24.Particles 3- fogs

Wednesday, November 11, 2020

Today:

Particles - how to get/make them
Finish air, then talk about particles in water.

Attend Monday 11/23 guest lecture:
A) Yes
B) Maybe
C) Probably not

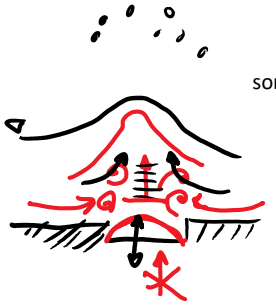
Attend Weds 11/25 lecture:
A) Yes
B) Maybe
C) Probably not

yes, Have lecture

B) Fog = aerosols of liquids

Water fog: Safe, but evaporates quickly

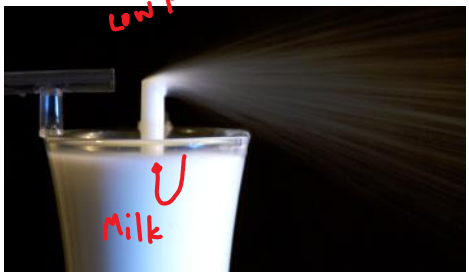
- ultrasonic humidifier http://www.youtube.com/watch?v=rN-OcMSwS2I&feature=youtube_gdata_player
- http://www.youtube.com/watch?v=rkrLl7tJOIg&feature=youtube_gdata_player with acoustic streaming
- medical nebulizer
- dry ice (solid CO2)



sonication

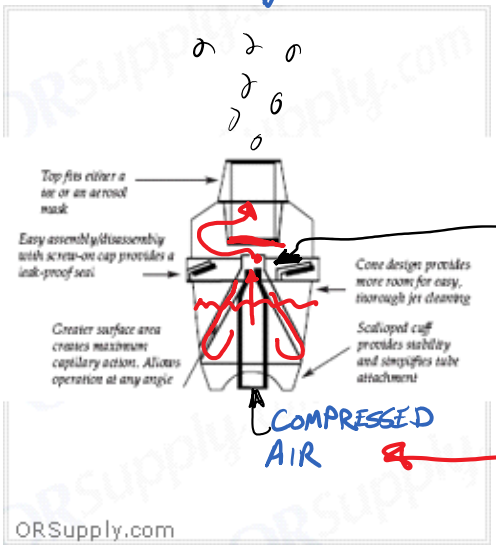
Synthetic jet

transducer = diaphragm vibrates @ n MHz



Matt Blessinger
Get Wet 2009

Bernoulli atomizer
Jet nebulizer
Small Volume Nebulizer (SMN)



Inexpensive: $3
Makes 1 µm to 100µm droplets
Larger droplets impact on surfaces, can't exit device.

Liquid is delivered to jet exit by capillary action

for checkout

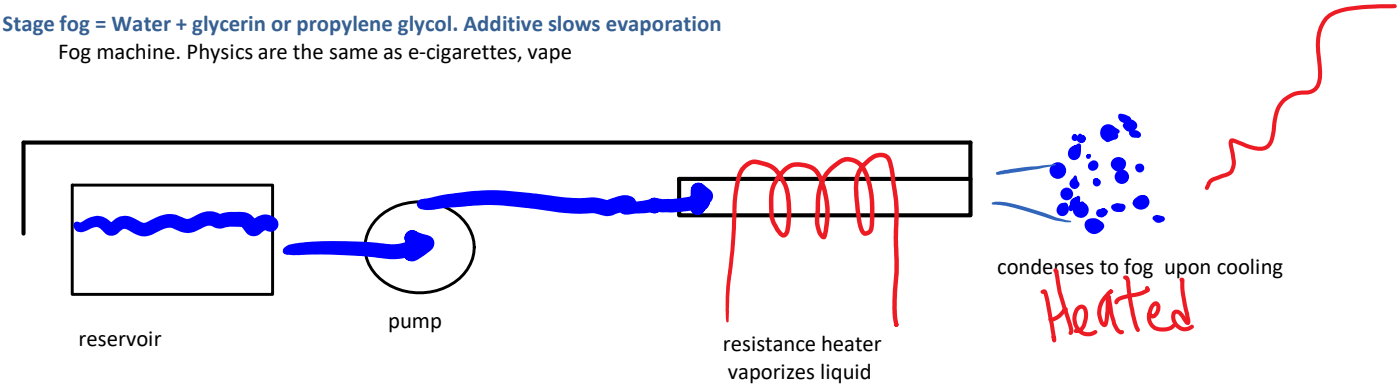
Dry Ice Vapor: Dry ice = solid CO2

Sublimates (solid to gas) at 1 atm, -78 C (-109 F)
http://www.dryiceinfo.com/fog.htm
Submerge in hot water: much water fog created.

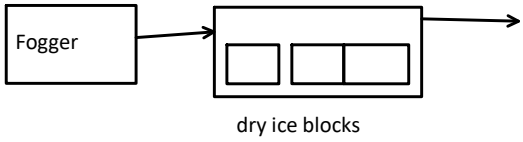
Fog production drops for water temperature < 50 F
60 Pounds of Dry Ice and a Swimming Pool, 2007. http://www.youtube.com/watch?v=uhXA9ON6igk&feature=youtube_gdata_player

Stage fog = Water + glycerin or propylene glycol. Additive slows evaporation

Fog machine. Physics are the same as e-cigarettes, vape



Small machines: heater too small to run continuously. Buy at Target, 1 month before Halloween for $35.



For fog-on-the-ground: chillers
Approximately 1 micron diameter droplets.

Yoshida, T., Y. Kousaka, and K. Okuyama. "A New Technique of Particle Size of Aerosols and Fine Powders Using an Ultramicroscope." *Industrial and Engineering Chemistry, Fundamentals*, Ind. Eng. Chem. Fundam. (USA), 14, no. 1 (February 1975): 47–51.

Large machines: can run continuously. For professional stage and theaters. $1000. Mfg: Roscoe, Le Maitre. 1 gallon lasts 4 hrs, $30.

E-cigarettes also use propylene glycol fluid. Same physics as fog machines.

$10 ?

Juul

http://science.howstuffworks.com/innovation/everyday-innovations/electronic-cigarette1.htm

Austin L is a vape artist. Builds his own custom vape device: https://www.youtube.com/watch?v=Syccl7rd3Lk

Anonymous clicker: Do you vape?

43% a) No, never
29% b) Tried a couple times
14% c) Sure, weekly
14% d) Daily
e) No, but I'll try it now after seeing that video!

Health effects of stage fog are minimal, except to asthmatics and opera singers.

Varughese, Sunil, Kay Teschke, Michael Brauer, Yat Chow, Chris van Netten, and Susan M. Kennedy. "Effects of Theatrical Smokes and Fogs on Respiratory Health in the Entertainment Industry." *American Journal of Industrial Medicine* 47, no. 5 (2005): 411–18. doi:10.1002/ajim.20151.
Wills, J. H., F. Coulston, E. S. Harris, E. W. McChesney, J. C. Russell, and D. M. Serrone. "Inhalation of Aerosolized Ethylene Glycol by Man." *Clinical Toxicology* 7, no. 5 (January 1974): 463–76. doi:10.3109/15563657408988020.
Yoshida, T., Y. Kousaka, and K. Okuyama. "A New Technique of Particle Size of Aerosols and Fine Powders Using an Ultramicroscope." *Industrial and Engineering Chemistry, Fundamentals*, Ind. Eng. Chem. Fundam. (USA), 14, no. 1 (February 1975): 47–51.

Health effects of vaping: Depends on the additives -
E-liquid concoctions usually include some mix of flavorings, aromatic additives and nicotine or THC (the chemical in marijuana that causes psychological effects), dissolved in an oily liquid base. “We think that some of the vaporized elements of the oil are getting deep down into the lungs and causing an inflammatory response,” explains Broderick.

From <https://www.hopkinsmedicine.org/health/wellness-and-prevention/what-does-vaping-do-to-your-lungs>

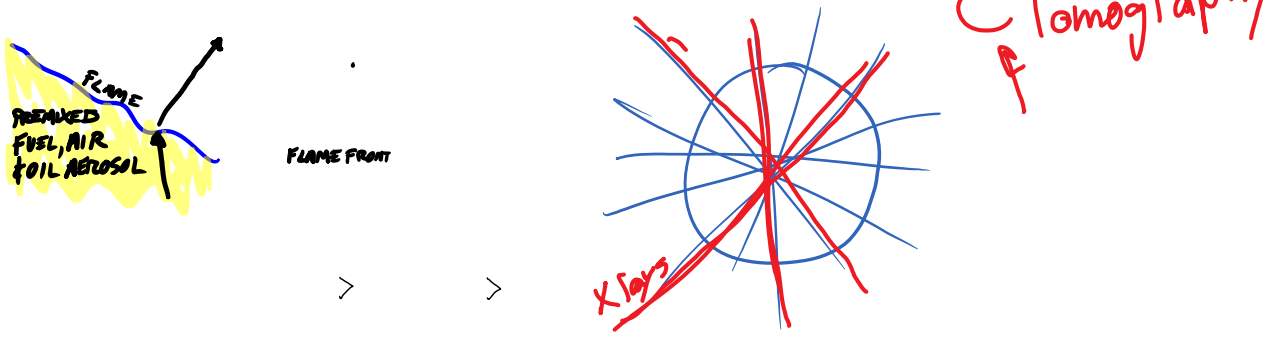
Cloud boost?

C) Oil aerosols

Nebulizer

Won't evaporate unless burned. Oil has low vapor pressure.
Use medical or Bernoulli atomizer/nebulizer

Can be used to mark flame fronts. Illuminate fog with a laser sheet = "laser tomography" in 1980s.



Danger! Oil aerosol will coat lungs = pneumonia = death
“Guidance-for-Aerosol-Applications-of-Silicone-Based-Materials.pdf.” Accessed November 11, 2015. http://sehsc.americanchemistry.com/Research-Science-Health-and-Safety/Guidance-for-Aerosol-Applications-of-Silicone-Based-Materials.pdf.
Discusses oil aerosol effects in general.

JEAN R. HERTZBERG, MEHDI NAMAZIAN, and LAWRENCE TALBOT. “A Laser Tomographic Study of a Laminar Flame In a Karman Vortex Street.” *Combustion Science and Technology* 38 (1984): 205–216.

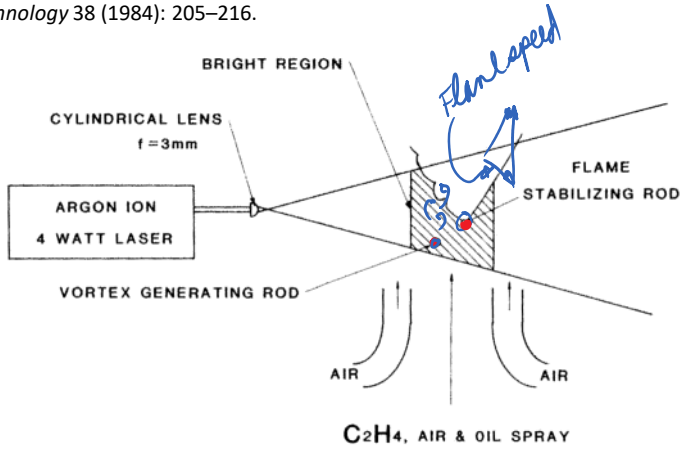


FIGURE 1 Experimental apparatus. The bright region is a cloud of oil droplets illuminated by the laser.

FIGURE 4 Example of tomography. Free jet, 1.2 m/s, issuing into stagnant room air.

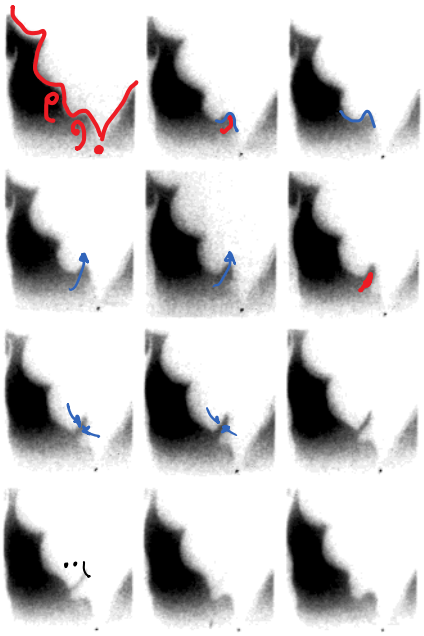


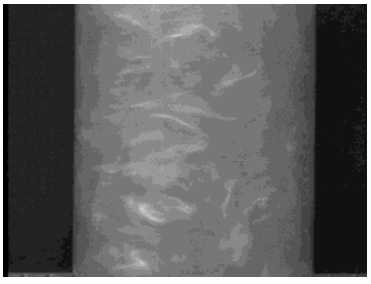
FIGURE 6 Example of tomography with combustion; from high-speed 16 mm film. The flame appears as the boundary of the dark V-shaped region. One complete cycle of interaction with vortex street is shown.

Particles for Water

Rheoscopic fluids:

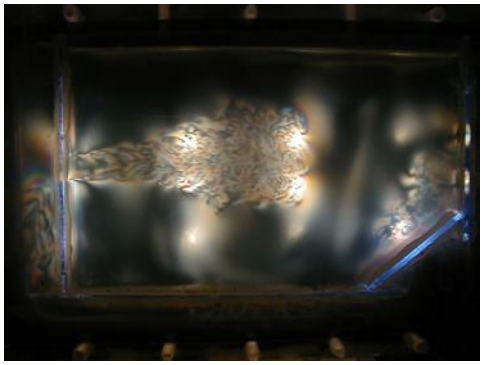
Pearl Ex (art pigment, TiO_2 coated mica).

- 'Pearl Swirl' $5/gallon from Steve Spangler Science
  Shiny opaque or translucent particles, crystal flakes, ~10 μm size, aligns with shear gradient.
  Used in soaps, shampoos
  https://www.youtube.com/watch?v=vrTM9O6owII
  Probably the same as:
  Stearic acid crystals extracted from shaving cream,
  Borrero-Echeverry, Daniel, Christopher J. Crowley, and Tyler P. Riddick. "Rheoscopic Fluids in a Post-Kalliroscope World." *Physics of Fluids* 30, no. 8 (August 1, 2018): 087103. https://doi.org/10.1063/1.5045053.



Check out the Taylor Couette Instability demo in the ITLL Lobby. Tall blue column. Nope, it's gone.

'Blackstock' fluid, now 'KaleidoFlow Rheoscopic Fluid'



andesite clay

http://buphy.bu.edu/~duffy/thermo/4B20_77.html

Streaming birefringence, seen when viewed between polarizing filters
Has 2 indices of refraction
Suspension of microscale mica flakes.

http://www.laminarsciences.com/

Bob Blackstock

Particle tracking

For individual particle images (PIV)

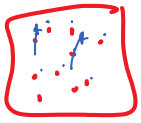
Neutral buoyancy
- Corn starch (diluted)
- Glass or polystyrene microspheres
- Latex bubbles
- Rust (filtered)
- Alumina
- Wax beads (Pine Sol)

Mica powder for makeup
polishing powder
ultrasound to break up clumps

- Pine pollen (floats on surface)
- Lycopodium powder (also used as flash powder)

http://vimeo.com/89491724 Cymatics

Susie Sie



cross correlate

Laser Doppler Velocimetry
Point meas of velocity