The WaterBackpack Company GmbH

PAUL® Station

Manual

– assembly, start-up, operation and maintenance –

last modified 02.08.2019

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1 Principle of the PAUL® Station

The **waterbackpack PAUL®** is the core of the **PAUL® station**. The basic idea behind it is that it is essential to be able to tap large amounts of water in a short time. As the filtration process in **PAUL®** is steady but slow, two additional tank are necessary:

- a **R**aw **W**ater **T**ank (**RWT**) that stores the raw water so **PAUL®** can filter continuously
- a **F**iltered **W**ater **T**ank (**FWT**) to store the filtered water during times where no water is tapped

Figure 1 shows a scheme of the **PAUL®** Station arrangement.

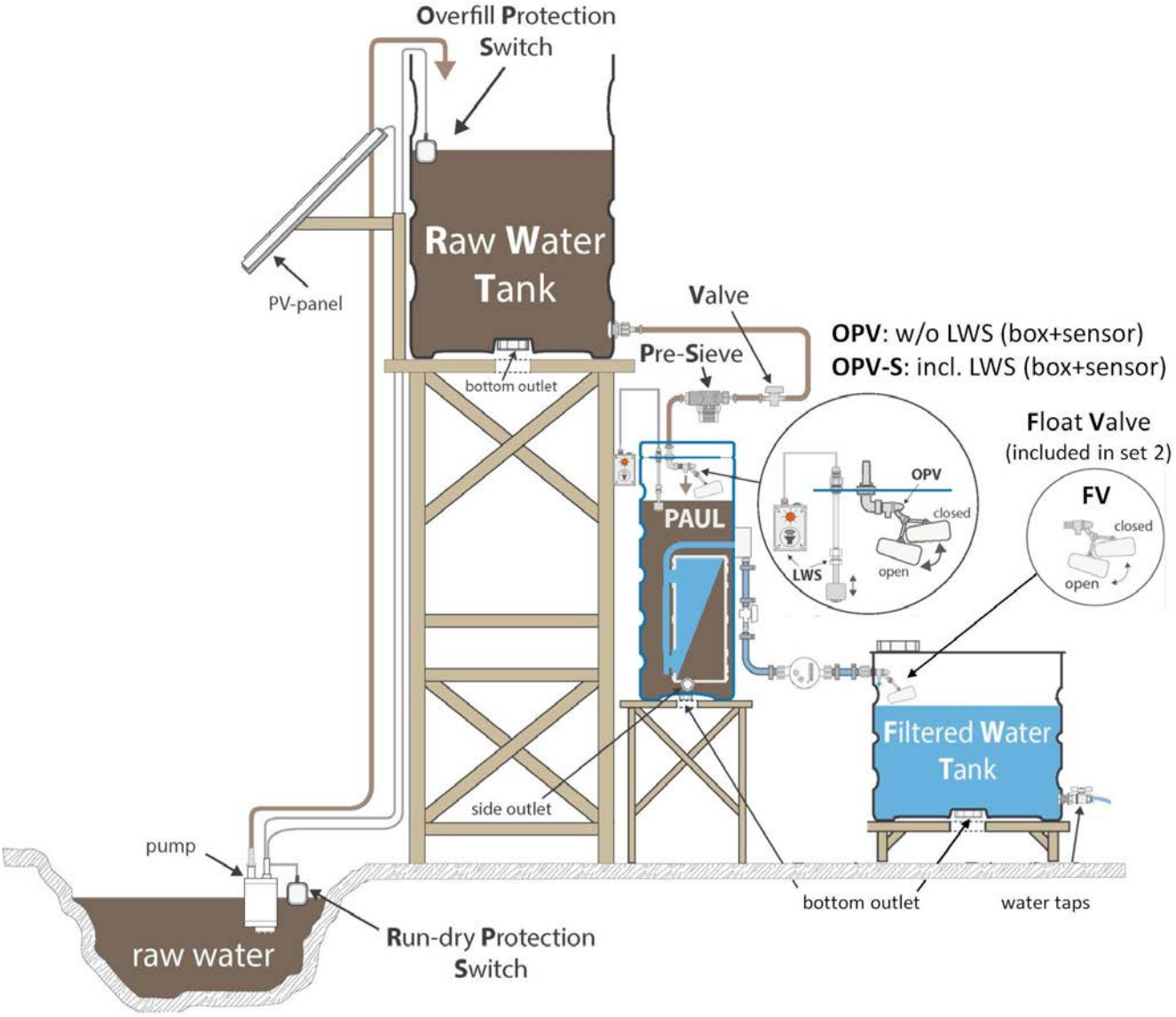


*Figure 1: Scheme of the **PAUL® station***

Water is pumped into the RWT (as an **example**, in the scheme above realized with a solar powered solution) and flows into the **PAUL®** unit. The filtered water from the **PAUL®** unit then flows into the FWT.

As a consequence, all three units have to be equipped with installations that **prevent overfilling** in order to allow **fully unattended use**.

This **automatic overfilling prevention** for the **whole PAUL® station** is realized by the following tools (see also Figure 1):

- in the **RWT**: the **OPS**, i.e. **O**verfill **P**rotection **S**witch, an electrical switch in a float is used that switches off the electrical raw water pump if the water-level exceeds an adjustable level
- in the **PAUL®** unit: the **OPV**, i.e. **O**verfill **P**rotection **V**alve (also called "auto-stop valve") is used that closes the inlet if the waterlevel in **PAUL®** exceeds a certain height
- in the **FWT**: the **FV**, i.e. **F**loat **V**alve (also called "auto-stop valve") is used that closes the inlet to the FWT if the water level in the FWT exceeds an adjustable level

Another thing that is necessary in most situations is the **RPS**, i.e. the **R**un-dry **P**rotection **S**witch for the electric pump. The device itself is identical with the **OPS**.

2 What can be delivered for the PAUL® Station

2.1 Overview

The **minimum** scope of delivery for a permanent water supply solution by the PAUL® station consists of

- PAUL® unit equipped with
- OPV (**O**verfill **P**rotection **V**alve) which replaces the standard sieve of PAUL®
  This is the minimum requirement for a permanent water supply with the PAUL® station, as it enables the connection between the RWT (or any other water supply connection) with PAUL® and a self-closing cover which can be opened in order to fill PAUL® with a bucket alternatively. Here a sieve is provided identical to the standard sieve.

In addition to this minimum scope of delivery, the following items are available and **recommended**, depending upon the local circumstances:

- set 1: connecting the RWT to PAUL
- set 2: connecting PAUL® to the FWT
- set 3: outlet of the FWT
- set 4: side outlet with hose
- OPS
- RPS

With the side outlet with hose, you can observe the water level inside PAUL®, as the hose is transparent. This is sufficient in most cases.

For those, however, who want/need an automated warning once the water level inside PAUL® is low, we offer a PAUL® control unit which consists of

- OPV-S (**O**verfill **P**rotection **V**alve with **S**ensor) which replaces the standard sieve of PAUL®, including the nozzle to connect the RWT with PAUL® and a self-closing cover which can be opened in order to fill PAUL® with a bucket alternatively. Here a sieve is provided identical to the standard sieve.
  It is identical with the OPV but also has the water level sensor mounted.

- **LWS** (**L**ow waterlevel **W**arning **S**ystem) **box**: this separate box is connected to the water level sensor mounted on the **OPV-S** via a 2-wire electric connection. The LWS box can be mounted close to **PAUL®** or even far remote by simply adding more wiring (regardless of polarity), e.g. in the house of the caretaker.

Although we recommend to solve the issue of water supply locally, see chapter 3.2, on special request we can also provide

- 12 V DC pump and
- the matching solar panel

Please note: If you ordered **PAUL®** together with the parts needed for the **PAUL® station** configuration, some items are already mounted on your **PAUL®** unit.

2.2 Upgrading an existing PAUL® standard unit

If you upgrade an existing **PAUL®** standard unit, simply exchange the sieve and mount the **OPV** (or the **OPV-S**) instead by removing the two screws that hold the sieve, and then mount the **OPV/OPV-S** in this place by using the same screws.

3 Before the assembly

3.1 Considerations on the raw water source

In general, it is recommended to use the best available water source. PAUL® is not able to desalinate or detox salty or toxic waters, as is also mentioned on the device.

Thus, which water can be used?

- Usually, stored rainwater, e.g. in cisterns or reservoirs is the **best raw water source**, as there is little or no contamination from industry, farming or geogenic origin.
- Also, rivers can be a good source, provided there is no influence of industry or farming upstream
- If – usually due to lack of water in sufficient quantity – wells have to be drilkled, this water may also be of very good quality. However, it is a minimum requirement to check concerning heavy metals, arsenic and fluoride, at least as a grab sample. Also the concentration on iron and manganese should be analyzed.

Advice can be given upon request.

3.2 Water supply for the Raw Water Tank

It has to be considered how the RWT can be fed with raw water. This will usually be done by an electric pump. Energy might be supplied by local grid or by solar power. Of course, the pump must fit to the type of energy supply.

Whatever solution is appropriate and feasible under the local circumstances, it should be assured that filling the RWT can operate fully unattended without overfilling the RWT.

In case of electric pumps, a float switch that breaks the electric circuit for the pump when exceeding a set water level in the RWT can also be provided, the so called OPS, see chapter 2.

When selecting the pump, important criteria include

- Suction or submerged pump

- Energy requirement, depending upon length and diameter of hoses and height to be sucked/pumped
- Ability of permanent operation
- Ability of running dry – if not, a Run-dry Protection Switch (RPS) is necessary, see chapter 2

3.3 Overview over available accessories for the PAUL® station

In this manual, the assembly of a **PAUL® station** is described, basing on all accessories mentioned in chapter 2. Also, important hints are given. Of course, except **PAUL®** and the OPV, everything can also be purchased locally, provided it has the same functionality. However, we assess as follows:

- Set 1: essential
- Set 2: essential
- Set 3: recommended
- Set 4: essential
- OPS: recommended (if an electric/solar pump is involved)
- RPS: dependent upon your chosen pumping solution

3.4 Necessary tools

- Screw-wrench AF 17, 22, 25, 30 and 32
- Hose cutter, alternatively stable scissor or cutter or knife
- Crimping tool, alternatively gripper
- Centre bit ¾“ or 1" and ½“
- Standard set of screwdrivers and phillips screwdrivers
- Drilling machine is recommended

3.5 Scope of delivery

This varies of course depending upon order.

However, in chapter 9 all single parts are listed an specified, so it is a good idea to first check the delivery for completeness. If any doubts, please contact us via Mail. Please include photos to explain your issue.

3.6 Height of the tanks relative to the PAUL® unit

Before assembling the **PAUL® station**, it is essential to determine the exact three-dimensional position of all three tanks, i.e. the **RWT**, **PAUL®** and the **FWT**, to assure that all connections between the tanks fit and fulfil specific restrictions and the hoses are long enough.

The only requirement concerning positioning is that we recommend minimum distances in height, as can be seen from Figure 2.

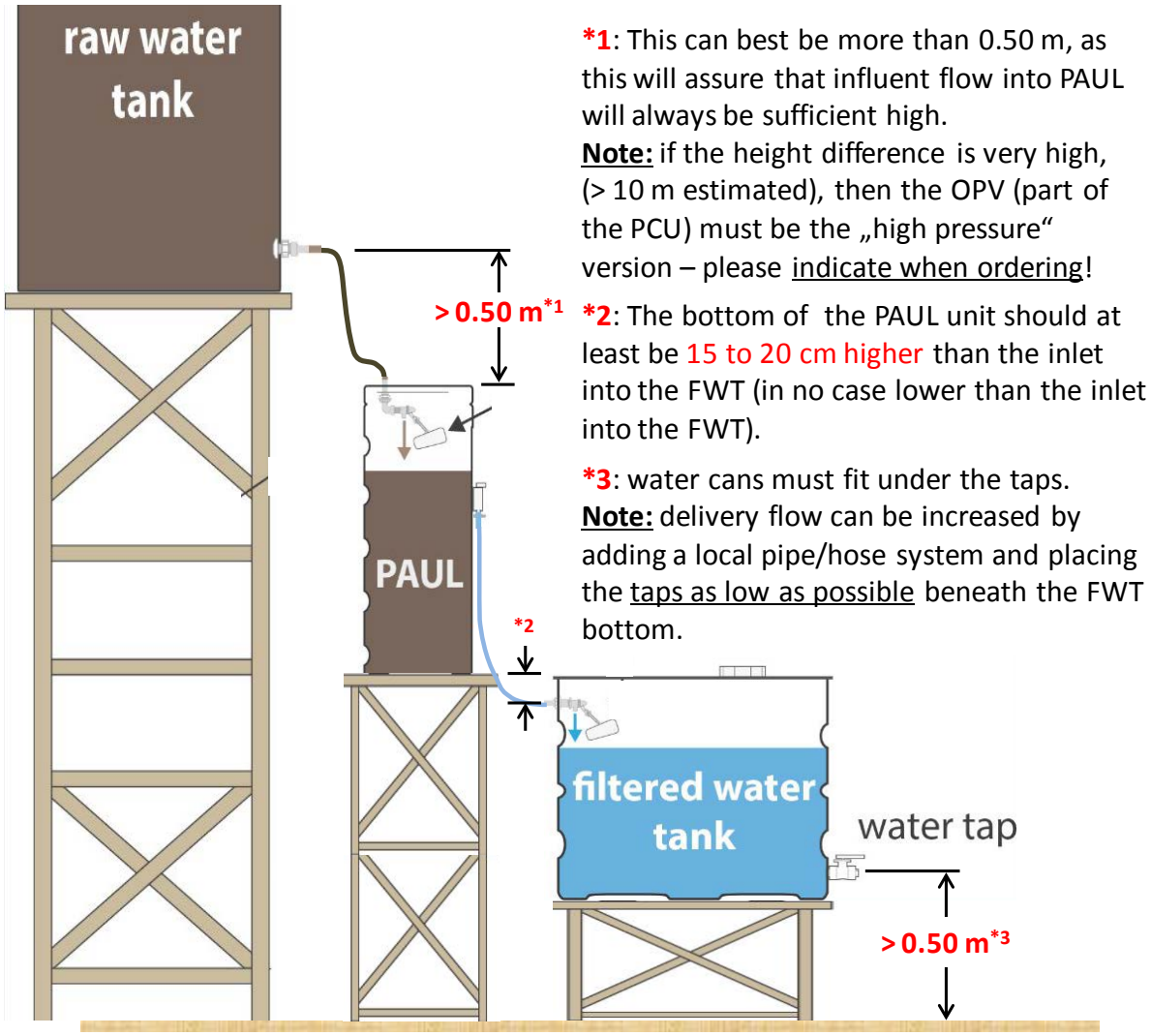


Figure 2: requirements concerning height of tanks and PAUL® unit

Please note that increasing the height difference between the bottom of **PAUL®** and the inlet into the FWT will increase the transmembrane pressure TMP. This results in higher flow, but it also might speed up pore blocking in the membrane, so please do not use this simple possibility to increase water production to a large extent.

4 Assembly

4.1 Set 1 to connect the Raw Water Tank with PAUL®

4.1.1 Overview

Figure 3 shows how to connect all parts that come with set 1.

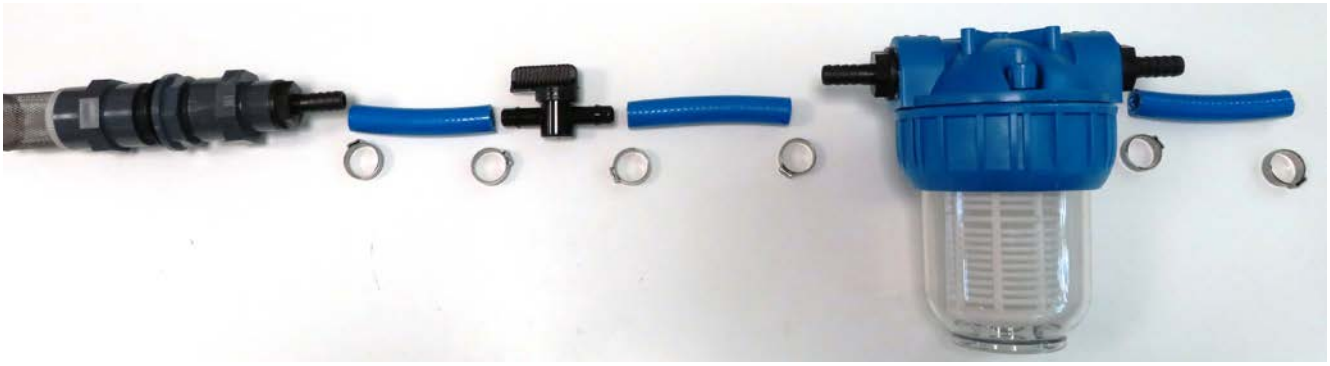


Figure 3: All parts that come with set 1 and how to connect

On the left hand side the RWT connector can be seen. This connector comes pre-assembled as can be seen in Figure 3.

Determine **where to mount the filter**. As this filter must be checked and – if necessary – cleaned, see chapter 6.1.2, choose a location where the filter is easily accessible, see also chapter 4.1.3. The valve is necessary to stop the water flow during filter cleaning, so the valve should be mounted close to the filter.

Connect the RWT connector with the valve and then with the filter using the blue hose.

Finally, connect the filter with the OPV or OPV-S mounted in **PAUL®** using the blue hose.

4.1.2 Mounting the tank connector on the Raw Water Tank

It might be a good idea to execute this step **before you put the RWT in place**.

Figure 4 shows the two versions of RWT connector. Due to the different diameter, each complete connector consists of different parts as can be seen from the figures and the list of parts in chapter 9.

The wall of the RWT must be between the two seals.

As the connector comes pre-assembled, it has to be divided according to Figure 5.

Then, drill a hole in the RWT using the centre bit ¾“ or 1", depending upon your tank connection diameter.

Figure 4: RWT connector parts of set1 (top: ¾" version, down: 1“ version) pre-assembled

Note: In raw water, even if filterd at the pump inlet, there will be settleable solids. They will accumulate at the bottom of the RWT. Thus, it is recommended to place the RWT connector a little higher above the bottom of the RWT, as is shown qualitative in Figure 2, depending upon solids content in the raw water etc.
Also, the RWT should have a bottom outlet at the very lowest point of the tank to enable flushing out solids from time to time.

Although you are free to chose your most convenient way of mounting, we recommend the following steps depending upon the diameter of the connector:

¾" version:

Divide the pre-assembled connector as can be seen in Figure 5:

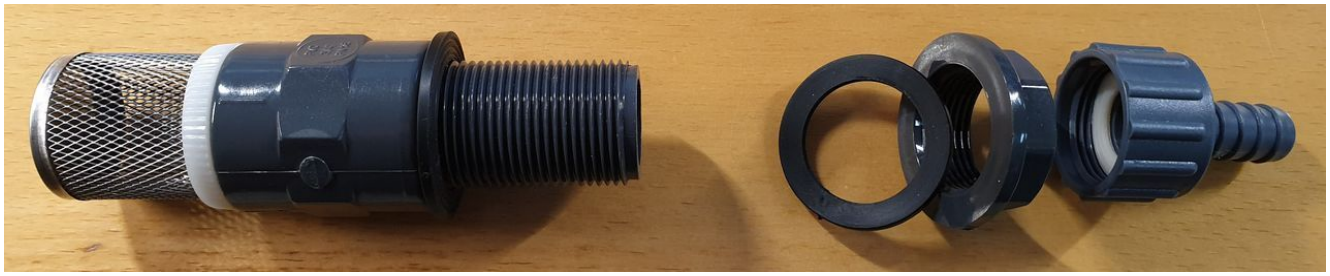


Figure 5: RWT connector parts of set1 (top: ¾" version, down: 1“ version) ready for mounting in the RWT

Make sure the threaded pipe with external thread is **firmly screwed** into the threaded pipe with internal thread which also holds the filter cage on the other side. Then place one of the seal on the threaded pipe with external thread, as can be seen from the left side of Figure 5

From inside the tank, push this left part of the connector together with the seal on the threaded pipe with external thread to the outer as far as possible.

Add the second seal on the threaded pipe with external thread.

Then tighten the connector with the counter nut on the threaded pipe, holding tight the inner part of the connector.

Finally, screw the hose nozzle with cap nut on the threaded pipe.

1" version:

Divide the pre-assembled connector as can be seen in Figure 6.

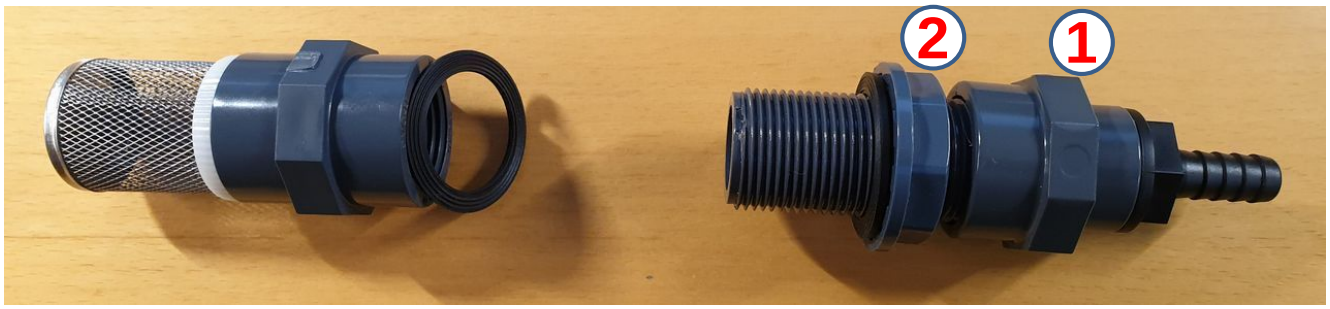


Figure 6: RWT connector parts of set1 (top: ¾" version, down: 1“ version) ready for mounting in the RWT

From outside the tank, push the right part of the connector as can be seen from Figure 6 together with one seal and the counter nut into the drilled hole.

Then, from inside the tank, screw the left part of the connector, i.e. the filter cage with the pipe coupling (internal thread) on the threaded pipe. Do not forget the second seal. To do so, use the pipe coupling ① to tighten the whole connection. The counter nut must be loos in this situation.

Finally, whilst still holding up the inner part of the connector, firmly tighten the connector to the wall of the RWT with the counter nut ②.

Be careful when putting the RWT in place and do not damage the connector.

4.1.3 Connecting the Raw Water Tank with PAUL®

Now you can connect the RWT with the **PAUL®** unit, and thus carefully decide where to cut the hose, **regarding the following issues**:

- the water filter has to be placed **horizontal** with the sieve facing downward, see Figure 3
- please regard the **direction of flow** through the water filter
- we recommend to place the valve close to the water filter
- we recommend to place both valve and water filter close to the **PAUL®** unit as this will ease maintenance (i.e. cleaning the filter from time to time, see chapter 6)

The hose clamps have to be fixed with a crimping tool or a gripper. They cannot be used multiple.

Please **clean the RWT** before you use it for the first time.

4.1.4 Remarks on the OPV or OPV-S

Usually the **OPV/OPV-S** is already mounted on **PAUL®** so you can directly start assembly and use the hose nozzle of the OPV/OPV-S.

But if you upgrade an existing **PAUL®**, then you will first have to remove the standard sieve on top of **PAUL®**.

Instead, mount the **OPV** or **OPV-S** in the place the standard sieve has been; it might be a good idea to store the sieve in a safe place.

Fixing the **OPV** or **OPV-S** with the two screws is very important as otherwise the **OPV** or **OPV-S** in total will float when the water level is rising, and thus will not prevent **PAUL®** from overfilling.

The **OPV-S** is equipped with a water level sensor that indicates if the water level falls below a certain limit. This water level assures that a long term standstill is possible. The sensor in the **OPV-S** must be connected by a very simple two line wire. At delivery, the connector is attached to the sensor cable, and this connector has to be plugged into the **LWS** box that can be seen in Figure 7.

Figure 7: LWS box

If desired (which might be the case in many situations), the wire can easily be extended to the desired length,. e.g. by placing the **LWS** box in a nearby flat etc.

The **LWS** operates with 4 AA batteries. If no warning is issued, there is no current, which means that the batteries last as long as their official lifetime is. Of course you can also use AA **rechargeable batteries**. In order to save battery power due to unwanted conditions during transportation, the test knob is covered with a plastic cap. If you need to replace the batteries, open the **LWS** (4 screws) and remove this plastic, insert new batteries/recharged batteries and close the box again and tighten the 4 screws properly.

Then check functionality of the **LWS** box itself by pressing the blue knob (see Figure 7, right hand side) – a LED light should appear and a sound should be

heard. Please check from time to time and replace/recharge batteries if needed, see below.

To check the functionality of the whole **LWS** system, connect the **LWS** box to the **OPV-S** at a low water level inside **PAUL®** – LED and beep should indicate low water condition. After reaching a certain height in **PAUL®**, the alarm will go off. Of course it can also be switched off by unplugging the sensor cable from the **LWS** box, but do not forget to **reconnect** it after **PAUL®** is filled up again.

4.2 Set 2 to connect PAUL® with the Filtered Water Tank

4.2.1 Overview

Figure 8 shows how to connect all parts that come with set 2.

Figure 8: All parts that come with set 2 including water meter (left) and float valve for the FWT (right) and how to connect

It is recommended to first put **PAUL®** and the FWT in place before cutting the hose that connects **PAUL®** into the necessary pieces. Also, the requirements explained hereafter have to be considered.

4.2.2 How to install

The standard **PAUL®** unit comes with a **white-blue** drinking water hose that ends with a valve.

From this valve, a hose connection to the water meter must be made using the **white-blue** hose, see Figure 9 and Figure 10.

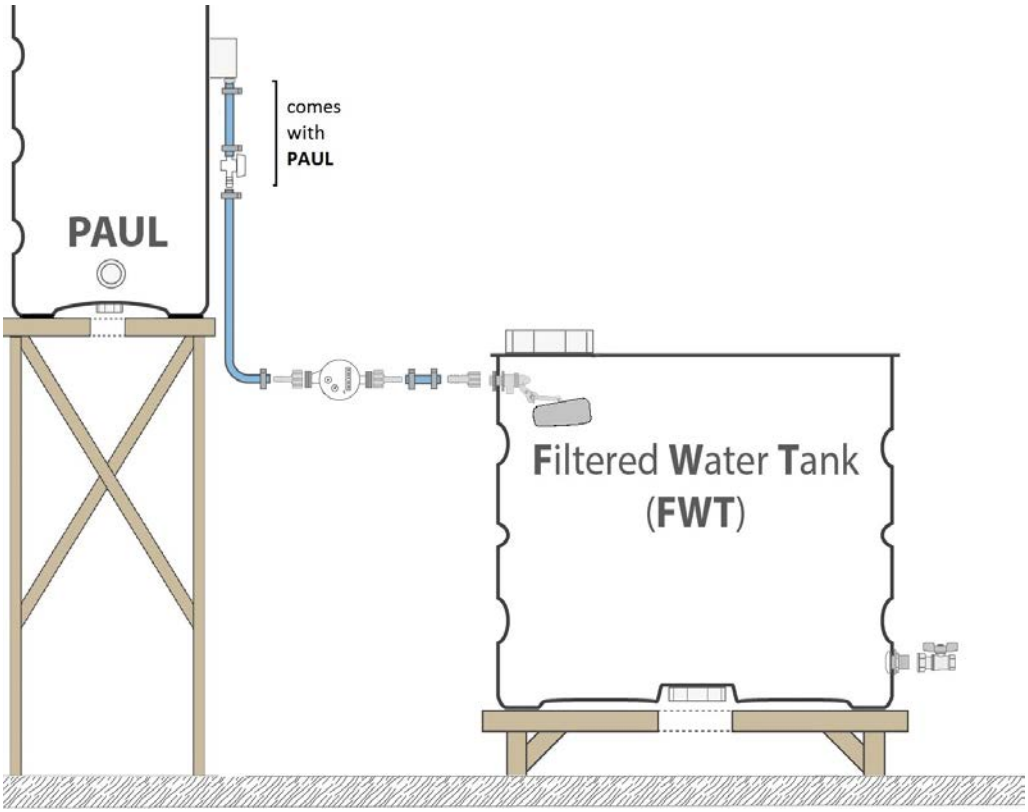


*Figure 9: Connection between **PAUL®** and the Filtered Water Tank – installation scheme*

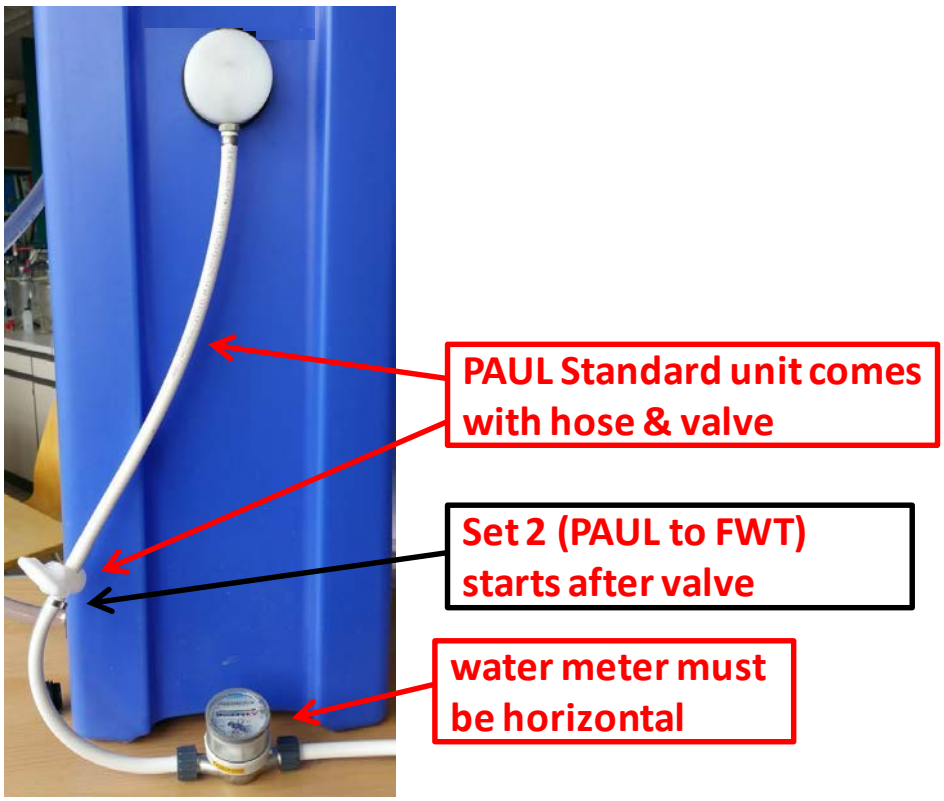


*Figure 10: Connection between **PAUL®** and the Filtered Water Tank (set 2) – what comes with **PAUL®** and how to mount the water meter*

From the water meter a hose connection must be made to the **float valve** that has to be mounted in the Filtered Water Tank to prevent from overfilling.

Drill a hole in the FWT close to the top of the FWT using the centre bit ½“. Remove the outer nut and seal from the float valve and push the float valve together with the other seal and nut from inside the tank to the outer. Fasten the valve with the seal and the nut you just had removed.

Note: The water meter must be fixed in a horizontal position., see Figure 10.

Note: The hose that connects **PAUL®** with the FWT is white-blue and has an inner diameter of 10 mm. This is essential. Do not use a hose with a bigger inner diameter, because this could affect the flow of water through **PAUL®!**

Note: Observe the height arrangements according to chapter 0.

4.3 Set 3 outlet FWT

In many cases, the outlets of the FWT will be provided locally. Nevertheless, set 3 can be obtained (also multiple, see note), consisting of a tank connector and a ball tap, both ¾", see Figure 11 and also Figure 9Figure 10.

Figure 11: Set 3 consisting of trank connector and ball tap

Drill a hole in the FWT close to the bottom using the centre bit ¾“. Then, push the tank connector (1) together with the white seal from inside the tank to the outer. Fasten the tank connector with the connecting nut **using the screw wrench AF 32** – please do not use any type of gripper, as the nut is made of plastic.

Be sure to mount the tap on the tank connector with the **inside thread**!

Note: As there is no pressure in the FWT, it is highly recommended to use multiple taps and/or taps with a large diameter.

4.4 Set 4 side outlet with hose

The side outlet near the bottom of **PAUL®** (and/or optional also the bottom outlet in the bottom of **PAUL®**) is used to flush the slurry that **PAUL®** retains and stores inside **PAUL®**. This has to be done from time to time, depending upon the solids content of the raw water. We recommend to flush out **PAUL®** every week so it will probably not been forgotten, see chapter 6.2.1.

In order to facilitate this, and also in order to be able to see the **waterlevel inside PAUL®**, we provide set 4, the side outlet with hose. Figure 12 shows how it works.

Figure 12: Side outlet with hose

Remove the black or red cap and install the brass screw with hose connector. Then mount the hose on the hose connector and fix it with a hose clamp.

In standard operation, fix the end of the hose higher than **PAUL®** is, so no water will flow out of the hose. As the hose is transparent, you can exactly see and observe the water level inside **PAUL®**. This is the "simple and no energy" version which in most cases makes the optional LWS unnecessary.

If flushing must be performed, lower the outlet of the hose so water and slurry can flush out of **PAUL®**.

Of course any other solution offering the same functionality is also possible.

4.5 Overfill Protection Switch (OPS) for the Raw Water Tank

The **O**verfill **P**rotection **S**witch (**OPS**) is to be installed in the RWT. This switch determines the maximum water level at which the feed pump must be switched off. By this, overfilling of the RWT will be prevented.

Concerning the necessary connections, please refer to the instructions provided with the OPS. The black wire is the zero connector. We recommend to test whether the blue or the brown wire is to be used besides the black wire.

4.6 Run-Dry Protection Switch (RPS)

It is highly recommended to prevent the feed pump that is used for raw water pumping from running dry. This can be done by using a **R**un-dry **P**rotection **S**witch (**RPS**) and realize the wiring according to this task, which means that the black wire is used and the second wire to be used is the opposite one compared with the wiring needed for overfill prevention at the OPS. We recommend to test whether the blue or the brown wire is to be used besides the black wire.

5 Start-up and operation

5.1 OPV adjustment

The **OPV** is fixed to the standard sieve with an overlying white plastic board whereof 50% can be opened, so it is still possible to fill **PAUL®** manually with a bucket via the sieve.

It is important that the arm with the float can **move freely**, as it has to float and thus stop water flow when the water level rises. Please check this and eventually assure this by checking that the screw, see Figure 13, is not tightened too hard.

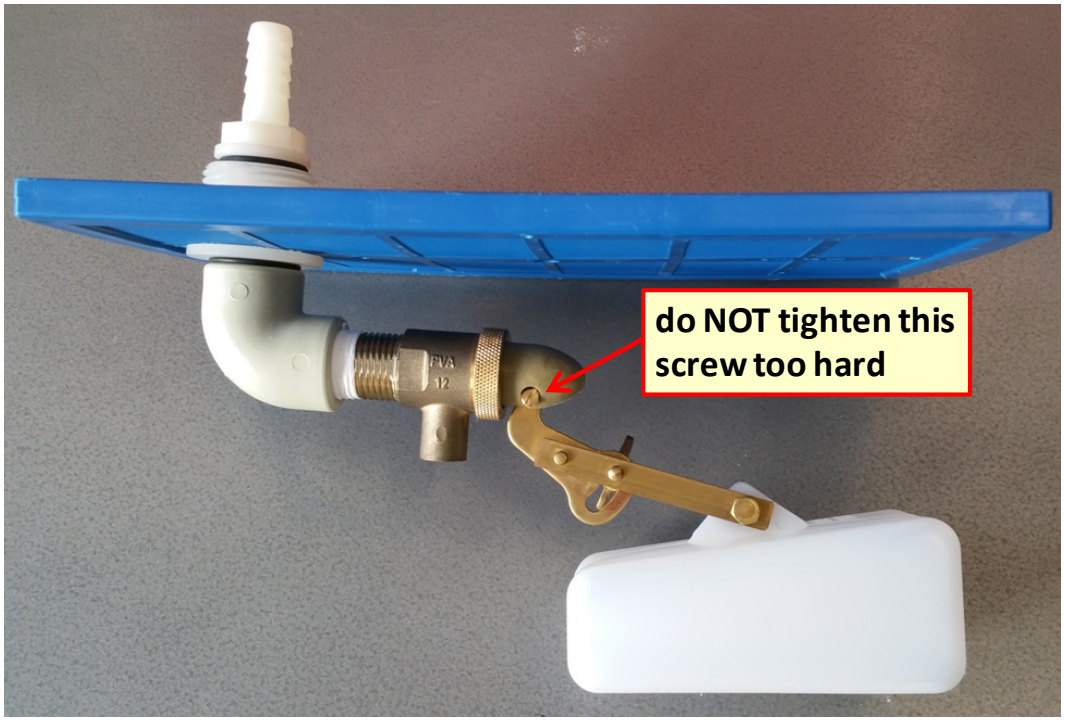


*Figure 13: OPV for **PAUL®***

If the screw is too tight, the arm with the float cannot move freely, which results in that it might stay in the "open" position although water level is rising even above the float, resulting in an unwanted overflow of **PAUL®**.

In case you receive the OPV separately and have to exchange the sieve by the OPV, please note the following: Due to transportation reasons, the arm with the float might be in a position as can be seen from Figure 14. Before mounting the OPV, please rotate the float arm so it is vertical below the sieve. To do so, loosen the screw (red arrow in Figure 14). After adjusting, please **tighten again this screw!**

Finally the OPV should look like can be seen in Figure 15.

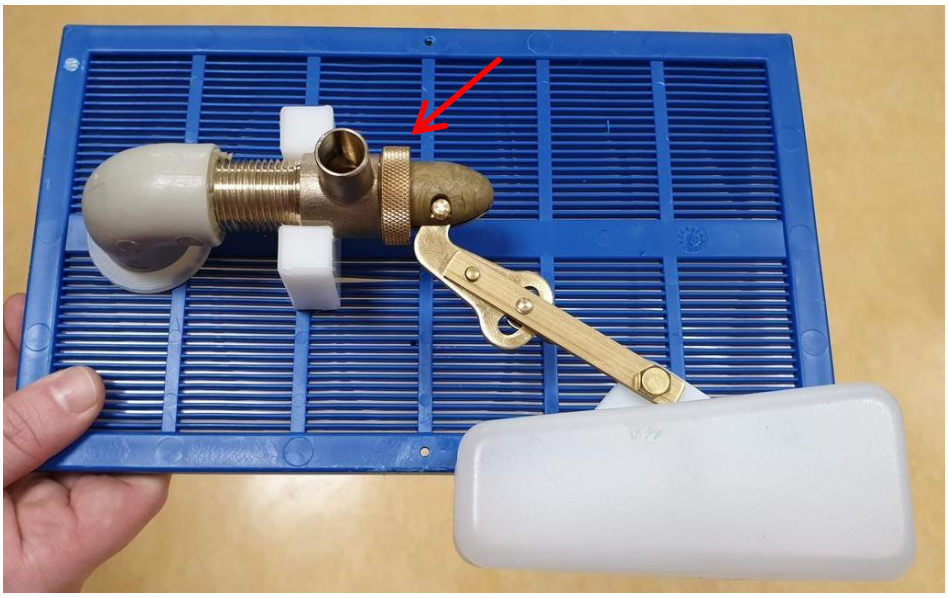


Figure 14: OPV with rotated float arm (transport position)

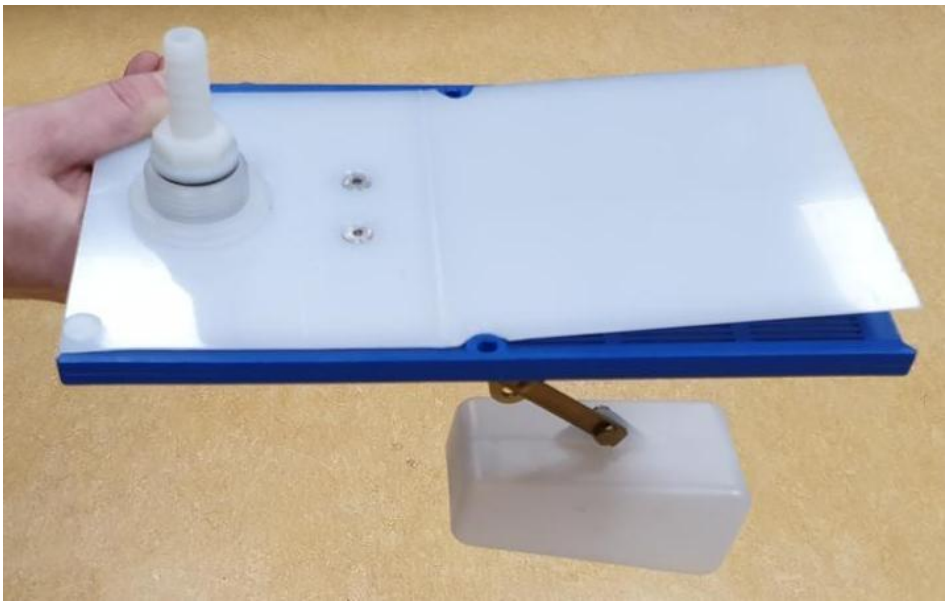


Figure 15: OPV correct adjusted

5.2 Start-up of the PAUL® station

After having assembled everything, please clean all installations, especially the FWT. Please close all valves and then follow these steps:

- fill RWT and check OPS

- ➢ in order to speed up, you can test the OPS in a low level position, so not too much water is needed before the autostop waterlevel is reached

➲ **open** the valve in the hose between **PAUL®** and the FWT

➲ open the valve in the connection between RWT and **PAUL®** unit

- ➢ **PAUL®** slowly is filled. If present, make sure to enable the LWS, so you can also check its function right now
- ➢ You can observe the water level rising in the transparent side outlet hose

➲ After some time close in the hose between **PAUL®** and the FWT

- ➢ This is to check whether the OPV in **PAUL®** is working properly. After successful test (please listen to the water flowing into **PAUL®**. This gentle sound must disappear without water overfilling **PAUL®**), open it again

➲ fill FWT (without tapping water) and check whether the SV in the FWT inlet closes properly when the FWT is full (this will take some time depending upon the volume of the FWT, but the **PAUL® station** can be left unattended during this test)

➲ remember **not to drink the first 200 Liter** of water as there might be a sweet taste from glycerine (which is not harmful!) which is used to preserve new membranes and which will be flushed out during the **first** usage.

5.3 Temporary stop of operation

If the operation of **PAUL® station** must be stopped for a short time (e.g. some hours, some days, but not several weeks), then please stop the process by **first closing the valve in the hose between PAUL® and the FWT**. This assures that **PAUL®** is filled with water during pause, which is necessary. Observe the water level in the side outlet transparent hose. Water level inside **PAUL®** should be at least half the height of **PAUL®**.

Then, all other necessary steps (switching off machines, closing taps etc.) can be done.

6 Maintenance

6.1 Daily

6.1.1 Water level inside PAUL®

The water level inside **PAUL®** should be checked daily. If the water level is considerably low, the **PAUL®** is able to filter more water than he gets from the RWT, which might be caused by a dirty sieve, see chapter 6.1.2.

If it is detected, that the water level is low, less than half the height of **PAUL®**, the close the valve in the connection between **PAUL®** and the FWT and fill up **PAUL®** with some water. Make sure enogh raw water is available.

6.1.2 Sieve between RWT and PAUL®

The sieve that is mounted between the Raw Water Tank and **PAUL®** should be checked daily. If it is obstructed, please clean carefully.

If cleaning of the sieve is frequently necessary due to a high Suspended Solids content of the raw water, maybe a different location of the tank connector in the RWT might help (maybe it is placed too close to the bottom of the tank where settleable solids accumulate).

Alternatively, a larger sieve would be necessary. This can be obtained by us upon request..

6.2 Weekly

6.2.1 Removing slurry from the PAUL® unit

All particles that **PAUL®** filters stay in the blue body of **PAUL®**. Thus, they must be removed on a regular basis.

This can be done by opening the bottom outlet underneath or on the side of **PAUL®**, whatever is easier.

Flush out the slurry, discard it the same way you do with toilet content, and close the outlet.

If you have mounted the **side outlet with hose**, see Figure 12, you can easily hold the hose down so water can flow out.

6.2.2 Measurement of maximum filtration capacity

In order to do this, please follow the steps:

1. Assure that **PAUL®** is filled up and enough water is in the RWT.
2. Assure that the effluent from **PAUL®** is unobstructed. If a FWT is connected, the float valve at the FWT inlet must be fully open.
3. Note all digits of the water meter, including the three red ones, see Figure 16, and the exact date and time (seconds!)

Figure 16: meter reading

4. Let **PAUL®** filter at least for 10 minutes, better 15 minutes, and then again note all digits and the exact date and time

It is the easiest way to make a photo at start and end with a smartphone, as then the exact date and time is included. **Please transfer this data (or, even better, the photos) to us from time to time.**

A sample protocol is seen in Figure 17. Please download the template from www.waterbackpack.org.

Maximum Filtration Test (see footnote / Manual Chapter 6.2.2)

Location: _____

PAUL S/N: _____

Start test			End test			Remarks
Date	Time hh:mm:ss	Count	Date	Time hh:mm:ss	Count	signature
15.02.19	11:02:00	12.214	15.02.19	11:17:00	12.242	this is a sample
	___:___:___			___:___:___		
	___:___:___			___:___:___		
	___:___:___			___:___:___		
	___:___:___			___:___:___		
	___:___:___			___:___:___		

Figure 17: sample protocol for maximum filtration test

6.3 Monthly

6.3.1 Cleaning of the FWT

Fresh Water Tanks are common and well known installations. Billions exist worldwide, so their maintenance basically is independent from the treatment method and thus has nothing to do with the **PAUL®** waterbackpack.

However, we would like to remind users that it is necessary to clean and disinfect these tanks from time to time. We recommend to do this once per month using a solution with 5 ppm up to 50 ppm available chlorine (ppm = mg/L).

Hints on chlorine dosing are presented in chapter 8.1.

First, the tank should be cleaned manually. Then, the solution can be used. Contact with the tank should be 30 minutes. Afterwards, flush the FWT with some filtered water.

6.4 Undefined frequency

6.4.1 Cleaning the RWT

As mentioned before, raw water will contain settleable solids. Thus, the RWT should be inspected from time to time and cleaned by flushing via the bottom outlet.

6.4.2 Cleaning the membrane module

Although usually **PAUL®** should not be opened and the membrane module does not need special care or attendance, in special situations it might be favourable to also clean the membrane module from time to time.

This can be done with a chlorine solution of ca. 5 ppm available chlorine (ppm = mg/L) as mentioned in chapter 6.3.1. Prepare the solution by filling **PAUL®**, closing the inlet to **PAUL®** and add sufficient chlorine (volume of **PAUL®** is ca. 100 Liter, so for **5 mg/L** you need **0.5 g available chlorine**).

Then let the solution soak for 30 min to 1 hour and then filter it into the FWT, and with the solution that now is in the FWT, you can also clean the FWT, thus combining the cleaning of both units.

7 Troubleshooting

7.1 Waterlevel in PAUL® is too low

This should be checked daily, see chapter 6.1, or it is indicated by the LWS box if installed.

This might have two reasons, and be solved as follows:

- there is no more water in the RWT. Solution:
  - fill RWT. In order to increase the water level inside PAUL® quickly, close the hose valve between PAUL® and the FWT temporarily.
- water flow from RWT is slower than filtration (more water per time is filtered than can flow into PAUL® from RWT). Reasons and solutions:
  - filter unit is dirty ➔ close hose valve in the hose between RWT and PAUL® and clean filter unit
  - OPV in PAUL® is blocked or dirty ➔ check OPV and remove dirt. See also chapter 5.1 and Figure 13.

If this does not help, you might also try the following:

- A larger filter unit or a larger hose diameter in the connection between RWT and PAUL® might be necessary. Also you can contact us after you tested the first two measures mentioned before without success.
- increase height difference between RWT and the PAUL® unit. Usually, this is not necessary, but in some cases the filtration capacity of PAUL® is so high that this measure might be necessary.
- decrease height difference between the PAUL® unit and the FWT. Usually, this is not necessary, but in some cases the filtration capacity of PAUL® is so high that this measure might be necessary.

7.2 How to disassemble and re-assemble PAUL®

Usually, PAUL® does not need to be disassembled. In severe cases of malfunction, please first seek for assistance by mail to paul@waterbackpack.org or call +49-172-6504683 (also WhatsApp).

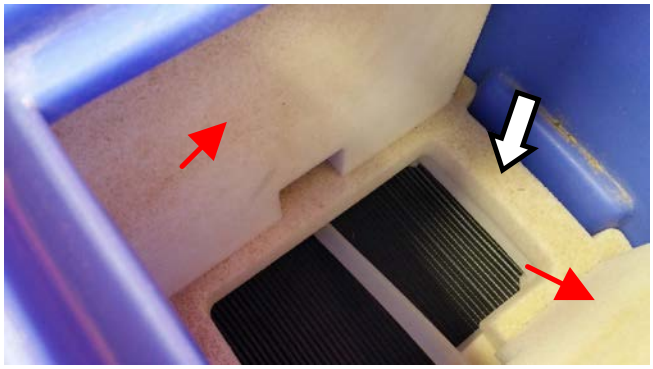
In case it is necessary to disassemble **PAUL®**, e.g. if the membrane module has to be exchanged or treated with special attendance or cleaning beyond the mechanism explained in chapter 6, disassembly and re-assembly can be conducted following the steps that are explained hereafter.

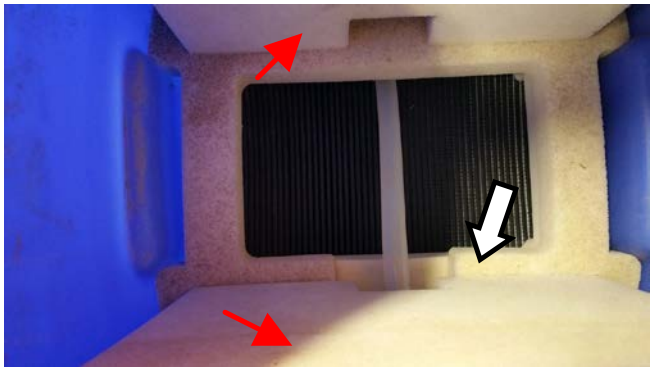
You will need an Inbus 5 tool for the 4 screws that hold the cover.

Step 1:

- Remove the 4 Inbus screws (red arrows) and lift the cover. Keep care of the 4 rubber parts (see samples in the yellow circle) that are under the cover, one for each screw.
- Note: to remove the sieve alone, just unscrew the two cross-slot screws.

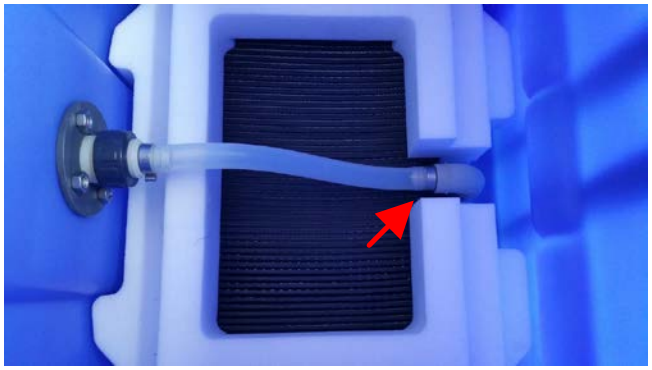
Step 2:





- Below the cover you see the white foam holding for the module, which consists of **5 parts**.
- The photos (only sieve removed, just for explanation) shows the two vertical plates (red arrow), which are fixed by the top cover.
- They can be removed after the top cover is removed.
- Now remove the 3rd foam holding part which is a horizontal frame (see white arrow) below the 2 foam plates that were just removed.

Step 3:



- Now it looks like on these photos.
- Please note that the 4th foam holding part also is a horizontal frame that fits just around the membrane module and holds it so it can't touch the PAUL body.
- Also, note that there is a slit (see red arrow) in this frame to give room for the connection between the membrane module and the outer tap

- Disconnect the filtered water hose from the outer tap.
- Take care of the black seal. It might occasionally fall down.
- It is essential that this **seal is correctly in place** when re-assembling!

Step 4:

- See the frame (4th part of the white foam holding) on this photo.
- Note that below the membrane module, as the basis for the module, there is another frame (5th and last part of the white foam holding) that is **identical with the 4th part**!.

- This is how it looks without the 4th part, and now you can carefully remove the module (red arrow)!
- Do not violate the membrane which is in the module.

- Assembly in reverse order!
- Take care that the module **slits into the basis frame** (5th part) (like your foot in a shoe!)

Once you removed the membrane module, please check whether you can see through the slits between the membrane plates, see Figure 18.

Figure 18: membrane module – look through the slits between the plates

If you find that some or even more of the slits are clogged (so you cannot see through them), possible reasons might be:

- Cleaning was not done properly, see chapter 6.2.1
- Too much transmembrane pressure, i.e. the height difference between **PAUL®** and the FWT massively exceeds the recommendations given in chapter 3.6.
- Eventually, your raw water has an extremely high solids concentration

In any case, please seek for assistance by mail to paul@waterbackpack.org or call +49-172-6504683 (also WhatsApp).

8 Additional information

8.1 Chlorine dosing

Please find a **sample leaflet** from a usual chlorine tablet. **Please note** that with any chlorine you obtain, a similar leaflet must be included, and **always refer to that product specific leaflet!**

Special attention should be devoted to the content of **available chlorine** in the product you have.

1 g available CHLORINE Effervescent Tablets

Each tablet contains 1.67g sodium dichloroisocyanurate (or NaDCC or sodium troclosene or sodium dichloro-s-triazinetrione) which releases 1 g available chlorine when it is dissolved in water. Sodium dichloroisocyanurate is a non toxic chlorine releasing disinfectant which can be used for disinfection of wounds, instruments, equipment, floors, drinking water.
Solutions of appropriated strength kill bacteria, fungi, spores, viruses including HIV.

Strength of solutions are generally expressed in content of available chlorine.

1 tablet per litre = 1 g/l or 0.1% or 1,000 ppm available chlorine.
(ppm=part per million).

Drinking Water Disinfection:
1 tablet per 200 litres clean water =
5 mg/l = 5 ppm available chlorine.
Allow contact for 30 minutes minimum before drinking.

To Treat Smaller Quantities:
Prepare first a 1,000 ppm available chlorine solution dissolving 1 tablet in 1 litre water. Then add 5 ml of this solution per litre water to be disinfected (using for instance a syringe).

Remarks:
- Heavily contaminated water should be first filtered or allowed to settle. Then treated with 10 mg available chlorine per litre (1 tablet per 100 litres).
- For large scale water treatment, residual available chlorine should be checked to fit chlorine dosage better to the water quality.

CAUTION
Avoid inhaling vapours or dust.
Do not expose the product to flame. Do not incinerate.
The product can be mixed with anionic detergents such as soft soap. But in case of doubt about the nature of the detergent avoid mixture. Toxic chlorine gas can be released with other types of detergent.
Do not mix with acid solutions. It causes release of toxic chlorine gas.
Store in dry and well ventilated places.
DO NOT SWALLOW THE TABLETS.

8.2 Taking PAUL® out of operation for a long period of time

If PAUL® has to be taken out of operation for a long time, e.g. for weeks or months, the following is recommended.

- Flush PAUL® with clean water according to chapter 6.2.1 until only clean water comes out of the bottom or side outlet.
- Fill PAUL® with at least 50 Liter of clean water (the membrane module must be immersed).
- Use a chlorine concentration in this water at about 1 mg/Liter (1 ppm) **active** chlorine. Example: If PAUL® is filled with 50 Liter, you need 50 mg active chlorine = 0.05 g active chlorine. See chapter 8.1 for further instructions.

The membrane can stand a chlorine load of 500,000 mg/(L*h). This means, that with a concentration of 1 mg/L, the maximum time to expose the module to this conditions (soaking time) is 500,000 hours (which is close to 60 years!), so there will be no chlorine introduced damage to the membrane material.

9 Detailed list of parts that come with set 1 to set 4

Besides **PAUL®** standard unit and the OPV, which is already mounted on **PAUL®** if ordered together (or can easily be mounted onsite), there are 4 additional sets of accessories, whose assembly is described in CHAPTER...

Please find hereafter the detailed list of parts for these sets.

*Table 1: List of parts included in set 1: connection between RWT and **PAUL®** (RWT connection with ¾" diameter)*

InvNr. / part no.	Anzahl / count total	Set 1	Set 2	Set 3	Set 4	other	Einh. / unit	only Set 1 Artikel / Item
i_0002	1	1					pcs	hose nozzle w. cap nut 3/4", Ø 13 mm (bore 8.5 mm)
i_0003	6	6					pcs	one ear hose clamp 22.5 (19.2 -21.8 mm), stainless steel
i_0004	2,5	2,5					m	drinking water hose "Rauaqua KTW A / DVGW W270" 12.8 mm (1/2") blue
i_0005	1	1					pcs	hose valve, HDPE, Ø 12-15 mm, bore 9 mm, length 97 mm
i_0071	1	1					pcs	water filter case 5", 2 connections 3/4"
i_0072	1	1					pcs	filter cartridge 5" Polyestergaze 60my
i_0073	2	2					pcs	PP hose nozzle external thread x nozzle 3/4" x 13 mm
i_0074	2	2					pcs	flat seal with profile for external thread 3/4"
i_0075	1	1					pcs	PVC-U counter nut cap nut 3/4"
i_0076	1	1					pcs	PVC-U threaded pipe, external thread 3/4"
i_0077	1	1					pcs	PVC-U pipe coupling, 2 internal thread 3/4"
i_0078	1	1					pcs	filter cage stainless steel, external thread 3/4"

Table 2: List of parts included in set 1: connection between RWT and PAUL® (RWT connection with 1" diameter)

InvNr. / part no.	Anzahl / count total	Set 1	Set 2	Set 3	Set 4	other	Einh. / unit	only Set 1 big (1'' diameter) Artikel / Item
i_0003	6	6					pcs	one ear hose clamp 22.5 (19.2 -21.8 mm), stainless steel
i_0004	2,5	2,5					m	drinking water hose "Rauaqua KTW A / DVGW W270" 12.8 mm (1/2") blue
i_0005	1	1					pcs	hose valve, HDPE, Ø 12-15 mm, bore 9 mm, length 97 mm
i_0071	1	1					pcs	water filter case 5", 2 connections 3/4"
i_0072	1	1					pcs	filter cartridge 5" Polyestergaze 60my
i_0073	3	3					pcs	PP hose nozzle external thread x nozzle 3/4" x 13 mm
i_0079	2	2					pcs	flat seal with profile for external thread 1"
i_0080	1	1					pcs	PVC-U counter nut cap nut 1"
i_0081	1	1					pcs	PVC-U threaded pipe, external thread 1"
i_0082	1	1					pcs	PVC-U pipe coupling, 2 internal thread 1"
i_0083	1	1					pcs	filter cage stainless steel, external thread 1"
i_0084	1	1					pcs	PVC-U pipe coupling, 2 internal thread 1" x 3/4"

Table 3: List of parts included in set 2: connection between PAUL® and FWT

InvNr. / part no.	Anzahl / count total	Set 1	Set 2	Set 3	Set 4	other	Einh. / unit	only Set 2 Artikel / Item
i_0006	1		1				pcs	hose nozzle w. cap nut 1/2", Ø 13 mm
i_0013	3		3				pcs	one ear hose clamp 16.8 (13.9-16.1 mm), stainless steel
i_0014	1,3		1,3				m	drinking water hose, 10 x 15 mm, white/blue
i_0015	1		1				pcs	low pressure float valve 1/2" with 1nut and 1 seal, 2nd nut and 2nd seal see i_0016+i_0017
i_0016	1		1				pcs	nut 1/2", wrench size 32
i_0017	1		1				pcs	flat seal with profile for ext. thread 1/2"
i_0019	1		1				pcs	water meter 3/4" type Zenner ETKD Q3=2.5 (Qn 1.5) 110 mm for cold water incl. 2 seals (to be used with ball tap
i_0024	2		2				pcs	hose nozzle with cap nut 3/4", Ø 10 mm (bore 6mm)
i_0051	1		1				pcs	one ear hose clamp 20.0 (17.1-19.3 mm), stainless steel

Table 4: List of parts included in set 3: outlet FWT

InvNr. / part no.	Anzahl / count total	Set 1	Set 2	Set 3	Set 4	other	Einh. / unit	only Set 3 Artikel / Item
i_0001	1			1			pcs	tank connection ext. thread PP, white, 3/4", bore 18 mm
i_0018	1			1			pcs	ball tap straight brass green knob int. Thread 3/4", cap nut 3/4", with one seal

Table 5: List of parts included in set 4: side outlet with hose

InvNr. / part no.	Anzahl / count total	Set 1	Set 2	Set 3	Set 4	other	Einh. / unit	only Set 4 Artikel / Item
i_0061	1,3				1,3		m	hose 20/24 transparent
i_0062	1				1		pcs	brass hose nozzle ext. thread 1" to nozzle 20 mm
i_0063	1				1		pcs	hose clamp screwable W2 12 mm width 25-40 mm

In addition, there are float switches available that are intended for

- **OPS** – Overfilling prevention switch of the RWT
- **RPS** – Run-dry protection switch

Both switches are intended to be jointly connected to an electrical pump for raw water pumping.

Weekly Maximum Filtration Test (see footnote / Manual Chapter 6.2.2)

Location: _____

PAUL S/N: _____ please return data to frechen@uni-kassel.de

Start test			End test			Remarks
Date	**Time hh:mm:ss**	**Count**	**Date**	**Time hh:mm:ss**	**Count**	signature
15.02.19	11:02:00	12.214	15.02.19	11:17:00	12.242	this is a sample
	___:___:___			___:___:___		
	___:___:___			___:___:___		
	___:___:___			___:___:___		
	___:___:___			___:___:___		
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	___:___:___			___:___:___		

1. **Assure that PAUL is filled up and enough water is in the RWT.**
2. **Assure that the effluent of PAUL is open. If FWT is connected, float valve in the FWT must be fully open.**
3. **Note all digits of the water meter, including the three red ones, see Figure 16, and the exact date and time**
4. **Let PAUL filter at least 10 minutes (or more) and then again note all digits and the exact date and time**