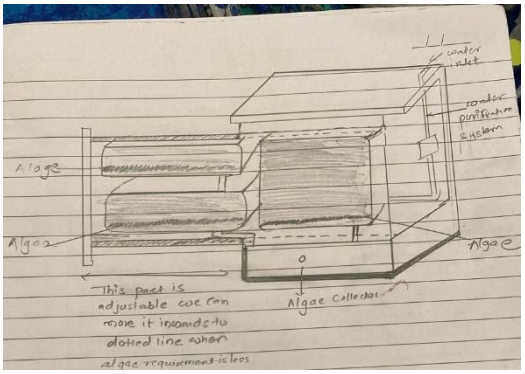
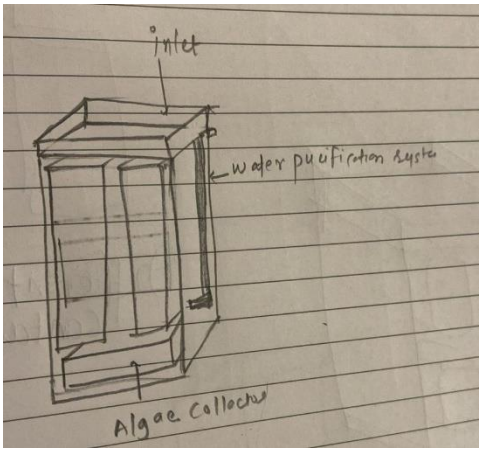
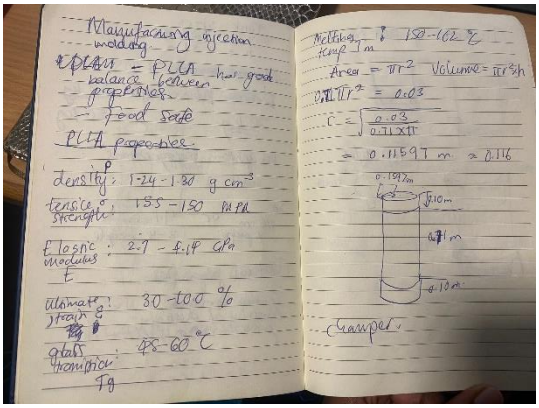
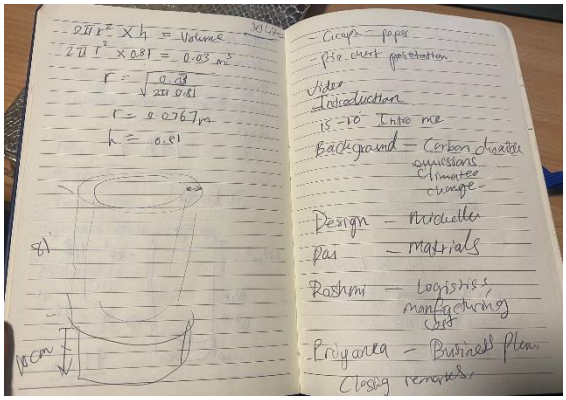
Evidence of Methodology

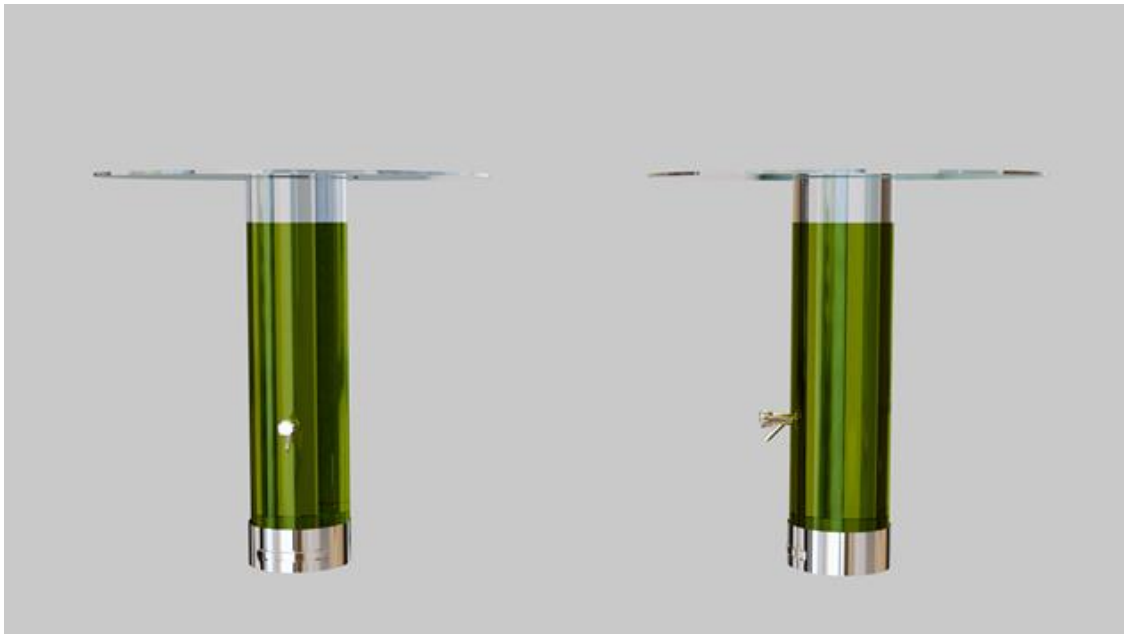
1. Initial Sketches and Brainstorming and final renders



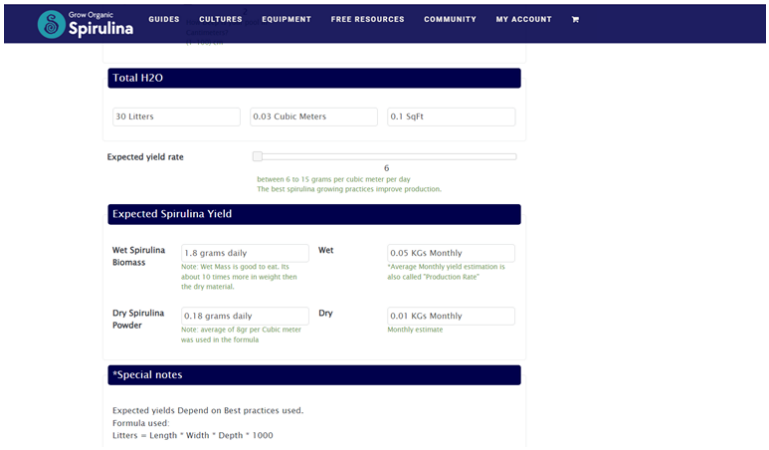








2. Engineering Calculations



<u>Algae Table Design Calculations</u>

The tank is cylindrical.

The material (PLLA) behaves uniformly.

Ignoring bottom thickness for initial calculations.

PLLA's tensile strength is estimated around 50 MPa for these calculations.

Calculating Pressure:

Water capacity = 30 litres = 30,000 cm^3,

Height of the tank = 0.71 m = 71 cm,

<u>Thickness of the Circular Flat Piece Acting as a Tabletop</u>

For the tabletop, we need to ensure it can withstand a load of 20 kg evenly distributed, along with its self-weight.

For a flat circular plate under uniform load, the deflection is given by:

δ = maximum deflection (aiming for less than 0.5 cm),

$$r = \sqrt{\frac{\text{Volume}}{\pi \times \text{height}}} = \sqrt{\frac{30000}{\pi \times 71}}$$

Where:

- δ = maximum deflection (aiming for less than 0.5 cm),

The radius of the tank is approximately 11.6 cm.

Calculating Pressure:

Finding total pressure at the bottom and then use it to determine the minimum wall thickness. We convert radius from cm to meters to match the units with the rest of the calculation.

The total pressure at the bottom of the tank is approximately 18,574 Pa (Pascals), with 6,965 Pa from the hydrostatic pressure of the water and 11,609 Pa from the additional load.

Calculating Minimum Wall Thickness

We aim for a safety factor of approximately 2 for the material stress limit (50 MPa for PLLA). The material's working stress, therefore, would be around 25 MPa, or 25,000,000 Pa to match units with pressure.

Using the stress formula:

$$P = 18{,}574\ Pa,$$

$$r = 0.116\ m,$$

$$\sigma = 25{,}000{,}000\ Pa.$$

The minimum wall thickness for the tank should be approximately 0.086 mm. Given the improbably thin result, this suggests that the stress limits or other parameters might be reconsidered for practical construction, such as using a higher safety factor or revaluating material strength. Typically, for plastic tanks, a minimum practical thickness would be around 2-5 mm depending on manufacturing capabilities and safety considerations.

The required thickness for the PLLA tabletop to ensure minimal deflection under a uniform load of 20 kg is approximately 10 mm. This thickness should provide sufficient rigidity to support the load with less than 0.5 cm of deflection, which is suitable for practical usage as a table top.

Price and calculation for water filter

To determine how much activated carbon, ion exchange resin, and foam to insert into a container with a depth of 9cm and a diameter of 22.5cm to create a water filter for filtration system.

For estimation, we can calculate the volume of the container. Let's start with calculating the volume of the container. Radius = 11.25cm

Activated carbon = 0.5 g/mL

ion exchange resin = 0.77 g/mL

Volume distribution (assuming a third of the container volume for each material)

Volume per layer(ml) = volume(ml) / 3

Calculate the mass of activated carbon and ion exchange resin needed

Activated carbon(g) = volume per layer(ml) * density activated carbon

Activated carbon(g) = 3578.470 /3 * 0.5 = 596.41g

Ion exchange resin(g) = volume per layer(ml) * density ion exchange resin

Ion exchange resin(g) = 3578.470 /3 * 0.77= 918.47g

Foam layer thickness, assuming it takes up approximately one-third of the depth of the container

Foam thickness (cm) = depth (cm) / 3

Foam thickness (cm) = 9/3 =3cm

PLA Plastic Container: For a small container, if 3D printed, the cost could range from $1 to $5, and price per kilogram is 1.2$ for 1 kilogram.

Activated Carbon: The price can vary, but a rough estimate might be $816 for 1000kg for bulk

Mass = Volume x Density

Volume V = 3706.835 cm3

Density of PLA = 1.25g/cm3

Mass = 3706.835 cm3x 1.25 g/cm3

Mass = 4633.54 grams

Cost of PLA

1kg = 1.2$

1g = 0.0012$

Cost of 4904.675g=0.0012×4633.54

=5.56 dollars + production cost 2$

= 7.56$

Foam filter = 1$

Total cost be like = Container + Filter cloth + Activated carbon + Ion exchange resin + Foam

= 7.56 + 0.3+ 0.52 +0.84 + 0.7

= 10$ for one Filter

Unit economics is a method of calculating the profitability of a single unit.

Final product render front and side view.

Unit of Economics Calculations.

Charges		Entity	Value	Unit			
Packing Charges	Bubble Wrap Roll	Bubble wrap width	1	m			
		Bubble wrap length	100	m	**MANUFACTURING COST**	410	41%
		Bubble wrap Area	100	m2	**PACKAGING COST**	23	2%
		Bubble wrap Price	21.44	GBP	**LOGISTIC COST**	19	2%
		Price per m2	0.2144	GBP/m2	**MARKETING COST**	100	10%
		Product dim	1	m	**NET MARGING**	447	45%

		Area	6	m2	**TOTAL**	999	
		Cost for BW	2.57	GBP			
	Cardboard Box	Cardboard Box length	1.2	m			
		Cardboard Box Width	1.2	m			
		Cardboard Box Height	1.2	m			
		Box Price	20	GBP			
		Total	22.57	GBP			
Logistic Charges		Logistic charges	15.99	GBP			
		VAT	3.198	GBP			
		Handling	0.1599	GBP			
		Total	19.3479	GBP			
Marketing Cost		Usually 10%of manufacturing for initial starting of business	100	GBP			
Gross Margin		Considered 45% Of selling price	447	GBP			
Manufacturing Cost		Tank + Magnets Table Top Tap Algae Harvesting System Monitoring & Control System Water Filter Total	410	GBP			