

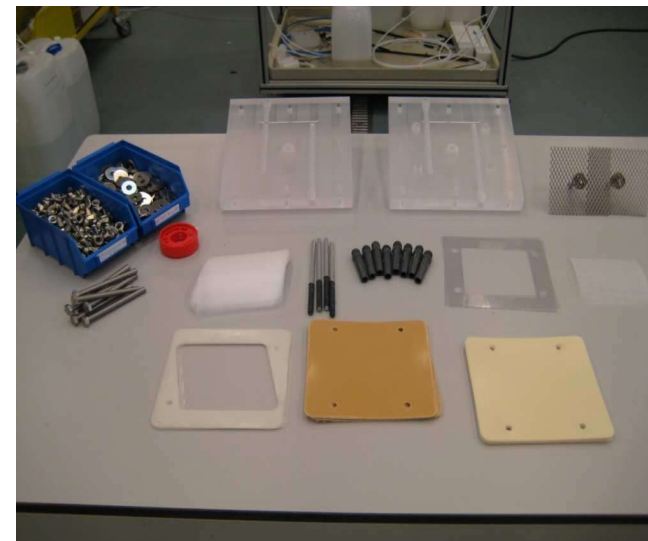
Module 1 - How to build the Blue Energy stack


Necessities



List of materials/tools

- Start and End plate
- Square packings (2x)
- Square spacers (2x)
- Silicone packings (20x)
- Spacers (20x)
- Cation membrane (11x)
- Anion membrane (10x)
- Electrodes (2x)
- Bolts/rings/wing nuts (8x)
- Water
- Salt (NaCl)
- Hose connectors (8x)
- Plastic tubes (4x)
- Potassium ferrocyanide (yellow)
- Potassium ferricyanide (red)
- Teflon tape
- Hoses
- Funnels
- Bottles
- Tripods

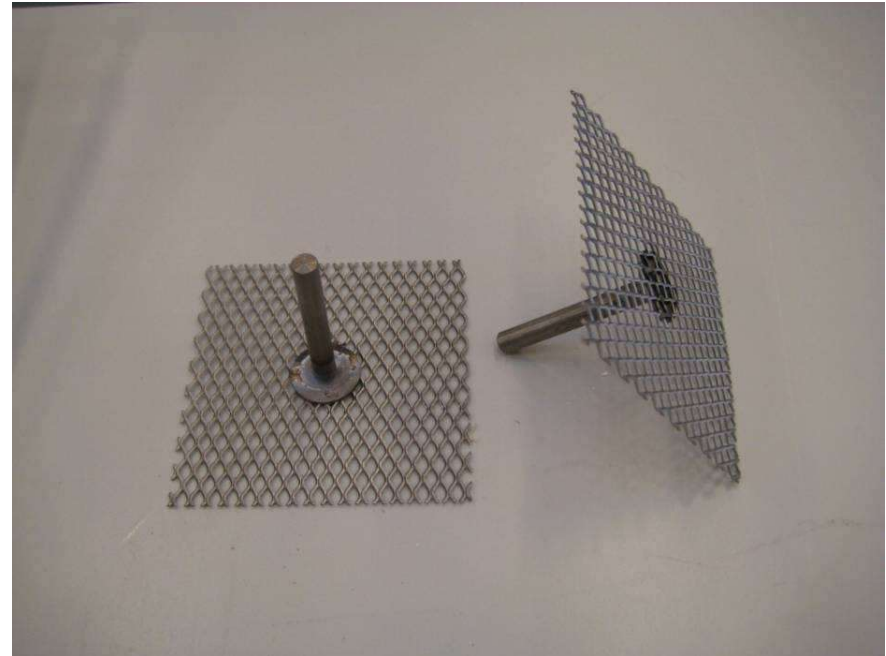


Reagents	Formula		Quantity (g) or Concentration (M)
Potassium ferrocyanide	$K_4[Fe(CN)_6] \cdot 3H_2O$	R53, R52, R53, S50, S61	0.05 M
Potassium ferricyanide	$K_3[Fe(CN)_6]$	H302, H315, H319, H332, H335, P261, P264, P270, P271, P280, P301+312, P302+352, P304+312, P304+340, P305+351+338, P312, P321, P330, P332+313, P337+313, P362, P403+233, P405, P501	0.05M
Salt	NaCl		Depends on research question. Seawater = 30g/L

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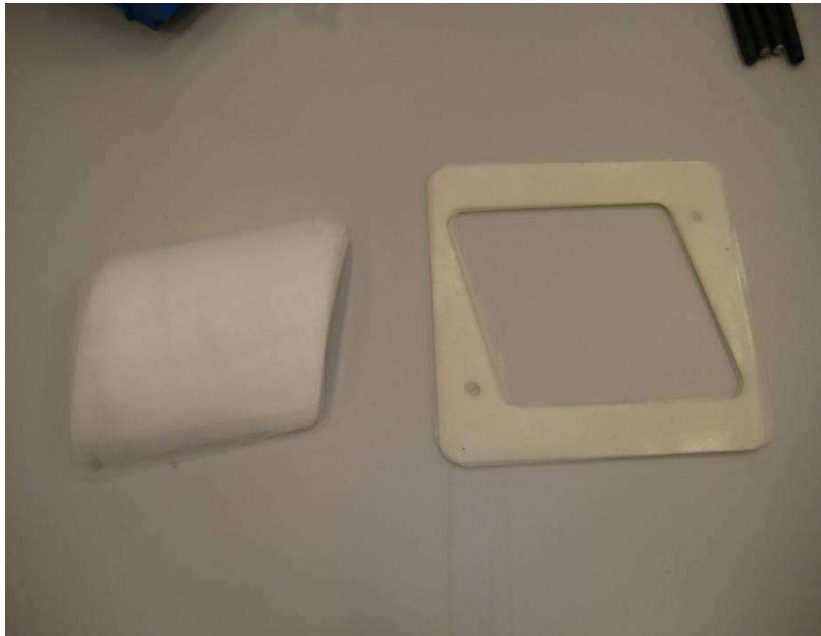


- Left/ with an extra hole: Cation Exchange Membrane (CEM 11x)
- Right/Without mark: Anion Exchange Membrane (AEM 10x)

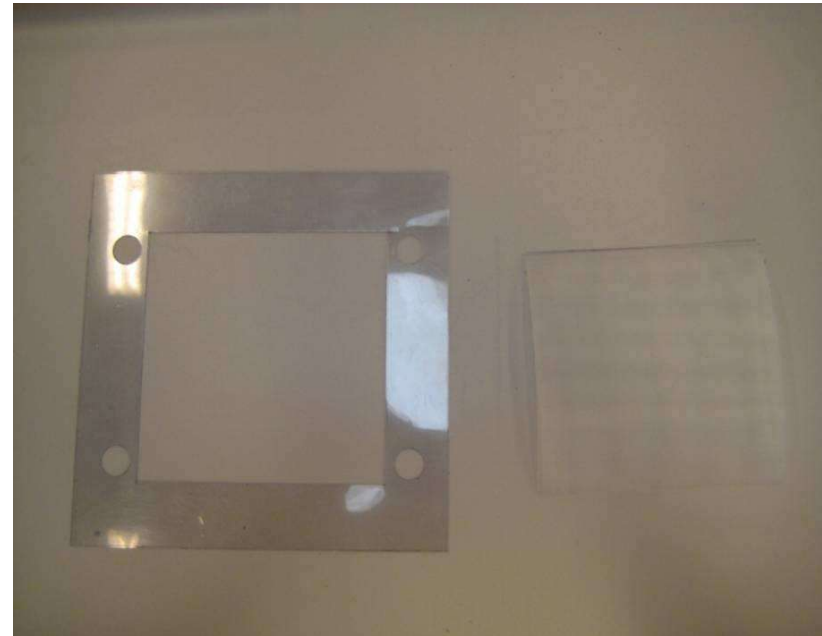


Elektrodes

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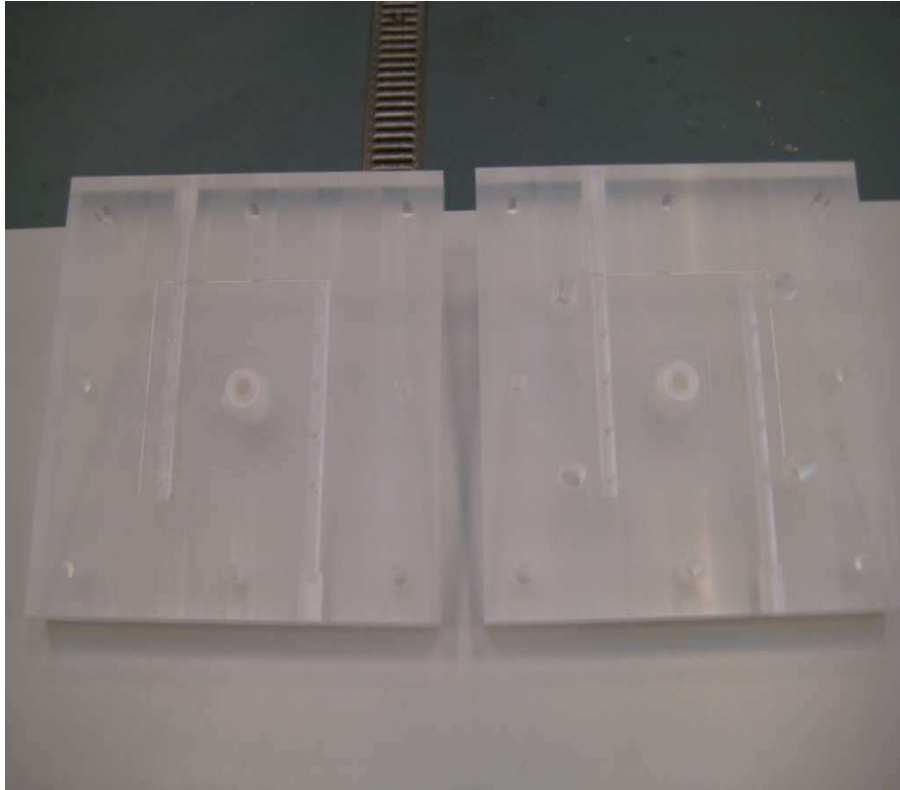


Left: Spacers
Right: Silicone packings

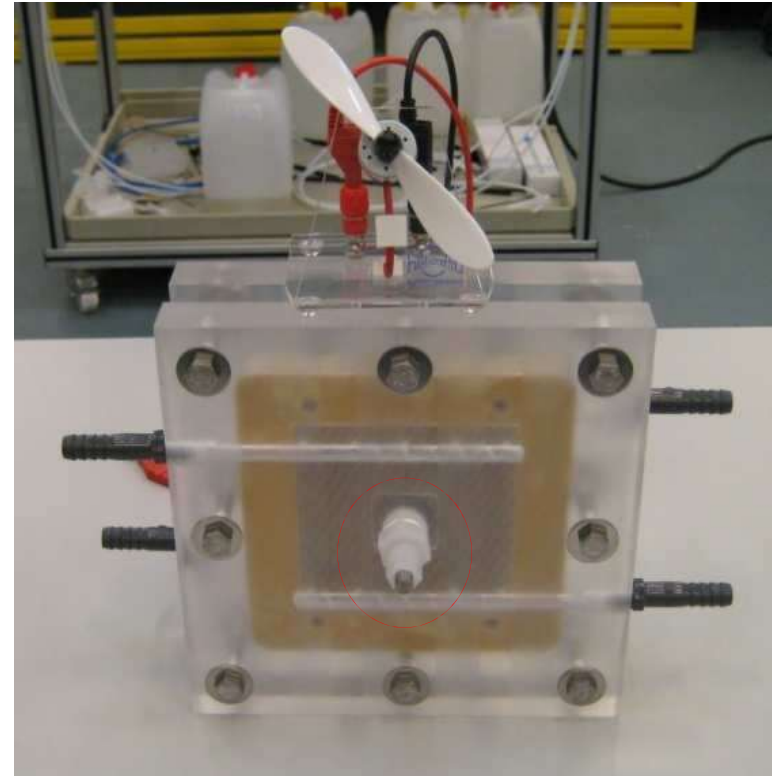


Left: Packings for start and end plate
Right: Spacers for start and end plate

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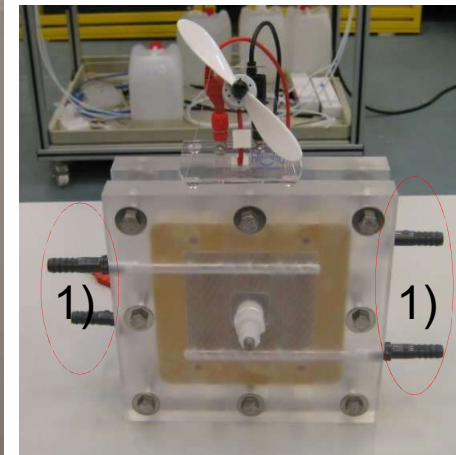
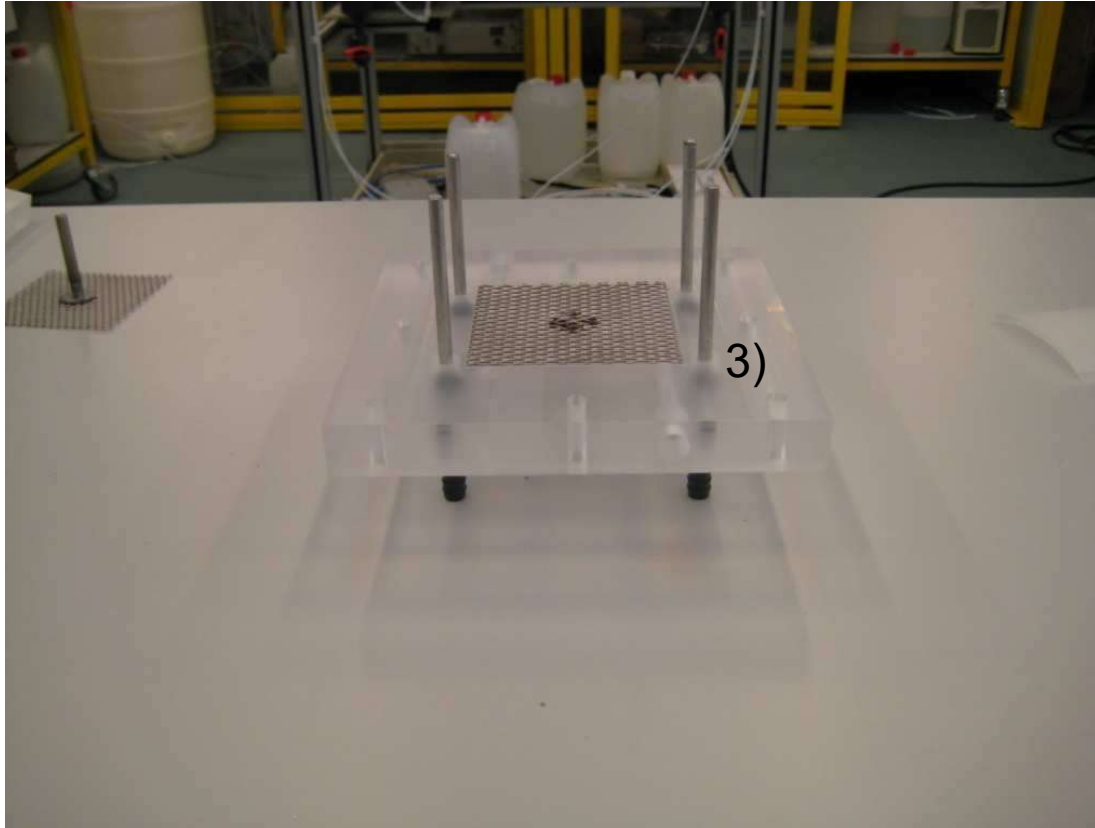


Left: End plate
Right: Start plate



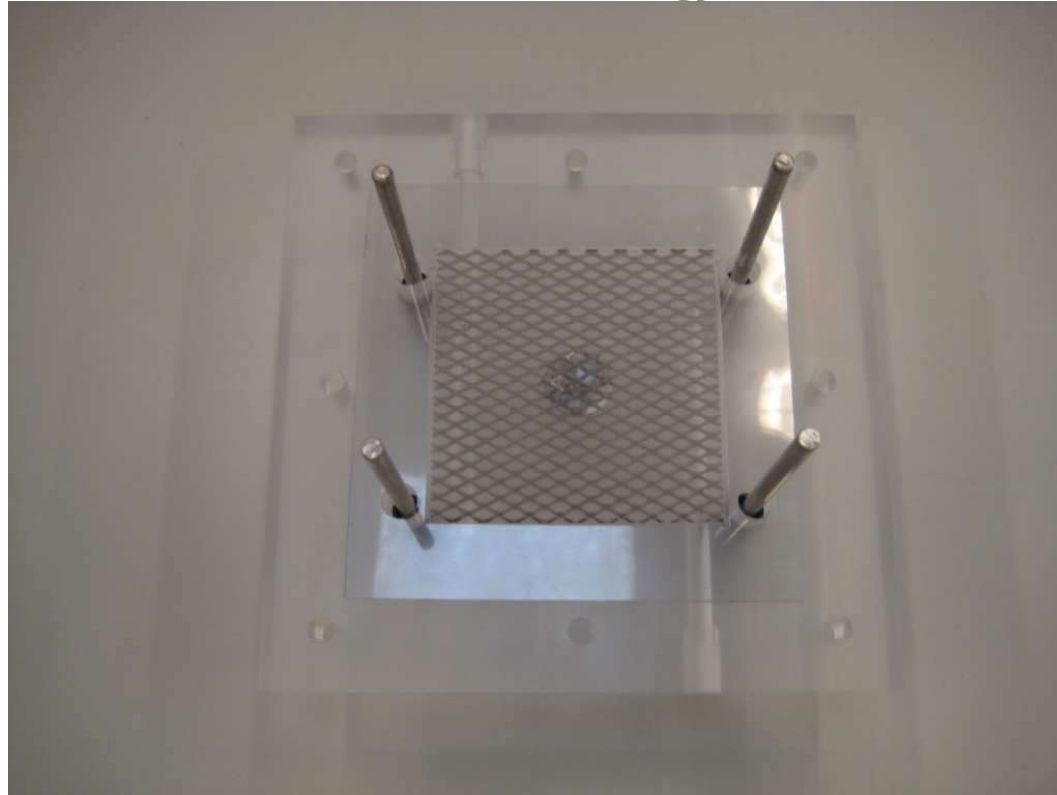
First connect the couplings to the start and end plate. Apply some Teflon tape on the threads, this will prevent leakage of the electrolyte later on.

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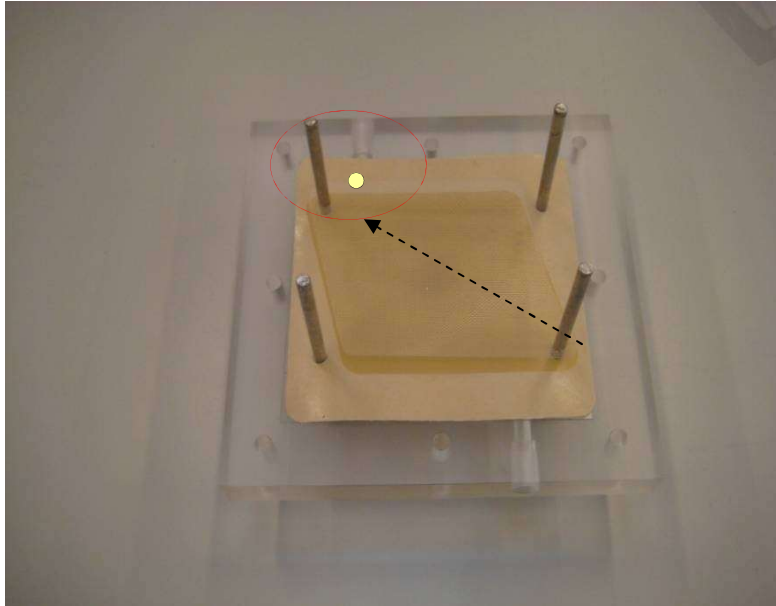
- 1) Attach the 8 hose connectors to both plates. Make sure they do not leak, so tape the threads with Teflon tape.
- 2) Then attach the electrodes to both plates.
- 3) Put the starting plate on the 4 hose connections and put the 4 tubes in the middle of the plate, as shown in the picture.

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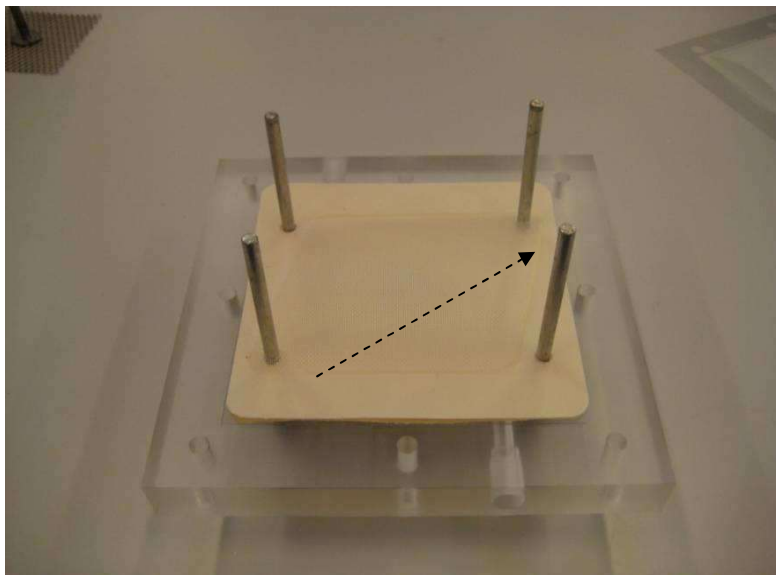


Place the gasket in the center of the plate and make sure the spacer is exactly in the center and does not overlap the spacer. This will prevent leaks.

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- 1) Start by stacking the membranes, spacers and silicone packings.
- 2) Before you stack everything on top of each other, make sure you pre-rinse all the parts with water for a while. This makes stacking easier and ensures that no particles get into the stack that could cause leaks.
- 3) Start with a cation exchange membrane.
- 4) Put a silicone packing around it and put a spacer in the middle. Again make sure the packing and spacer do not overlap.

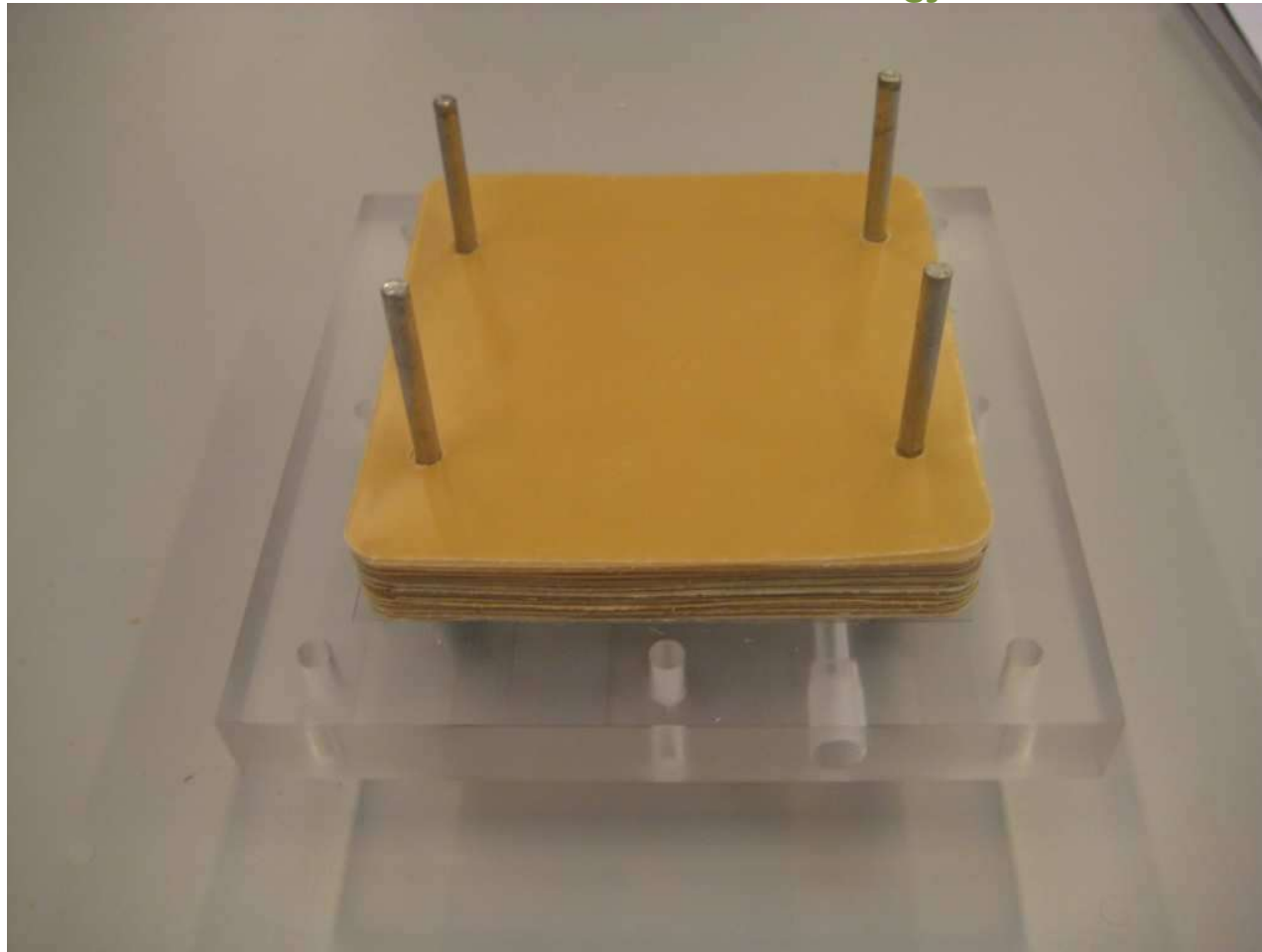


- 1) Next, place an Anion membrane on top of the Cation membrane.
- 2) Again, put a silicone packing around it, but in opposite direction of the previous one!!!!

This is very important for the flow direction of the fresh and salt water. In the picture above the packing is pointing to the upper left corner. In the photo below it is pointing to the upper right corner.

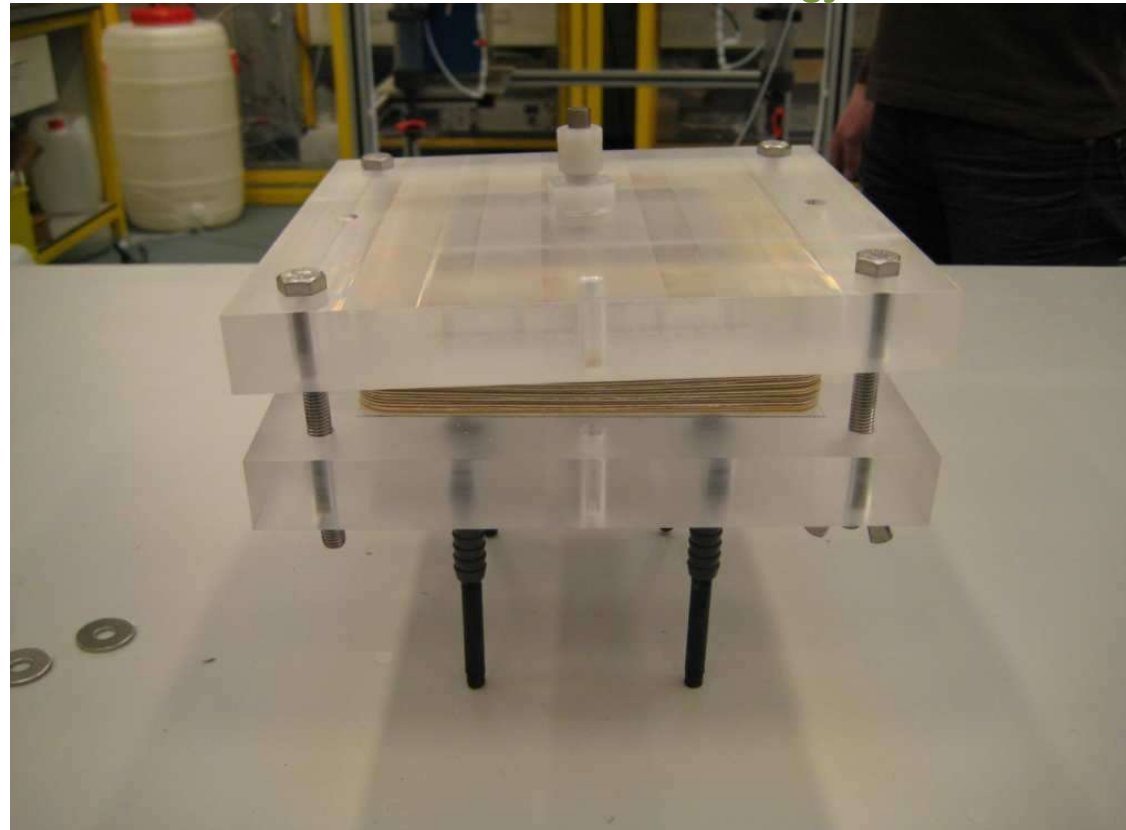
Repeat this process until you have used all the membranes. And keep paying attention to keep putting the packings and spacers in opposite directions from each other.

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Once you've put everything in the right order, you should end up with a Cation membrane.

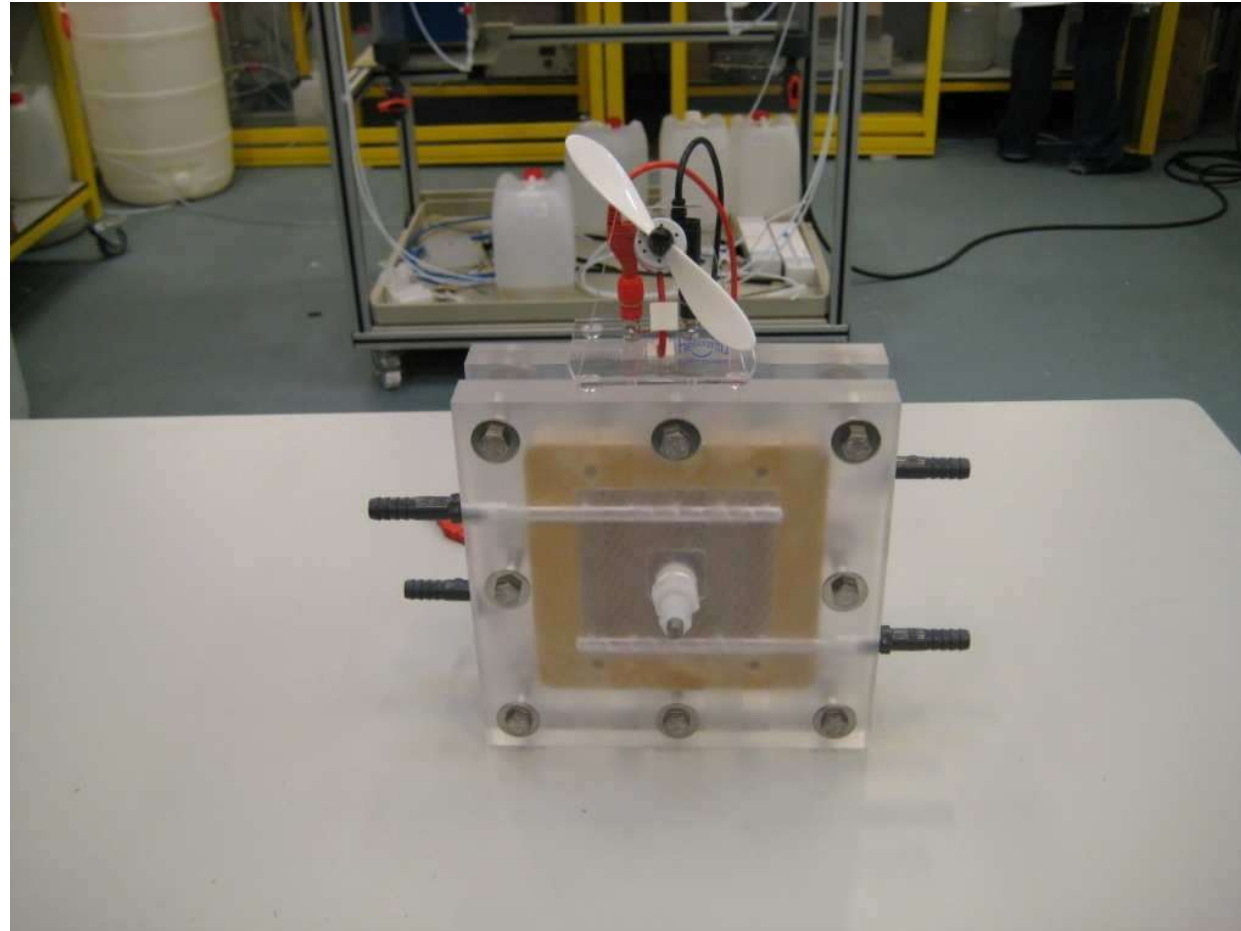
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Now comes the trickiest part: Attach the end plate to the stacked membranes. Don't forget to put the square packing with spacer in place before you attach the end plate! The tubes can be pushed through the hose connectors as far as half a centimeter above the membranes, the stack must not move at all! Have a classmate hold the bottom plate while you carefully place the end plate on top. Press it firmly and fasten them together with the bolts and wing nuts, first the corners then in the middle. Tighten them firmly so there are no leaks....but tight is tight!.

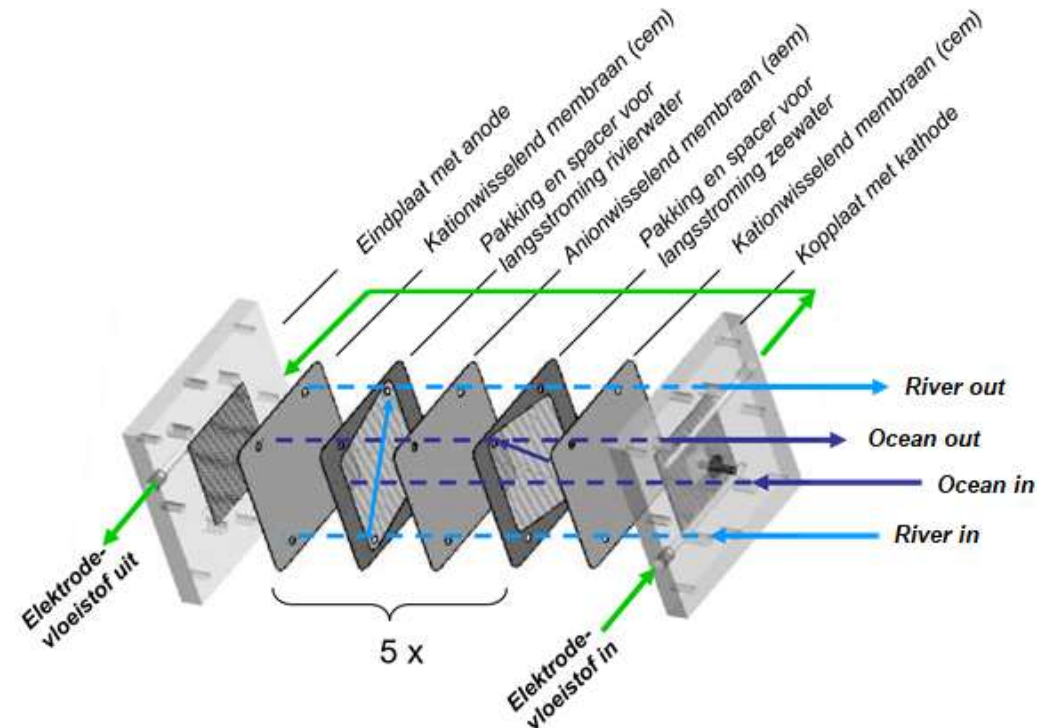
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If you did everything right, this should be the end result.



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Preparation of Electrode Solution



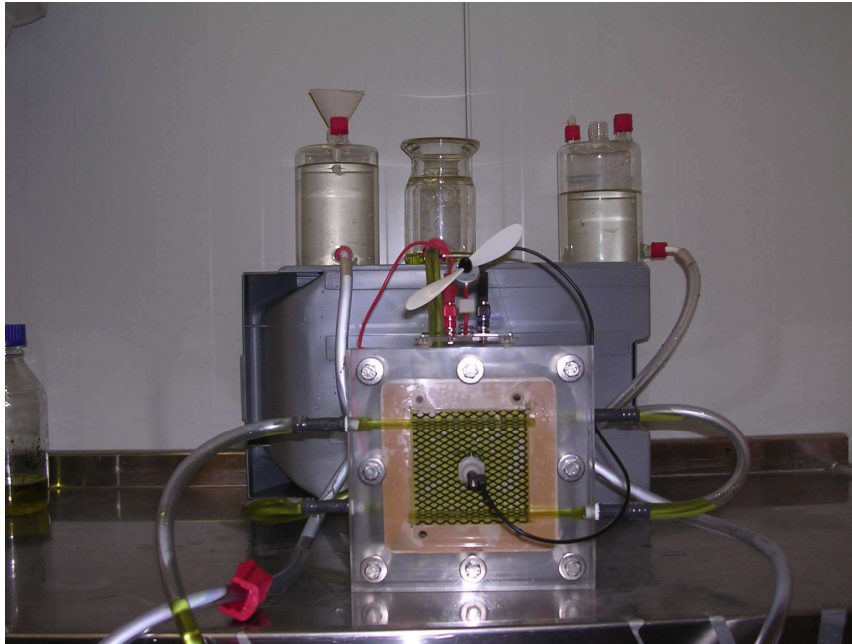
Make from 1 liter water, electrode rinsing solution by adding Prussian yellow and red (potassium hexacyanoferrate) (about 0.05M of each).

Before performing the experiment, review the chemistry chart of Prussian yellow and red ($K_4Fe(CN)_6 \cdot 3H_2O$ and $K_3Fe(CN)_6$).

Note: Always work with a lab coat and lab goggles when doing experiments.

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Setup as you might eventually build it.



Cleaning up

- Take the demo apart and rinse all the parts with tap water.
- Note: The membranes must be kept wet all the time! Make sure they are kept in a container with water. This way they will not dry out and they can be used for the next experiment.

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This toolkit was made possible by:



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