

X-Cell – Electrolyser test cell

X-cell with ports for reference electrodes

Overview & assembly manual

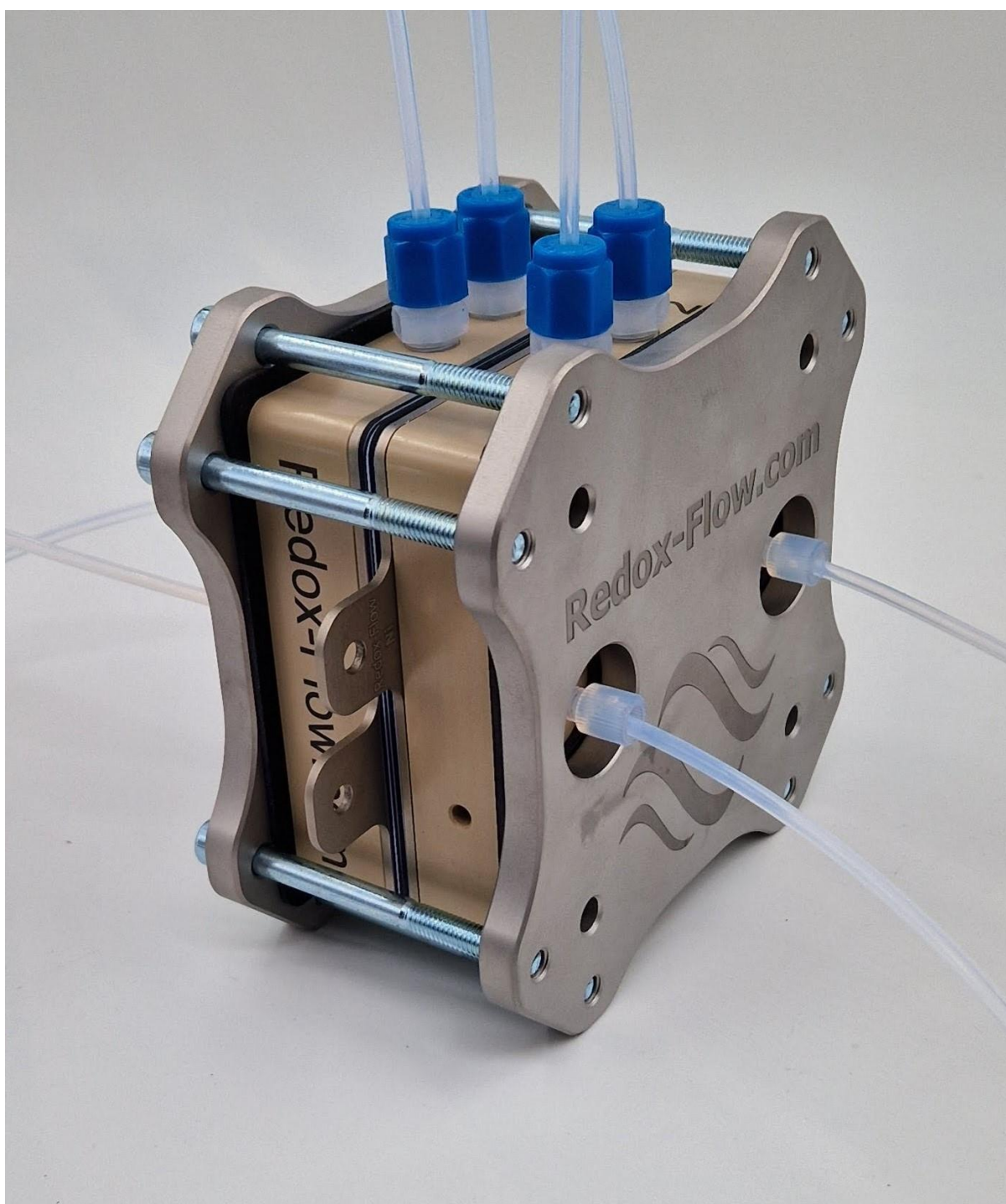


Notes

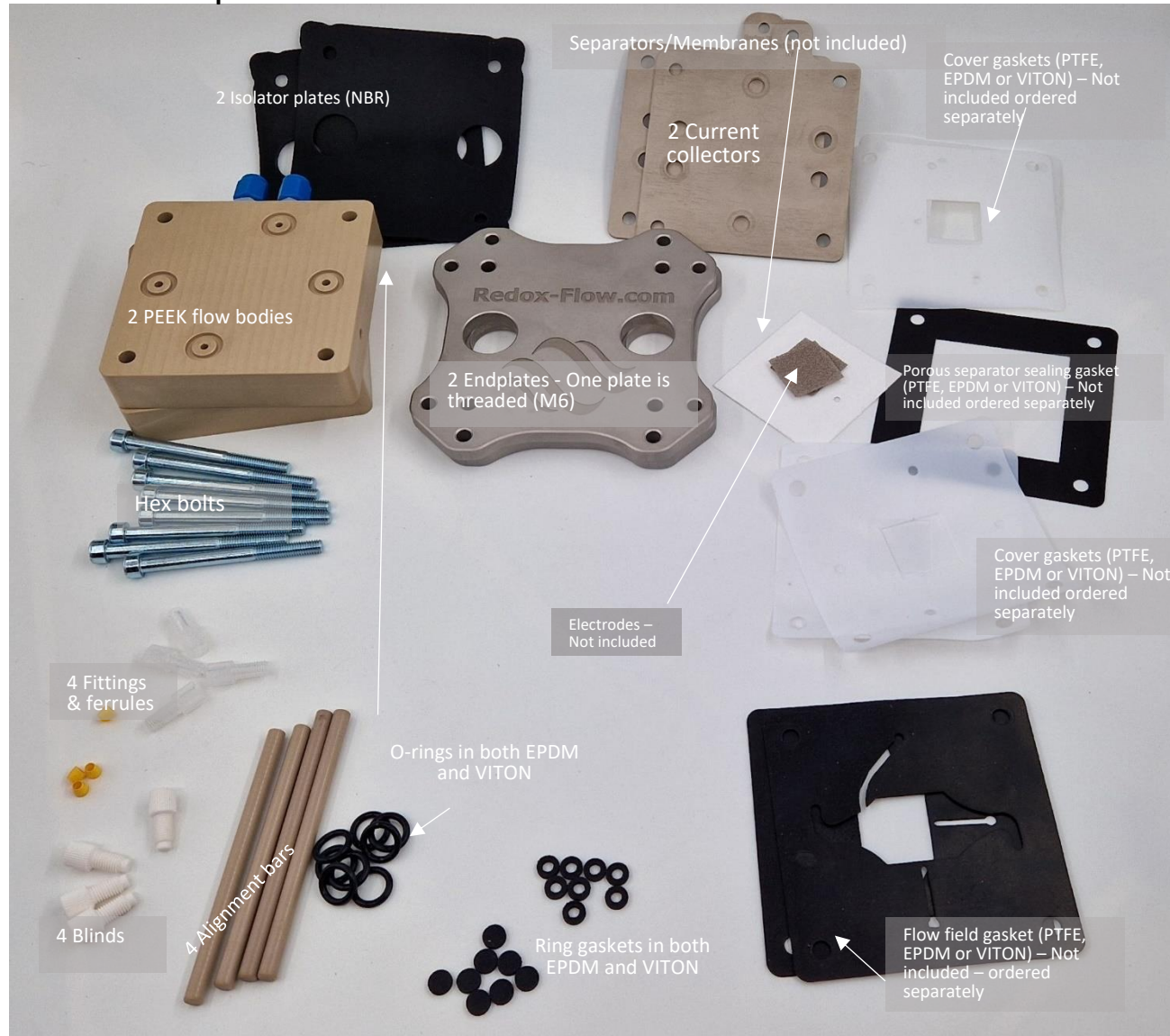
This electrolyser cell is intended for research purposes only and can be assembled in several ways.

There is no warranty on performance, corrosion, or lifetime on the items. It is purely for research purposes.

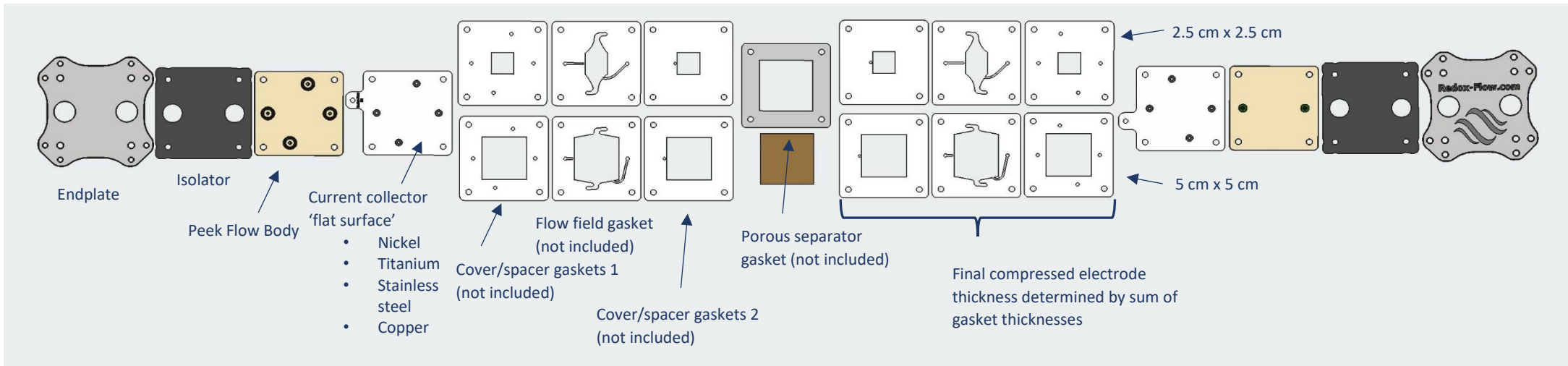
Version 1.0 – July 7, 2024



Overview of included components



Overview of variants

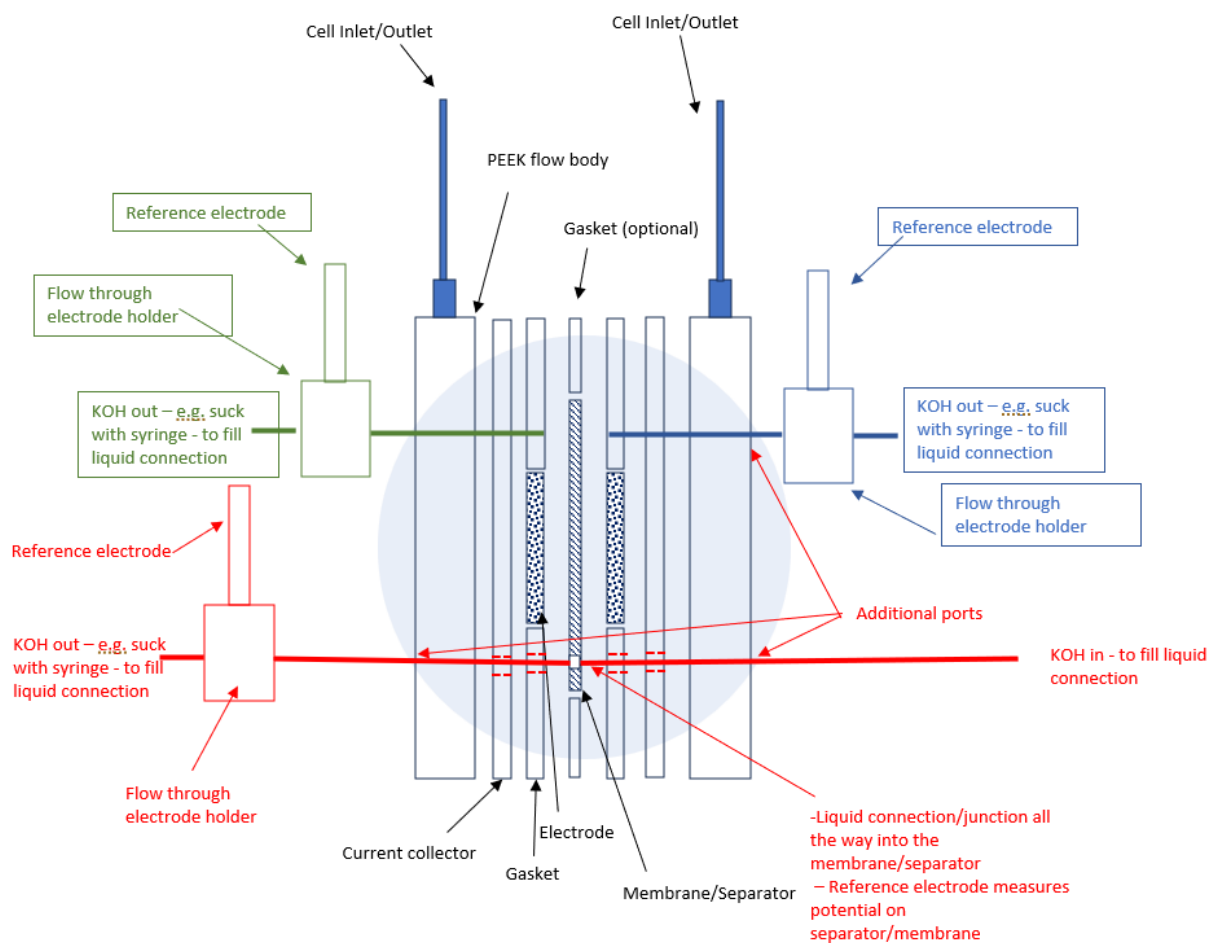


Overview of variants and assembly from left to right – top shows 2.5cm x 2.5cm while bottom shows 5cm x 5cm assembly. Current collectors with flow field are possible (but not shown in figure)

X-cell with additional ports

This cell is a variant of the X-cell, the main difference being additional ports for a (reference) electrode that is coupled, to measure on the separator/membrane, through a Luggin capillary type setup. The figure below is a schematic overview of the working principle. Red parts are reference electrodes and the hydraulic circuits of these, while blue parts are the X-cell. The reference electrodes at the top can be connected through a T piece (and are not in scope in this manual).

The main difference between the standard X-cell and the one is highlighted by the blue shaded round area. Here additional ports on each side of the cell are included. This enables a hydraulic connection to (i) the separator/membrane which can be used for a reference electrode measurement (Luggin capillary type) and (ii) electrode inlets on both the cathode and anode side. To ensure a unbroken galvanic connection between the separator/membrane there are ports on each side. One is used for a reservoir (right side) while the left side is connected to the reference electrode (e.g. through the Redox-flow 'Flow Through Electrode Holders'). The galvanic connection is obtained by sucking electrolyte through the ports with a syringe.

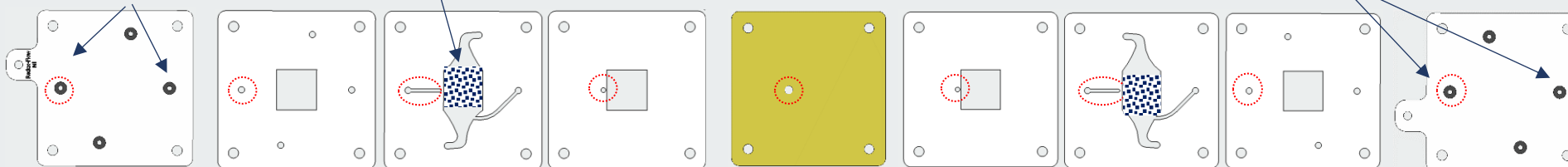


Two additional ports on each side of the cell (four in total)

Electrode

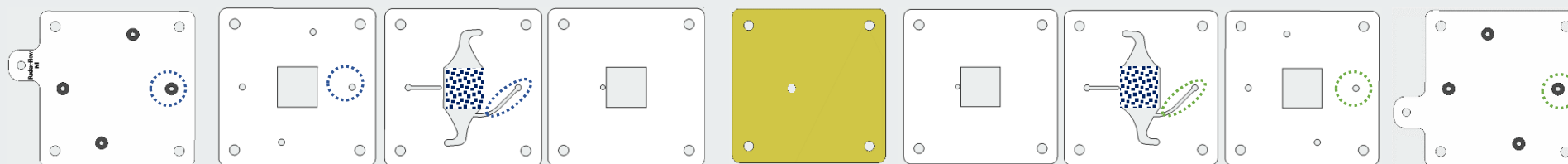
Membrane / Separator

Two additional ports on each side of the cell (four in total)



HYDRAULIC CONNECTION 1

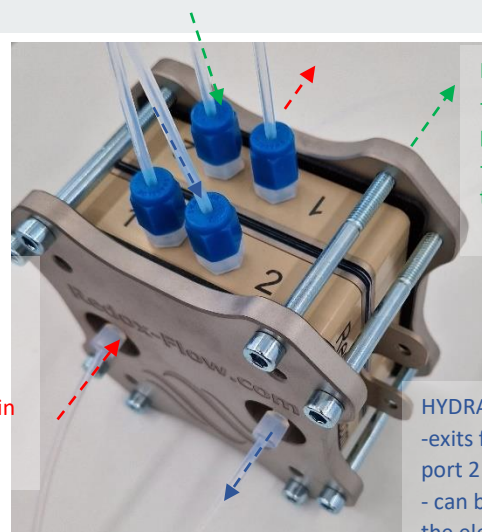
This option connects each side of the cell through a hydraulic channel that is in contact with the membrane/separator. Connecting a reference electrode to this channel allows measurement of electrode overpotentials in a manner similar to a three electrode setup where the reference electrode is placed in between the working and counter electrode.



HYDRAULIC CONNECTION 2

HYDRAULIC CONNECTION 3

Hydraulic connection 2 and 3 connects the outside port to the inlet flow channels on the anode and cathode side respectively. This can also be used for reference electrode measurements in some more specialized setups



HYDRAULIC CONNECTION 1

-goes through the cell and exits on opposite side – in contact with membrane only
- can be used for reference electrode measurements on the membrane/separator (in between the electrodes as in standard 3 electrode configuration)

HYDRAULIC CONNECTION 3

-exits from the flow field connects through the cell to top at port 2 (same as connection 2 but on opposite side)
- can be used for reference electrode measurement just before the electrolyte enters the electrode

HYDRAULIC CONNECTION 2

-exits from the flow field and connects through the cell to top at port 2 (same as connection 3 but on opposite side)
- can be used for reference electrode measurement just before the electrolyte enters the electrode

Assembly

The following is an example on a 2.5cm x 2.5cm cell.

NOTE: The order of assembly does not strictly need to follow this assembly manual. Depending on use and experience it can be done in several ways.

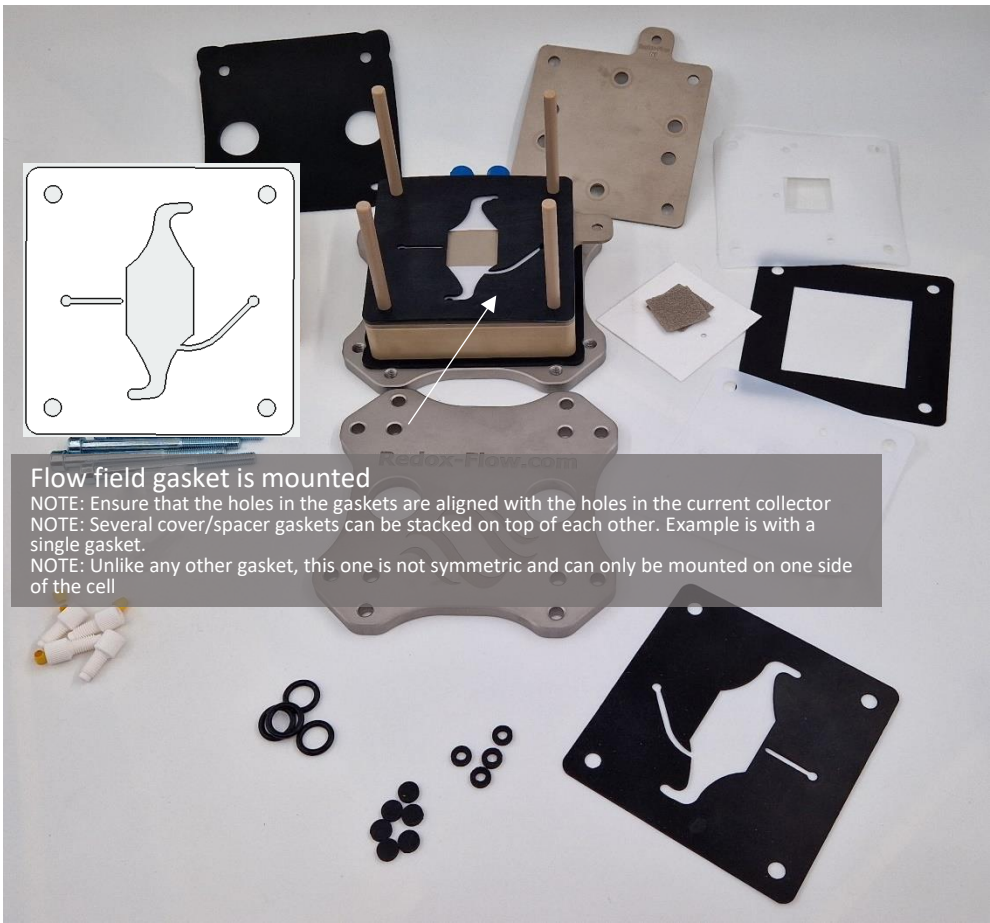






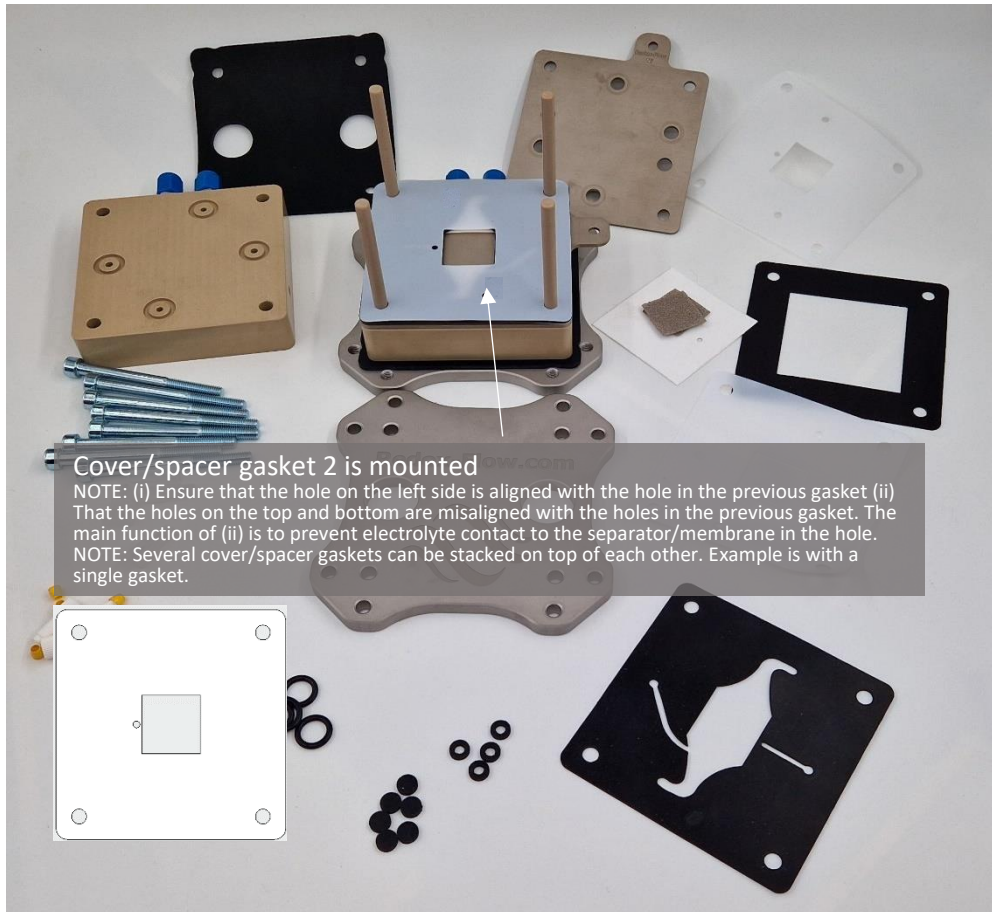
Cover/spacer gasket 1 is mounted

NOTE: Ensure that the holes in the gaskets are aligned with the holes in the current collector
 NOTE: The cover/spacer gasket is not strictly necessary. The function is minimise parasitic electrochemical reactions on the surface of the current collector.
 NOTE: Several cover/spacer gaskets can be stacked on top of each other. Example is with a single gasket.



Flow field gasket is mounted

NOTE: Ensure that the holes in the gaskets are aligned with the holes in the current collector
 NOTE: Several cover/spacer gaskets can be stacked on top of each other. Example is with a single gasket.
 NOTE: Unlike any other gasket, this one is not symmetric and can only be mounted on one side of the cell



Cover/spacer gasket 2 is mounted

NOTE: (i) Ensure that the hole on the left side is aligned with the hole in the previous gasket (ii) That the holes on the top and bottom are misaligned with the holes in the previous gasket. The main function of (ii) is to prevent electrolyte contact to the separator/membrane in the hole.
 NOTE: Several cover/spacer gaskets can be stacked on top of each other. Example is with a single gasket.



Electrode is inserted

NOTE: The sum of the thicknesses of all cover/spacer and flow field gaskets determines the final compressed thickness of the electrode.

IMPORTANT – In the following two different ways of assembling the cell is shown.

- A. For dense separators/membranes.**
- B. For porous separators (e.g. Zirfon) - to prevent leaking through the side of the separator.**

Assembly A - For dense separators/membranes

Dense (ion exchange) membrane is mounted

NOTE: The membrane does not need to fill the whole area of the cell (10cm x 10 cm) smaller pieces can be used. But there area must extended to the hole for the reference electrode as indicated by the red dotted area.

NOTE: A small hole in the membrane must be made around the hole in the gasket (marked by yellow)

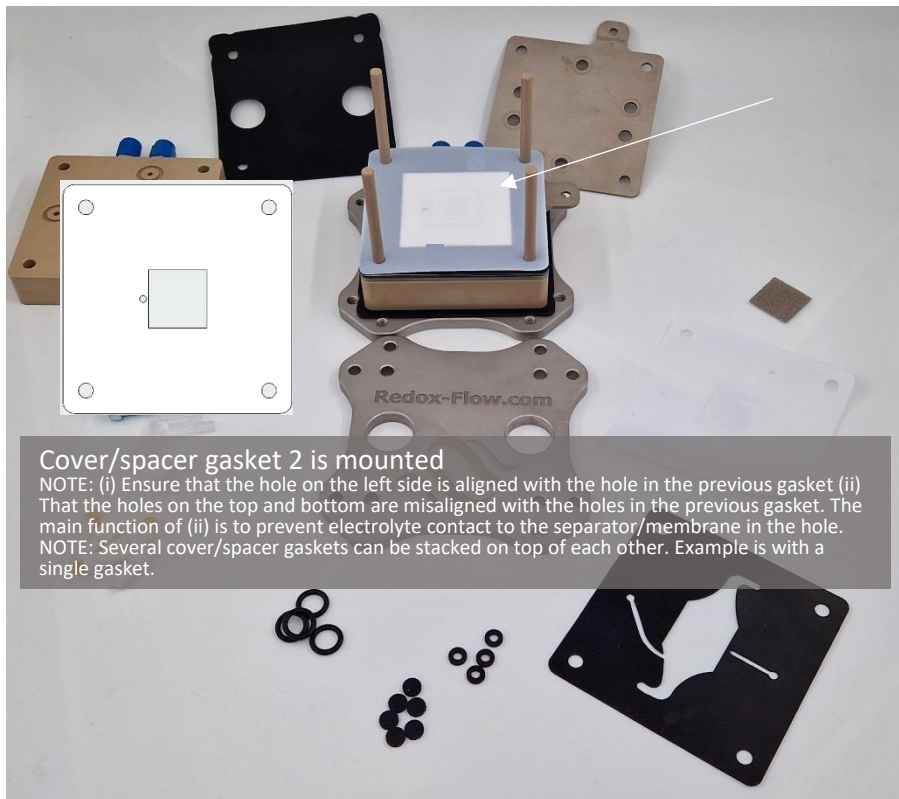
NOTE: The hole is to ensure that electrolyte can be sucked through the cell and create a galvanic bridge to the reference electrode.

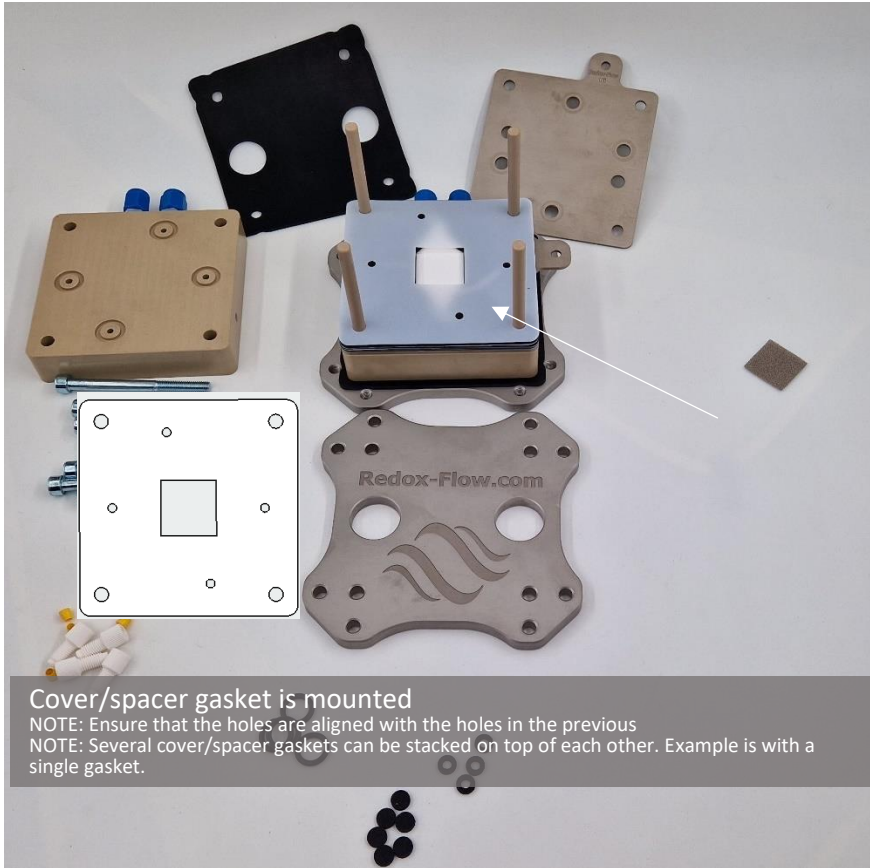


Assembly B - For porous separators



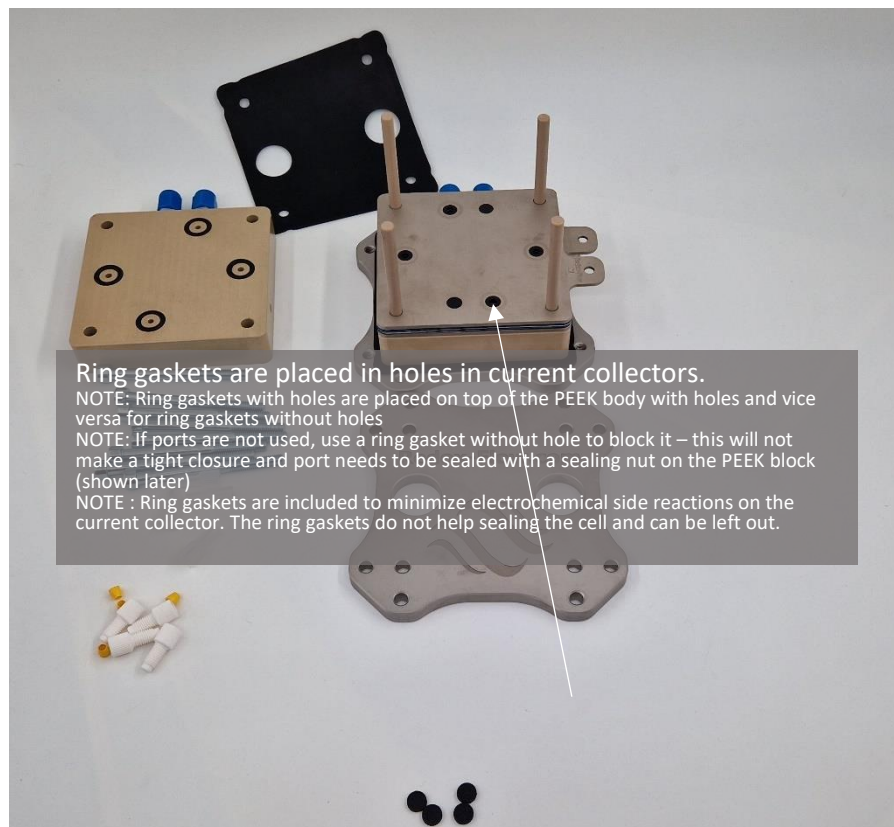
From here both assembly A and B follows the same procedure



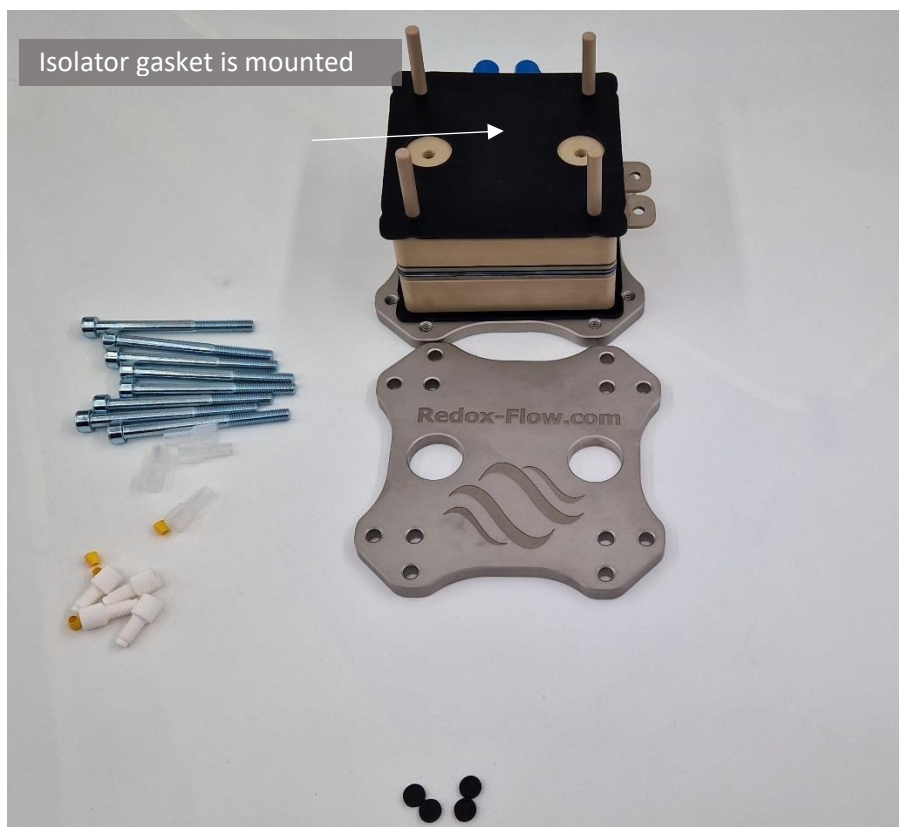


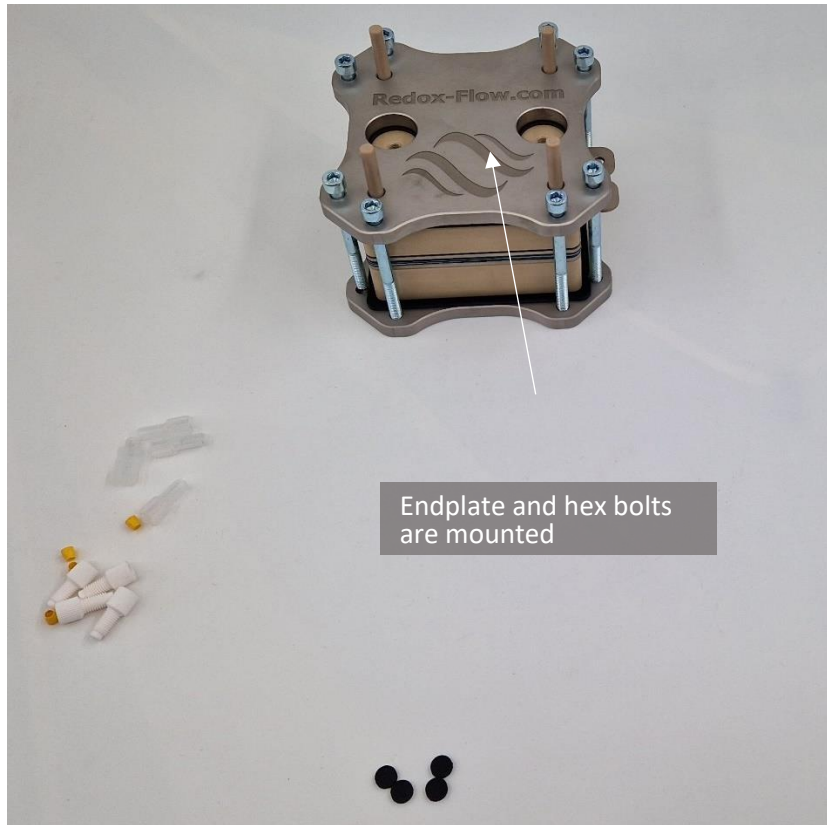


Current collector is mounted
 NOTE: All three holes in the previous gasket should be visible

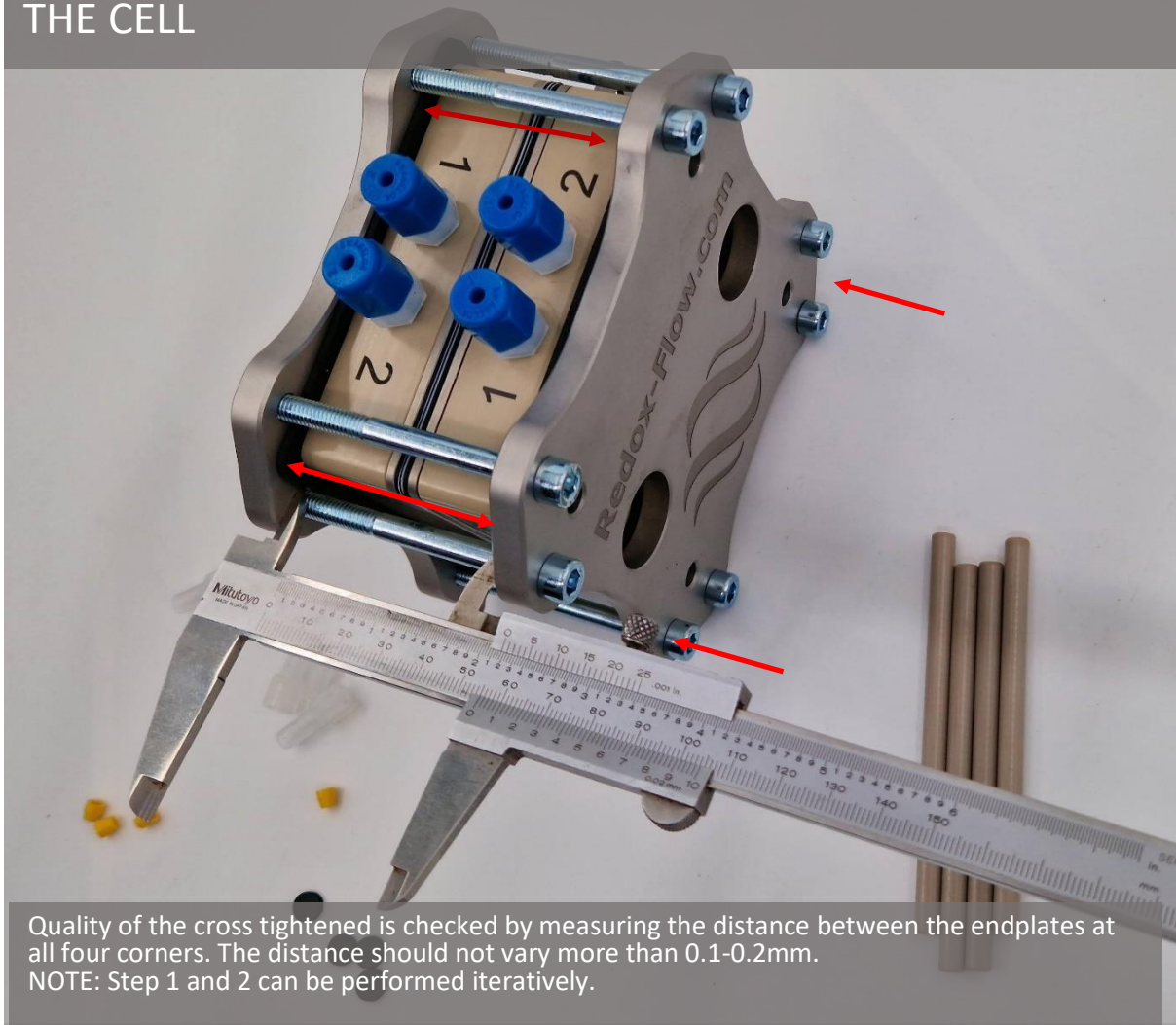


Ring gaskets are placed in holes in current collectors.
 NOTE: Ring gaskets with holes are placed on top of the PEEK body with holes and vice versa for ring gaskets without holes
 NOTE: If ports are not used, use a ring gasket without hole to block it – this will not make a tight closure and port needs to be sealed with a sealing nut on the PEEK block (shown later)
 NOTE : Ring gaskets are included to minimize electrochemical side reactions on the current collector. The ring gaskets do not help sealing the cell and can be left out.





STEP 2 - IS VERY IMPORTANT FOR A TIGHT SEALING FOR THE CELL



Quality of the cross tightened is checked by measuring the distance between the endplates at all four corners. The distance should not vary more than 0.1-0.2mm.
NOTE: Step 1 and 2 can be performed iteratively.

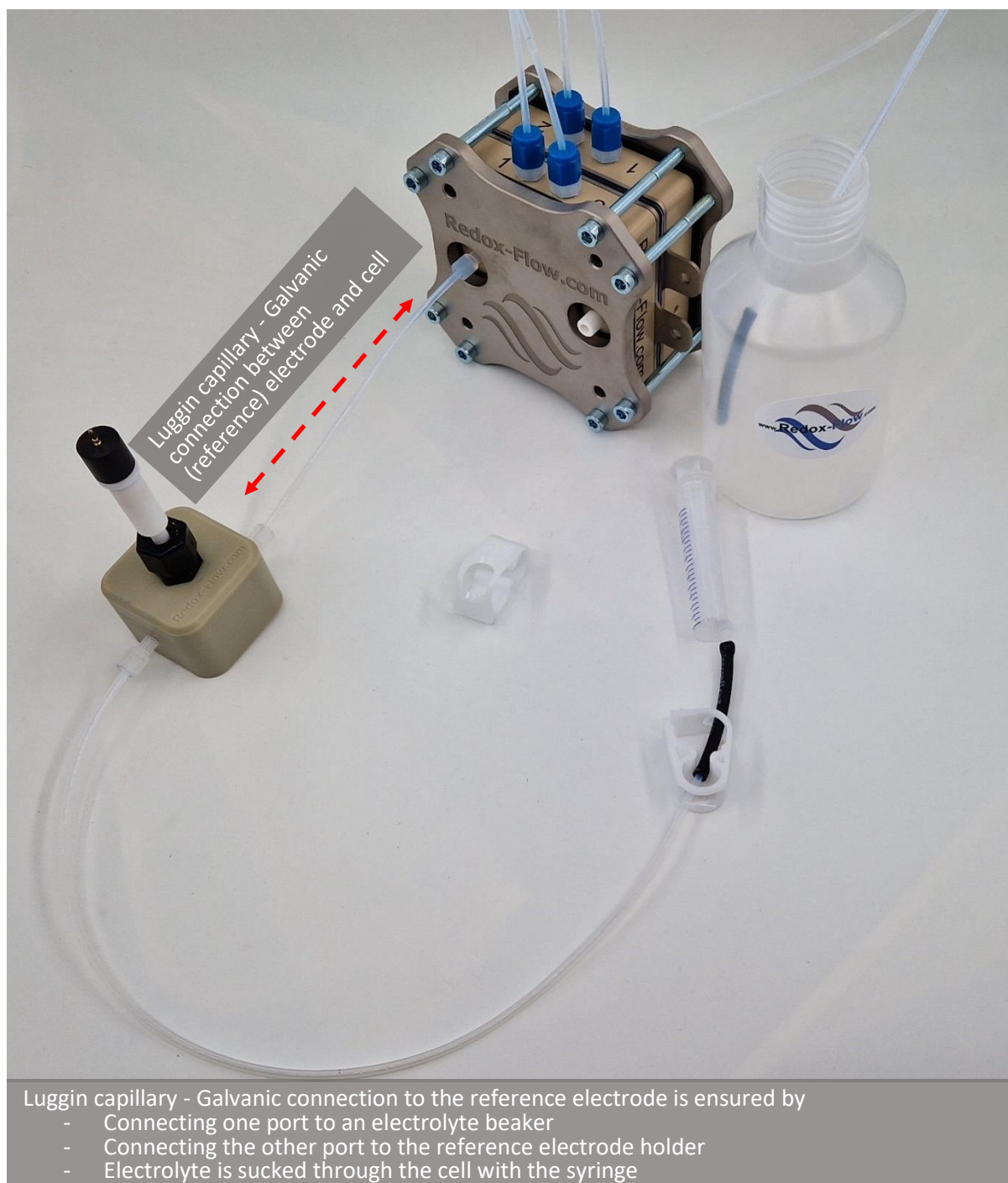
MEASUREMENT WITH CALIBER IS PARAMOUNT FOR A TIGHT SEALING – IT IS NOT THE TORQUE THAT SEALS THE CELL IT IS A CORRECT ALIGNMENT OF THE FLOW BODIES

General Information

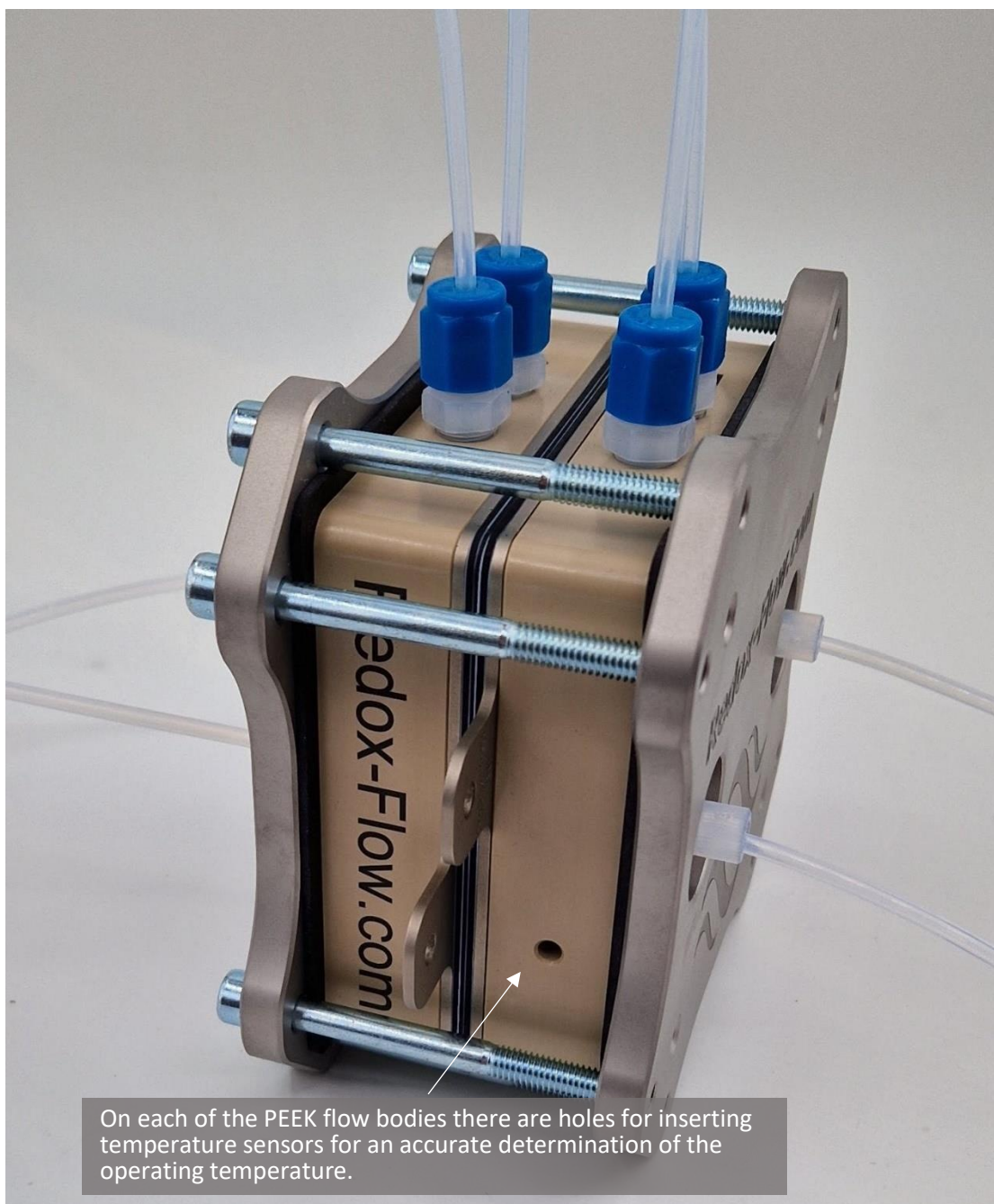


Application notes – Reference electrodes

- Items shown in the following may not be included with the cell and needs separate ordering



Application notes – Temperature sensors



Application notes – Electrical connections

