21.ParticleGenH20

Monday, April 19, 2010
2:14 PM

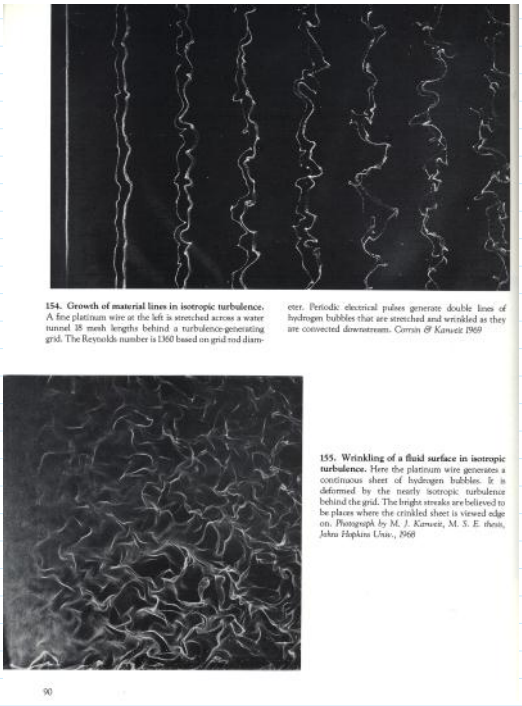
Tomorrow: Setup help 1:30 in EC Lobby

Particle Generation in Water

- Hydrogen bubbles
- Electrolytic precipitation
- Latex bubbles
- Pearl Ex
- Corn starch (diluted)
- Glass or polystyrene microspheres

Pine pollen
Rust (filtered)
Alumina

Want neutral buoyancy, but for very small particles viscous forces are high. Can use up to 100 μm particles. Good scatterers.



154. **Growth of material lines in isotropic turbulence.** A fine platinum wire at the left is stretched across a water tunnel 38 mesh lengths behind a turbulence-generating grid. The Reynolds number is 1360 based on grid rod diameter. Periodic electrical pulses generate double lines of hydrogen bubbles that are stretched and wrinkled as they are convected downstream. *Corrsin & Kistler 1969*

155. **Wrinkling of a fluid surface in isotropic turbulence.** Here the platinum wire generates a continuous sheet of hydrogen bubbles. It is deformed by the nearly isotropic turbulence behind the grid. The bright streaks are believed to be places where the crinkled sheet is viewed edge on. *Photograph by M. J. Karweit, M. S. E. thesis, Johns Hopkins Univ., 1966*

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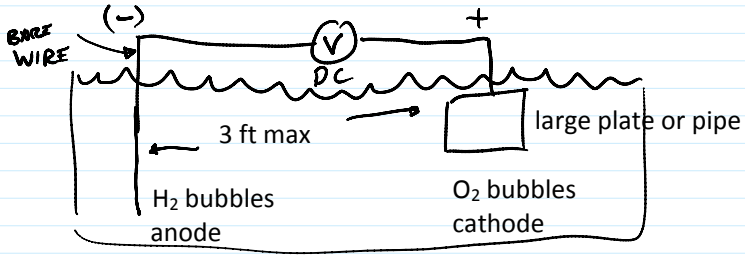
Hydrogen Bubbles



Smallest H_2 bubbles if wire is very thin. Bubbles

= 1/2 to 1 wire diameter = 25 to 50 μm
Want small enough bubbles to track flow, and have a slow rise time, so < 100 μm needed.
Best if wire is platinum. Other wires oxidize, and don't provide a clean sheet of bubbles.

Twice as much
diffusivity
relative solubility
surface tension

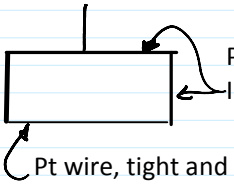
Minute paper: Why not use O_2?

Need 50 - 70 VDC, 1 amp minimum.
For long wires (200 mm) need 250 V, 2 amps
Expensive power supply.

Get ½ as much for same current

The water must conduct well.
Add salt. Some refs say sodium sulfate is better than sodium chloride, table salt.
Weak acid or base would also conduct, but may eat wire.

Too much salt ⇒ bigger bubbles



Any ions in the water are attracted to the electrodes, so material plates onto the electrodes, fouls the wire.
"Cleaning" = Reverse polarity briefly now and then for a few seconds

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Electrolytic Precipitation Technique

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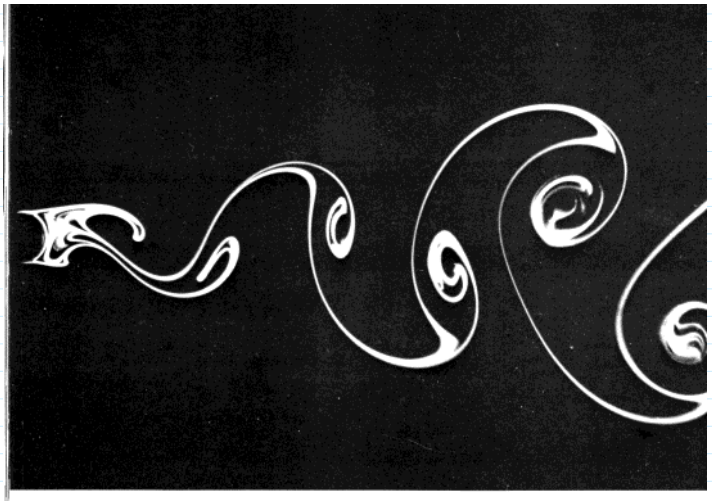
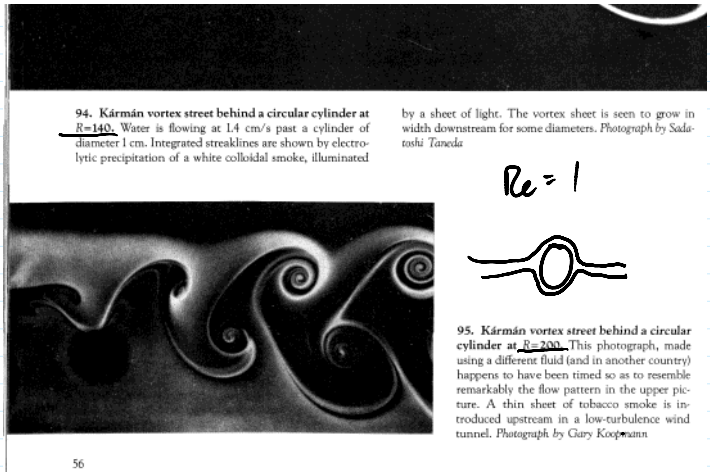
Same circuitry as H2 bubbles, but 10VDC, 10 mA. Much more reasonable requirements but….
Tracer is electrolytically precipitated oxide at anode, of anode material.
Metal often used = solder = tin+lead. Two heavy metals you don't want to put down the drain; needs 5 um filter.



MIT5.Electrolytic_Tec...

$\frac{fD}{U}$ = STROUHAL #



94. **Kármán vortex street behind a circular cylinder at** $R=140$. Water is flowing at 1.4 cm/s past a cylinder of diameter 1 cm. Integrated streaklines are shown by electrolytic precipitation of a white colloidal smoke, illuminated by a sheet of light. The vortex sheet is seen to grow in width downstream for some diameters. *Photograph by Sadatoshi Taneda*

95. **Kármán vortex street behind a circular cylinder at** $R=200$. This photograph, made using a different fluid (and in another country) happens to have been timed so as to resemble remarkably the flow pattern in the upper picture. A thin sheet of tobacco smoke is introduced upstream in a low-turbulence wind tunnel. *Photograph by Gary Koopmann*

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$\frac{fD}{U}$ = STROUHAL #

$= St$

$Re = 1$

$Re < 40$

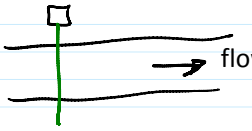
St
α_f
turb
Re

Latex Microbubbles.
If too dense, can be 'cooked' to expand to neutral buoyancy

Very expensive! $100 for a few grams worth.

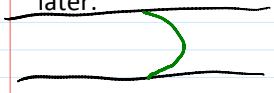
Molecular Tagging Velocimetry

Laser beam "uncages" dye along a beam line,
which then deforms with the fluid:

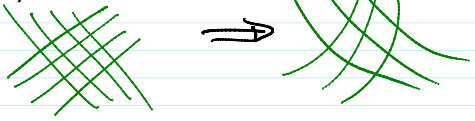


flow in a tube

later:



Many beams



Can be quantified to measure velocity field.

Dye is molecular, no seed problems.

http://www.egr.msu.edu/tmual/MTV.html