ABSTRACT
With the growth and advancement of the world’s human population, global demand for freshwater is expected to increase by 55% between the years 2000 to 2050 (2). However, only 0.3% of the Earth’s water is usable freshwater, a fraction of which is accessible. Advancements to small and large scale water purification systems have been made, but most are still costly. The proposed technology is a novel approach to water filtration that is cost-effective and efficient. The method combines mechanical filtration and ion exchange by using a ceramic membrane filter. Important mechanical properties of membrane filters such as compression strength and permeability will be controlled through thermal treatment and use of various grain sizes of the adsorbent material. With optimized levels of strength and permeability, in addition to the low cost and accessibility of the base material, these ceramic membranes will have high potential for use in small- and large-scale water purification operations.

BACKGROUND
- Reverse osmosis systems require high energy to force water through filters, resulting in excessive waste: up to 20 gallons of wasted fluid per gallon of purified water (1).
- The inefficient use of energy by reverse osmosis systems extends the filtration time to roughly 3-4 hours per gallon of purified water produced (1).
- Reverse osmosis systems unnecessarily remove most of the minerals from the water, leaving it with an acidic pH (1).
- The proposed ceramic filter will allow for selective filtration of water by utilizing the chemical-altering properties of the subject material (3).
- The material used will reduce costs of filtration because it is naturally accessible, inexpensive, and replaces the need for additional, chemical water treatments.

OBJECTIVES
- Develop a ceramic membrane filter for water purification that:
  - Is Efficient, Accessible, and Durable
  - Utilizes Ion Exchange

APPROACH
Use a natural material with unique properties that facilitate purification by mechanical filtration and ion exchange. Fabrication will involve dry pressing material (Phase 1), heat treatment (Phase 2), and a chemical functionalization process (Phase 3). During Phase 1, properties will be optimized by controlling variables, shown in Table 1.

| Table 1: Controlled Variables and dependent properties |
|-----------------|-----------------|
| Independent Variables | Properties |
| Force             | Strength        |
| Volume            | Permeability    |
| Grain Size        | Permeability    |

METHODOLOGY
- Punch mold: Allows for uniaxial compression, which standardizes the size of the filter specimens (Figures 1, 2).

RESULTS
Table 2: Results of Fabrication attempts using varying grain size and applied force.

<table>
<thead>
<tr>
<th>Grain Size</th>
<th>Force</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2-0.7 mm</td>
<td>30 ton</td>
<td>Unsuccessful</td>
</tr>
<tr>
<td>&gt;0.7 mm</td>
<td>30 ton</td>
<td>Unsuccessful</td>
</tr>
<tr>
<td></td>
<td>60 ton</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Successful</td>
</tr>
</tbody>
</table>

CONCLUSION
The natural subject material can be formed into a cylindrical ceramic wafer at a force near 300 MPa using a grain size of 0.7 mm. If parameters are optimized for desired characteristics, the material may gain enough strength to withstand fluid flow. If further research is done beyond fabrication, this ceramic membrane has potential to replace mechanical filtration processes such as reverse osmosis.

NEXT STEPS
- Create a new mold of hardened steel, in order to withstand the high load without deformation.
- Continue fabricating filters with large, medium, and small grain size.
- Begin heat treatment process and vary temperature in order to find optimum range.
- Measure filtration effectiveness of non-fabricated filters to find optimal parameters using UV Spectroscopy.

REFERENCES

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