Polymers in reverse osmosis membranes

Polymers have many different uses. We use membranes made of polymers to produce highly treated recycled water at St Marys Advanced Water Recycling Plant.

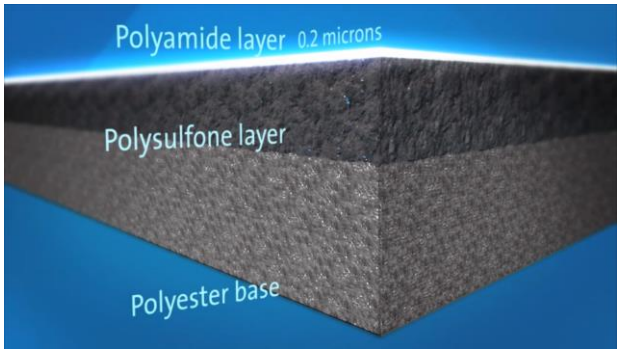
What are membranes?

Membranes are thin layers of material that allow only some substances from a solution to pass through them.

We use polymers as the reverse osmosis membrane material for advanced water recycling at St Marys.

What polymers are used?

The reverse osmosis membranes at St Marys are made up of three layers of polymer.



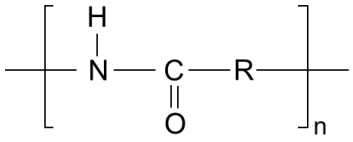
Polyamide layer

The thin top layer of the membrane is the barrier layer. It must allow the water to flow through, but trap tiny substances like nutrients, chemicals, bacteria and viruses in the water.

Polyamide is a category of polymer that contains the amide functional group.

Different monomers can be used in the polyamide layer to suit the purpose of the membrane.

It's important to consider the solubility, charge, polarity, size and shape of the substances we're trying to remove, and then select the functional group that's best suited.

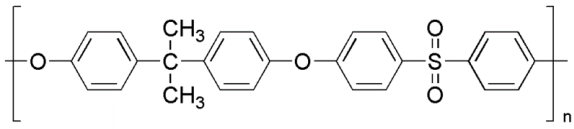


Generic chemical structure of polyamide. R = any functional group, n= number of monomer repeats.

Polysulfone layer

The polysulfone layer supports the barrier layer. It needs to be microporous, tough and hold up to the high pressure of the water being pushed through the membrane.

Polysulfones contain the sulfone functional group (subunit aryl-SO2-aryl).



Chemical structure of a polysulfone unit. n= number of monomer repeats.

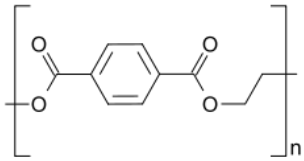
Polysulfone can be modified by co-polymerisation with other monomers to tailor the function of the membrane.

Polyester base

The membrane needs a supportive base layer that is strong yet flexible.

Polyester is a category of polymers that contain the ester functional group in their main chain.

We use a specific polyester known as polyethylene terephthalate (PET).



Chemical structure of polyethylene terephthalate (PET).

PET is strong, flexible and cheap to produce. It's commonly used for things like plastic bottles and textiles.

The PET chains are formed into fibers that are used to make a fabric sheet.

Making a choice

We can choose different polymers, structures and functional groups to suit our purpose.

Some factors we consider are:

Selectivity & permeability

- How easily does water move through?
- What pore size do we need?
- Does the membrane catch what it needs to?

Energy

- Can the energy used to push the solution through the membrane be reduced?
- Does the membrane catch everything, or does it need to be filtered several times?

Manufacturing

- Are there cheaper polymers?
- What are the physical properties of the polymers?
- Do delicate polymers need to be supported by stronger ones?

Lifespan & durability

- Can the membrane be easily cleaned?
- Is the polymer resistant to cleaning or cleaning chemicals?
- Does the polymer attract things that will clog the membrane?

Want to know more?

St Marys Advanced Water Recycling Plant

https://www.sydneywater.com.au/education/Wastewater-recycling/Water-recycling/st-marys-advanced-plant.html

How does reverse osmosis work?

https://youtu.be/aVdWqbpbv_Y