Vertical Lab Planetary Ball Mill

User Manual

DECO-PBM-V-0.4L

Hanchen Instrument

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1 General Information / Introduction

1.1 Notes about Operating Instructions

- The copyright to these technical documents is the property of DECO, Manufacturers of Laboratory Grinding Equipments.
- These operating instructions are not to be reprinted or copied without the express approval of DECO.
- Please study these instructions carefully before operation.
- All operators must be familiar with the contents of the operating instructions.
- Please observe all notes concerning your safety.
- The mill was designed with the user's safety in mind; however inherent risks cannot be excluded. Follow the advices in these instructions to avoid risks to users.

Attention!

- The symbols in the right hand margin highlight the risks described in the text. Symbols are also to be found on the instrument warning users of possible risks. Warning symbols are surrounded by a triangle.
- These operating instructions do not constitute a complete technical description. They describe only the details required for safe operation and maintenance for usage under normal conditions.

1.2 Explanations of the signs at the instrument and in the operating instructions

Attention! warning against danger spot observe operating instructions	
Attention! mains voltage	
Attention! risk of explosion	

Attention! hot surface	
Attention! inflammable substances	
wear protective gloves	
wear ear protectors	
wear safety goggles	
Attention! lifted load	

1.3 Short Description of the Machine

1.3.1 Applications

The horizontal laboratory planetary mill is universally applicable for quick dry or wet grinding of inorganic and organic samples for analysis, quality control, materials testing and mechanical alloying.

In synthesis, the horizontal ball mill can be used for mixing and homogenization of dry samples, of emulsions and of pastes.

1.3.2 Working Principle

The material is crushed and torn apart in two or four grinding jars by grinding balls. The grinding balls and the material in the grinding jar are acted upon by the centrifugal forces

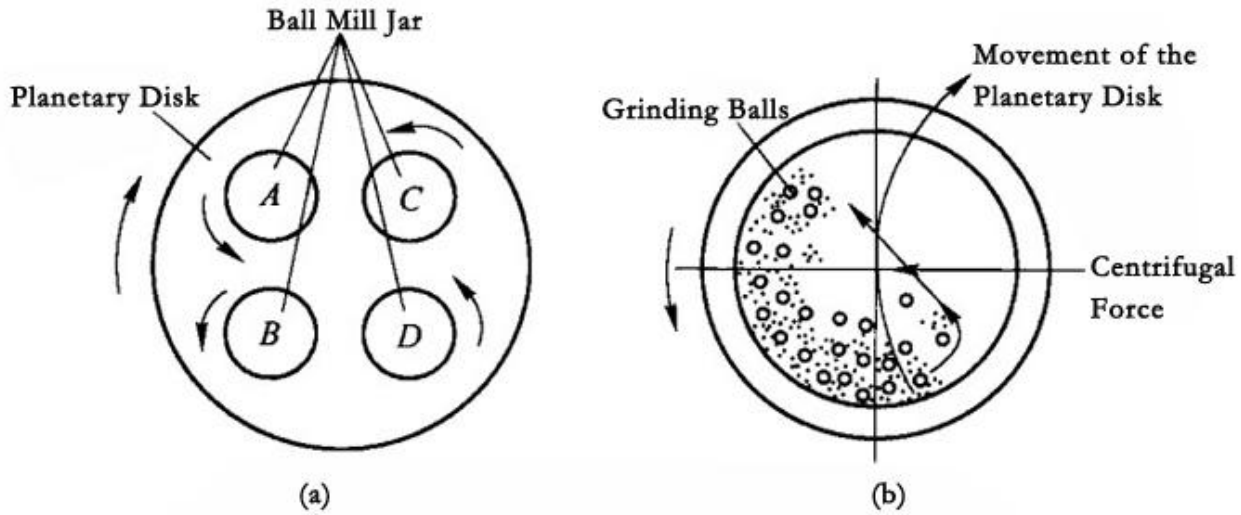
due to the rotation of the grinding jar about its own axis and due to the rotating planetary disk.

The grinding jar and the planetary disk rotate in opposite directions, so that the centrifugal forces alternately act in the same and opposite directions.

This results in, as a frictional effect, the grinding balls running along the inner wall of the jar, and as an impact effect, the balls impacting against the opposite wall of the grinding jar.

The impact effect is enhanced by the grinding balls impacting against one another.

Loss-free grinding, even in the case of grinding of suspensions, is guaranteed by a hermetic seal between the grinding jar and the cover.



Working Principle of Lab Planetary Ball Mill
(a) overall layout of planetary disk (b) horizontal section of grinding jar

1.3.3 Drive Motor and Speed Control

The machine is driven by a single phase AC motor, which receives 110/220 VAC of variable frequency from a frequency converter.

1.4 Technical Data

1.4.1 Item Number

Ball Mill: DECO-PBM-V-0.4L

Ball Mill Jars: Single Jar: 250ml,500ml,1000ml,1500ml

Jar Materials: Stainless steel, PA6, PU, PP, PTFE, HDPE, Agate, Alumina, Zirconium oxide, Tungsten carbide

Jar Types: normal, vacuum, with stainless steel jacket

Max Feeding Capacity: 2/3 capacity of the grinding jar

1.4.2 Operating Noise

The noise level is about 70dB. The value fluctuates greatly depending on the speed and the material being ground and on the type of grinding jar and grinding balls.

1.4.3 Electrical Details

Single-phase alternating voltage 110v/220v ± 10% (110v or 220v are both customizable.)

The maximum power consumption is approx.: 750W

Switch on by pressing in the green button at the rear of the machine.

1.4.4 Material

Maximum feed size in the case of hard material approx. 10 mm

Maximum feed quantity 2L/4L/6L divided in 4 x 500/1000/1500 ml grinding jars + grinding balls

Achievable mean final fineness (depending on material) down to d50 < 1 µm

1.4.5 Grinding Speed

Revolution (Grinding Speed of Planetary Disk): 400rpm

Rotation (Grinding Speed of Ball Mill Jar): 800rpm

2 Operating Safety

2.1 General Safety Instructions

- Read the operating instructions carefully before use.
- The instrument can only be used for the purpose described in Section 1.3 Short Description of the Machine.

- Use only original accessories and original spare parts. Failure to do so may call into question the performance of the instrument.
- Do not use damaged accessories.
- The operators must be familiar with the contents of the operating instructions. To this end, for example, the operating instructions must with the instrument.

- Do not remove labels.
- Protective devices must not be made unserviceable or removed.
- Unauthorized modification of the instrument or any part thereof will result in the loss of the conformity to European directives which are asserted by Fritsch and the warranty.
- Wear protective gloves! Grinding jars may be very hot after grinding.

- Wear safety glasses wet grinding may cause high pressure in the grinding jar- Danger of squirting!
- Wear ear protectors - noise level up to 70dB.

- Don’t run the instrument several hours without cooling phases - Danger of overheating.
- Behavior at all times must be such as to strictly preclude any accidents.
- Furthermore, the MAC values at place of work specified in the pertinent safety regulations must be adhered to. Where applicable, ventilation must be provided or the instrument must be operated under an exhaust hood.

- When oxidizable materials such as metals, organic materials, wood, coal, plastic, etc. are ground or sieved, the risk of spontaneous ignition (dust explosion) exists whenever the fine particles exceed a specific percentage. While such materials are being ground, it is therefore necessary to take special safety precautions (e.g. wet grinding) and the work must be supervised by a specialist.

- The instrument is not explosion-proof and is unsuitable to grind or sieve materials which are explosive, combustible or promote combustion.
- Do not allow the instrument to run unsupervised. Due to the vibrations, under certain operating conditions, the machine may creep along the surface on which it is located or mounted.

2.2 Operators

No one other than authorized persons should operate the instrument and it must be serviced and repaired by trained specialists.

No one suffering from medical problems or under the influence of medications, drugs, alcohol or overtiredness should be permitted to operate the instrument.

2.3 Protective Devices

Protective devices should be used for the intended purpose and must not be made unserviceable or removed.

All protective devices should be regularly checked for completeness and to ensure that they are functioning correctly. See section 6 Maintenance.

The hood must be closed when the machine is started up.

The hood must be closed:

- when the machine is connected with the mains supply
- during operation

The hood can be opened only when the drive of the mill has come to a standstill.

2.4 Danger Points

Danger of crushing when the hood is being closed.

Danger of crushing at the grinding jar holder.

2.5 Electrical Safety

2.5.1 General

The main switch disconnects the machine from the mains supply at two poles.

Switch off the main switch if the instrument is to be inoperative for an extended period (e.g. over night).

2.5.2 Protection against Restarting

In the event of a mains failure during operation or after switching-off with the main switch, the hood can be opened. When the mains voltage is restored, for safety reasons, however, the instrument will not start again.

2.5.3 Overload Protection (see 7 Troubleshooting Checklist)

In the event of overloading, the speed of the machine will be reduced.

If the drive motor overheats, the machine will switch off.

If the drive is obstructed, the machine will switch off.

2.5.4 Unbalance Detection (see 7 Troubleshooting Checklist)

In the event of an excessive unbalance, the machine will switch off.

2.5.5 Operation on a residual current circuit breaker

It is possible that the leakage current could approach limit values during operation. This can result in tripping of residual current circuit breakers. Through the addition of all devices onto the power circuit, these values can be reached very quickly.

Solution: Use a power circuit without residual current circuit breaker or increase the residual current limit of the circuit breaker.

3 Installation

3.1 Unpacking

- Cut the packing belt; tear the tape off the cardboard box.
- Take the hood off the cardboard box.
- Check that the items supplied correspond to your order. Grinding jars of hardened steel may exhibit surface indentations caused by the manufacturing process. These do not influence the grinding or the grinding result and generally disappear after the first grinding. When present, these surface indentations lie within the permissible manufacturing tolerance ranges. Accordingly, complaints regarding such grinding jars cannot be accepted.

3.2 Transport

Transport the mill on the transport pallet with a fork lift truck or a hand fork lift truck.

To carry the machine, grip it below the edge of the housing.

3.3 Erection

- Lift the instrument with the transport pallet.

Do not walk below the transport pallet.

- The instrument is attached to the transport pallet without screws.
- Lift the instrument off the transport pallet.
- Place the instrument on a level, stable surface, indoors. It is not necessary to fasten the instrument on the erection site. The instrument can also be mounted on a sturdy table.

It is inadvisable to operate the instrument while it is standing on the transport pallet.

- Ensure that there is good access to the instrument. There must be enough space to reach the main switch.
- Do not block the exit of air from the ventilator louver at the side. There is a danger of overheating if the louver is blocked.

3.4 Ambience conditions

- Use the instrument only inside.
- The air must not contain any electrical conductive dust.
- The ambient temperature must be between 5 and 40°C.
- Height up to 2000m M.S.L.
- Maximum relative humidity of air 80% temperature up to 31°C, linear de-creasing down to 50% relative humidity of air at 40°C
- Contamination level 2 (IEC 664)

3.5 Electrical Connection

Before making the connection, compare the voltage and current values shown on the nameplate with the values of the mains supply to which the instrument is to be connected.

Single-phase alternating voltage with protective conductor (see section 1.4 Technical Data).

Electrical Safeguard!

Danger of damages due to short-circuit.

Ensure that the socket is connected to a power line secured with a circuit breaker.

Non-observance of the values on the type plate may damage electrical as well as mechanical components.

Mains Voltage!

The connector may only be altered by a trained expert.

3.6 Switching On for the First Time / Test for Correct Functioning

Switch on the machine only when all the work described in section 3 Installation has been done.

Switching On

1. Connect the machine to the mains supply.
2. Switch on the machine with the main switch at the top of the machine.
3. POWER SUPPLY shines
4. Open the hood.
5. There should be nothing in the grinding jar holder.
6. Close the hood.
7. Turn on the Emergency stop clockwise.
8. Press RUN on the control panel.
9. The mill will run at the preselected speed.

Switching Off

- Press STOP on the control panel.
- After a short period (after the mill has come to a standstill), open the hood.

4 Working with the mill

Warning!!!

Before starting the machine, ensure that the grinding jar is correctly braced and there are no loose parts inside the device. There is a risk that loose grinding jars or parts will be thrown out.

If this instruction is not observed, no guarantee or claims will be accepted for damages to the device or injuries to persons.

Caution!!!

The grinding tools are subject to normal wear. Prior to each comminution the thickness of the grinding jar wall is to be inspected. With severe wear the grinding jar is to be changed. If not, the possibility exists that the grinding ball due to high centrifugal forces which occur during the grinding may strike through the grinding jar wall, damaging the mill. We don't

honor the warranty or accept complaints for instrument damage or personal injuries occurring when disregarding the above information.

4.1 Choice of Grinding Jars and Grinding Balls

Caution!!!

No warranty or claims shall be accepted in case of damages caused on account of using grinding jars and grinding balls that are not original accessories of the appliance.

In order to prevent excessive abrasion, the hardness of the grinding jar used and of the grinding balls must be higher than that of the material used.

Material		**density***	**resistance to abrasion**
(jar and balls)		in g/cm^3	
Agate	(99.9% SiO_2)	2.65	Good
Sintered corundum	(99.7% Al_2O_3)	3.8	Fairly good
Zirconium dioxide	(95% ZrO_2)	6.06	Very good
Stainless steel	Jars: (17-19% Cr + 8-10% Ni) Balls: (12,5-14,5% Cr + 1% Ni)	7.93	Fairly good
Tungsten carbide	(93%WC+6% Co)	14.95	Very good

The grinding jars and grinding balls of zirconium dioxide are resistant to acids with the exception of hydrofluoric acid.

Normally, grinding jars and grinding balls of the same material should be chosen.

Exception: Tungsten carbide balls (<20mm) may be combined (just a few minutes) with steel jars. The size of the grinding jars and grinding balls should be determined experimentally.

4.1.1 Size of the Grinding Balls

Type of feed material	Ball diameter
Hard samples feed particle size <10 mm	30 mm or 40 mm
Medium piece size (<5 mm)	20 mm
Fine material (0.5 mm)	10 mm or 5 mm
Homogenization of dry or liquid samples	10 mm
Homogenization of viscous samples	20 mm

These are just clues: the size of the grinding jars and grinding balls should be determined experimentally if necessary.

4.1.2 Number of Balls per Grinding Jar

A larger number of balls reduce the grinding time, and the grinding result will lie within a narrower grain band width.

Ball Ø (mm)	Jar volume (ml)	100	250	500
5	Number of balls (piece)	250 - 300	1200 - 1300	2000 - 2500
10	Number of balls (piece)	25-30	50 - 150	100 - 250
15	Number of balls (piece)	10	45 - 50	70 - 100
20	Number of balls (piece)	5	15 - 20	25 - 35
30	Number of balls (piece)	5 - 6		10
40	Number of balls (piece)			4

These values are just clues: the number of balls should be determined experimentally if necessary.

For Ø 30 and Ø 40 mm balls, please keep the machine under observation during operation. Because of the vibrations, there is a danger of the machine creeping.

4.1.3 Calculated Ball Weight

Ball Diameter (mm)		3	5	10	15	20	25
Material	Density (g/cm³)	Calculated Ball Weight (g)					
Stainless steel	7.93	0.11	0.52	4.15	14.01	33.20	64.84
Zirconium dioxide	6.06	0.09	0.40	3.17	10.70	25.37	49.55
Agate	2.65	0.04	0.17	1.39	4.68	11.09	21.67
Sintered corundum	3.8	0.05	0.25	1.99	6.71	15.91	31.07
Tungsten carbide	14.95	0.21	0.98	7.82	26.41	62.59	122.25

4.2 Filling the Grinding Jar

It is imperative that the following sequence be observed:

1. Place the grinding balls in the empty jar.
2. Fill the material to be ground on the balls.

Never use the mill without sample material!

Danger of badly damage of the grinding balls and jars!

4.3 Influencing Quantities During Grinding

Grinding time

A longer grinding time will increase the fine fraction. To reduce the grinding time you can use grinding jars and balls with a higher density and therefore with a higher impact energy.

Speed

A higher speed will reduce the grinding time and increase the fine fraction.

Reversing operation (regular reversal of the direction of rotation)

- useful for mechanical alloying
- improves homogenizing of the material

Number and size of the balls

Pregrinding coarse, hard material with large balls.

Use of many small balls will increase the fine fraction if the running time is increased.

Mass of the balls (type of material)

A higher mass (spec. weight) of the grinding balls will accelerate the grinding.

4.3.1 Dry Grinding

Below a particle size of approx. 20 µm, surface forces predominate and the material will start to "stick".

Further dry grinding can be achieved if surface-active substances are added to the material.

4.3.2 Wet Grinding (Grinding in Suspension)

When grinding in suspension, you can add auxiliary substances in liquid form with a high boiling point and low vapor pressure.

Flammable liquids with a boiling point <100°C should not be used.

4.4 Clamping the grinding jars

4.4.1 Clamping with the Stainless Steel Jar Fasteners

The following tests should be performed before the grinding jars are clamped in the machine before each grinding operation:

- The flat sealing gasket (for sealing between the lid and the jar) must not be damaged or dirty. Replace severely deformed flat sealing gasket.
- The surfaces of the lid and of the jar on which the flat sealing gasket rests must be clean.



Clamping

After a few minutes of grinding, and in the cooling phases, check that the clamping is secure.

4.5 Mass Balance

Important! Symmetrical charging!

For weight balancing, always clamp a grinding jar of the same weight with a cover and sealing gasket in the opposite pot mounting.

As a temporary solution, use an empty jar as a counterweight.

4.6 Grinding Time

In accordance with the application, the grinding time should be adapted to the heating of the jar. The temperature inside the jar is about 20-30°C higher than the outside of the grinding jar.

The max. temperature at the outside walls of the jar is about 100- 110°C (Agate max. 70-80°C). The grinding time is determined by this temperature. The grinding time which does not exceed this temperature depends on the sample material, the balls und the speeds. For this reason the grinding time has to be determined experimentally by the user.

Clue

In the case of grinding at high speeds and with large jars, the grinding time should not exceed 1 hour (temperature-dependent). Then allow to cool for 0.5 to 1 hour.

- Pay attention to the heating of the material.
- In the case of extended running times, if necessary set a break time for cooling.
- Before switching on again after a cooling phase, check that the clamping is secure.

To reduce the grinding time you can use grinding jars and balls with a higher density and therefore with a higher impact energy.

In the case of operation for mixing and homogenization at low speeds, the mill may run for several hours without harm being done.

The machine cannot be operated with an external timer.

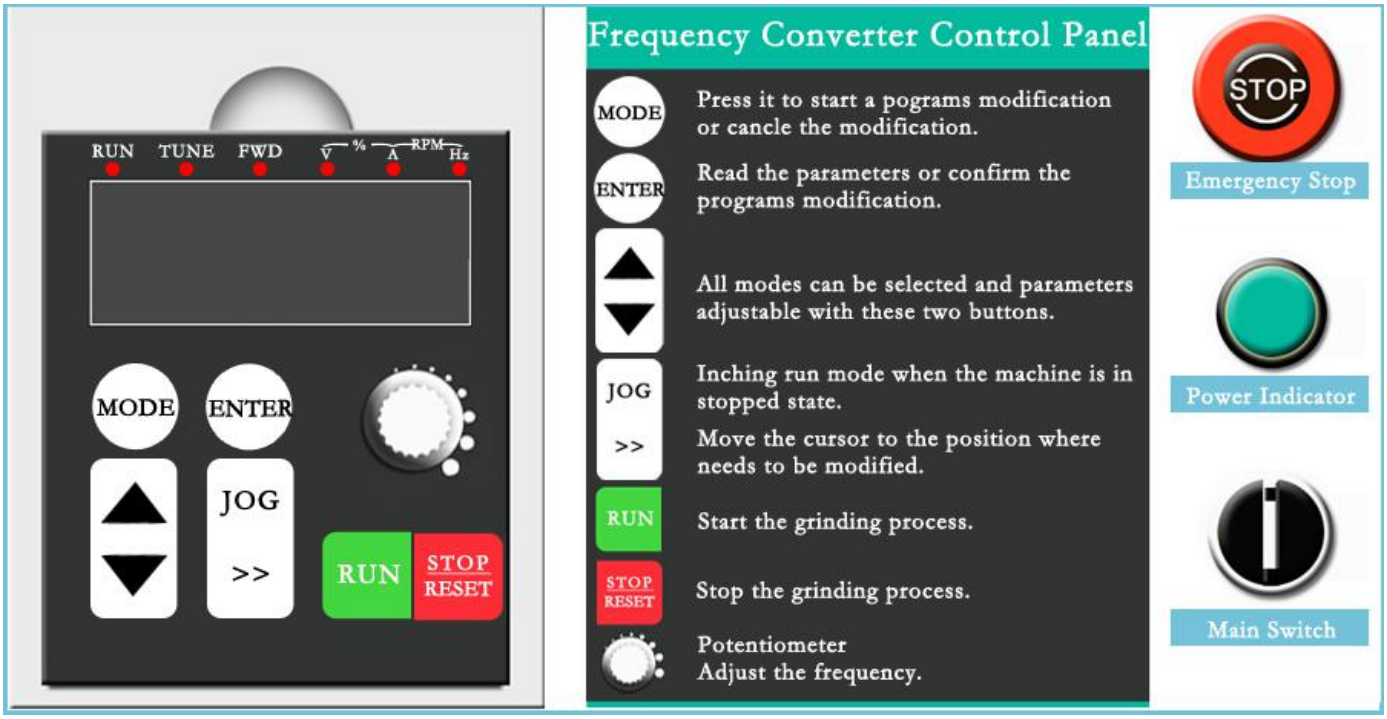
4.7 Frequency Conversion Control System

- Switch on the main switch at the top of the machine.



- The POWER SUPPLY light will come on.

4.7.1 Control Panel



4.7.2 Main Programs

- Single direction without timing
- Single direction with timing
- Bi-direction with timing
- Single direction with paused interval and timing
- Bi-direction with paused interval and timing

4.7.3 Functional Codes

Functional Code	Name	Range	Factory Settings	Program Modifications
U0.0.01	Display Mode	0: basic mode (prefix “P”) 1: user mode (prefix “U”) 2: checkout mode (prefix “C”)	1	No need to modify this mode.
U0.0.02	Control Mode	0: V/F control 1: open-loop vector control 2: close-loop vector control	0	
U0.0.03	Grinding Control Mode Selection	0: panel control 1: terminal control 2: communication control	1	
U0.0.11	Time of Speed Up	0000.0~6500.0s	0010.0	Extend or shorten the time.
U0.0.12	Time of Speed Down	0000.0~6500.0s	0002.0	
U0.1.16	Grinding Time before Speed Down	0000.0~6500.0s	0002.0	
U3.0.00	Grinding Mode	0: single cycle and stops 1: single cycle and keeps the value 2: always grinding 3: grinding N cycles	2	Modify it upon your actual needs.
U3.0.01	Grinding Cycles	00000~65000	00000	
U3.0.02	PLC Power Off Selection	The first number: data recall selection when the machine stops 0: not recall 1: recall The second number: data recall selection when the power suddenly off 0: not recall 1: recall	00	
U3.0.04	Grinding Time of Phase 0	0000.0~6500.0min	0010.0	Extend or shorten the time.
U3.0.06	Grinding Time of Phase 1	0000.0~6500.0min	0010.0	
U3.0.35	Grinding Direction of	H.010: default direction	H.010	No need to

	Phase 0	H.110: the counter direction		change.
U3.0.36	Grinding Direction of Phase 1	H.010: default direction H.110: the counter direction	H.110	If you change it to be H.010, it will be single direction grinding.
U3.2.11	Timing Control	4200: untimed 4239: timing	4239	If timing grinding is not needed, modify it.
U3.2.17	Paused Interval Time	0.0~3600.0s	0000.0	Extend or shorten the time.
U3.2.24	Total Grinding Time	0.0~3600.0min	0600.0	
U5.0.15	Displayed Ratio	0.0001~6.5000	0.1600	Always keep it!
U5.0.19	Restore Factory Setting	000: no operation 030: backup the data 060: recovery the data 102: restore factory settings	000	Modify it upon your actual needs.

4.7.4 Setting the Grinding Parameters

- Example: modify parameter U5.0.19 to 'backup the data'

Steps	Buttons	Display	Specifications
1	Connect with the power		Ball mill display mode.
2	Press [MODE]		Start the mode modification.
3	Press [▼] 6 times		Find the parameter U5.0.19.
4	Press [ENTER]		The parameter of U5.0.19 can be modified.
5	Press [>>] 2 times		Choose the second value.
6	Press [▲] 3 times		Value changes from 0 to 3.
7	Press [ENTER]		The modification of U5.0.19 is confirmed.
8	Press [MODE]		Back to the ball mill display mode.

4.8 Performing a Grinding Operation

- After everything has been set up as described in section 4 Working with the mill, close the hood.

- Switch the Emergency Stop clockwise.
- Press the RUN button on the control panel.
- The mill will run.
- The mill will rotate at the speed set – if the load is too great, e.g. if the grinding jar is too large, the machine will be run at a lower speed so as to prevent overloading.



4.8.1 Overloading

In the event of overloading of the mill, the speed will be reduced.

4.8.2 Miscellaneous

During operation, the hood must remain closed even during the breaks, and the fan will run.

4.8.3 Switching Off

- Press STOP on the control panel.
- When the drive has come to a standstill, the hood can be opened.
- Switch off the main switch at the top of the machine if the machine is to be inoperative for an extended period.

4.9 Cooling the Grinding Jars

- with the hood open or
- at the programmed break times with the hood closed and the ventilator running.

5 Cleaning

5.1 Grinding accessories

- Clean the grinding jar and grinding balls after each use: e.g. brush them clean under running water with usual cleaning agents.
- Fill the grinding jar with grinding balls and some sand and water half-full and run the planetary mill for 2 to 3 minutes (with the grinding jar correctly clamped in position).
- Cleaning in the ultrasonic bath is permissible.

- When sterilizing the grinding jars and grinding balls in the heat cabinet, heat only to 100°C.

Parts of agate, sintered corundum, zirconium oxide should being cooled down carefully and slowly.

Agate parts must never be heated in the microwave (they heat up too rapidly).

They must never be subjected to temperature shocks, such shocks may destroy the parts →They burst apart explosively.

5.2 Mill

- When switched off, the mill can be wiped down with a damp cloth.

Do not allow any liquids to seep into the machine.

6 Maintenance

Before commencing maintenance work, disconnect the mains plug and secure the machine against being switched on again unintentionally.

When maintenance work is being performed, this should be indicated with a warning sign.

Regular cleaning is the most important part of maintenance.

Functional part	Task / Description	Test	Maintenance interval
Gears	Permanent lubrication	Bearing play	Every month
Drive motor	Permanent lubrication	Bearing play	Every 4,000 hours or annually
Belt	Motor planet disk	Check the tension Disconnect the mains plug, pull down the mill; the belt should not yield by more than approx. 10 mm under thumb pressure.	1 x annually
Fan	Cooling the grinding chamber and electronics	Operation: clean when dirty	2 x annually
Grinding jar sealing gasket	grinding jar lid seal	If dirt pressed in the sealing, replace it!	Every 100 hours

grinding jar holder	support clamping system	Minimum 11mm!	1 x annually

7 Trouble Shooting

Malfunction	Possible cause	Elimination of error
POWER SUPPLY display not illuminated	Not connected to mains	Plug in mains plug
	Main switch	Switch on the main switch
	Safety switch	Check if the ball mill hood is well closed or not.
RUN button pressed but mill does not start	if POWER SUPPLY display not illuminated check see above	see above
	Break time active	wait for the break to end or press STOP
	safety switch is not pressed down	Check if the ball mill hood is well closed or not.
Mill speed reduced	overloading	Reduce the load or accept the reduced speed
Mill stops	overheating of the drive motor	Let the mill cool down and select lower speed
	Mass balance not adequate	improve mass balance: see section 4.5 Mass Balance
	drive is obstructed	eliminate trouble in grinding chamber
	belt loosen or broken	check or change belt
Material escapes	Holder loose	check
	Sealing ring defective or dirty	Replace or clean the sealing ring
Uneven running with severe vibration	Mass balance not adequate	improve mass balance: see section 4.5 Mass Balance

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Store Front

Store