RECYCLING AND REMOVAL OF WASTE WATER FROM LEATHER INDUSTRIES.

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***1.* ABSTRACT:** *A large amount of harmful chemicals and organic pollutants are produced from the leather tanning industries. These are directly disposed to the canals which in turn mixes with the rivers causing harm to aquatic animals as well as humans too. This project tells us about how the purification of the effluents can be done and making the water reusable. In this project we deal with five types of purification processes that are cost effective, environmentally friendly and more efficient. These processes also explore the physical and chemical treatments. These consist of sedimentation process, adsorption process, oil filtration, Hardness removal and reverse osmosis filtration process. In hardness removal, polymer coagulants will be more successful at the removal of chromium from the discharged water and at last reverse osmosis method will be most effective in generating purified water which will gain the potentiality to reuse in the tannery industry. Finally we also did the simulation of the design for various analysis like thermal analysis that include heat flux and temperature gradient and other static analysis including stress, strain displacement and safety factor for the conclusion of how good our design is.*

KEYWORDS: wastewater, Leather tanning, treatment, reuse.

2. INTRODUCTION

In the leather industries the methods used give us a lot of chemically polluted water that contains a large number of chemical coagulants, dyes, dissolved salts etc which impacts human life and aquatic life. For encountering the problem proper methods are required to regulate the impact. Not only this but also with these techniques we can make the water reusable. Some of the pollutants are sulphuric acids, phosphoric acids and few organic pollutants. One such important pollutant is chromium, which cannot be easily eliminated from the water. Few companies have come up with their own solution to get rid of these chemicals but their setup is either costly or included with so much technical difficulty in it. And these were not environmentally friendly and cost effective when compared to our filtrations and processes.

Here in this project, we have come up with the best feasible solution to the problem that is eco-friendly and cost effective. The main important thing is that its setup can be organized in a single hall. This project includes some basic purification methods that are cost effective along with the design that includes each purification technique in it.

3. LITERATURE REVIEW

[1] Compared to C2 and C3, C1 has more adsorption capacity for the removal of Cr (III). For eliminating of chromium, C1 obtained from local sugar factory is more effective. For the Cr (III) extraction within the range of pH 5.0–6.0, which is likely to be at pH 5.0, three adsorbent materials C1, C2 and C3 are effectively working. [2] Utilization of waste Capiz-shell

as a stimulant for the producing biodiesel from leather tanning industry is proposed by this research.[3] Tanneries installed RO membrane procedures are analysed to raise their standards and also to be economic are located in Vellore District, Tamil Nadu, India. [4] How to minimize the environmental impact of the water used by tanneries through the study of reuse possibilities of wastewater tanning floats. [5] RO, flocculation, filtration, are used for effectively treating wastewater by discovering various physical and chemical treatment processes. [6] Predicting the performance in chemical separation of two ultrafiltration (UF) polymeric membranes for potential use in the purification of the waste stream of vegetable tanning liquors, a synthetic wastewater was prepared.

[7] In order to attain effective results and appropriate selectivity the membrane can be amended. Based on observation we can find some aspects, based on the way we are leading in the evolution of Nano membrane filtration. [8]An advanced oxidation-Nano filtration integrated hybrid process can be used to reuse the wastewater in the leather industry. The integrated process successfully removes chromium (99.5%), COD (> 99%) and TDS (> 96%) while retaining the essential ions (Ca^{2+}, Mg^{2+}) substantially. [9]N-ACs with different physical and chemical properties were synthesized from leather solid waste (LSW) by different activation methods. The obtained N-ACs were characterized by various techniques, including SEM, XRD, XPS, and BET analysis. [10]The waste red mud from hazardous alumina industry has been activated with hydrazine sulphate (HSRM) and investigated for its sorption capability towards an anionic Indigo Carmine (IC) dye from contaminated water samples using batch methods of adsorption in treating such effluents from Indigo Carmine (IC) dye industry. [11] Textile wastewater typically consists of different types of dyes, detergents, grease and oil, heavy metal, inorganic salts and fibres in amounts depending on the process. The effluent is generally characterized using parameters such as BOD, COD, Total Dissolved Solids (TDS), pH and colour. In this study the Nano-TiO_2 membrane was used as a filter in the effluent water treatment.

[12] For processing hides tanneries use large quantities of water. The recovery of Cr from the wastewater produced in the tanning step is environmentally friendly and economically viable. [13]Pollutant's removal efficiency is increased. Recycling treated water and removal of WW pollution. [14] Microwave irradiation was employed to improve the re-dissolution of Cr-sludge for reuse. Reducing the settling time of sludge sedimentation. [15]To study the effluents released by the tannery and its effects on water bodies. [8]To study about advanced technologies such as nanocomposite to recycle waste water released from the tannery industries. [16]In order to make the best use of the activity of dispose in unhairing waste-waters and reduce the amount of waste-water discharge, some unhairing waste-water was used for next cycle unhairing and some was used for fibre opening.

4. METHODOLOGY:

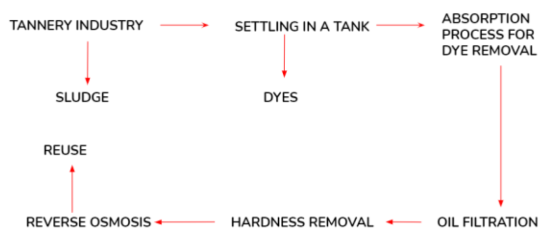

Chart-1: Methodology Process of wastewater treatment

- The entire methodology of our project which includes
- The methods, which we are going to use in the filtration and the impurities that are going to

remove in each filtration process.

- The process will also follow the same direction that was mentioned in the flow chart. The 3D View of the design and the use of trays for holding the filtres will be shown further.

5. FILTRATION PROCESS:

- Sedimentation
- Adsorption Process
- Oil filtration process
- Hard Water filtration process
- Reverse osmosis filtration process

6. SEDIMENTATION:

- This is the physical water filtration process in which due to gravity the molecules with higher density than water settle down and the remaining water will be on the top of it. In our project, we will take out the filtered water after sedimentation and allow for further treatments, the sludge will be removed from another pipe, and this sludge will be decomposed in a pit.

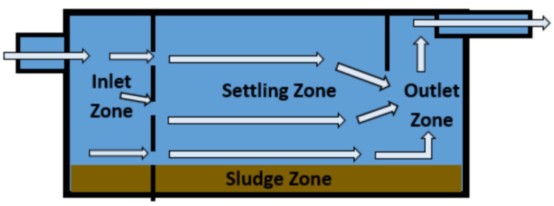

Fig-1: Sedimentation in a tank

7. ADSORPTION PROCESS:

- Adsorbent process is considered as one of the prominent methods which can be used in the filtration process of tannery water in the leather industries.

- The **principle** behind the Adsorption process is the adhesion between layers and the substrate used. It is a process of adhesion of positively and negatively charged ions between the substrate body and the layer.

- **The cellulose** present in the tea leaves with the adsorbents like **hemicellulose** and **lignin materials** when they are exposed alternatively to their aqueous solutions to the fiber forming a multi layered material.

Fig-2: Adsorption process by tea leaves powder

- However, this attempt is made to render a adsorption process derived from a renewable resource of tea leaves. This material is economic and surplus in nature.

- Tea leaves is a costly and abundant material compared to other materials used in this process and it is also having reliable physical properties like wear resistance which will be suitable for using it in adsorption process. But we can actually use the tea leaves that are of no use anymore for this process.

8. OIL FILTRATION PROCESS:

- Oil filtration is done by using sustainable polysulphides for oil absorption which is cost effective. Sulphur and used cooking oil are used for preparing the sorbent, which indicates to us that each and every sorbent atom can be derived from waste produced from industries. Considering sulphur which is produced as a by-product from the petroleum industries, the unsaturated cooking oil which is produced from restaurants as waste is used for preparing polysulfide. Here the Oil Extracted from Tannins in water Gets absorbed, and water is sent to the next process. The picture shows the process of making sustainable polysulphides for Oil absorption, which is very light in weight, made from the products from the industries Such as Sulphur and used cooking Oil.

9. HARD WATER FILTRATION PROCESS:

- Hard water doesn't lather with soap. In tanning we wash the tannins with soft water that produces lather with soap. So, for reusing the purpose of water we need to remove the hardness of Water by Removing the calcium, magnesium ions and other Mineral content present in the Water. We check for cod, bod and TDS other parameters for Quantity of Minerals present in a Litre.
- We use 2 Methods to form Sediments on the Filter
    - Clark's Method
    - Calgon's Method
- **Clark's Method:**
    - Here we add Calcium hydroxide to react with bi carbonates to form carbonate sediments. In this way we can remove calcium from water. Clark's reagent calcium hydroxide is in this process. Hardness of the water is eliminated by converting bicarbonates to carbonates.

$$Ca(OH)_2 + Ca(HCO_3)_2 \rightarrow 2CaCO_3\downarrow + 2H_2O$$

- **Calgon's Method**

Sodium-hexametaphosphate $(NaPO_3)_6$ commonly known as Calgon is used in this procedure. The hardness in water is abstracted by the adsorbing virtue of Ca^{++} and Mg^{++} ions.

Calgon acts as an anion when added to hard water causes Ca and Mg ions of hard water to displace sodium ions. Sodium ions are released into the water after the water is softened.

$$Ca2 + Na4P6O182 - \rightarrow 2Na+ + CaNa2P6O182$$

10. REVERSE OSMOSIS

- RO is commonly used for purification of water that include simple steps for removing undesirable contaminants.
- Various industries use the applications of RO for achieving highest purified water which helps them in treating wastewater from industries. Dissolved solutes can be salts, or they can be organics, such as sugar or dissolved oils.
- The solutes are the species of lesser concentration held in solution by molecular attraction with the solvent, which is in greater concentration.
- The fundamental procedure of RO uses a siphon and a semi permeable membrane. A thrust force is provided by the pump and the solute present in the water is passed through the semipermeable membrane. This process separates the water from the solute when the solute dissolved water is passed through the semipermeable membrane.
- A RO membrane is extremely hydrophilic, suggesting that water is drawn to its substance structure. Water can bond with the closures of the polymer sections making up the membrane.

- This enables the water to promptly diffuse into and out of the polymer construction of the membrane.

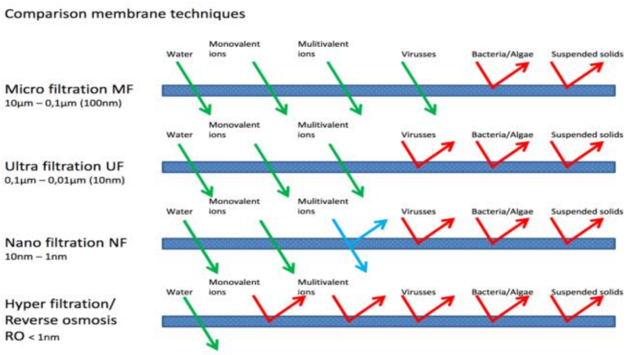

Fig-3: Reverse Osmosis Process

11. DESIGN OF THE PROJECT

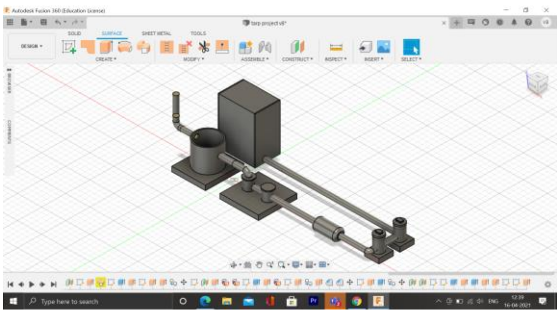

Fig-4: Design of the Project

- Firstly water enter in the tank present at the starting of the design from the **factory outlet**
- The First tank is where the **sedimentation process** takes place; it generally takes **8 - 10 hours** for this.
- Next after the sedimentation water is taken from sedimentation tank and is allowed to flow through the pipe for **adsorption process**
- In the **adsorption process** the dye removal takes place which is only **50% efficient** so the no. of times we do the more purity amount of water we get
- After the adsorption process the **oil filtration** process takes place in the **cylindrical structure** where all the oil present in the water has been removed.
- The **next two tanks are for hardness removal** from the water which is done by Clark's method and Calgon's method. On the top of the tanks, we have an **opening through which the chemical coagulants enter** and **after the chemical reaction the purified water is sent for membrane filtration i.e., Reverse osmosis** which is taking place in the final pipe for the storage tank.

12. MATERIAL OF THE DESIGN:

In the design, we took copper for the tank because the effluents coming inside the tank will contain different chemicals and organic pollutants. So, in order to make sure that the tank is away from the corrosion we preferred the copper which is corrosion resistant and good on terms of mechanical, chemical and thermal properties and the material used for chambers and the trays are stainless steel which is having good mechanical strengths and also cost effective and the pipes are normal pipes which is made up of polyethylene high density which is of different diameters according to the requirements. The thickness will be the same for all the pipes. These pipes contain a lock and open key which stops and allows the water into the filters from the tank.

13. COST ESTIMATION OF THE DESIGN:

Particular	Sub- particulars	cost
Manufacturing cost	Sedimentation tank	Rs.1,00,000
	Absorption tank	Rs.20,000
	Oil filtration	Rs.1,80,000
	Hard water filtration	Rs.40,000
	Chemical coagulants	Rs.10,000
	Pvc pipes	Rs.1,500
	Storage tanks	Rs.15,000
	Reverse osmosis filters	Rs.1,400
Installation cost	For complete setup	Rs.5,000
Maintenance	Electricity + Transport + Labour charges + Cleaning	Rs.20,000
TOTAL		**Rs.3,92,900**(Approx.)

Table-1: Cost Estimation of Setup

14. SIMULATION OF THE DESIGN

Thermal Analysis of sedimentation tank

- **Heat flux**

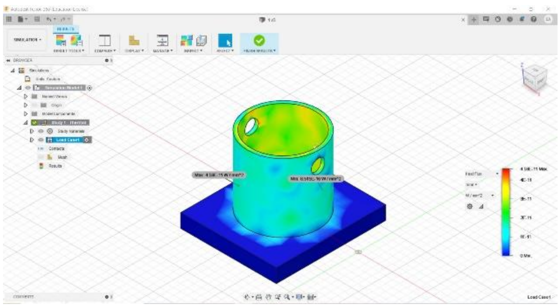

Fig-5: Heat Flux of sedimentation tank

- **Temperature gradient**

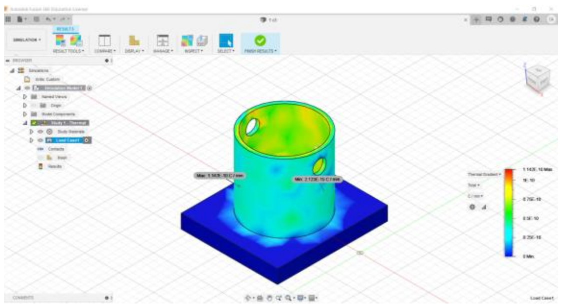

Fig-6: Temperature Gradient of Sedimentation Tank

Thermal Analysis of adsorption tanks

- **Heat flux**

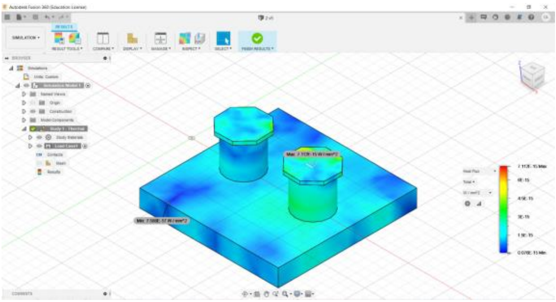

Fig-7: Heat Flux of adsorption tanks

- **Temperature gradient**

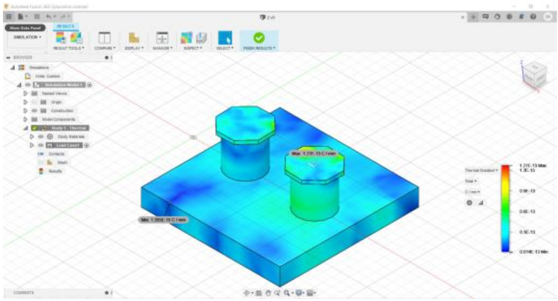

Fig-8: Temperature gradient of adsorption tanks

Thermal Analysis of oil filtration tank

- **Heat flux**

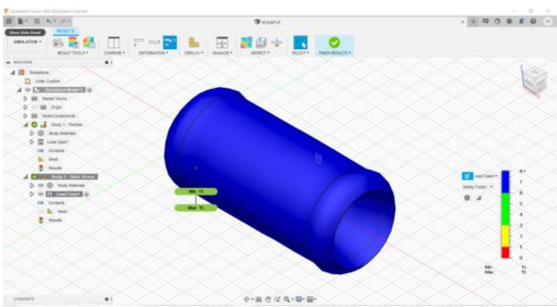

Fig-9: Heat Flux of oil filtration tanks

- **Temperature gradient**

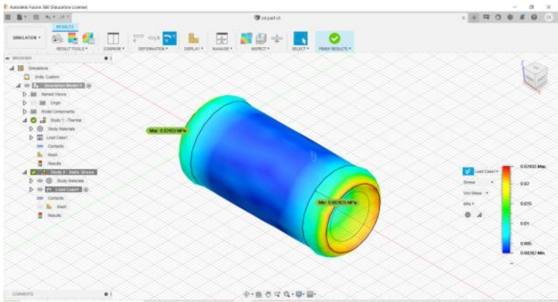

Fig-10: Temperature gradient of oil filtration tanks

Thermal Analysis of hard water removal tank

(Clark's Method and Calgon's Method)

- **Heat flux**

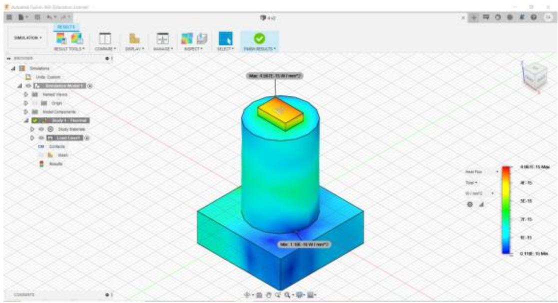

Fig-11: Heat flux of hard water removal tank

- **Temperature gradient**

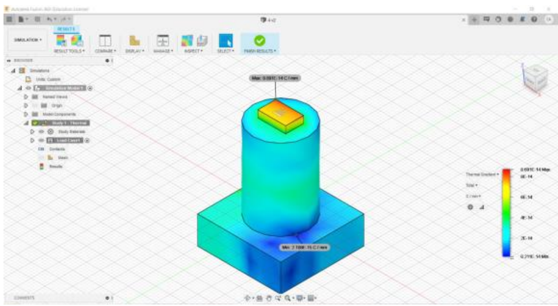

Fig-12: Temperature gradient of hard water removal tank

Thermal Analysis of storage tank

- **Heat flux**

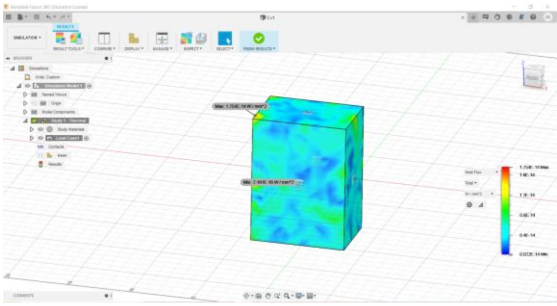

Fig-13: Heat flux of storage tank

- **Temperature gradient**

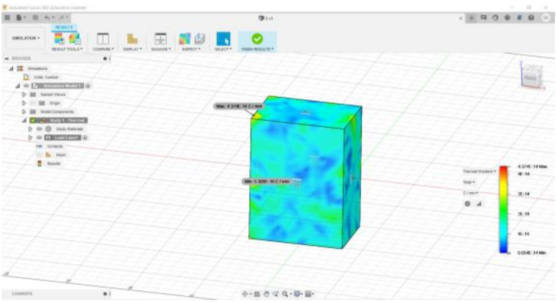

Fig-14: Temperature gradient of storage tank

Static analysis (includes safety factor, stress, strain and displacement)

For sedimentation tank

- **Safety factor analysis**

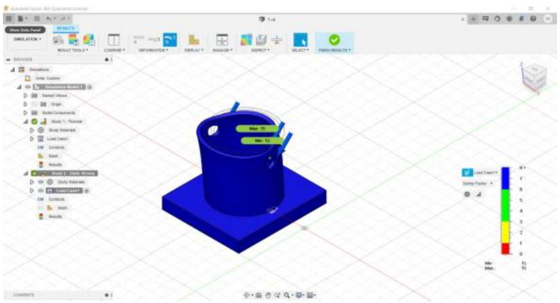

Fig-15: Safety factor analysis of sedimentation tank

- **Stress analysis**

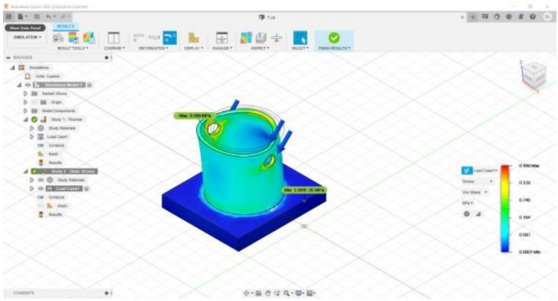

Fig-16: Stress analysis of sedimentation tank

- **Strain analysis**

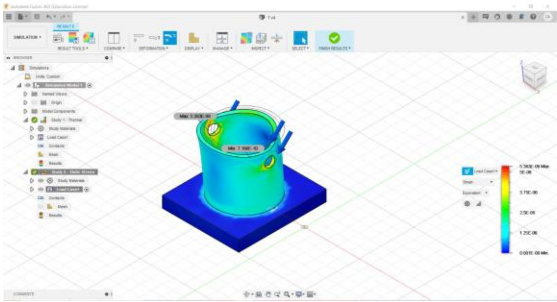

Fig-17: Strain analysis of sedimentation tank

- **Displacement analysis**

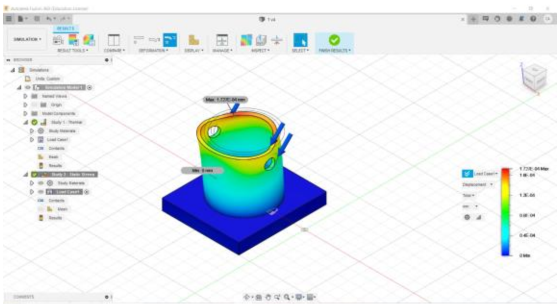

Fig-18: Displacement analysis of sedimentation tank

For adsorption tanks

- **Safety factors analysis**

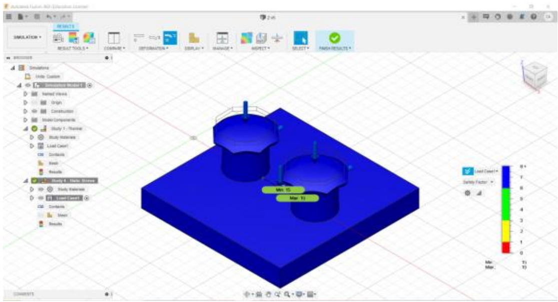

Fig-19: Safety factor analysis of adsorption tank

- **Stress analysis**

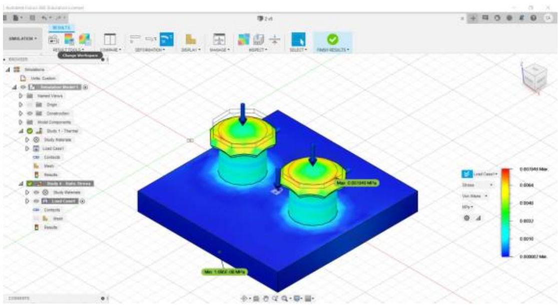

Fig-19: Stress analysis of adsorption tank

- **Strain analysis**

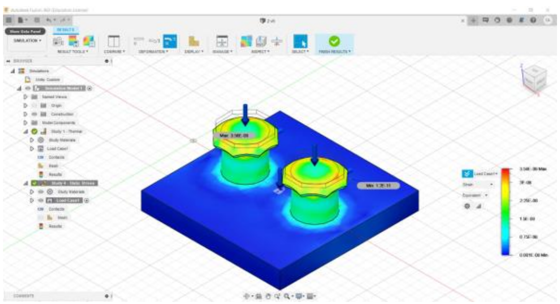

Fig-20: Strain analysis of adsorption tank

- **Displacement analysis**

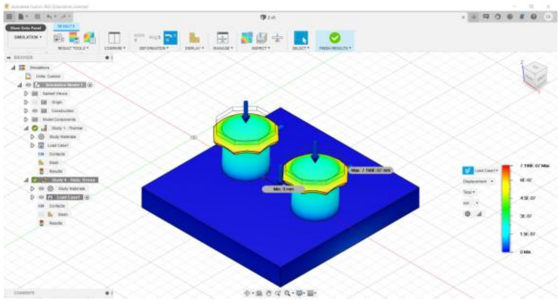

Fig-21: Displacement analysis of adsorption tank

For oil filtration tank

- **Safety factor analysis**

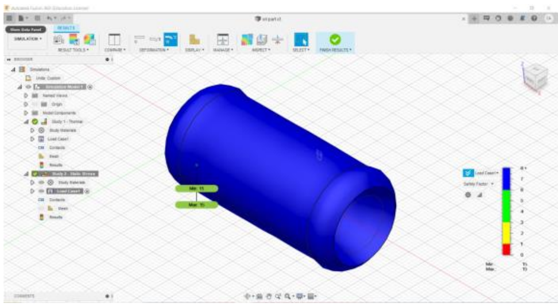

Fig-22: Safety factor analysis of oil filtration tank

- **Stress analysis**

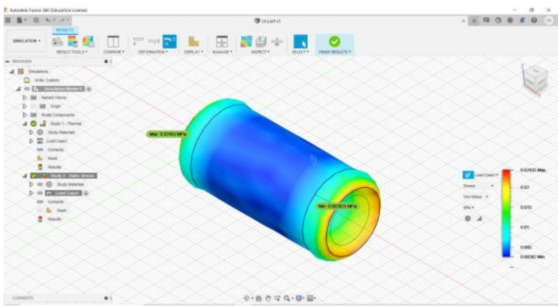

Fig-23: Stress analysis of oil filtration tank

- **Strain analysis**

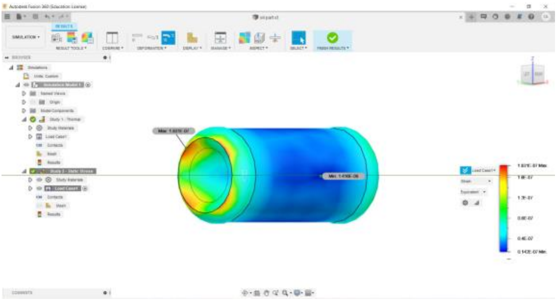

Fig-24: Strain factor analysis of oil filtration tank

- **Displacement analysis**

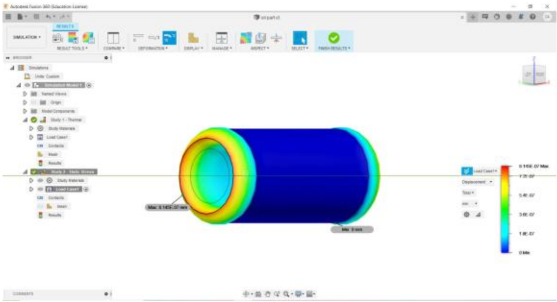

Fig-25 Displacement analysis of oil filtration tank

For hardness removal tanks (Clark's and Calgon's method)

- **Safety factor analysis**

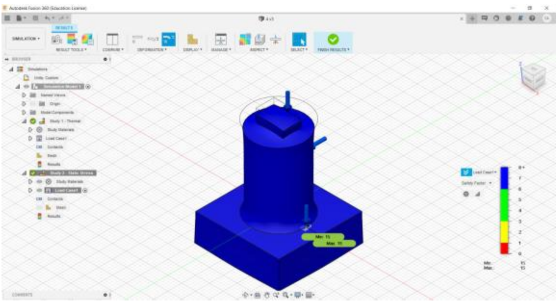

Fig-26: Safety factor analysis of hardness removal tank

- **Stress analysis**

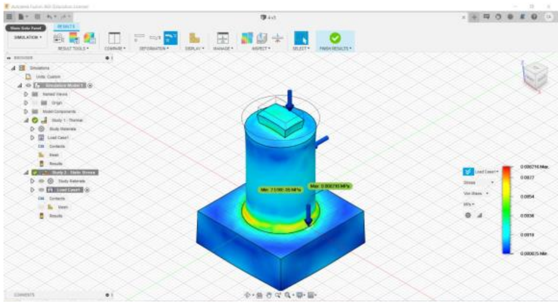

Fig-27: Stress analysis of hardness removal tank

- **Strain analysis**

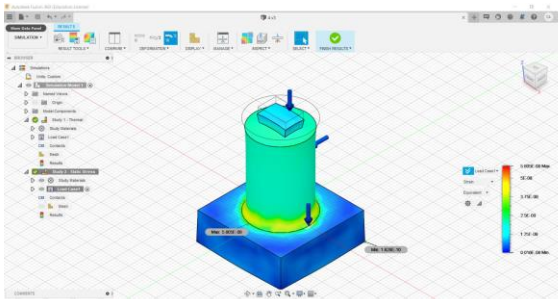

Fig-28: Strain analysis of hardness removal tank

- **Displacement analysis**

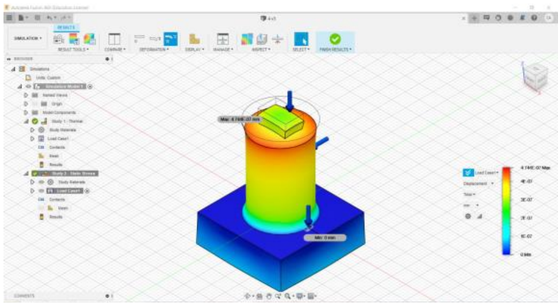

Fig-29: Displacement analysis of hardness removal tank

For storage tank

- **Safety factor analysis**

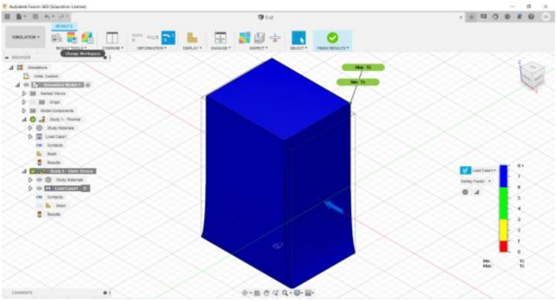

Fig-30: Safety factor analysis of storage tank

- **Stress analysis**

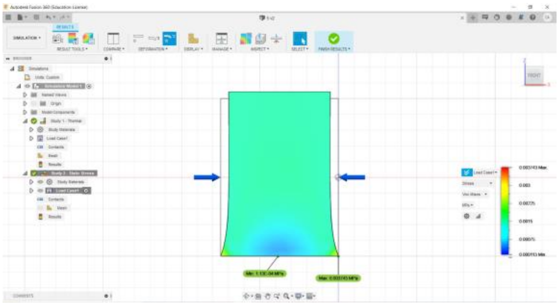

Fig-31: Stress analysis of storage tank

- **Strain analysis**

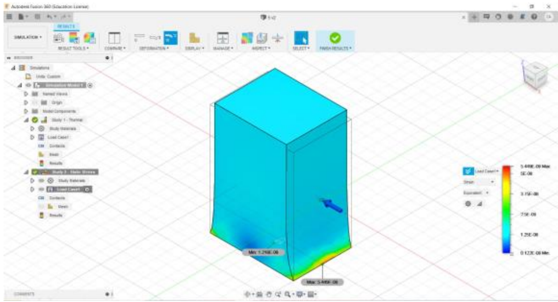

Fig-32: Strain analysis of storage tank

- **Displacement analysis**

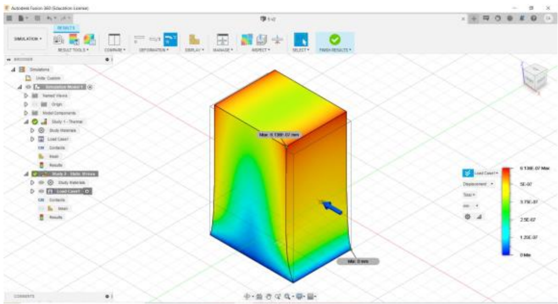

Fig-33: Displacement analysis of storage tank

15. SIMULATION RESULTS:

Thermal analysis

part	analysis	Results Maximum	Results Minimum
Sedimentation tank	Heat flux (W/mm^2)	4.58E-11	0
	Temperature gradient (c/mm)	1.142E-10	0
Adsorption tanks	Heat flux (W/mm^2)	7.112E-15	0.076E-15

	Temperature gradient (c/mm)	1.27E-13	0.014E-13
Oil filtration tank	Heat flux (W/mm^2)	2.636E-11	0.003E-11
	Temperature gradient (c/mm)	4.707E-10	0.006E-10
Hardness removal tank	Heat flux (W/mm^2)	4.867E-15	0.118E-15
	Temperature gradient (c/mm)	8.691E-14	0.211E-14

Table-2: Thermal analysis Results

Static analysis

part	analysis	Results	
		Maximum	Minimum
Sedimentation tank	Safety factor	15	0
	Stress (MPa)	0.409	0.0006
	strain	2.363E-06	0.001E-06
	displacement (mm)	1.727E-04	0
Adsorption tanks	Safety factor	15	0
	Stress (MPa)	0.00798	0
	strain	3.56E-08	0.001E-08
	Displacement	7.199E-07	0

	(mm)		
Oil filtration tank	Safety factor	15	0
	Stress (MPa)	0.0245	0.0026
	strain	1.831E-07	0.142E-07
	Displacement (mm)	8.145E-07	0
Hardness removal tank	Safety factor	15	0
	Stress (MPa)	0.0082	0.000002
	strain	5.805E-08	0.016E-08
	Displacement (mm)	4.744E-07	0

Table-3: Static analysis Results

16. DISCUSSIONS

- The simulation is carried out considering the various pressure forces acting on the setup and how the temperature of the water varies as it passes through each stage of the setup process.
- We have observed in the results that the temperature of water at the setup varies linearly as it passes through the different stages in the set up indicating us that water is getting purified because we know that pollutant water is always of more temperature than that of the pure water which we learnt from our literature review
- Apart from this we have also got the best safety factor values for each of the parts in our design set up irving us that it is a safest set up with less danger
- We also observed how the design components are affected by various strains since we need to maintain them properly
- The displacement values for all components is almost zero since we have taken stainless steel as our material that is not that easily displaced by the water forces.

17. Advantages

- It is a most affordable set up
- It has less danger encountered as the safety factor values obtained in simulation are high
- It won't occupy much storage space
- It is an eco-friendly setup
- It uses the processes which make the water reusable for the industries as observed in the thermal and heat flux results
- It is more convenient to operate

18. Disadvantages

- It requires more maintenance
- Skilled operators required

19. CONCLUSION

The water from the leather industries contains a lot of chemicals in it which causes great impact to nature if they are disposed directly to the water bodies and later if this water is used again for other purposes like drinking water for animals or watering the field causes an adverse effect to the living beings. Hence this project helps us to purify the water using several water purifying techniques along with design which can be easily established if wanted thereby helping the people in not contaminating the water in the water bodies and also helping the industries to reuse the water which in turn saves a lot of money for the industries.

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