DEPARTMENT OF MECHANICAL ENGINEERING

# WASABE
# Low Gravity Mini Water Activity Meter

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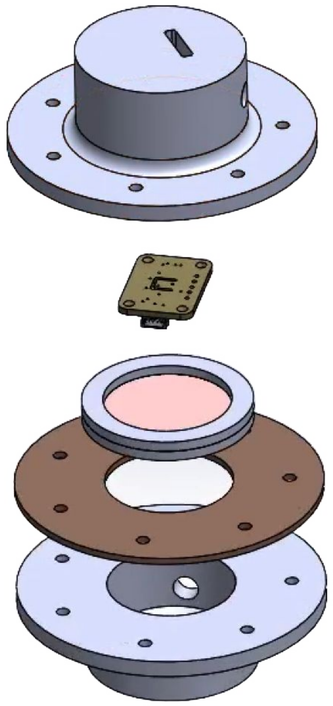
## Problem Statement

**Our team aims to create a solution which will allow for testing of water activity in low gravity environments.** Water activity is defined as the amount of water in a material that is able to react with or attach itself to another material. Generally, the existing models of water activity meters are designed with a humidity sensor at the top of the water chamber. The evaporated water vapor rises and the humidity sensor provides a measurement of the water activity from the provided sample of brine. However, in a low gravity environment the evaporated water vapor does not stay separate from the liquid water and the humidity sensor is not able to take an accurate measurement.



## Prototype Design

Our iterative prototyping focused on validating different elements of our design. Our final prototype integrated all of the necessary subsystems (sensor, membrane, heater, rinse/flush, sample i/o) which allows for the constant and accuracy measuring of the humidity level for the brine sample.

The image on the left shows the structure of the testing vessel (sample base, seal, membrane, sensor headspace top)

Detailed results in the presentation.

## Final Considerations

Going forward, the team will send our data and experimentations to our sensor APL. We recommend integrating smaller parts that were too expensive for our budget. For example, the team recommends replacing the pumps with the  LT series HF SDC disc pump that would perform the same function while further reducing the size and weight of the system.

## Customer Requirements

1. Brine must not contact humidity sensor
2. The measurement system must accurately and repeatedly measure the humidity of the headspace above the brine solution.
3. Brine separator must be securely clamped into vessel and be leakproof.
4. Brine separator must not clog before measurement can be taken
5. Designed to accommodate 1 mL brine solution sample
6. Materials must not outgas
7. System must function in low gravity environments and at different angles.
8. System must take a measurement as soon as possible within 1 hour
9. System accommodates a temperature sensor.
10. System accommodates a COTS heater.

## Product Functions

1. Separate brine sample from sensor
2. headspace and water vapor
3. Measure humidity level of the brine vapor
4. Receive brine sample from external system
5. Store brine solution below membrane
6. Store evaporated filtered brine sample
7. Record water activity level from the brine vapor
8. Attach membrane inside the container
9. Clean salt build up on membrane
10. Measure temperature of the system
11. Regulate temperature of system

## Significance

**Water activity (aw) is crucial in determining whether an environment can support microbial life.** It tells us not just how much water is present, but how available that water is for biological and chemical processes. On Earth, microorganisms can't grow below a certain water activity threshold (generally around 0.6). So, measuring aw in extraterrestrial environments directly ties into astrobiology: **the search for life beyond Earth.**

## Environmental, Social, and Economic Impact

The potential positive social impacts can be sorted into a few different categories:

- Advancing Space Exploration & Colonization
  - Helps identify planets or moons with habitable conditions
  - Aids in determining locations for future space colonies
    - Especially where water might be usable for drinking, agriculture, or fuel production
- Enhancing Scientific Knowledge
  - Contributes to planetary science by understanding how water behaves in extraterrestrial environments
  - Supports astrobiology research by finding regions where microbial life could potentially exist
- Environmental and Climate Awareness
  - Raises public interest in water conservation and planetary sustainability
  - Provides comparative data that may help understand Earth's changing climate

Low weight, reuse, modular design that mitigates economic and environmental impacts allowing for one or more pieces of the contraption to be used in more than one mission