



Bench Electrodialysis Pump Unit

PCCell BED 1-2 / 1-3

and

Accessory

Solvent container systems: BED1-620-110 / BED1-620-120

Tripod set: BED1-620-310



Operation & Maintenance Instruction

*Read these operation & maintenance instructions before start up!
To be held for future reference.*



PCCell GmbH
Lebacher Str. 60
66265 Heusweiler
Germany
Phone: ++49 - 6806 - 603732
Fax: ++49 - 6806 - 603731
E-mail: pccell@electrodialysis.de
www.pccell.de

Version: Nov 2013

Table of Contents

1. Safety Instructions.....	4
1.1. Identification of safety instructions in this operation manual.....	4
1.2. Hazards due to non-compliance with the safety instructions.....	4
1.3. Qualification and training of personnel.....	5
1.4. Electrical Hazards.....	5
1.5. Chemical Hazards.....	5
1.6. Safety instructions for installation, inspection and maintenance.....	7
2. General.....	9
2.1. Scope of Delivery.....	9
3. Function.....	11
4. Components of the PCCell B-ED System.....	13
4.1. Control Box.....	14
4.2. Power Supply.....	14
4.3. Electrolyte Container.....	15
5. Technical Data.....	16
6. Installation and Startup.....	18
6.1. General Remarks.....	18
6.2. Installation Location.....	18
6.3. Installation of the pump unit	18
6.4. Connection of the Stack with the ED Pump unit.....	21
6.5. The Electrolyte circuit and connection to the system.....	22
6.6. Start-up procedure.....	22
7. Warranty	24
8. Further Information / Contact Address.....	25
ED-Test Protocol	26

1. Safety Instructions

This Operation & Maintenance Manual contains basic information to be noted during installation, operation and maintenance of this product. It has to remain accessible at the device for reference at all times.

In addition to the general safety instructions under this main heading “Safety Instructions”, special safety precautions outlined in other sections must also be observed.

1.1. Identification of safety instructions in this operation manual

The following information may endanger people, the environment and the device if they are disregarded. They are identified by the following symbols:



DANGER!

Indicates an immediate danger. Failure to follow this instruction may lead to death or extremely serious injuries.



WARNING!

Indicates a potentially hazardous situation. Failure to follow this instruction may lead to death or severe injury.



CAUTION!

Indicates a potentially hazardous situation. Failure to follow this instruction may lead to minor injury or damage to property.



ATTENTION!

Failure to follow these safety instructions may endanger the machine and its functions.



IMPORTANT!

This refers to additional information to facilitate operation and ensure the smooth running of the equipment.

Appropriate references attached directly on the products or any of its other parts like labels or markings e.g. for electrical connections or process fluid connections must be respected and held in completely readable condition for future reference.

1.2. Hazards due to non-compliance with the safety instructions

Failure to follow the safety instructions may endanger not only persons, but also the environment and the device. Failure to follow the safety instructions will invalidate any damage claims.

Non-compliance with the safety instructions may give rise to the following hazards:

- Failure of major functions of the device.
- Failure of important methods for maintenance and repair.
- Danger to persons due to electrical, mechanical and chemical effects.
- Danger to the environment due to leakage of hazardous substances.

1.3. Qualification and training of personnel

The personnel employed for installation, operation, inspection and maintenance must be qualified for this work. The areas of responsibility, competence and supervision of the personnel must be precisely defined by the owner. Personnel who do not have the required knowledge must be duly trained and instructed. If necessary, this training can also be provided by PCCell on behalf of the ED system's owner.

In addition, the owner of the system must ensure that the relevant personnel are fully familiar with and have understood the contents of this Operation & Maintenance Manual.

1.4. Electrical Hazards

Basic safety precautions should always be followed when installing and using this electrical equipment. These include the following:



WARNING!

Risk of electric shock. The device has to be connected to an earthed socket outlet protected by a ground fault circuit interrupter (GFCI).



WARNING!

Replace any damaged cables immediately to reduce the risk of electric shock.



WARNING!

The control box and any electrical components may only be opened and serviced by qualified personnel.

For further details concerning electrical security, refer to the German VDE standards as well as local rules and regulations.

1.5. Chemical Hazards

When working on systems with chemicals, the accident prevention regulations applicable on site must be observed and the specified personal protective equipment worn. The following protective equipment is recommended at least:



Always wear protective glasses or a face protection shield.



Wear protective gloves suited for your process solutions.



Wear protective working clothes.

All people responsible for installation, operation and maintenance are advised to wear this protective equipment at least. Depending on the chemical nature of the process solutions, additional protective equipment may be necessary. It is in the responsibility of the owner to conduct a complete risk assessment before starting any work with the ED system.

Before doing any maintenance on the device, disconnect it from the mains supply and protect it against unintended restart.



CAUTION!

Any chemical still present in the hydraulic system may spray or flow out when the voltage supply is reconnected. This may lead to chemical burns or severe injuries.

System parts and lines may be pressurized. Working on the device requires special safety precautions and may only be carried out by instructed technical personnel.



CAUTION!

Always relieve the pressure before starting work on the device. Chemicals may spray out. This may lead to chemical burns or severe injuries.

The unit must be rinsed thoroughly with water when work is carried out in order to prevent any unintentional contact with the dosing medium. Never look into the open end of a blocked line. Chemicals may emerge unexpectedly.

Before start up, all hydraulic connections must be inspected for correct tightness and, if necessary, must be tightened up using appropriate tools.

CAUTION!



If connections are loosened for venting or other reasons, leaking chemical must be removed professionally. This is the only way to avoid the danger of physical injury and corrosion of the components.

The supplier of chemicals used in this product provides Material Safety Data Sheets (MSDS). They must be followed and must be accessible to anyone who uses the unit. These Safety Instructions do not replace the supplier's MSDS.



WARNING

The electrodialytic process can produce new chemicals or chemicals with higher concentrations than originally used, especially concentrated acids and bases. Adequate protective measures have to be taken.



CAUTION

At the electrodes, explosive and/or toxic gases and aerosol may be produced. Also in this case, appropriate protection has to be ensured.

The cell has to be run in a tank large enough to collect any liquids passing out of the system. Leakage of hazardous substances (e.g. toxic, corrosive or abrasive) must be discharged in such a way as to exclude all danger to people and the environment. Statutory regulations must be observed.

1.6. Safety instructions for installation, inspection and maintenance

The owner must ensure that all installation, inspection and maintenance work is undertaken by authorized and duly qualified skilled personnel who have also studied this Operation & Maintenance Manual.

The ED stack must always come to a complete stop before starting any work on it. Assembly and maintenance work on the control system must only be carried out after disconnecting the device from the power supply. The procedure specified in the operating manual for shutting down the installation must be observed without fail. Whilst the work is in progress, the unit must be safeguarded from being reactivated! Cables must only be connected in this condition. Non-compliance can lead to defects in the unit and will invalidate the warranty.

Pumps or units in contact with potentially harmful media must be decontaminated. Leakages of dangerous substances (e.g. aggressive, toxic), for example due to a broken diaphragm, must be suitably drained away so that they do not cause danger to persons or

the environment. A safe and ecologically beneficial disposal of process materials as well as replacement parts must be ensured.

All safety mechanisms and guards must be refitted and reactivated as soon as the work is completed. The instructions outlined in chapter “Installation location” and “Start up” must be observed before starting the system again.

All safety instructions contained in this operating manual must be observed. The operating company is responsible for ensuring compliance with local safety regulations. Any faults that could affect safety must be rectified immediately.

Legal requirements must be observed.

Risks from electric power must be excluded (for further details, refer to the german VDE regulations and the requirements of the local public utilities).



IMPORTANT!

The device may only be modified or converted in consultation with the manufacturer by qualified technical personnel. The manufacturer declines any liability for any damage or injuries caused by wrong configuration or assembly of the device.

Genuine spare parts and accessories authorized by the manufacturer ensure greater safety.

Liability for damage or loss may be voided if non PCCell parts are used.

2. General

The laboratory electrodialysis pump unit PCCell BED 1-2 and PCCell BED 1-3 are used in laboratory electrodialysis processes to remove ions from one solution (diluate). The ions are collected in another solution (concentrate). It allows with an electrodialysis unit (like the PCCell ED 64 0 02, PCCell ED 64 0 04 or PCCell ED 200) to carry out different types of experiments for a variety of applications, to examine the characteristics of ion exchange membranes in use. It is designed as an easy-to-manage laboratory cell.

2.1. Scope of Delivery

IMPORTANT!

Please unpack the ED system and ordered accessories carefully in order not to miss small parts. Immediately compare the scope of delivery to the delivery note. If there are any discrepancies, contact your local distributor.

The following tables show the positions related to the mentioned products. Please refer to your packing list / order to find the matching products:

ED Pump units:

BED1-2	1 x Pump unit # <serial number> 1 x Key of control box 1 x Euronorm connector plug 1 x PVC tube set 10x8x1 2 x Hose Clamp 1 x Handling instruction
---------------	---

BED1-3	1 x Pump unit # <serial number> 1 x Key of control box 1 x Euronorm connector plug 1 x PVC tube set 10x8x1 3 x Hose Clamp 1 x Handling instruction
---------------	---

Optional External solvent cylinder basic, PP or glass for BED1-2 (1-3):

BED1-2-100	2 x (3x) Tube adapter 3/8" - 10 mm 2 x (3x) PVC tube 0,5 m
-------------------	---

BED1-620-100	2 x (3x) External solvent cylinder PP 2 x (3x) pump connector with sample valve 1 x (1x) Mounting set
---------------------	---

BED1-620-110 2 x (3x) Glass cylinder
2 x (3x) Connector set cooling jacket
1 x (1x) Mounting set
2 x (3x) Connector pump-cylinder
2 x (3x) Sealing Set

Optional tripod set:

BED1-620-310 7x V2A steel rods (2x500mm/1x800mm/4x845mm)
For BED 1-2 4 x brackets
10 x sleeves
8 x plastic mounting sleeves

BED1-620-311 7x V2A steel rods (2x500mm/1x900mm/4x845mm)
For BED 1-3 4 x brackets
10 x sleeves
8 x plastic mounting sleeves

3. Function

The bench electro dialysis pump units PCCell BED 1-2 (PCCell BED 1-3) provides 3 (4) Electrolytic circuits: 2 (3) external circuits and one internal circuit. All circuits consist of a pump with flow- through meters (see the left two circuits in Fig. 2). The internal circuit consist of an additional 9 l electrolyte container, which is built into the pump unit (see the right circuit in Fig. 2). They are designed to work in combination with an ED cell to set up a variety of experiments like desalination.

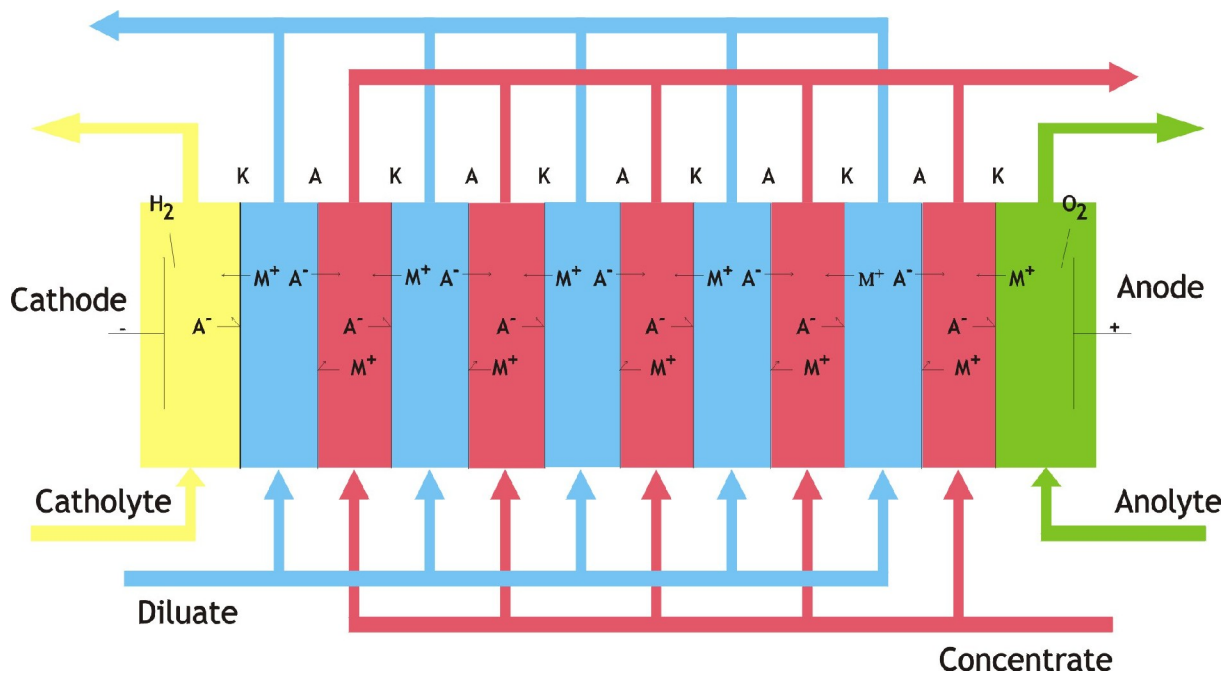


Fig. 1: Functional setup of an ED stack. Salts are removed in cells called "Diluate" and are collected in the Concentrate. Beside this, the electrodes need a solution, the Catholyte and the Anolyte.

An ED cell like the PCCell ED 64 can be used to run a standard ED. The ED stack provides n cell pairs (typically $n = 5, 10, 50$ or even 100), which are formed by $n+1$ cation exchange membranes, n anion exchange membranes and $2n$ spacers. At the shown polarity (Fig. 1), one of the cell systems is the diluate (where the ions are removed) and the other one is the concentrate in which the ions are collected. If the polarity is changed, the function of the cell system changes accordingly.

A complete ED System is set up by this ED Cell in combination with this ED pump unit and the external solvent tanks (Fig. 2).

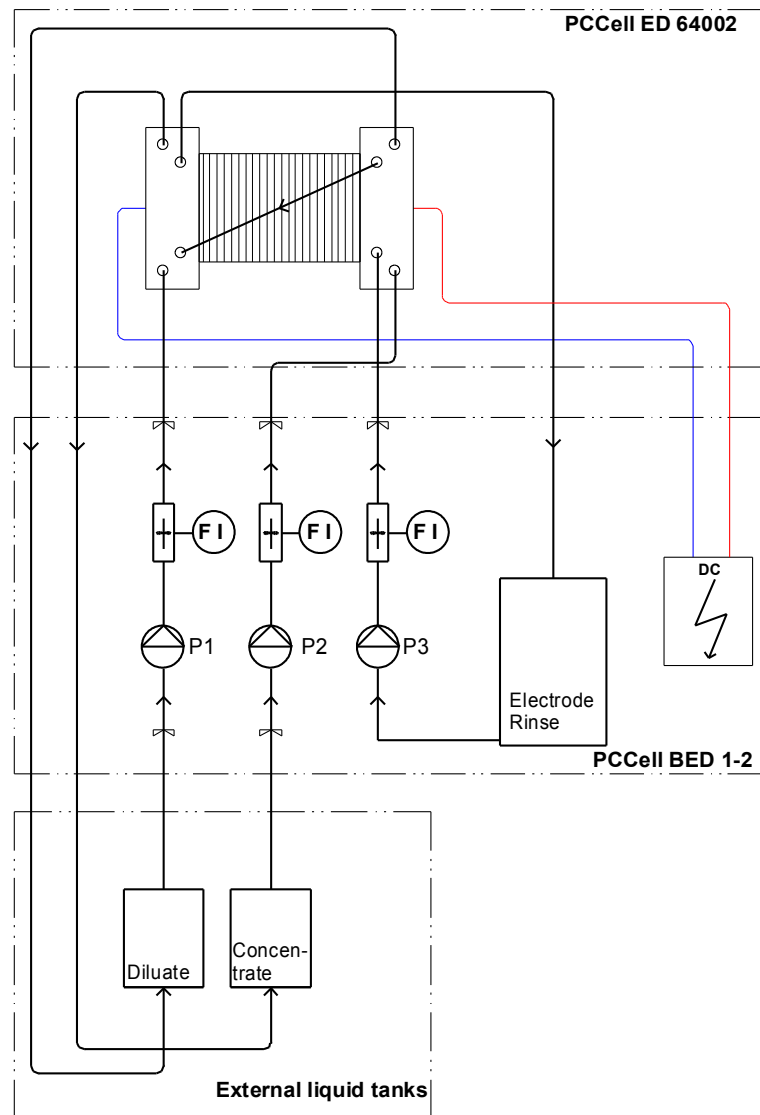


Fig. 2: A complete ED setup: it consists of the stack (upper dotted rectangle), the ED pump unit (middle) and the external electrolyte containers (below).

4. Components of the PCCell B-ED System

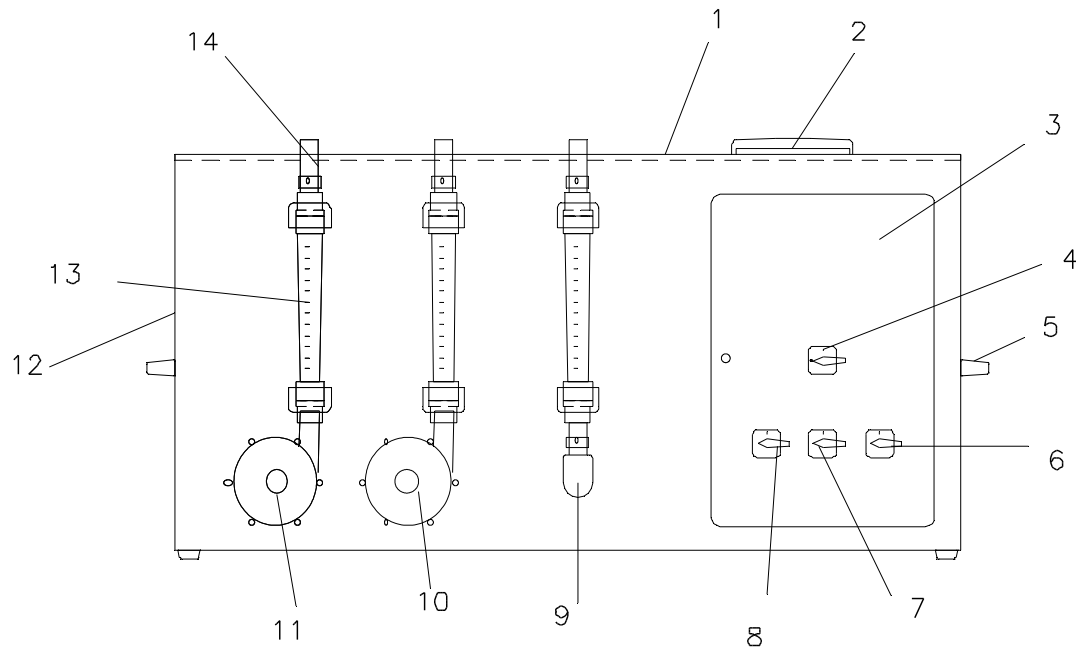


Fig. 3: PCCell B-ED 1-2 setup and functional parts.

#	Description
1	Working plate with waterproof beading
2	Electrolyte container screw top cap
3	Control box
4	Main switch
5	Handles
6	Electrolyte pump switch
7	Pump II switch
8	Pump I switch
9	Electrolyte solution circuit and flow meter
10	Pump II with flow meter
11	Pump I with flow meter
12	Power supply
13	Flow meter of circuit I
14	Outlet of circuit I

4.1. Control Box

The bench electrodialysis pump unit PCCell BED 1-2 (PCCell BED 1-3) is controlled by 4 (5) switches (see fig. 3) in the front of the control box:

- Main switch (Fig. 3: 4): activates the electrical supply for the pumps and the DC power supply to the eED cell.
- pump switches: activate the single pumps.
 - Pump 1: Diluate (Fig. 3: 8)
 - Pump 2: Concentrate (Fig. 3: 7)
 - Pump 3: Electrolyte (Fig. 3: 6)
- The BED1-3 model possesses one more pump for an auxiliary circuit.

4.2. Power Supply

The DC power supply can be switched on (at its main switch, No. 1 in Fig. 4) only in case the pump unit's main switch (Fig. 3: 4) is in position "on".

NOTE: The Power supply includes a heat control. This will switch the supply "off" in case of overheating or short-circuit.



Fig. 4: The power supply and position of electrolyte container in PCCell B-ED 1.

#	Description
1	Main switch
2	Minus pole of output power
3	Plus pole of output power
4	Potentiometer to adjust the maximum output amperage
5	Potentiometer to adjust the maximum output voltage

#	Description
6	Screw cap of the electrolyte container

4.3. Electrolyte Container

The bench electrodialysis pump unit PCCell BED 1-2 and PCCell BED 1-3 contains an internal electrolyte circuit. Fig. 4 no. 6 shows the cap of the electrolyte container. It consists of a polypropylene tank with a nominal volume of 9 l. It should be filled with 2 liters electrolyte minimum, to fill the internal impeller pump. This pump is activated by a switch on the control box (Fig. 3 no. 6).

5. Technical Data

Dimensions and Weight (without accessories)

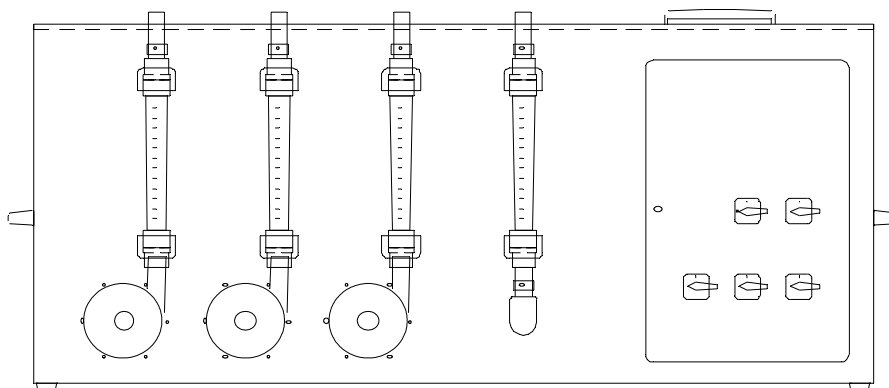


Fig. 5: PCCell B-ED 1-3: Front view.

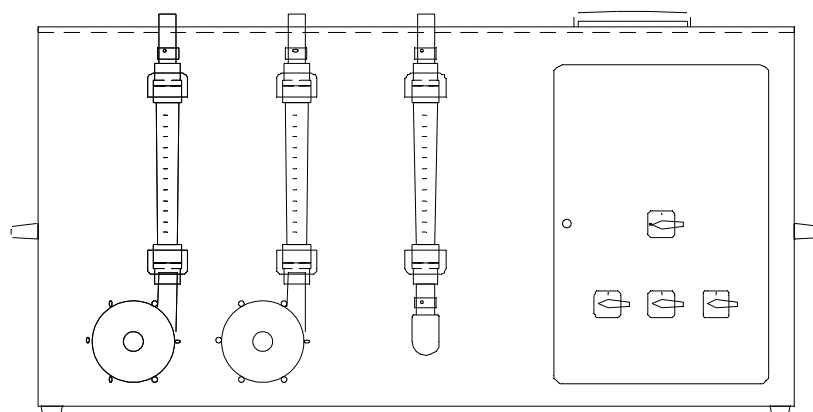


Fig. 6: PCCell B-ED 1-2: Front view.

	B-ED 1-2	B-ED 1-3
Width / mm	755	825
Height / mm	380	380
Depth / mm	410	410
Weight / kg*	26	28

* incl. Power supply

Electrical Connecting data

Input Voltage	230 V 50/60 Hz	
Max. Power consumption	max. 500 W	B-ED 1 - 2
	max. 650 W	B-ED 1 - 3
Protection Class	IP 42	

Medium Contacting Materials

Housing	polypropylene
Pumps	polypropylene
Pump shaft	Ceramic
Electrolyte container	polypropylene
Sealing	EPDM
Flowmeter	PVC
Hoses	PVC with softener

Power Supply Specification

Output Voltage	max. 24 V
Output Amperage	max. 6 A (short time) 4,5 A (continuous)

Pump Specification

	External circuit pumps	Electrolyte pumps
Max. output	25 l / min	14 l / min
Max. pumping height	3,5 m	2,4 m
Max. casing pressure	1,4 bar	1,4 bar
Max. Temperature*	5 - 50 °C	5 - 50 °C

*Max. pump temperature is 85 °C. Rotameter are max. 50 °C

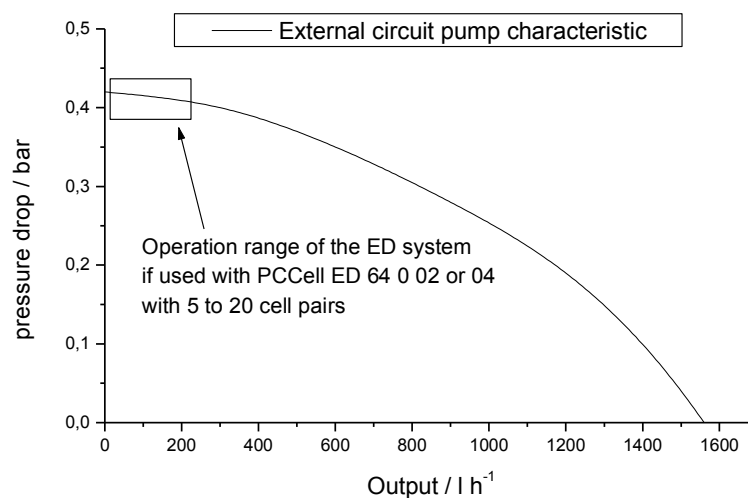


Fig. 7: Pump Characteristic for the pumps driving the inner solvent circuits of the ED stack.

6. Installation and Startup

6.1. General Remarks

The designer and the user are responsible to make sure that the whole system including the ED stack is operated so that neither plant equipment nor buildings are damaged in the case of leakage or malfunction due to the failure of any parts (e.g. spacer rupture) or burst tubing. If the chemicals treated by the system represent a potential danger, the installation must be carried out in a way that no unreasonably high consequential damages occur, even if the system fails.

Always use appropriate tools for the installation of plastic connecting parts. To avoid damage, never apply excessive force.

6.2. Installation Location

The installation location of the system must be a dry place, easily accessible for operating and service and should be at ambient temperature. The cell and liquid in the circuits should be prevented from freezing conditions as well as direct sun.

6.3. Installation of the pump unit

Setup of the external solvent cylinders: Standard

The standard connectors are grommets as shown in Fig. 8 a). Please screw them on the pump and use the tube to connect your solvent container with the pump.

Setup of the external solvent cylinders: PP solvent cylinders (optional feature)

For connection of the PP solvent cylinders, a connector as shown in Fig. 8 b) is provided including a sample valve. Please check out the marking "Pump I" or Pump II" or "Pump III" (Only for BED 1-3) as shown by the red arrow in Fig. 8 b) and screw the respective connector to its pump.

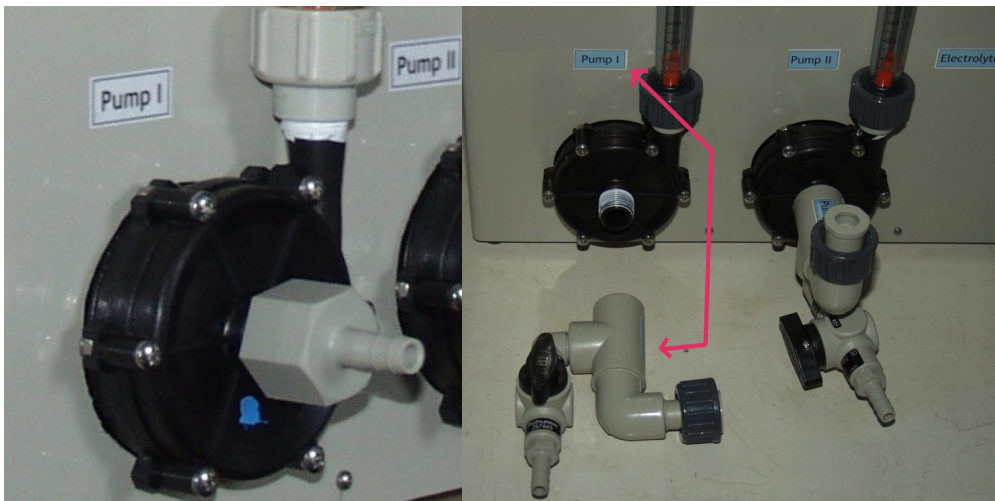


Fig. 8 a)

b)

Each cylinder is marked with an red, blue or dark violet arrow. Please mount the cylinders on its corresponding position as shown in Fig. 9.



Fig. 9 a)

b)

Mounting PP solvent cylinder to its respective position

Setup of the external solvent cylinders: Glass cylinders (optional feature)

For connection of the Glass solvent cylinders, a connector as shown in Fig. 8 b) is provided including a sample valve. Please check out the marking “Pump I” or Pump II” or “Pump III” (Only for BED 1-3) as shown by the red arrow in Fig. 8 b) and screw the respective connector to its pump.

After this, the Glass cylinder holder need to be mounted at the pump unit as shown in Fig. 10 a). The glass cylinder is to be mounted at the connector with the two sealing sheets and the PP-disk (see Fig. 10 b).

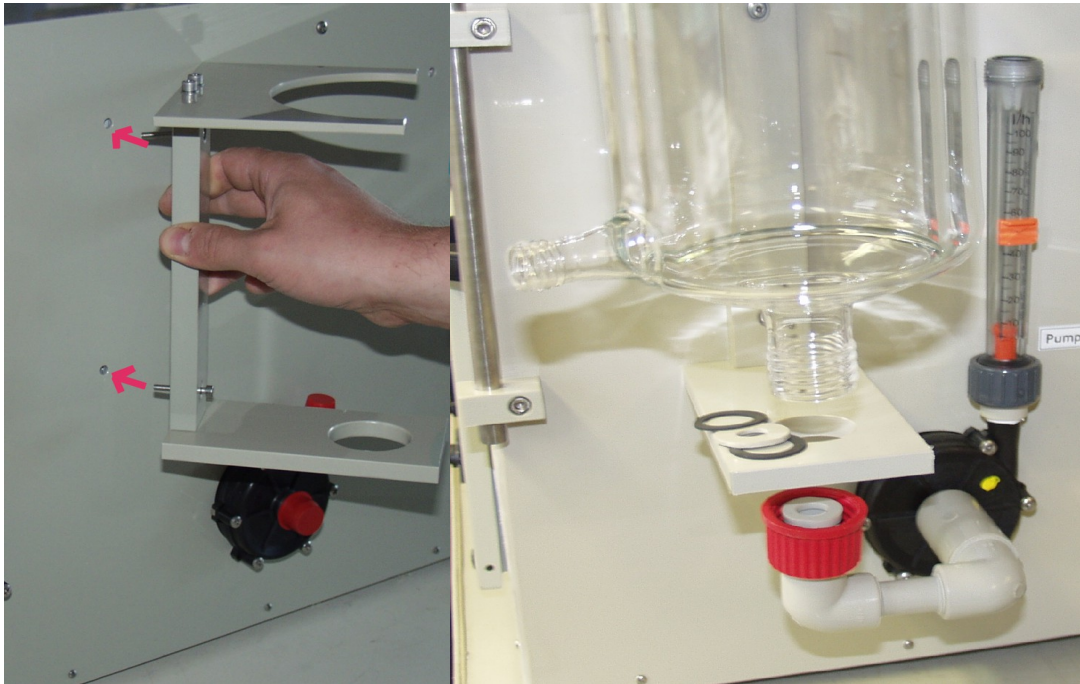


Fig. 10 a) b)
Mounting of the Glass cylinder holder and setup of the cylinder.

Setup of the tripod set (optional feature)

The tripod set is supposed to be set-up as shown in Fig. 12. The main rods (Fig. 12.1) should be mounted in the holders at the edge of the pump unit as shown in Fig. 11 a) and be fixed with an Allen key (Fig. 11 b)).



Fig. 11 a) b)
Mounting of the main rod of the tripod set.

The small rods (3) and the long rod (2) should be mounted with the sleeves.



Fig. 12 View of a mounted tripod-set.

6.4. Connection of the Stack with the ED Pump unit

The PCCell B-ED 1 in combination with an ED Cell, e.g. PCCell ED 64 0 02 and the external solvent tanks build the complete ED System (Fig. 1).

Connectors of the ED Cells:

- The four liquid systems of the cell (catholyte, anolyte, concentrate and diluate, see Fig. 1) require one inlet and outlet, each.
- Their direction can be changed, but inlet and outlet of both, diluate and concentrate, should be at the same cell face to reduce trans membrane pressure.
- The connectors for diluate and concentrate are situated diagonally opposite of each other,
- those of the electrode chambers in the interior at the same sides respectively.

Connection of the diluate and concentrate to the System

- Connect the concentrate tank to the circulating pump inlet, the pump outlet to the inlet of the concentrate chambers of the cell, and take the outlet of the concentrate back to the concentrate tank.
- Afterward, fill the concentrate tank up, let the liquid flow into the the pump.

- Make sure that all connections are firmly fixed and leak proof.
- Switch the pump on and look for leakage again.
- Build up the diluate circuit (connections 3 and 3') in the same way.

6.5. The Electrolyte circuit and connection to the system

The electrolyte container has to be filled with 2 - 4 l of the electrolyte solution. Generally, a 0,1 - 1 molar (preferably 0,25 m) solution can be used. The pump and flow meter has to be degassed by the electrolyte solution.

<i>Diluate pH</i>	<i>acid</i>	<i>neutral</i>
no divalent cations present	sulfuric acid	sodium sulfate
divalent cations present	amidosulphonic acid	sodium amidosulphonate

Tab. 1: possible electrolyte substances. The choice of the best option has to be done by reviewing the particular application.

The anolyte chamber and the catholyte chamber may be connected in one circuit: the pump outlet is connected to the inlet of the anolyte chamber, the anolyte outlet is connected to the catholyte inlet, and the catholyte outlet tube goes back to the tank.

6.6. Start-up procedure

At start up, the flow of the chemicals should be started first . A pressure difference over the membranes has to be strictly avoided! Sometimes, a soft start of the pumps is recommended.



Fig. 13: The steel bracket to squeeze the tube for adjustment of flow through.

Tip: Soft start

Use the steel brackets provided with the pump unit (See fig. 13) to close the tube between pump outlet and cell completely.

Start the pump.

Open the bracket slowly until the desired flowthrough is achieved.

When all electrolytes flow correctly, the height of liquids within the external cylinders should be monitored. As there should not be any hydraulic leakage, (Please refer to the handling instruction of the cell), the filling level of the liquids should achieve a constant level as long as no current is flowing.

The current can be applied after all air bubbles within pump, tubing and stack are removed and an air-free stream of liquid is observed.

Caution:



EXPLOSIVE HYDROGEN will evolve from the electrolyte container. It has to be vented properly to hold the hydrogen concentration below the explosion limit. Avoid ignition sources! Do not close the cap of the electrolyte container completely to avoid overpressure.

7. Warranty

ED Cells and Ion Exchange Membranes are offered for sale and warranted, as indicated below.

All information included herein falls within the normal range of product properties and is based on technical data that PCCell believes to be reliable. This information should not be used to establish specification limits, nor used alone as the basis of design. It is the user's responsibility to determine the suitability of the product described in this bulletin and that the user's particular conditions of use present no health or safety hazards. Product samples are routinely offered by PCCell to establish suitability and conditions of use, both of which are the sole obligation of the user.

PCCell warrants this product to be free from defects in material and workmanship upon delivery. The apparatus and parts supplied by PCCell meet PCCell's standard specifications. PCCELL MAKES NO OTHER WARRANTY, EXPRESSED OR IMPLIED. NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE IS GIVEN. This warranty and the specifications appearing herein may not be altered except by express written agreement signed by an authorized representative of PCCell. Representations, oral or written, which are inconsistent with this warranty or technical data are not authorized and if given, should not be relied upon.

PCCell assumes no liability in connection with any use of this information or product or for results obtained in reliance thereon. The disclosure of this information is not a license to operate under or a recommendation to infringe any patent of PCCell or others.

In the event of a claim under the foregoing warranty, PCCell's sole obligation shall be to replace any product or part thereof that proves defective in material or workmanship provided the customer notifies us of any such defect within 30 days of delivery. The membrane in question must be returned to PCCell for review and testing only with prior authorization. PCCell shall not be liable for consequential, incidental or any other damages resulting from economic loss or property damages sustained by user from the use of its products.

8. Further Information / Contact Address

For further information, visit our web site www.electrodialysis.info.

In case of any technical questions, please contact

PCCell GmbH

Dr. Patrick Altmeier

Phone: ++49-(0)6806/603730

Fax: ++49-(0)6806/603731

email: pccell@electrodialysis.de

Note:

The information in this handling instructions is presented in good faith, and all recommendations or suggestions are made without guarantee. The products are intended for use by persons having technical skill, at their own discretion and risk. PCCell is not responsible for any risks or liabilities which may result from the use of its products.

Date:	Task:	Project Name:
-------	-------	---------------

Type: _____

Membranes: _____, _____ pcs. Cell pairs: _____
 _____, _____ pcs.

Volume / l	Flow l/h	pressure /bar

[illegible]