GRAPHENE FILTER

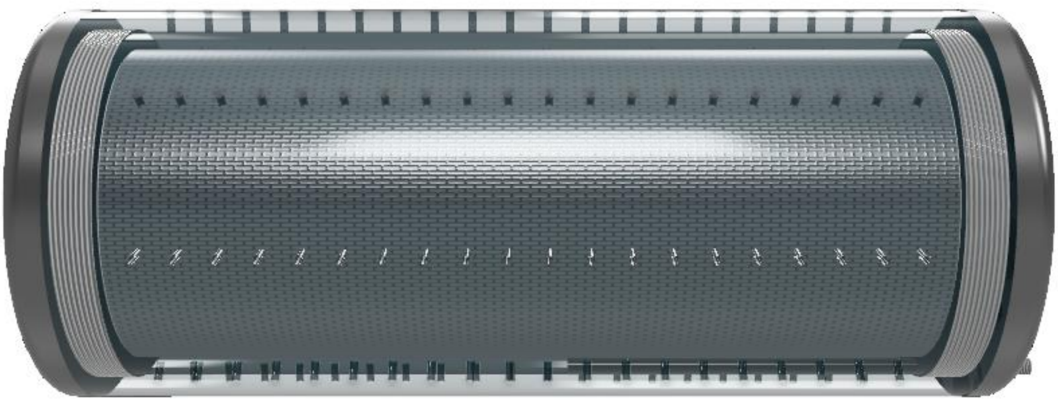

Figure 1 Graphene filter

PhD Proposal

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Research Proposal

My project proposal is based on a Graphene Filtration System, in short, the Graphene Filter will be able to turn seawater or dirty lake water into drinkable. Ideally used to solve for drinking seawater, this will demonstrate the devices maximum deliverable ability. Primarily, the implementation will take place within developing countries, and secondly, any country that could benefit. The device will be a part of a prevention strategy aiming to solve for the water-crisis we currently face. This Filter will be able to remove salt particles and toxins directly without the huge resources it currently takes to transform dirty lake or seawater into fresh water. This Graphene Filter has many benefits and applications. The main benefits are cost, quick implementation and the utilization of by-products. (Rooney, 2018)

Pumping Water

Once we have a Filter, we need to pump water, we can use several methods to do this, a hand pump for small installations, or solar and wind energy for large electrical based water pumping applications. Thus, a sustainable efficient methodology is at the core of this project. The water will either go directly to the consumer, for example, a small village costal based in Africa, or pumped inland to cities via solar powered pumps. If the continent in question was Africa or Asia, solar pumping would be a factual reality. We can use two methods to do so regarding seawater. Pump the seawater directly inland to the water treatment facility, or treat the water by the sea, using costal based facilities, and then send fresh water inland direct to consumers. (Rooney, 2018) (Well Masters, 2019) (Pumps, 2019) (Machinemart.co.uk, 2019)

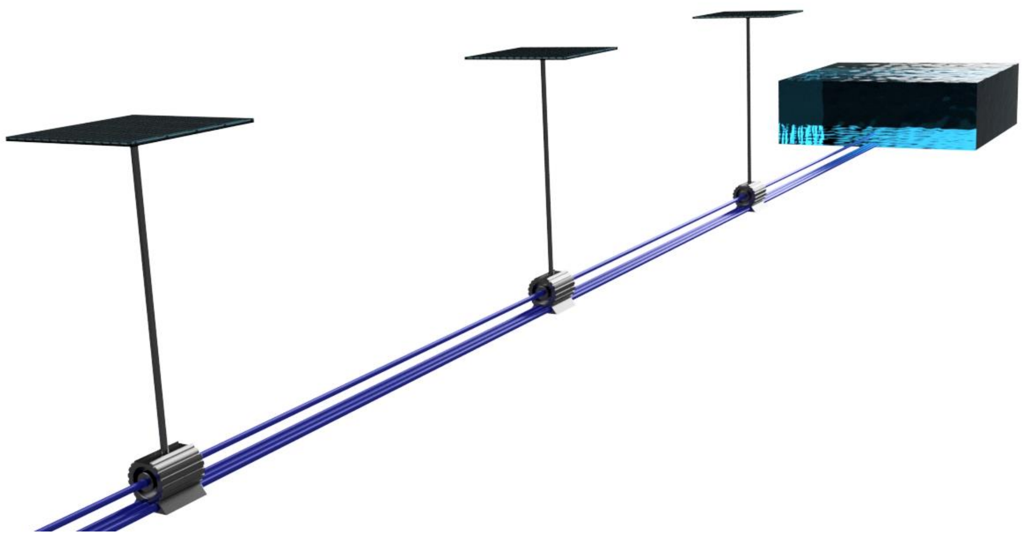

Figure 2 Transport of water

Buffering

PH will also be adjusted depending on Acidity or Alkaline of seawater for a neutral balance, so a buffering technique will be utilised. (Chemistry LibreTexts, 2019)

Minerals

Minerals will be stripped from the contaminated water when using Graphene, Minerals will be added back into the freshwater to suit regions, this is an important aspect due to the environments of which we have become accustomed to. (best-ro-system.com, 2019)

Why Graphene?

The reason for using Graphene is due to it being a nano porous material; under microscope its structure is of a hexagonal lattice, resembling chicken wire. When Graphene is combined with an Oxide Membrane it stops the swelling of Graphene in water, thus making it an excellent water based sieving technique. This will be my initial testing method, once testing commences material selection and usage may adjust depending on results. (Graphene.manchester.ac.uk, 2019)

About Graphene

Graphene was discovered in 2004 by Manchester University, it is not a man-made synthetic material, it is a crystalline allotrope of Carbon, it is utilised for its excellent electrical, conduction and mechanical properties. It has been briefly used as a basic filtering method to prove its filtration ability. However, it has never been used towards an unblock-able, affordable, independent, filtration system. Graphene is characterised as a wonder material, it is 1 atom thick, and therefore a very light weight material. To put this into perspective, if a single layer of Graphene was to cover Leicester City's football pitch, it would weigh less than a single gram and boasts strengths 200 times greater than steel. (The Engineer, 2019) (Explain that Stuff, 2019)

Waste and Toxins

Obviously, as well as by-products we will obtain waste and toxins, this is to be collected inland and disposed of accordingly, the Graphene Filter will help reduce toxins and waste in are seas. Which, we as humans have put there through accidents, disrespect and negligence, thus it is detrimental towards sea life and affects the food chain. (Marinebio.org, 2019)

Sodium Chloride

The main by-product salt, specifically using the seawater application, can be sold on to countries that require it. For example, gritting road's, table and baths salts, and building blocks in dessert areas such as Egypt. (Buildingcentre.co.uk, 2019)

Oil

Toxins such as oil do not mix with water and forms a film on top of are oceans, this kills the environment it absorbs when abundant. The Graphene Filter/s can be positioned near the surface to help remove oils. On a big scale operation, Filters can be joined together as part of a bigger network. We could then separate the oil inland by running the assigned pumping programme. Hopefully reusing it to reduce oil consumption in general and helping maintain the Filters pumps and other useful applications. (Scienceprojectideas.co.uk, 2019)

Human Impact

The human impact on this world is biggest problem of this planet, without a shadow of a doubt. We are driven by greed, money, corruption and selfishness, and this leads to the neglect of the earth. However, we can change by educating from the bottom up. The industrial revolution, greenhouse effect, plastics and waste disposal are just some of the problems we as humans have created. We have endangered animals, sea life and ourselves. And time is running out if it has not already. (Engineering et al., 2019)

Water Crisis

There is only 2.5% of freshwater on this planet, and we can only access 0.7%, leaving 97.5% completely unusable, and 1.8% inaccessible. The ice caps are melting directly into the sea, the sea will rise by 6 meters and all coastal towns and cities will be gone. A way to reduce this effect would be to use seawater for agriculture and drinking. I am not saying it is a cure, but it would slow down the rise of water, even a small fraction is beneficial. The irony is, by 2050 freshwater will be a scarce commodity due to climate change. England will run dry; we do not have much choice in the matter. (News.bbc.co.uk, 2006) (Business Insider, 2019)

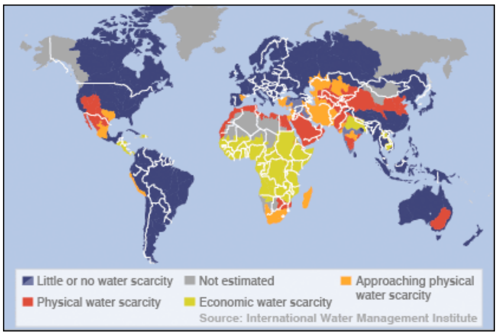

Figure 3 Map details global water stress (BBC News, 2006)

My Opinion

Everybody should be entitled to clean drinking water, and this is a cost-effective, efficient method to do so using sustainable energy techniques. On a big scale installation, salt and oil is an optional sellable by-product, in theory it could pay for installation costs, thus making this device completely affordable at every level. Hopefully creating jobs selling water, salt and oil. The water in Asia and Africa should be free in my opinion, my intention is not to make money, but to help people. (Rooney, 2018)

Passionate Thought

Growing up as a child seeing the troubles in Africa and Asia regarding fresh water has haunted my mind for a long time. Seeing children die due to lack of water is disgusting, people would sooner cause wars and send rockets to space than tackle the real issue. (Rooney, 2018)

Methodology

The method would be to design the Filter and put that Filter to test, we can assume an ideal approach, incorporating calculations and researched theoretical outcomes. However, without the actual device in place of its working environment it is very difficult to anticipate the real outcome. So, we must complete an ideal design to a highly critical standard, evaluate and then tweak the device to obtain the intended results. The intention is to have a fully working prototype which can then be subjected to variations of testing techniques. On paper, and in the real world the materials and equipment selected do what they should. I will be using some of the materials in a way never used before, so the outcome is uncertain, but good enough to proceed. The validity of this device is clear, it will help those that cannot obtain clean drinking water and that is priceless. (Rooney, 2018)

Design Theory

The Graphene Filter will transform dirty lake and seawater into a clean drinking water. It will be cylindrical in design with three filtration chambers, two Active Carbon and One Graphene Oxide Membrane; the outer casing has holes situated all around to allow water entry. Holes are designed to allow water but not Sea life. This is the first stage of filtration and the first waste pipe will remove any debris and large objects. Then we have the first Active carbon chamber, this chamber will remove toxins and microbes and a fair amount of chloride via the second waste pipe. Water then penetrates to the second Active Carbon chamber, at this point majority of the salt is removed via the third and last waste pipe. The waste pipes are situated at the base, and between each chamber where sediment is likely to build up. Finally, water with a small amount of chloride enters the Graphene chamber, at this stage all particles are stripped, and only pure water exits through the freshwater pipe. (Sciencedirect.com, 2019) (The Engineer, 2019)

The flowrate is slow operating as to reduce pressure build up over the Graphene, this is to increase life expectancy and reduce maintenance. Too much force will break components and the reason why a compression type filter is not a valid option. (Rooney, 2018)

Construction

The construction of the Filter is detrimental to operation, two threaded end caps at each end connect the outer casing and each containment chamber in place, this ensures no leaks or contamination. A threaded ringlet connects end caps to containment chambers, it acts as a contamination barrier, leak preventer and means of easy access to add or remove chambers for maintenance. The Graphene Oxide Membrane and Active Carbon are situated inside of these containment chambers. The design will allow for each section to be disconnected and reconditioned. If it develops a fault in one section, we can replace it without replacing the whole device. (Rooney, 2019)

Design Assumption

The reason for the cylindrical Russian doll design method is due to removing the work done and put over the Graphene. Graphene is expensive, and although 200 times greater than steel at 1 atom thick, even layered, it is still a temperamental material and It will be subjected to a consistently harsh environment. The Graphene Oxide Membrane will be wrapped around a penetrable housing case to keep it sturdy reducing movement. by reducing the duty, gradually through stages at a fixed position, fatigue is a much slower process which increases the life expectancy of the Filter. (Rooney, 2019)

Graphene Oxide Membrane comes in sheets similar in size to A4 paper, it is an ultra-thin material and doubling up sheets is a valid option. But an expensive one, so additionally pin holed imperfect Graphene sheets which are much cheaper will be added as part of the second line in defence. This will give added protection to the initial perfect Graphene sheet in order to maintain strength and stop contamination. (ACS Publications, 2019)

An assigned pumping programme and manual technique will allow this Filter to breath upon application, this allows for de clogging/blow back and reduces/prevents blockages which is ultimately the biggest obstacle to overcome. (Rooney, 2018)

Testing

In order to test the device, we need materials, apparatus, equipment and manual labour. Testing will include flow rate analysis, denoted as $\dot{m}$ (metres per second). Hand calculations will be compared to CAD techniques which determine ideal and realistic outcomes. Graphene Oxide Membrane has no CAD based material input valuation, so manual testing will give factors for incorporating this information into future CAD material requirements, specifically in the case of flowrate analysis. (Rooney, 2019)

Testing includes buffering, which is the adjustment of PH and the addition of minerals formally stripped. Pre-treated water with an index of contents needs to be clarified. For example, hard, soft and mineral water. An Electroconductivity meter measure solids in the water, this is the clear indication of what was there initially, what we have stripped, and what we have added back in. The result I aim to obtain would register zero via EC measurement, this means there are no solids in the water. However, it does not have to register exact zero to pass for drinkable water. This would provide proof that Graphene Oxide Membrane does exactly what it is supposed to do. Currently, fresh water from the tap according to the Electroconductivity meter has an EC solid state value of 0.6, which is a concoction of minerals and toxins. This value does fluctuate slightly from region to region. (Sciencing, 2019) (Rooney, 2019)

Materials, Apparatus and Equipment

Material List

- Graphene Oxide Membrane
- Activated Carbon
- Saltwater
- Waterproof Resin
- High density polyethylene (HDPE)

Alternative Materials

- Sand
- Fabric
- Cloth

Apparatus

- Five transparent aquatic containers, 20 litres
- Worktop
- Plastic bottles 300ml
- Study area

Equipment

- Four, electrical low voltage pumps
- Electrical cable
- PH meter
- Contactors/relays and timers
- Electrical supply
- Manufacture machinery
- Electroconductive meter
- Waste and freshwater pipes, standard plumbing size
- Pipe connections
- SolidWorks flow analysis
- Pressure sensors
- Temperature sensors
- Computer/Laptop
- Tooling
- Calculator
- Note pad
- Pen
- Pencil
- Paper

Visual Method and Components

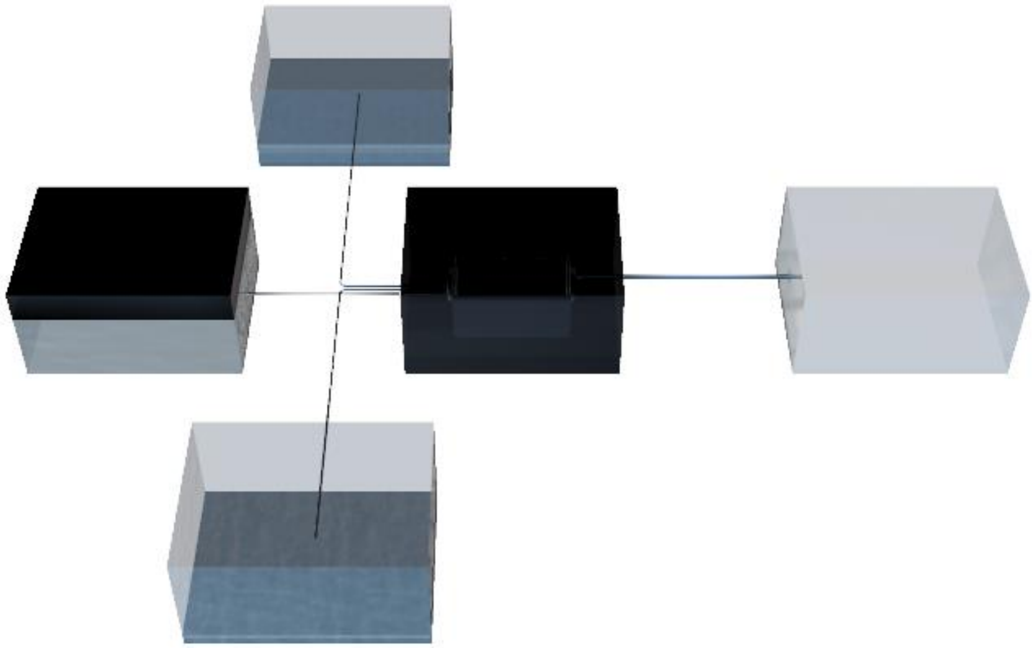

Figure 4 Water separation picture 1

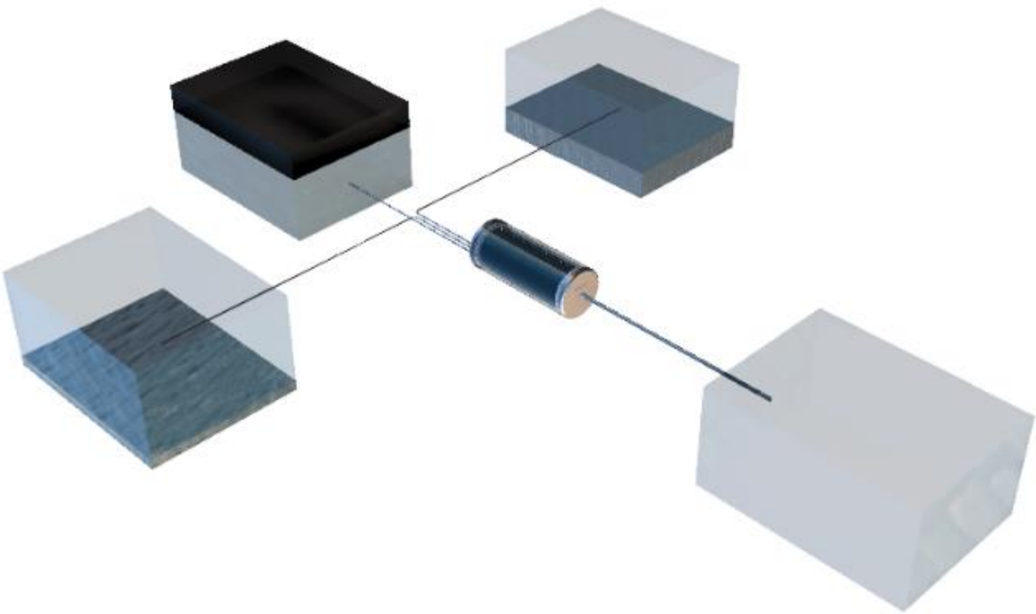

Figure 5 Water separation picture 2

Graphene Filter Visual

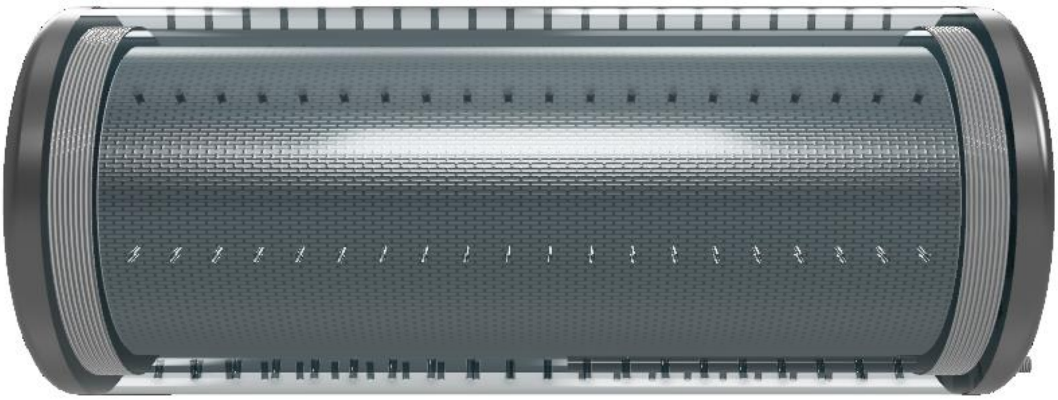

Figure 6 Graphene filter methodology

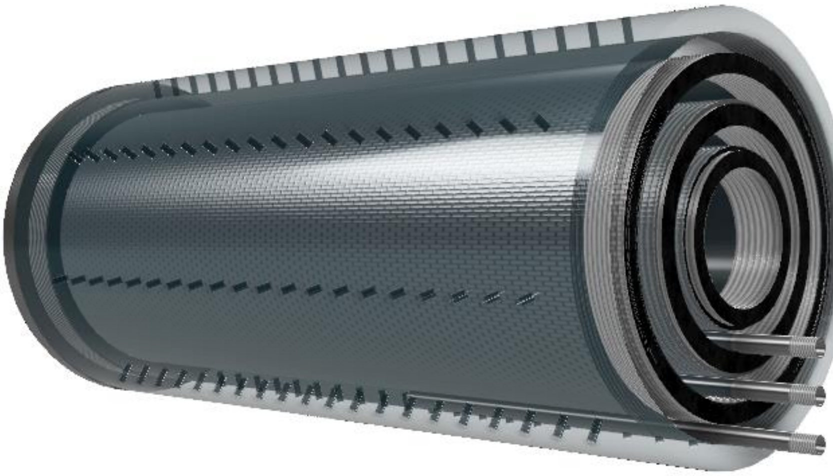

Figure 7 Graphene filters end cap for waste removed

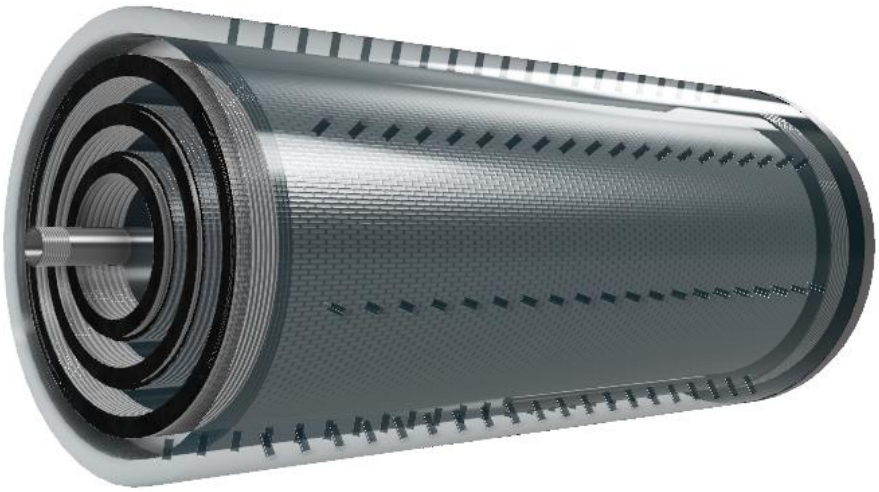

Figure 8 Graphene filters end cap fresh removed

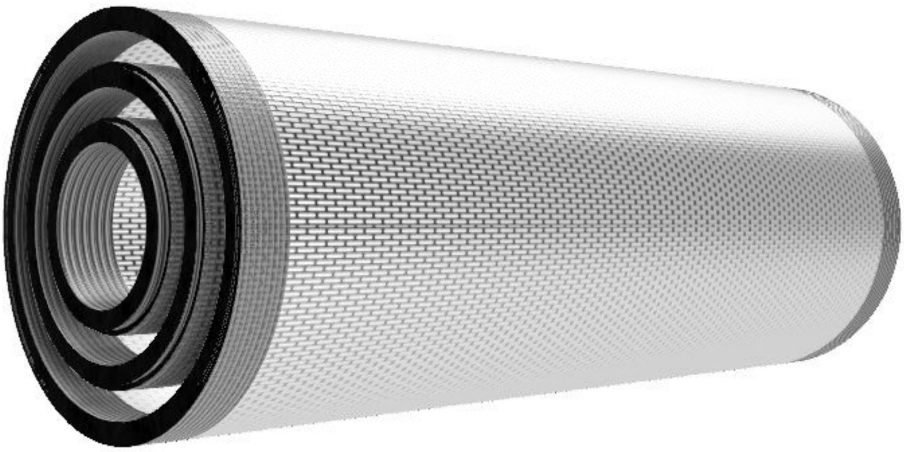

Figure 9 Containment chamber with ringlet in place

Figure 10 Containment chamber without ringlet in place

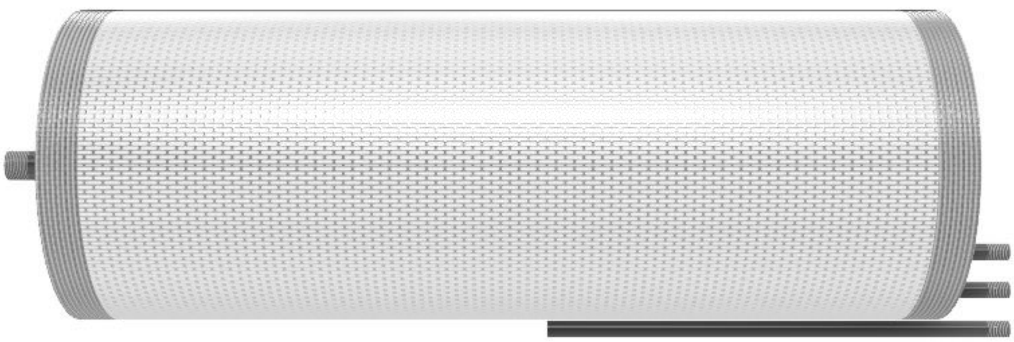

Figure 11 Containment chamber with waste and freshwater pipes

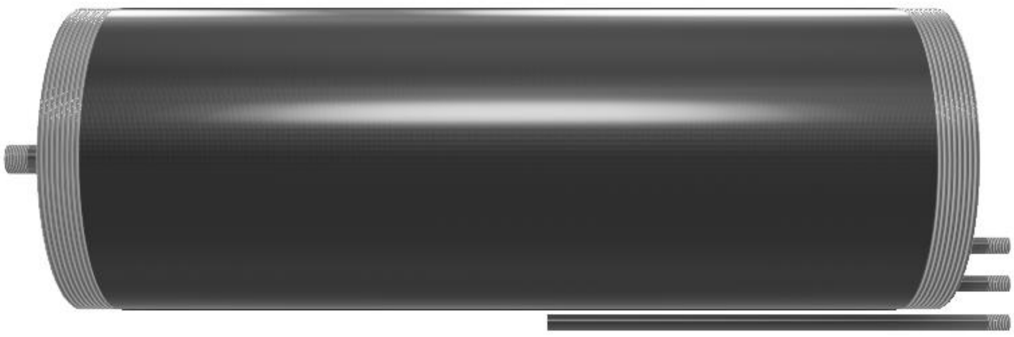

Figure 12 Containment chamber removed showing active carbon

Figure 13 Ringlets and pipes positioned

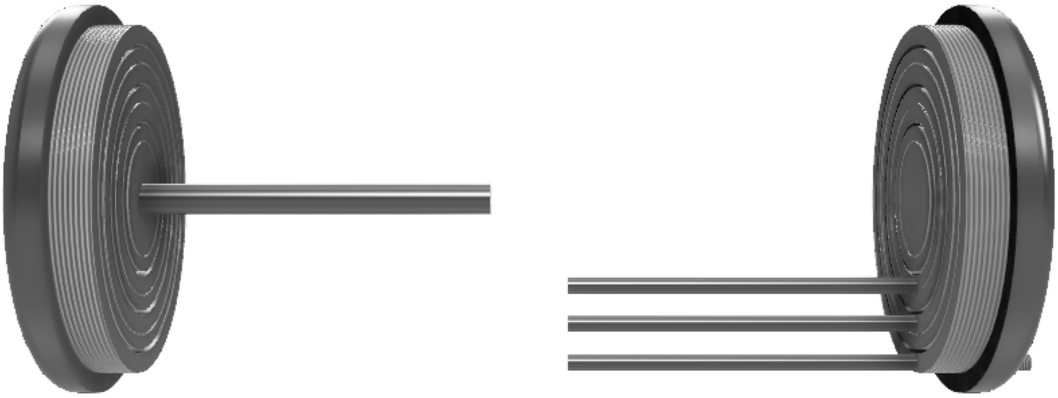

Figure 14 End caps with ringlet and pipes positioned

Figure 15 Freshwater end cap

Figure 16 Waste end cap

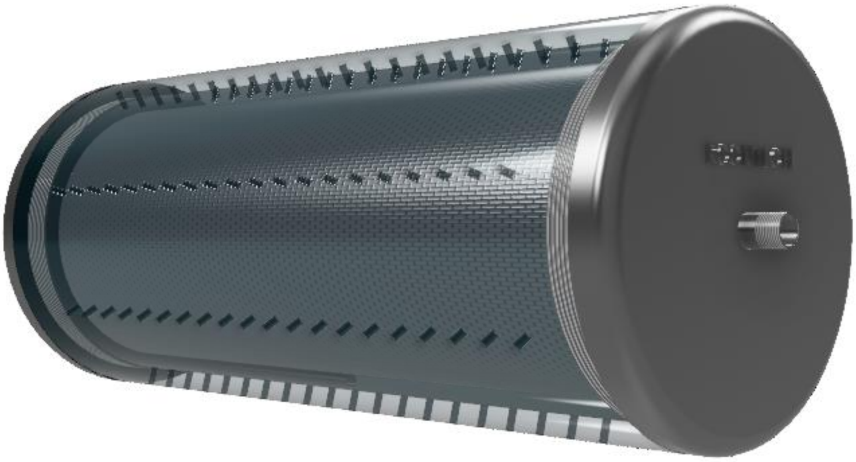

Figure 17 Graphene filter final design view 1

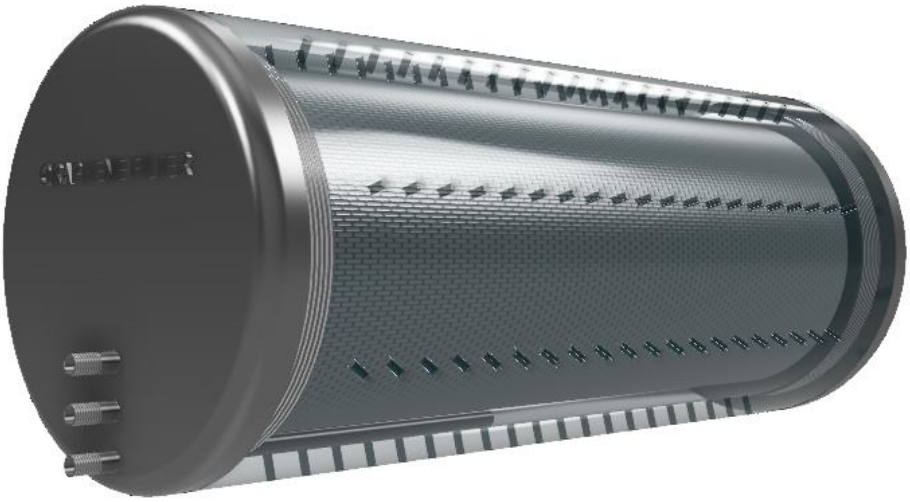

Figure 18 Graphene filter final design view 2

Furthered Existing knowledge

My research will show others if it is a viable solution to solving for water filtration, specifically seawater using my methodology and techniques. Failure or success, my research is vital information. The cost and quick implementation is unique and makes this device a valuable commodity. (Rooney, 2019)

Failure

It will save time if others decide to undertake such work, if failure is imminent, eras can be learned from without testing. If others believe I have missed valuable information or have overlooked a certain scenario. A mistake on my behalf would still be valid information If others learn from it. Information I have sourced may well be subjected to negativity, and others may see a better way, this does not mean my work is a waste of time, it means I have to readjust and change my path to get it right, or see that others do get it right. The importance of this device is monumental to the world.

Success

If successful, then this will be a benchmark platform to move forward from, creating industry, jobs and giving life to those that would otherwise lose it. (Rooney, 2019)

Previous work Proposed

Previous work includes a BSc Independent Project via Derby University, the bases of this proposal was founded on that information and vision that I had two years ago. The design has been innovated further as an extra chamber has been added, but the initial Graphene Filter project still maintains the original characteristics. All work completed will be subjected to scrutiny further by the completion of a PhD investigation. To view the full BSc report, copy and paste the 2nd last refence via the bibliography into the internet browser and view the pdf via google documents. (Rooney, 2018)

Conclusion

The project aim is to provide people with a means to fresh water, effectively, efficiently, whilst using sustainable methodologies. The project will allow a deep understanding of how to deliver an idea to manufacture. If it fails to deliver, then it will be used as a means of avoidance.

This project will prove if Graphene Oxide Membrane, combined with Active Carbon does what research has led me to believe. It will provide a valuable insight into material behaviours. I believe it to work, and the question I ask is “what is the estimated overall lifespan of the materials when used in a water-based environment?”. Sodium chloride is difficult to remove regarding individual particles, fortunately they tend to bound together, and it is this basis the nano porous material Graphene can be very effective sieving method for seawater.

Over the five-year course all data and information will be collected, this will include research and development, design, materials, overall cost, competition, stakeholders, marketing, tool requirements and manufacture. At the end of each term a thorough investigation of that terms work will be recorded and documented in detail. All information will be recorded and finally used to write a critical report come year five. (Rooney, 2019)

Project Timetable

Table 1 Time period, year 1

Time Period	Anticipated Activities
Year One October 2019 - December 2019	Research, In-depth Knowledge to be obtained, data collected via Internet, books and experts. Revisit work completed on the subject. Data Collected.
December 2019 - April 2020	Begin Initial Design Phase.
April 2019 - July 2020	Design Phase Completed.

Table 2 Time period, year 2

Time Period	Anticipated Activities
Year 2 September 2020 - July 2021	Select materials, manufacture components, build Graphene Filter Prototype. Data Collected.

Table 3 Time period, year 3

Time Period	Anticipated Activities
Year 3 September 2021 - July 2022	Thorough testing of Graphene Filtration, hand calculations and flow analysis. Data Collected.

Table 4 Time period, year 4

Time Period	Anticipated Activities
Year 4 September 2022 - July 2023	Optimisation, tweaking for the best outcome. Organise potential clients and stakeholders. Data Collected.

Table 5 Time period, year 5

Time Period	Anticipated Activities
Year 5 September 2023 - July 2024	Critical conclusive write up, all scenarios covered, difficulties and self-criticism. Win or lose. Evaluation, dissertation.

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