Lab 1: Open-Base Cylinder Fog Formation and Dilution Test

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Outline

Objective

The objective of this lab was to test the first iteration of the equipment at a basic level. Investigate the concept that water vapor would build up inside a tall cylindrical open-base container when supplied with water vapor by an ultrasonic mist module, and observe the visible mist behavior under different conditions. The goal was to confirm that the experimental setup allows for mist accumulation and to inform later iterations of the overall project. For this reason, I did not collect quantitative data on the first iteration.

Theoretical Background

Weather has 6 components [1]: Temperature, Atmospheric Pressure, Cloud Formation, Wind, Humidity, Rain.

Fog and Cloud Formation

Clouds are made up of water vapour (tiny water droplets) formed by evaporated water. As they collect moisture, the droplets become heavier and heavier until they become heavy enough to drop from the cloud.

Temperature and Humidity

The temperature of the air affects density. Atmospheric pressure decreases as you move higher into the atmosphere. Humidity is the amount of water vapour in the air. Warm air molecules have more energy and move further apart. This means cold air is denser than warm air. Warmer air can carry more water vapor than cooler air. Colder air can facilitate the rapid formation of denser clouds because it has a lower capacity to hold moisture. It can even lead to larger droplets.

Ultrasonic Mist Maker

Mist makers use ultrasonic vibrations to create tiny water droplets. These tiny water droplets become visible as fog above the water reservoir.

Cloud Seeding [2]

Clouds are made up of tiny water droplets. These water droplets are formed by dust or salt particles (condensation nuclei), where water vapor condenses. We can accelerate cloud or precipitation formation by seeding the cloud with condensation nuclei.

Procedure

- I set up the experiment as shown in Fig. 1.
- The cylinder container made of plastic sheet(height: 8 ⅗”, open-base diameter: 1 ⅞”) is placed upright on a flat surface.
- The ultrasonic mist maker was placed below the cylinder container, submerged in the water of varying temperatures (cold, room temp, and boiling water).

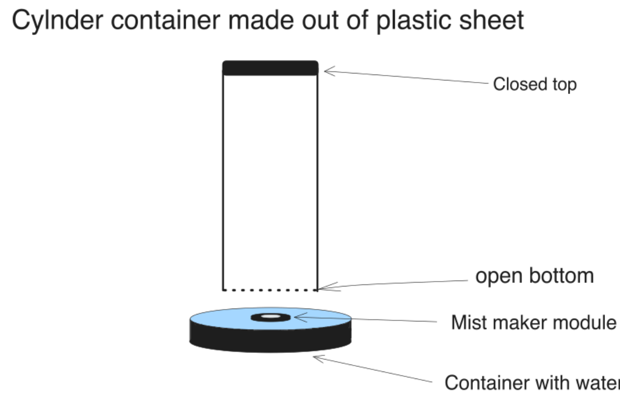

Fig. 1.

Observations

From my visual observation, I was able to determine that fog visibly accumulated inside the cylinder; however, the build-up of mist was very minimal. Most of the mist appeared to dissipate over time. I initially expected there to be a noticeable build-up in the chamber, since the container was fairly small in size. When the water was in its hottest state (boiled water), the mist did last longer, but it was not significant.

Conclusion

The mist build-up of water vapor was very minimal. I could get it to build up, but it was not getting any denser; it was more like getting filled up like a cup. The open base of the container likely allowed the water vapor to escape. However, I think the real problem is condensation buildup. There was no condensation for the water droplets to form, so I couldn’t get condensation to build up in the air.

The experiment succeeded as a proof-of-concept for system assembly. It also raised the need for an instrument to gather quantitative data for future tests.

Future Work / Reflections

Putting sensors inside the chamber might be more important than I initially speculated. For future iterations, I plan to include an RH sensor (relative humidity) and a particle sensor. With these sensors, I can collect quantitative data about the state of the environment and cloud state, which are things I can’t determine through observation alone.

1. Relative Humidity (RH Sensor)

The RH% indicates the amount of moisture in the air compared to the maximum amount of moisture the air can hold at a given temperature. We can use the RH Sensor to indicate if our environment is in the right condition, meaning indicating the humidity. This won't tell us anything about the cloud but about the environment (in this case air).

2. Particle Sensor

A Particle Sensor measures the solid/liquid particles suspended in the air (not gas) by shining a laser through the air and detecting light scattered by physical particles. **Being able to detect the particles allows us to measure the density of a cloud or mist suspended in the air. Since these particles are at a microscopic size, the sensor will be able to sense these particles even if the observer can't see them with their naked eyes.**

Out of the two sensors, the Particle sensor is the more critical one for directly measuring the clouds' properties. The RH sensor tells the humidity state of the environment; it can't actually detect clouds, and the environment can be in perfect condition without a cloud. It does provide context about the environmental conditions, which can help give a better understanding of vapor and droplet dynamics, but it won't be necessary for moving forward.

Annotated Bibliography

[1] National Centre for Atmospheric Science. (n.d.). What causes weather? NCAS. https://ncas.ac.uk/learn/what-causes-weather/

This Article from the National Centre for Atmospheric Science (NCAS) talks about what causes weather. Specifically, temperature, humidity, atmospheric pressure, wind, clouds, and precipitation. It provides a general overview of weather phenomena.

[2] Desert Research Institute. (n.d.). Cloud Seeding Program: What is Cloud Seeding?
https://www.dri.edu/cloud-seeding-program/what-is-cloud-seeding/#:~:text=How%20we%20Cloud%20Seed,for%20appropriate%20cloud%20seeding%20conditions.

This Article from the Desert Research Institute provides basic background information about Cloud Seeding techniques.