

Coalescence Unit Operation Development for Microwave Mint Extraction

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Background

- Mint industry currently relies on steam distillation to extract mint oil.
- Experimental microwave mint extraction method has potential of higher efficiency and lower cost.

Problem

Extracted oil/steam mixes with air and forms an aerosol, which is difficult to recover in typical condenser system. Industrial microwave process implementation requires coalescer development.

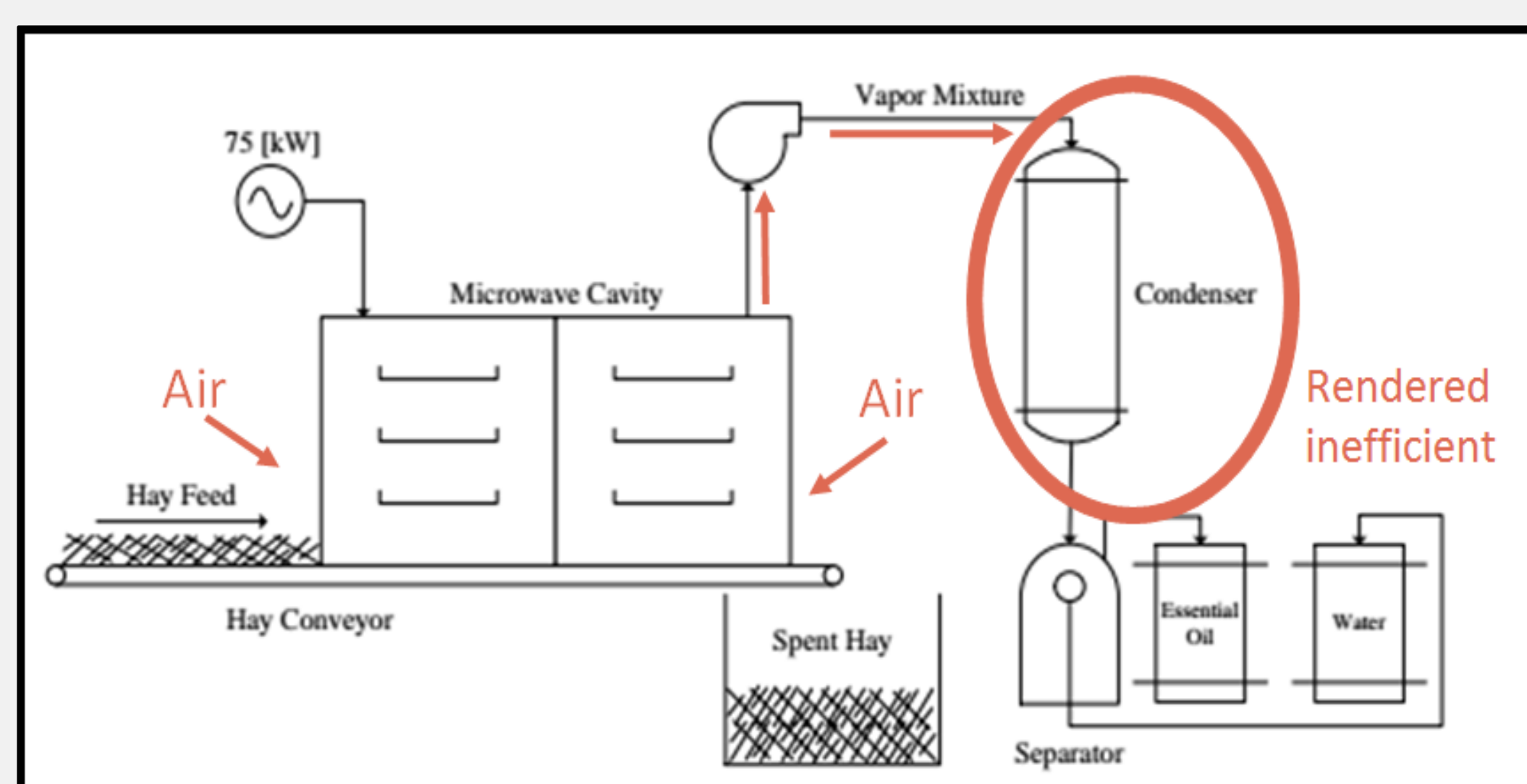


Fig. 1: Continuous Solvent-Free Microwave Extraction Process Flow Diagram (Smith, C. MS. 2013.)

Possible Solution

A coalescer: equipment to mechanically force aerosol droplets together, therefore increasing size and allowing for more efficient oil recovery.

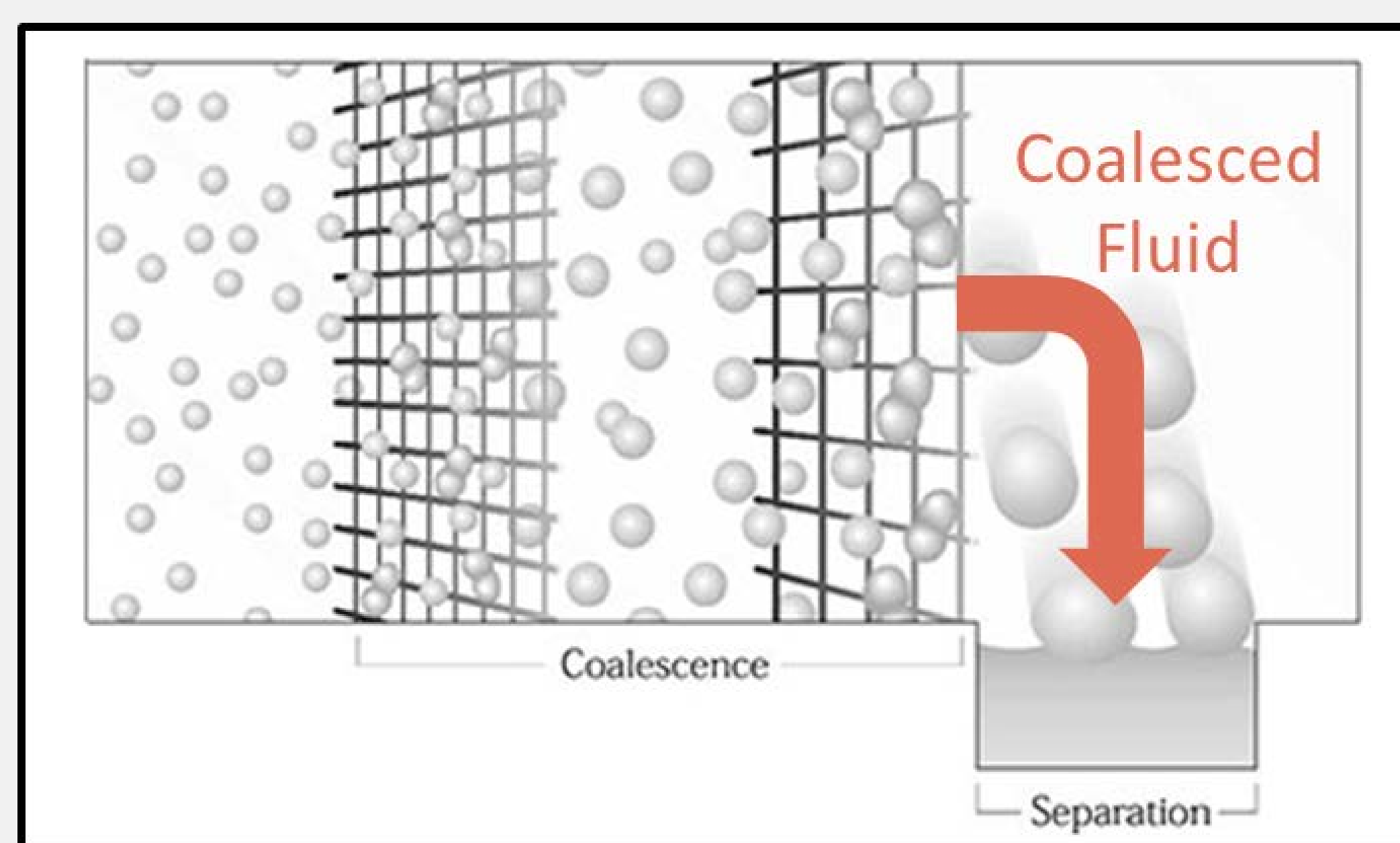


Fig. 2: Coalescence process capturing the aerosol droplets, coalescing, and releasing fluid for recovery.

Objective

To build aerosol generator capable of producing aerosol from steam and create documentation for future teams to reproduce and test with a coalescer.

Methods

A pilot plant operating at about 17% industrial capacity was constructed in order to set up for experimental coalescer operations. Steam from Oregon State University pipelines was used in place of the microwave apparatus.

Aerosol Generator System

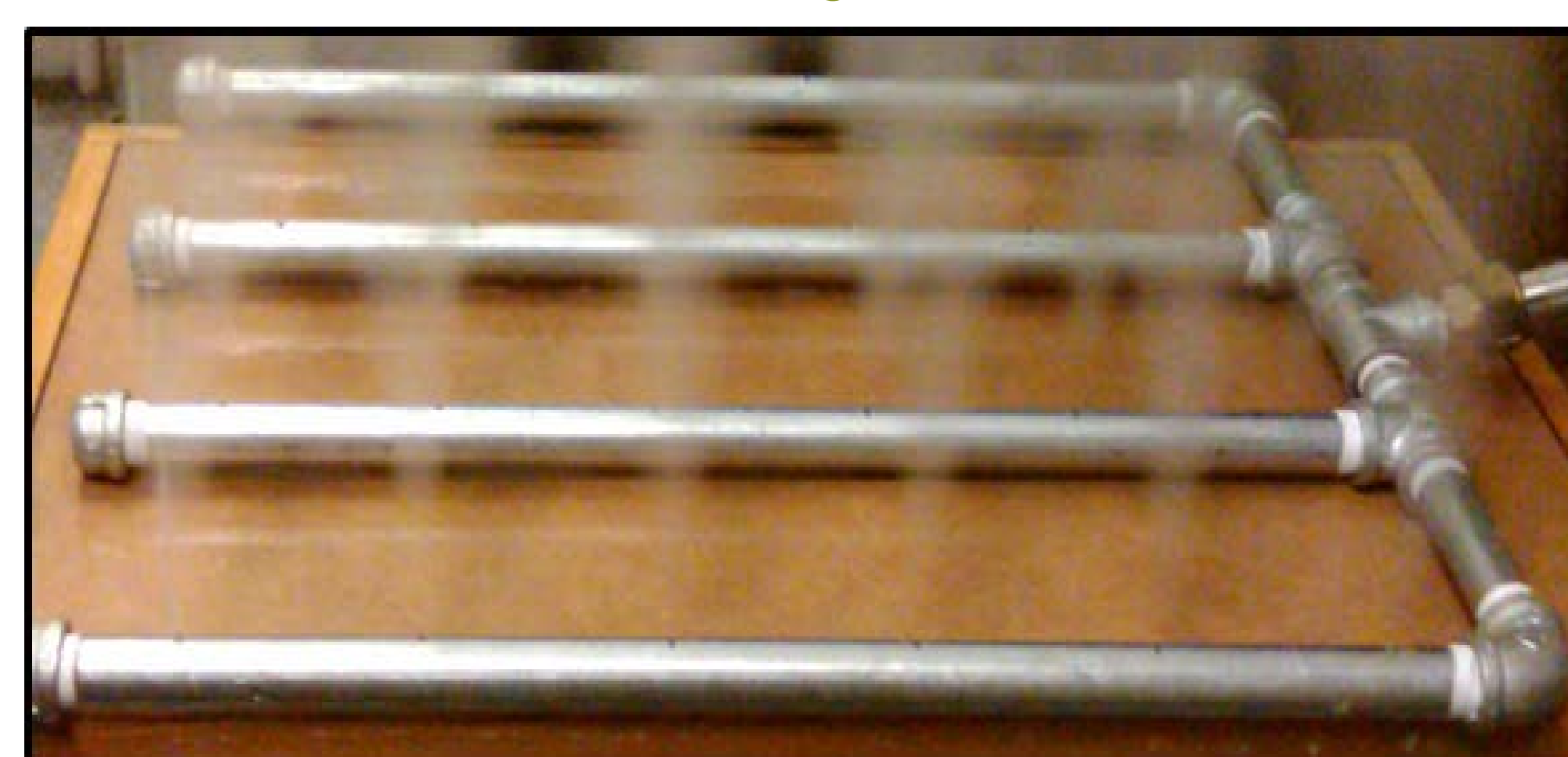


Fig. 3: 1/2" diameter piping manifold delivers steam to hood through holes of varying diameter along length of pipe.

- 30 psi steam source piped to globe valve to control steam flows.
- 1/2" galvanized steel pipe manifold delivers source steam into generator.
- Steam discharge port diameters increase along pipe length as pressure decreases.



Fig. 4: Hole diameters along each pipe.

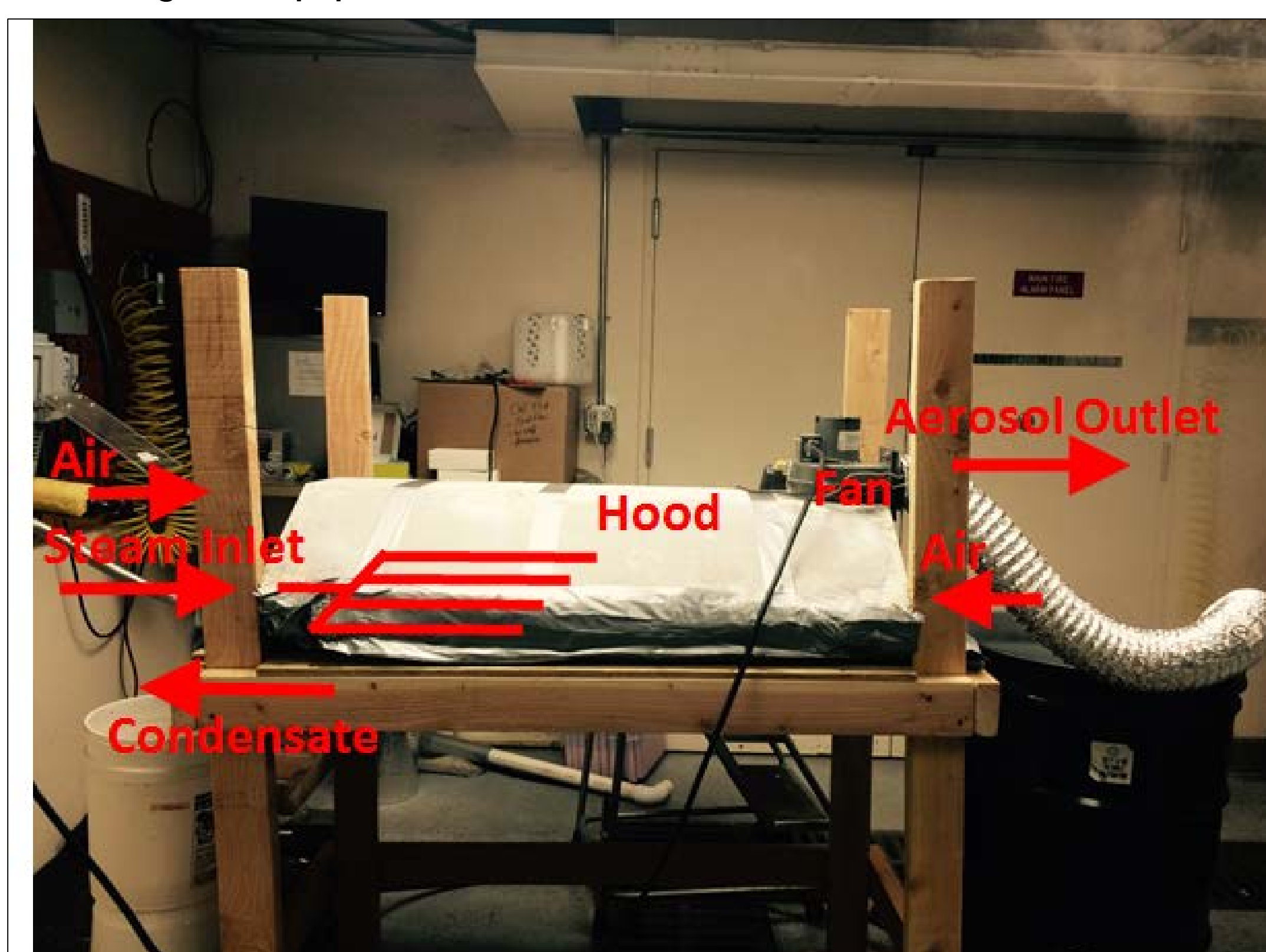


Fig. 5: Aerosol generator system side view. Steam is delivered through pipes and collected in the hood where it mixes with air to form aerosol.

Temperature Profile

Vernier temperature probes determined a 1/2 globe valve rotation to reach 70°C outlet temperature and system startup time of less than 2 minutes.

Aerosol Droplet Sizing

Aerosol droplet images were collected on glass covered in Rain-X and captured by Proscope HR2 with 50x lens. Analytical Digital Image software calibrated images to find 21 pixels:0.01 inch ratio.

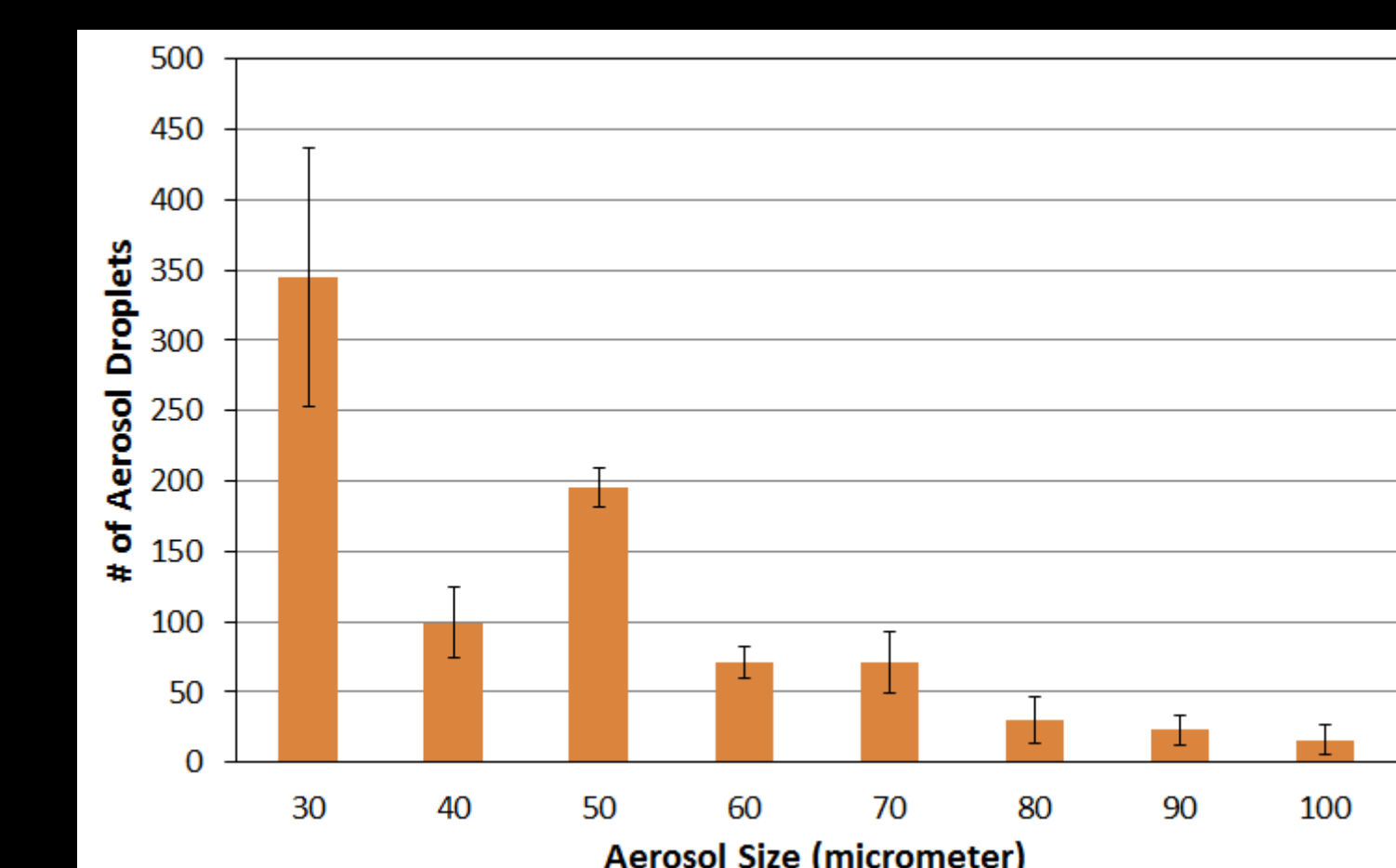


Fig 7: Aerosol droplet sizing distribution under 100 μm.

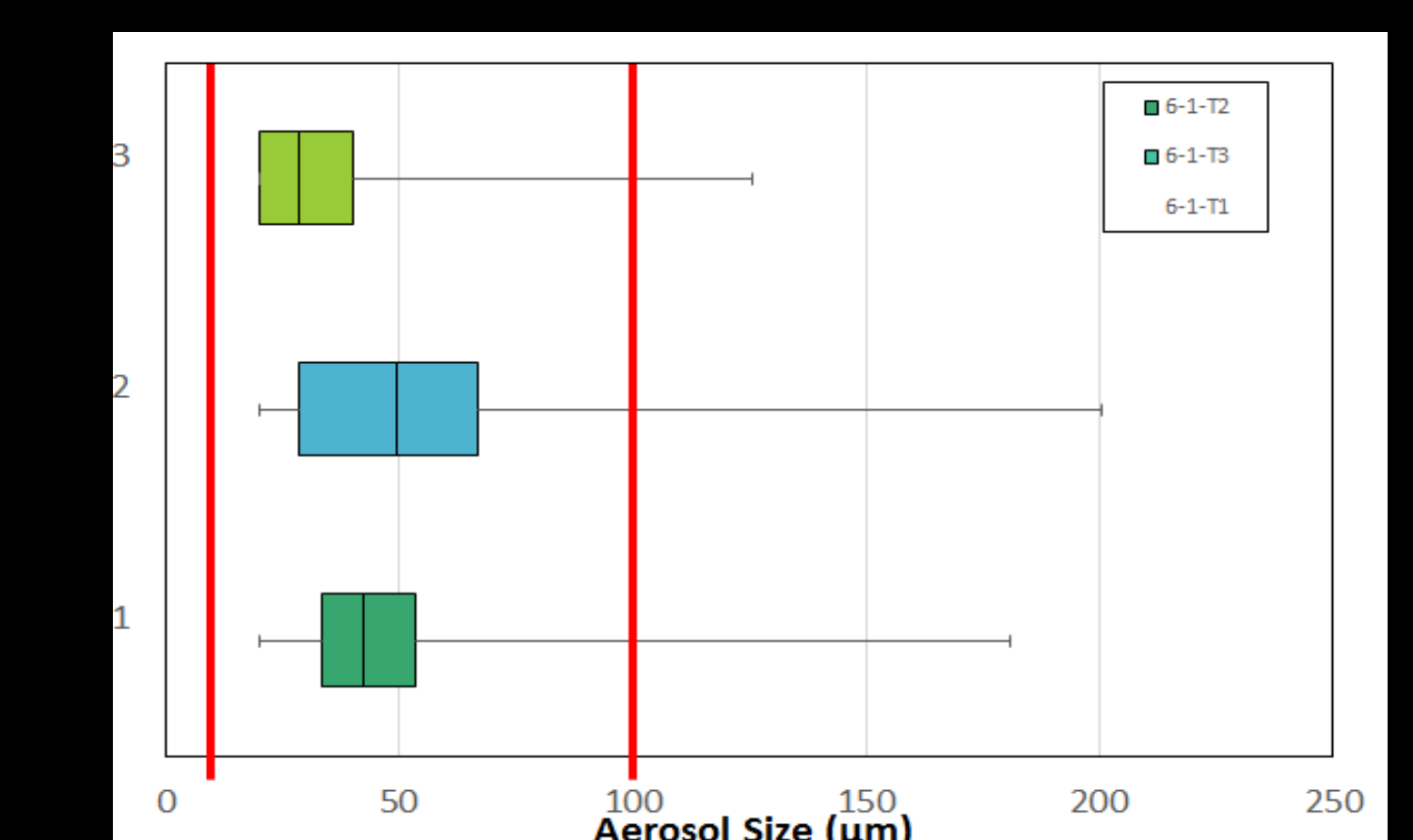


Fig 8: Overall aerosol droplet sizing distribution. Desired distribution of 10-100 μm lies between the two red lines.

The average aerosol droplet over multiple images and sessions was approximated to be 45 μm, which fits within the 10-100 μm industrial standard.

Steam Flow Determination

Steady state flow at ~ 1/4 globe valve rotation was found as 21 kg/hr. This value in combination with process conditions helps determine an experimental coalescer model.

Conclusions

- Aerosol generator operated successfully in pilot tests and could be tested with coalescer in the future.

Future Work

Aerosol generator can be rebuilt using assembly instructions and run following SOP (standard operating procedures) to be tested with a coalescer.

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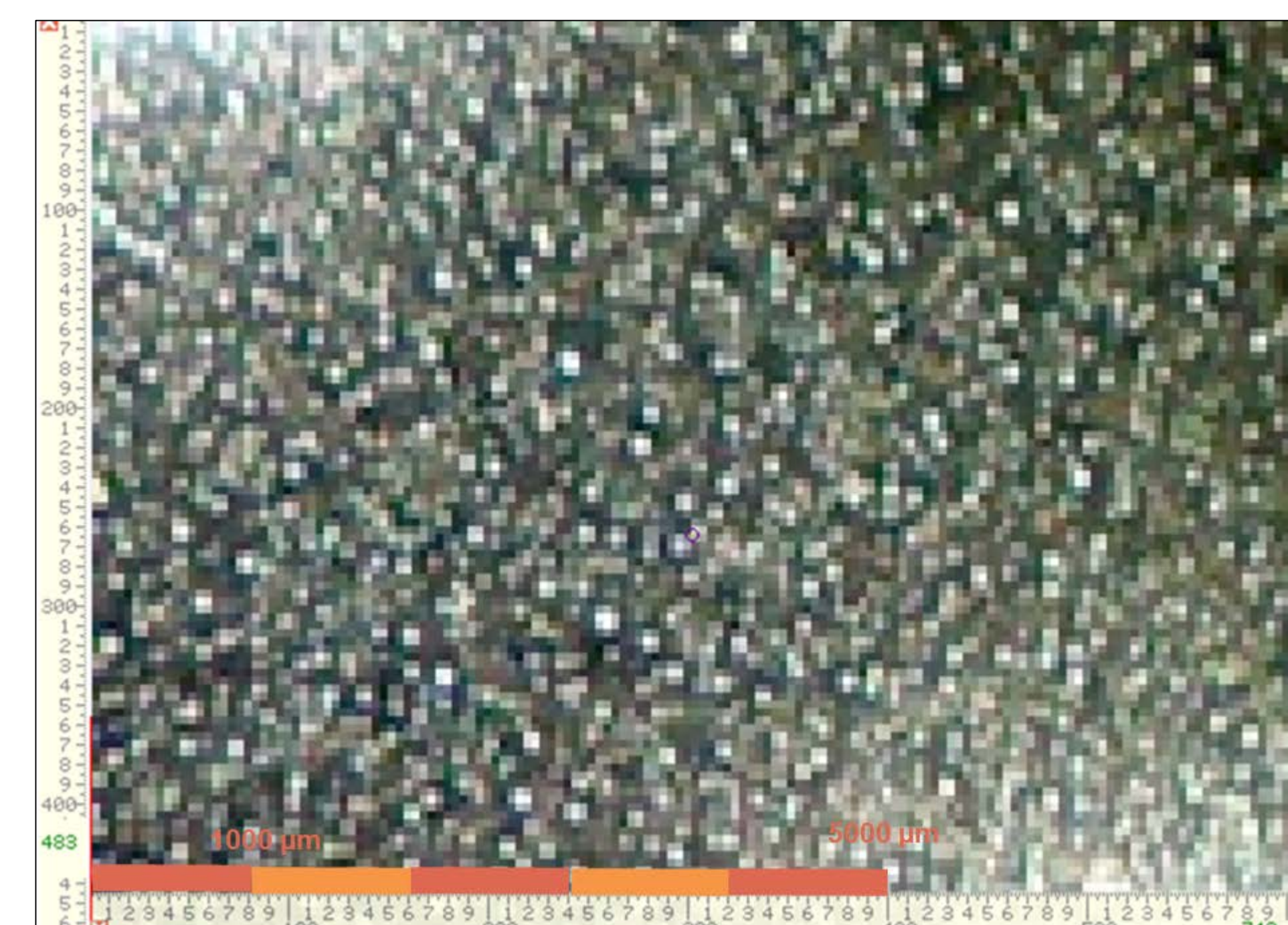


Fig 6: Aerosol droplets collected on glass surface.