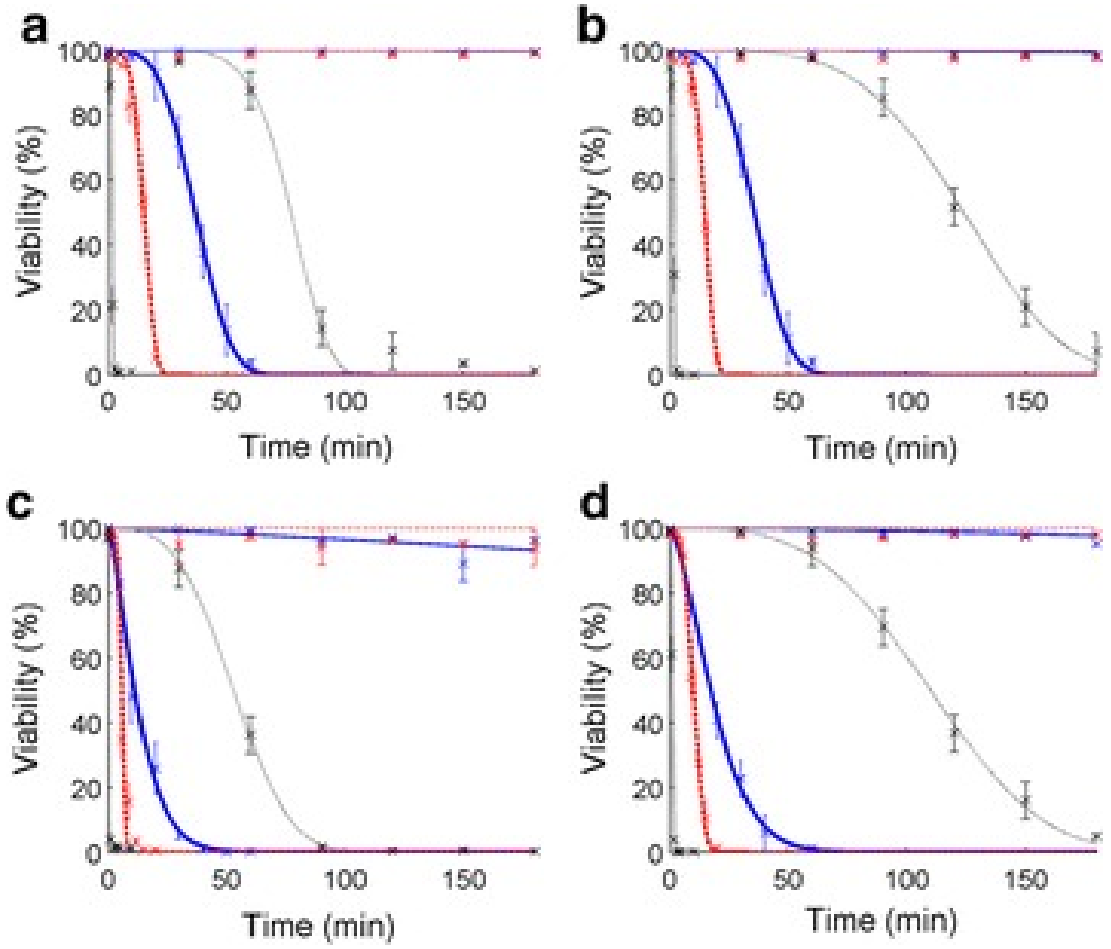
Heating system:

Water consumption:

Quantity of water per cycle based on dishwasher size					
Company:	Model	Size (in^3)	Water ussage (gal)	gal/in^3	Links:
Amana	ADB1300AF	19872	3.5	0.0001761272142	Link
Beko	DDT38530	19872	3	0.0001509661836	Link
Beko	DIT29430	19872	2.4	0.0001207729469	Link
Bosch	SHEM78WH#	19872	2.9	0.0001459339775	Link
Bosch	SHPM865Z5#	19872	3.5	0.0001761272142	Link
Frigidaire	FGID2476	19872	2.7	0.0001358695652	Link
KitchenAid	KDTE304G	19872	3.5	0.0001761272142	Link
LG	LDT780#	19872	2.9	0.0001459339775	Link
Samsung	DW80R2031	19872	3.5	0.0001761272142	Link
Whirlpool	WDF518SAHB	19872	3.1	0.0001559983897	Link
Avanti	DW1832D1BE	19872	3.1	0.0001559983897	Link
Electrolux	E24ID75	19872	2.7	0.0001358695652	Link
Maytag	MDB8959SK	19872	3.5	0.0001761272142	Link
Average:		19872	3.1	0.0001559983897	
J.A.D	1	27000	4.211956522	0.0001559983897	
Data: Link					

Temperature:



This table was taken from a research paper done on the percent of viable D.Salina cells based on the temperature. D.Salina is a form of green microalgae that grows within mineral rich lakes and areas. This makes it very similar to the algae being removed in our case as it is a green algae growing in a mineral rich environment. Thus , an assumption is being made that the percentage of viable D.Salina cells will be closely representative of the percentage of our given algae. The tables reveal that exposed to a temperature of $T = 50$ °C there was a rapid decline in the viability percentage and at $T = 60$ °C there was a near instant drop to 0%. Thus, the target specification for the heat of our water should strive to be around the 50 - 60 °C range.

Most algae will die around temperatures of 35°C (C. Clifford, n.d), and once the algae is dead it is reportedly easier to clean off of a surface (S. Giguere, 2022).

Power usage:

$$Pt = (4.2 * L * T)/3600$$

$$Pt = (4.2 * 16 * (140 - 78))/3600$$

$$Pt = 1.157\ kWh$$

$$Time = Pt/power\ usage$$

$$Power\ usage = 1.157/0.167$$

$$Power\ usage = 7kW$$

Washing system:

Pressure:

According to (Moffat, 2018) commercial dishwashers operate in the range of 200 - 300 kPa (this converts to approximately 30 - 50 psi) Most stainless steel pipes are rated for

over 2000 psi.

Wall Thickness (in) (mm)	Pressure Rating (psig) (kPa)		
	100	200	300
	16700	16700	16700
0.133	2205	2205	2205
0.179	3061	3061	3061
0.250	4493	4493	4493
0.145	1629	1629	1629

Initial benchmarking:

Type of cleaning products	Name of Benchmarked Product	Hours per raft to clean (rafts/ hour)	Autonomous (yes or no)	Rate of error (clean%)	Physically demanding (1-10)	Life expectancy (years)	Cost ($)	Quality (Review stars)	Dimensions (in)	Quantity of water (L/ 1 cycle)
What Growcer is currently doing	Brushes	2.6 - 3.4	no		8	NA	Labour cost	NA	NA	Unknown
1 Dishwasher (GIOVANNI)	Hobart	40 (1-6 min per cycle)	Yes	99.999	3 (once every 800 washes clean the pump)	10	8,716	4	18 x 26 x 27	3.04
	LG (Front Control, QuadWash, 24")	0.4	Yes	99.999	2	12	648	4.5	23 ¾ x 33 ⅝ x 24 ⅝	10.85

Type of cleaning products	**Name of Benchmarked Product**	**Hours per raft to clean (rafts/ hour)**	**Autonomous (yes or no)**	**Rate of error (clean%)**	**Physically demanding (1-10)**	**Life expectancy (years)**	**Cost ($)**	**Quality (Review stars)**	**Dimensions (in)**	**Quantity of water (L/ 1 cycle)**
	Bosch (100 series 24”)	0.44 - 0.5	Yes	99.999	2	10	650	4.4	33 ⅞ x 23 ½ x 22 ½	12.11
	Samsung (Stormwash)	0.357 - 0.588	Yes	99.999	2	10	950	3.9	23 ⅞ x 33 ⅞ x 24 ¾	13.25
2 pressure washer (alex) [assuming the use of a 40deg head at a 7.5in distance]	Rock and Rocker (Electric Pressure Washer Von 3.2)	12 to 18 Boards per hour	No	N/A	8	5 to 10	209.98	unavailable	unavailable	0.5L soap tank
	Sun Joe (SPX 3000)	12 to 18 Boards per hour	No	N/A	8	5 to 10	229.00	4.4	15.6x13.5x33.9	Two 0.9L detergent tanks (therefore 1.8L total)
	Westinghouse (WPX3400)	12 to 18 Boards per hour	No	N/A	8	5 to 10	379.00	4.6	21x19.5x23.6	1.6L detergent tank
	Simpson (MSH3125 MegaShot)	12 to 18 Boards per hour	No	N/A	8	5 to 10	749.00	4.5	21x24x34	unavailable
3 disposable coat	Duvet Cover	Range of times from #1	No	N/A						
	Car cover	Range of times from #1	No	N/A						
	Table cloth	Range of times from #1	No	N/A						
4 Algaecides(Kalan)	Lo-Chlor tropiclear algaecide (copper based)	Takes 1-2 hours per few boards	No	N/A	5	N/A	13.5/2.5L	5 stars/ 1 review	none	2.5L/50000L of water
	Polyquat In the	Takes 1-2	No	N/A	5	N/A	25.9/L	4.8 stars/	none	N/A

Type of cleaning products	**Name of Benchmarked Product**	**Hours per raft to clean (rafts/ hour)**	**Autonomous (yes or no)**	**Rate of error (clean%)**	**Physically demanding (1-10)**	**Life expectancy (years)**	**Cost ($)**	**Quality (Review stars)**	**Dimensions (in)**	**Quantity of water (L/ 1 cycle)**
	swim algaecide	hours per few boards						413 reviews		
	HTH Super algae guard	Takes 1-2 hours per few boards	No	N/A	5	N/A	42/L	4.5 stars /9300 reviews	none	N/A
	Kem-Tek KTK-50-0006 Pool and Spa 60-Percent Concentrated Algaecide	Takes 1-2 hours per few boards	No	N/A	5	N/A	40/L	4.9 stars/1300 reviews	none	N/A
5 Car wash (ALI)	X2 Automatic car wash system	1 car / 5-7min	Yes	NONE	1	indefinitely	15000-200000	4.9	18879.038in^2 1709519.17in^3	60 L/min
	X1.1 Automatic car wash equipment	Standard time (4-5min)	Yes	NONE	1	indefinitely	15000-200000	4.9	Do calc	60 L/min
	KKE wave touchless car wash equipment	Standard time (4-5min)	Yes	NONE	2 (automatic+manual)	indefinitely	15000-200000	None	Do calc	106 L/min
	KKE SpeedoClean: Automatic car wash equipment	1 car/ 6-8min	Yes	NONE	1	indefinitely	15000-200000	None	Do calc	40 L/min
6 UV Sterilisation	Emperor Aquatics / Pentair 25 Watt	360 gallons per hour (good for a	Yes	99.9%	1	13 months per lamp bulb of continuous use	825.99	N/A	30 x 2.5 x 2.5	N/A

Type of cleaning products	**Name of Benchmarked Product**	**Hours per raft to clean (rafts/ hour)**	**Autonomous (yes or no)**	**Rate of error (clean%)**	**Physically demanding (1-10)**	**Life expectancy (years)**	**Cost ($)**	**Quality (Review stars)**	**Dimensions (in)**	**Quantity of water (L/ 1 cycle)**
	SMART UV LITE (reference 1)	1600 gallon tank)								
	GKM24W (reference 2)	120 gallons per hour (good for a 100 gallon tank)	Yes	99.9%	1	6 to 9 months per bulb	119.99	N/A	4x4x17	N/A
	Coospider Sun JUP-01	210 gallons per hour (good for a 80 gallon tank)	Yes	99.9%	1	N/A	49.99	N/A	12x3.3x3 .75	N/A
	Advantage 2000+ UV 15-Watt Barb x Barb Unit	280 gallons per hour (good for a 300 gallon tank)	Yes	99.9%	1	14 month lamp life	274.00	N/A	12.5x2.7 5x4	N/A
Criteria		Lower		Higher	Lower	Lower		Higher	Lower	Lower
Target Specifications	NA	< 1.7/hr Manual <0.16/hr Automatic		> 50%	< 5	Profitable in < 4 months ROI = 4x (over lifetime)		>4	≤ 30”x96”x 36” or 48”x72”x 36”	NA

Design criteria:

Needs	Design criteria	Mertics	Units	Ranking

Non-manual	Autonomous	YES/NO	N/A	3
Cleans the boards	Rate of error of cleanliness	The % of algae over the area of the boards (%algae/area)	%	5
Reduce manual labour	Time	Time spend on 1 board (board/hour)	n/hour	5
Cheap	Cost	The cost over the quality of the product ($/quality)	($/quality)	3
Space efficiency	Area and Volume	in^2 and in^3	in^2 and in^3	4
Environmentally safe	Reduction of water contamination	%contamination of water	%	4
Safe and simple to use	Quality of product	Reviews on google	*(stars)	5
Low water consumption	Quantity of water	% intake of water in litres per board (%L/board)	(%L/board)	3
Mass production	Quantity of boards cleaned	#boards per wash	n/w	3

Cad file:

Cad Link: Link

BOM:

Overall				
Material:	Cost per unit:	Quantity	Total cost	Source:
Universal size measurement: Inches Shipping prices unknown				
Metal sheet 30 x 30 x 0.1	6.84/inch³	2	$1391.26	Link
Metal sheet 30 x 10 x 0.1	6.84/inch³	9	$2086.88	Link
Metal sheet 15 x 15 x 0.1	6.84/inch³	2	$347.81	Link
Metal sheet 15	6.84/inch³	8	$927.50	Link

x 10 x 0.1				
Metal sheet 10 x 10 x 0.1	6.84/inch³	2	$154.58	Link
Metal sheet 10 x 3 x 0.1	6.84/inch³	4	$92.75	Link
Metal sheet 1 x 30 x 0.1	6.84/inch³	1	$23.19	Link
Metal block 1 x 3 x 1	6.84/inch³	3	$69.56	Link
Metal block 1 x 2 x 1	6.84/inch³	6	$92.75	Link
Metal rod 1 diameter	6.84/inch³	75”	$1821.15	Link
Metal tube 1 diameter	$1/inch	75”	84.75$	Link
Stepper motor	$15 each	3	$50.85	Link
Nozel	$20.13 each	2	$45.49	Link
Heating element	$62.47 each	1	$70.9	Link
Silicon tube 2 diameter	$14.95/10 Feet	120”	$16.89	Link
3d printed triangle	$0.10/ml	1	$5	Link
3d printed case	$0.10/ml	1	$10	Link
Fasteners	$19.26/8	16	$43.53	Link
Bolts ¼	$0.10 each	64	$7.23	Link
Nuts	$0.10 each	64	$7.23	Link
Wassher	$0.10 each	64	$7.23	Link
Screws	$0.10 each	4	$0.45	Link
Glue	$19.80/6g	5 mL	$22.37	Link
Wires	$2.50/5ft	5ft	$2.83	Link
Arduino Uno	$9 each	1	$10.17	Link