

18. Particles 2

Thursday, March 03, 2011

Today: Critique catch up
Particles

News: research independent study opportunities; see me

Next: How to make or get particles

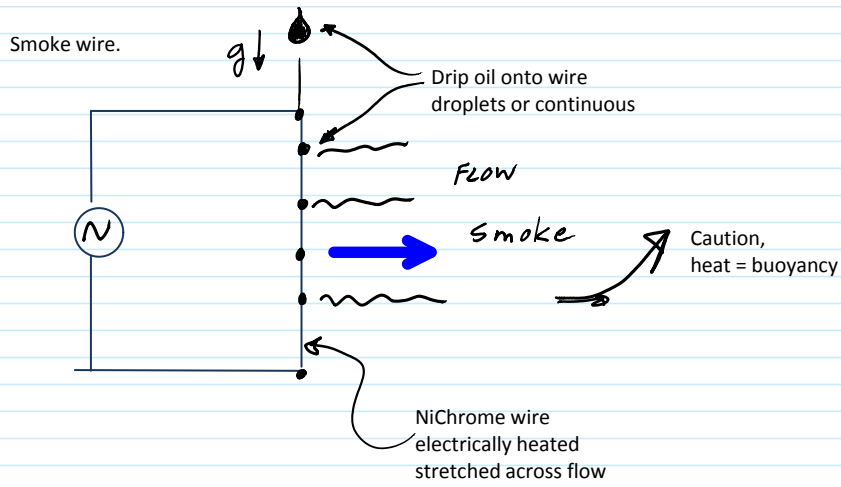
<http://www.youtube.com/watch?v=DOUfyDHxkYQ&feature=related>

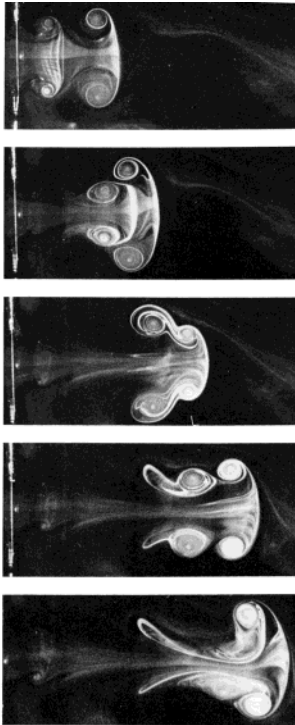
NCFMF film 'Flow Visualization'
Hydrogen bubble technique

— got to streamline defn

In air: smoke and fog
solids liquids

A) Smoke = soot usually, carbon particles

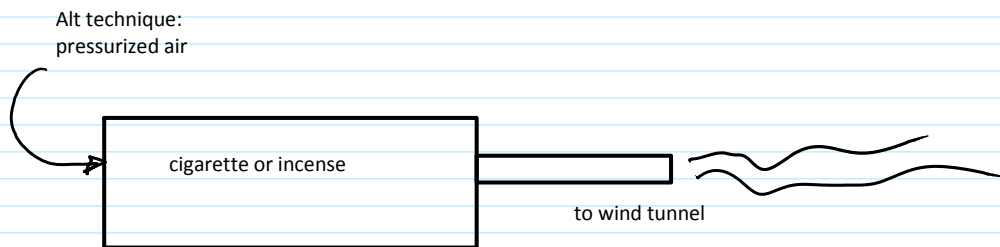




79. Leapfrogging of two vortex rings. Two successive puffs of air are ejected from an orifice of 8-cm diameter by a piston that is driven by the impacts of two pendulums. The flow is made visible by a smoke wire stretched across the orifice, at the left of the photographs. At this Reynolds number of about 1600 based on orifice diameter, the second ring travels faster in the induced field of the first, and has slipped through it in the third photograph. Then the process is repeated, the first ring slipping through the second in the last photograph. Yoneda & Matsui 1978

Van Dyke, Milton.
Album of Fluid Motion.
 10th ed. Parabolic Press,
 Inc., 1982.

Most oils work. Veg is less toxic.
 Generates $1\mu\text{m}$ particles. Penetrates into lungs, causes cancer,
 regardless of composition.



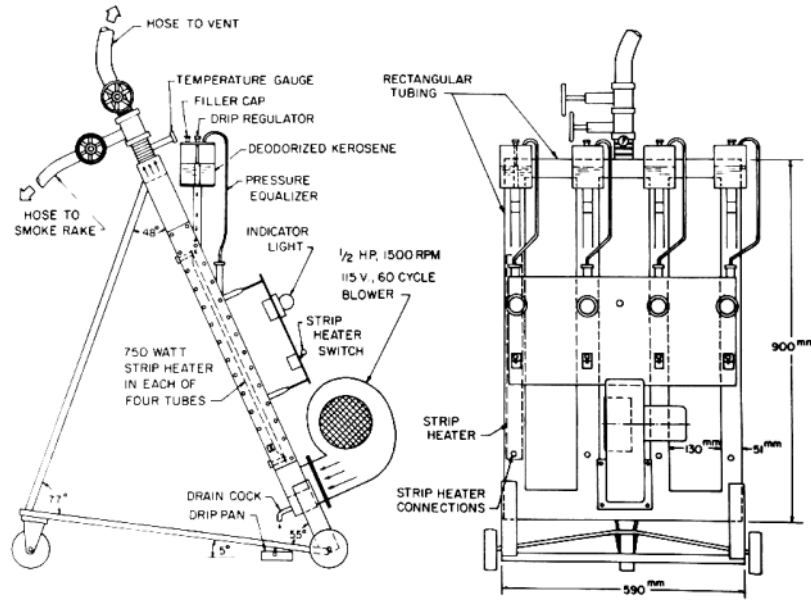
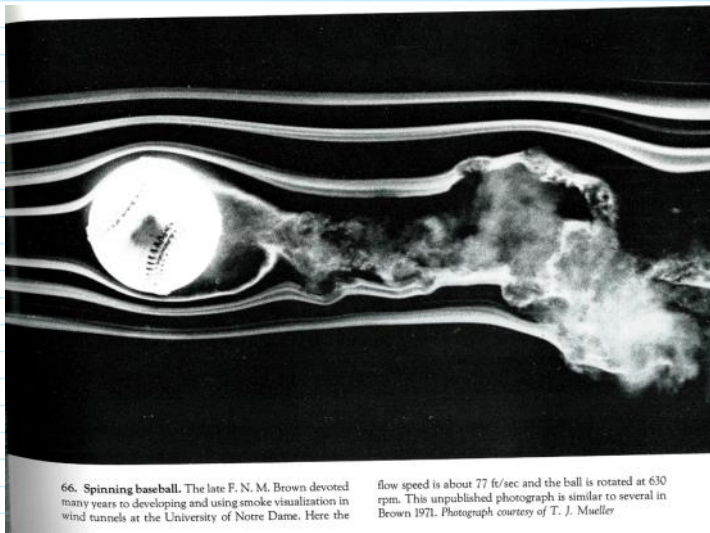


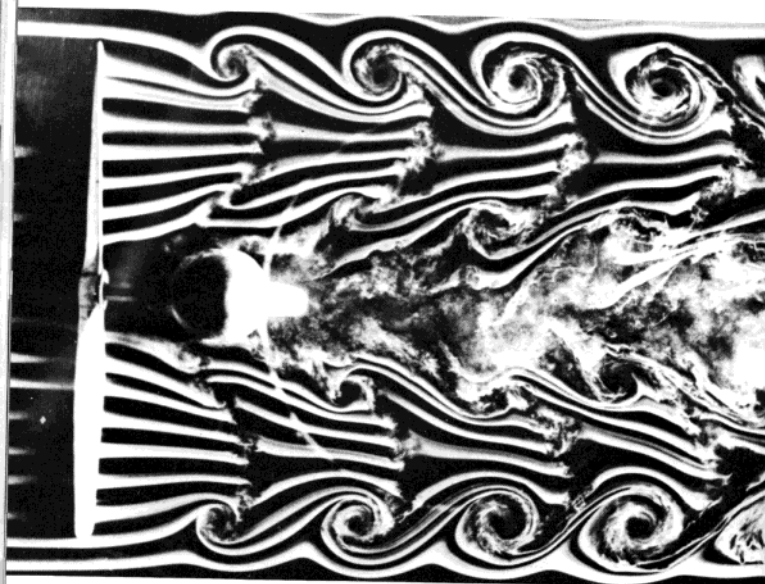
Fig. 2.6 Smoke generator designed at the University of Notre Dame. (From Mueller, 1983. Published by Hemisphere Publishing Corporation.)

Merzkirch, Wolfgang. *Flow Visualization, Second Edition*. 2nd ed. Academic Press, 1987.



66. Spinning baseball. The late F. N. M. Brown devoted many years to developing and using smoke visualization in wind tunnels at the University of Notre Dame. Here the

flow speed is about 77 ft/sec and the ball is rotated at 630 rpm. This unpublished photograph is similar to several in Brown 1971. Photograph courtesy of T. J. Mueller



75. Vortices behind a rotating propeller. A striking pattern of helical tip and root vortices is revealed by smoke in the Notre Dame wind tunnel. The stream flows at 48

ft/s while the propeller rotates at 4080 rpm. Brown 1971, courtesy of T. J. Mueller

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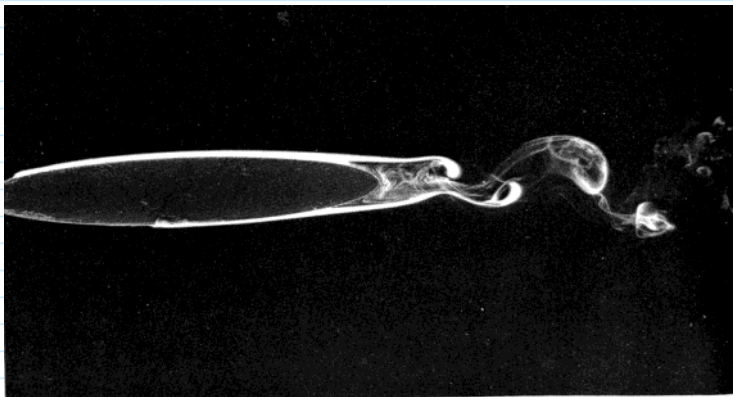
Chemically generated particles:

TiO₂ Titanium dioxide particles from

titanium tetrachloride + water vapor = dense TiO₂ smoke + HCl

HCl + water vapor = hydrochloric acid vapor

Spectacular smoke, but toxic, and hard on equipment, corrosive



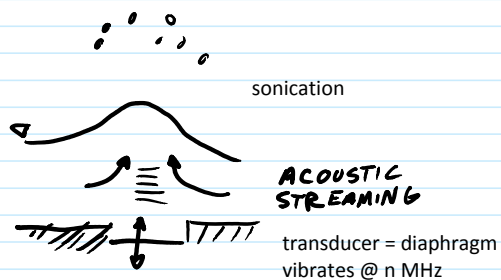
32. Laminar separation on a thin ellipse. A 6:1 elliptical cylinder is held at zero angle of attack in a wind tunnel. The Reynolds number is 4000 based on chord. Drops of ti-

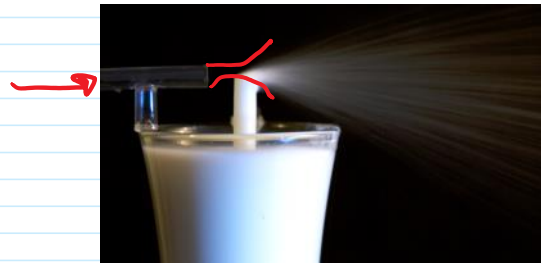
tanium tetrachloride on the surface form white smoke, which shows the laminar boundary layer separating at the rear. Bradshaw 1970

B) Fog = aerosols of liquids

Water fog: Safe, but evaporates quickly

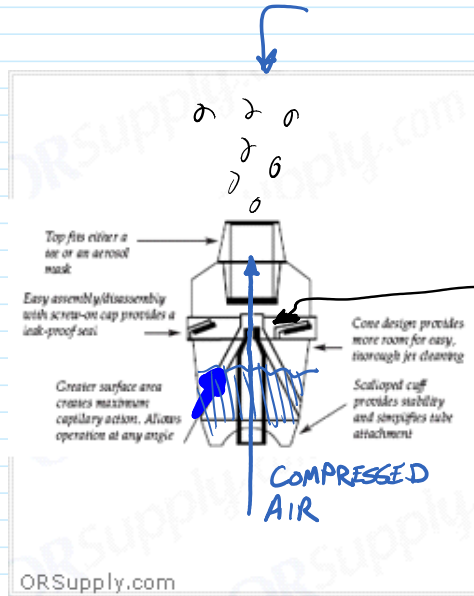
- ultrasonic humidifier http://www.youtube.com/watch?v=rN-OcMSwS2I&feature=youtu_gdata_player
- http://www.youtube.com/watch?v=rkrL17J0Ig&feature=youtu_gdata_player with acoustic streaming
- medical nebulizer
- dry ice (solid CO₂)





Matt Blessinger
Get Wet 2009

Bernoulli atomizer
Jet nebulizer
Small Volume Nebulizer (SMN)



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

Liquid is delivered to jet exit by capillary action

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=uhXA9ON6jgk&feature=youtube_gdata_player

*Yes at King Soopers
Arup, Table Mesa 2013*