets during subsequent operation.

Cleaning recommendation for stainless steel parts:
Ultrasonic bath

- 40°C
- 10 liters of tap water
- 1 liter H3PO4 60%
- Time: 12 hours

## 6.2. Maintenance

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

**DANGER**

**Pressure Vessel!**

Use only pressure vessels and spare parts authorized by Berghof Products + Instruments GmbH for use with the laboratory reactor. These can be obtained either from your local representative 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.

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.

**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.

**WARNING**

**Always wear personal protective equipment!**

Always wear your personal protective equipment during work which may involve contact with chemicals, that is, when working with acids, pressure vessels, during cleaning, etc.!

### 6.2.1. Seal

In order to ensure a proper reactor seal, the seal surfaces in the locking area must be kept clean and smooth.

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).

The O-ring should be replaced regularly after several uses.

### 6.2.2. Rupture disc

**⚠ 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.

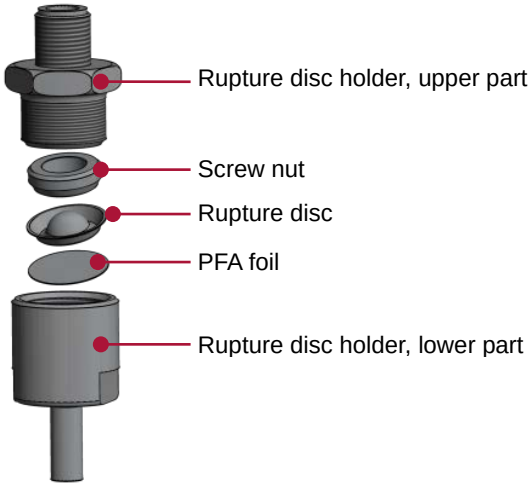
Only OEM rupture discs specified by Berghof Products + Instruments GmbH for your specific reactor may be used. These can be obtained from your local representative or directly from Berghof Products + Instruments GmbH (refer to the "Repair / Customer Service' section for the contact address).

After being placed under extreme pressure loads several times, the rupture disc may become fatigued, thus altering its activation pressure. This component should then be replaced. The valve threads should also be lightly lubricated from time to time by using a PTFE paste.

Install a new rupture disc as shown in the illustration on the right.
The bulge of the rupture disc must face upwards.

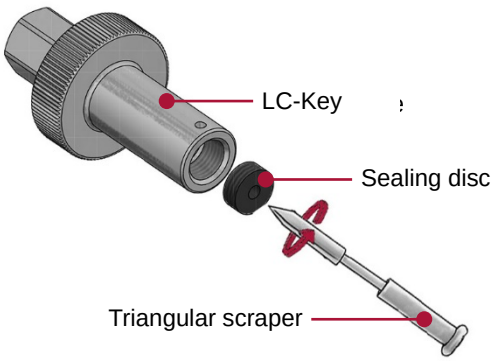
The PFA foil serves both as a seal as well as to protect the rupture disc from aggressive media.

The valve threads should also be lightly lubricated from time-to-time by applying a thin layer of PTFE paste.



### 6.2.3. LC-Key

The sealing disc, which is located in the LC-Key, is to be removed by using a triangular scraper and replaced.



## 6.2.4. Quick Connects

After several thermal load cycles, the fittings should be checked to make sure they are firmly seated and, if necessary, they should be retightened.

All components are connected together with ring clamp screw-on connectors.
The fittings in the reactor lid are screwed in with NPT fittings.

**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.

**WARNING**

**Venting Pressure vessel!**

Do never vent the system by loosening coupling nut or blind plug.

**NOTICE**

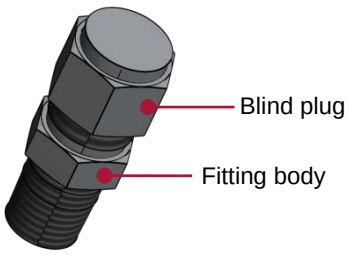
**NPT-Fittings**

**Never** turn fitting body. Instead, hold fitting body and turn nut!

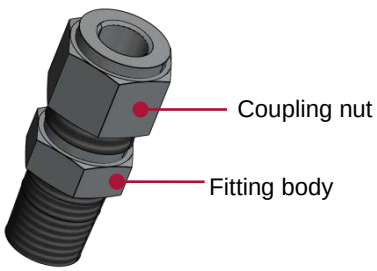
**NPT-connection (conical)**

To remove the blind plug, hold the fitting body steady by means of an open end wrench, while untighten the blind plug with a further open end wrench.

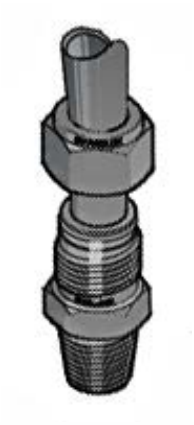
To insert the blind plug again, hold the fitting body steady tighten the blind plug one-quarter turn from the finger-tight position.



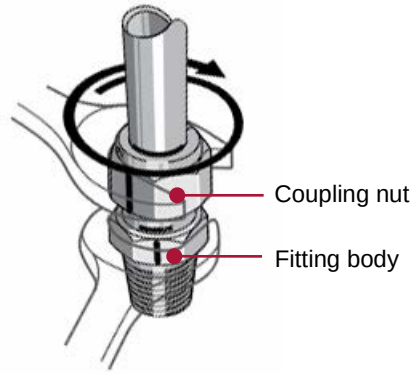

To remove the coupling nut, hold the fitting body steady by means of an open end wrench, while untighten the coupling nut with a further open end wrench.



For reassembly insert tubing into the fitting body till it rests firmly on the shoulder of the tube fitting body.

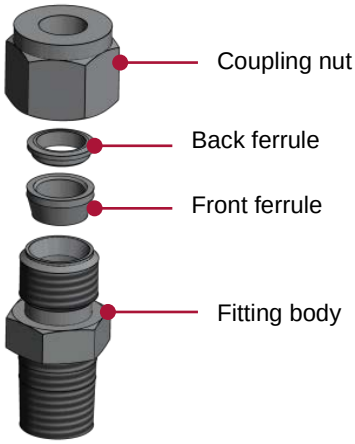


While holding the fitting body steady, tighten the coupling nut with a wrench, until an increase resistance is felt.



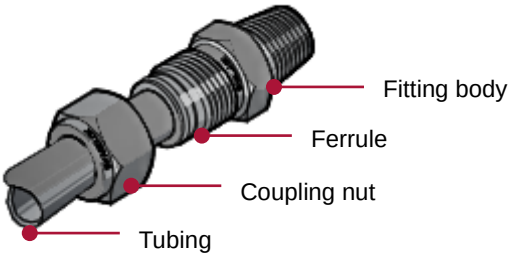
**Ring clamp screw-on connectors**

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




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

Tighten the coupling nut finger-tight.
While holding the tube fitting steady, tighten the nut **1 ¼** turns with a wrench.




**Please note:**
**For reassembly the coupling nut is tightened only ¼ turn.**
At this point, an increase resistance is felt.

(Note: For tube fittings with 2, 3 or 4 respectively 1/16, 1/8 or 3/16 inch tighten the nut ¾ turns only.)

### 6.2.5. Overflow Valves

Since the seals of the overflow valves tend to stick, the overflow valves must be checked regularly for their function. For test reactors, a test must be carried out before each test.

For cleaning, remove the overflow valve from the reactor lid, disassemble and clean with water or suitable solvent. Reassemble in reverse order (see also manufacturer's instructions).

For sealed overflow valves, please contact the appropriate notified body.

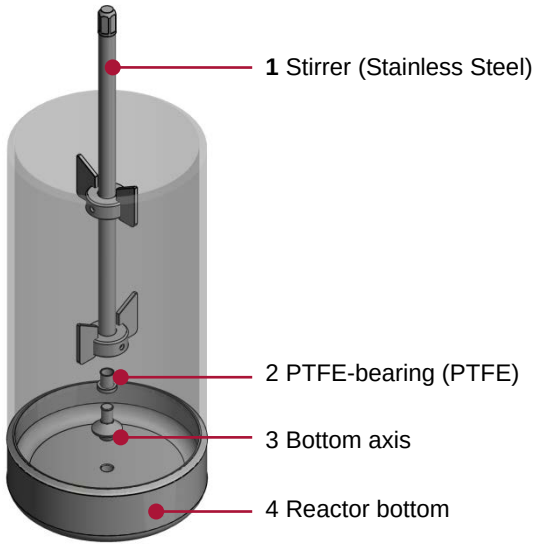
### 6.2.6. Sliding sleeve

**NOTICE**

**Inspection**

After each use the PTFE-bearing of the bottom axis must be visually inspected and replaced if necessary.

Screw the bottom axis **(3)** into the bottom **(4)** of the laboratory reactor, and then attach the PTFE-bearing **(2)** and the stirrer **(1).**
(see user manual BRM)



### 6.2.7. Recurring Inspection

See chapter 1.5 Legal Requirements.

### 6.2.8. Inspection

See chapter, 1.5 Legal Requirements.

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. The tightness can be checked e.g. by means of leak detection agent or by immersion in water. However, the reactor must then be carefully dried afterwards.

## 6.3. 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<br>Do not overwind the screws.<br>(See chapter 6.2.4 Quick Connects) |

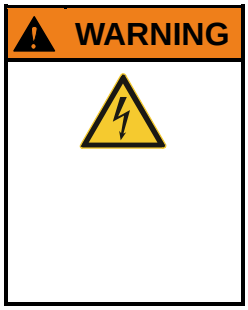
You can obtain technical support from your regional Berghof representative or directly from Berghof Products + Instruments GmbH by contacting:

→ Berghof Service

Berghof Products + Instruments GmbH
Arbachtalstraße 9/2
72800 Eningen
Germany
T +49.7121.894-170
F +49.7121.894-300
E-Mail: service.bpi@berghof.com
www.berghof-instruments.com

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

## 6.4. Repairs / Customer Service




**Accessories use low voltage 230V!**

The heating and stirring systems must always be connected to a ground conductor. The enclosed power cable ensures the grounding, given that the socket outlet is equipped with a protective grounding conductor. 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.

**Repairs and service may only be performed by properly trained and qualified personnel.**


**Caution electrical voltage!**

The housing cover may only be removed by authorized trained personnel!

The instrument must be disconnected from the power outlet before being serviced.

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

→ Berghof Service

Berghof Products + Instruments GmbH
Arbachtalstraße 9/2
72800 Eningen
Germany
T +49.7121.894-170
F +49.7121.894-300
E-mail: service.bpi@berghof.com
www.berghof-instruments.com

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

### 6.4.1. Reshipment

**NOTICE**

**Cleaning and decontamination methods**

Before using any cleaning or decontamination methods except those specified by Berghof Products + Instruments, users should check with Berghof Products + Instruments or your regional Berghof representative that the proposed method will not damage the equipment.

→ Safety and Health Declaration

Customers wishing to return instrumentation and/or associated materials to Berghof Products + Instruments GmbH or regional representative for repair, maintenance, warranty, inspection or trade-in purposes are advised that all returned goods must be certified as clean and free from contamination.

The customer´s responsible body is required to fill in and sign the form “Safety and Health Declaration” and to display this declaration on the exterior of the shipping container.

This document is available at:

Berghof Service (see contact data above)

Outside the Federal Republic of Germany goods may only be returned to us via our authorized representative.
Before returning the goods, please contact our service department.

### 6.4.2. Safety and Health Declaration

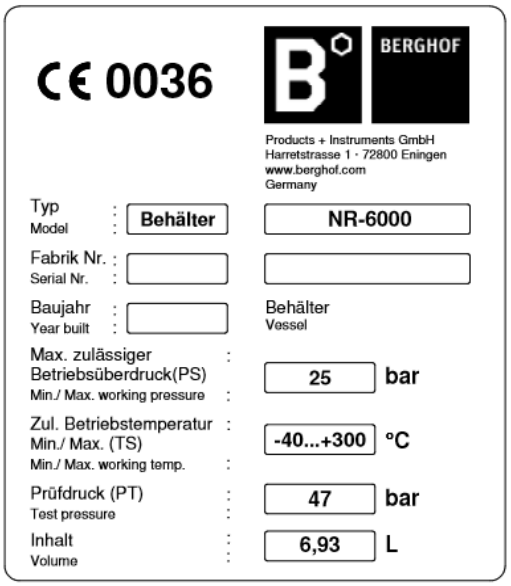
Return shipments of instruments and equipment not having decontamination certificates display on the exterior of the shipping container will not be processed and will remain unopened, in a sealed condition, until a determination of decontamination is received.

# 6.5. Nameplate

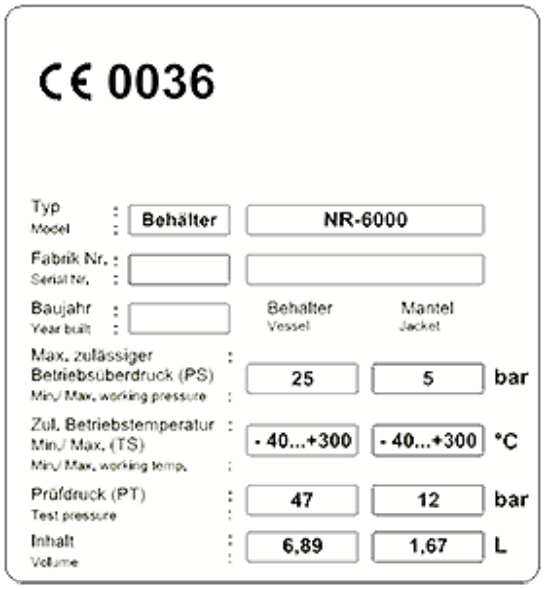
## 6.5.1. Reactor

**Example**

Reactor

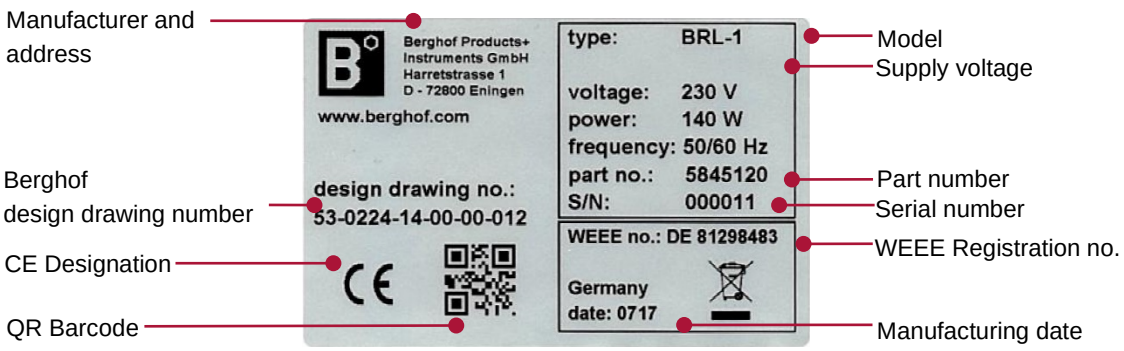



Reactor vessel with welded-on and isolated jacket



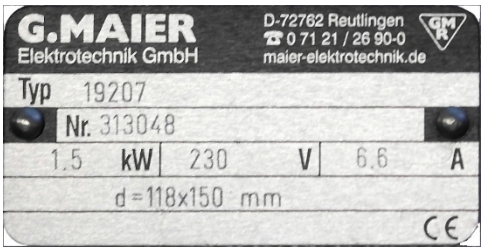

## 6.5.2. BRL-1

The nameplate is located on the bottom of the device.



### 6.5.3. Electric Jacket Heater (NHM)

Example




Das Typenschild befindet sich neben dem Temperaturregler.

# 7. Appendix

## 7.1. Declaration of conformity

### 7.1.1. Pressure Vessel (NR-Reactor)

The current EC-Declaration of Conformity for the NR-Reactors are enclosed with the delivery.

### 7.1.2. Lift system (BRL)

DECLARATION OF CE-CONFORMITY P. 1/1

**BRL-1**
Lift System

| | | | | |
|---|---|---|---|---|
| **Manufacturer** | Berghof Products + Instruments GmbH<br>Arbachtalstraße 26<br>D - 72800 Eningen | | | |
| **Product** | BRL-1 | | | |
| **Part number** | **NR-1500** | **NR-3000** | **NR-6000** | **NR-10000** |
| | 5845115 | 5845120 | 5845125 | 5845130 |
| | 5845135 | 5845140 | 5845145 | 5845150 |
| | 5845155 | 5845160 | 5845165 | 5845170 |

**This declaration of conformity is issued under the sole responsibility of the manufacturer.**

The object of the declaration described above is in conformity with the relevant Union Harmonisation Legislation:

Low Voltage Directive (LVD) 2014/35/EU
EMC Directive 2014/30/EU
RoHS Directive 2011/65/EU

The following harmonized standards and technical specifications have been applied:

| | |
|---|---|
| **Safety requirements for electrical equipment for measurement, control and laboratory use Part 1: General requirements** | IEC 61010-1:2010/AMD1:2016 |
| **EMC – Generally** | Professional equipment.<br>The equipment is suitable for use in all establishments other than domestic and those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes (Class A). |
| **Electrical equipment for measurement, control and laboratory use – EMC- requirements Part 1: General requirements** | EN 61326-1:2013<br>IEC 61326-1:2012 |

Eningen, December 19, 2023
Date

Dr. Dieter Gutwerk
CEO

BERGHOF

### 7.1.3. Heating Jacket (NHM)

G. MAIER

ANTRIEBSTECHNIK
ELEKTROWÄRME

G. MAIER Elektrotechnik GmbH · Gustav-Schwab-Str. 14 – 20 · 72762 Reutlingen

## EG-Konformitätserklärung

**G. MAIER Elektrotechnik GmbH**
Gustav-Schwab-Straße 14 – 20
72762 Reutlingen, Germany
Telefon +49 (0) 7121 2690-0
Telefax +49 (0) 7121 2690-90
info@maier-elektrotechnik.de
www.maier-elektrotechnik.de

Aussteller: G. MAIER Elektrotechnik GmbH
Gustav-Schwab-Strasse 14-20
D-72762 Reutlingen

Produkt: **Zylinderheizband #17249, #24054, #12758, #27680, #12332, #11406, #15718, #38106, #10840, #38981**

Das bezeichnete Produkt stimmt mit den Vorschriften folgender Richtlinien überein, nachgewiesen durch die Einhaltung folgender Normen:

**2014/35/EU** [Niederspannungsrichtlinie]
mit Änderungen

***Richtlinie des Rates zur Angleichung der Rechtsvorschriften der Mitgliedstaaten betreffend elektrischer Betriebsmittel zur Verwendung innerhalb bestimmter Spannungsgrenzen***

| Norm | | |
|---|---|---|
| | **DIN EN 61010-1:2011-07** | **EN 61010-1:2010** |
| | **DIN EN 61010-2-010:2015-05** | **EN 61010-2-010:2014** |

**2014/30/EU** [EMV-Richtlinie]
mit Änderungen

***Richtlinie des Rates zur Angleichung der Rechtsvorschriften der Mitgliedstaaten über Elektromagnetische Verträglichkeit***

| Norm: | | |
|---|---|---|
| | **DIN EN 61 326-1:2013-07** | **EN 61326-1 :2013** |

Reutlingen, den 06.04.2017

ppa.

G.MAIER Elektrotechnik GmbH

Diese Erklärung bescheinigt die Übereinstimmung mit den genannten Richtlinien, beinhaltet jedoch keine Zusicherung von Eigenschaften. Die Sicherheitshinweise der mitgelieferten Produktinformationen sind zu beachten.

Geschäftsführer: Hans-Jürgen Maier, Kristin Maier-Müller · AG Stgt. HRB 351281 · USt.-Ident.-Nr. DE 146 479 488 · Kreissparkasse Reutlingen BIC: SOLADES1REU IBAN: DE68 6405 0000 0000 0905 01 · Volksbank Reutlingen BIC: VBRTDE4RXXX IBAN: DE68 6409 0100 0108 6000 09

Es gelten die umseitig abgedruckten Allgemeinen Geschäftsbedingungen.

## 7.2. Conversation Table

| Conversation of units | | |
|---|---|---|
| **Dimension** | **Unit** | **Conversation** |
| Temperature | °C =<br>°F = | (°F – 32°) / 1.8<br>1.8 * °C +32° |
| Length | 1 cm =<br>1 inch = | 0.3937 inch<br>2.540 cm |
| Volume | 1 ml =<br>1 $inch^3$ =<br>1 gallon = | 0.06102 $inch^3$ = $2.642*10^{-4}$ gallon<br>16.387 ml = $43.29*10^{-4}$ gallon<br>3785 ml = 231 $inch^3$ |
| Pressure | 1 bar =<br>1 psi =<br>1 Mpa = | 14.504 psi = 0.1 Mpa<br>0.06895 bar = 0.0068948 Mpa<br>10 bar = 145.04 psi |
| Weight | 1 kg =<br>1 lb. = | 2.2046 lb.<br>0.4536 kg |

## 7.3. Abbreviation

| Plastics | |
|---|---|
| **Abbreviation** | **Technical term** |
| PE | Polyethylene |
| PFA | Perfluoralkoxy |
| PP | Polypropylene |
| PTFE | Polytetrafluorethylene |
| TFM™-PTFE | Modified Polytetrafluorethylene |
| Kalrez® (FFKM) | DuPont™ Perfluoroelastomer |
| Viton® (FPM) | DuPont™ Fluoroelastomer |

| Metals | |
|---|---|
| **Abbreviation** | **Technical term** |
| SS | Stainless steel with the corresponding material number |
| HC-4 | Hastelloy C-4 |
| HC-22 | Hastelloy C-22 |
| HC-276 | Hastelloy C-276 |