

Today: Admin

Finish particles in water

Light bending: Shadowgraphy,
schlieren

Admin: Need group time? Send plans email

Monday for Team Third. Hele Shaw cell is available.

Monday: Clouds 2 due.

Invite friends, family for class show, Engr lobby

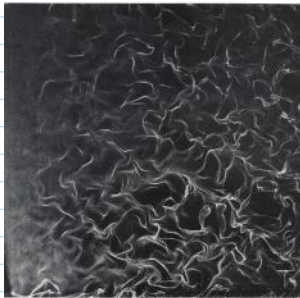
Friday April 29, 2-5 pm. Snacks, projected images. Bring demos?

Particle generation in Water



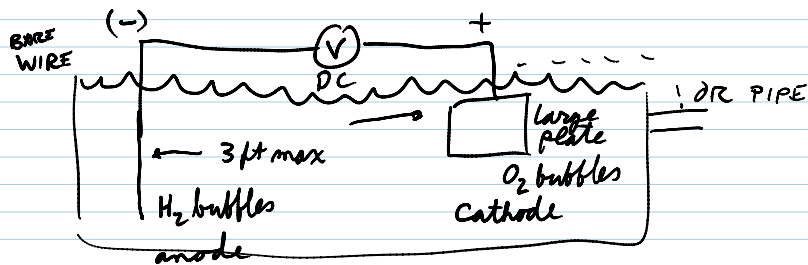
154. Growth of material lines in isotropic turbulence. A fine platinum wire at the left is stretched across a water tunnel 18 mesh lengths behind a turbulence-generating grid. The Reynolds number is 1360 based on grid diameter.

etc. Periodic electrical pulses generate double lines of hydrogen bubbles that are stretched and writhed as they are convected downstream. Corrsin & Kanetkar 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 planes where the wrinkled sheet is viewed edge on. Photograph by M. J. Kanetkar, M. S. E. thesis, Johns Hopkins Univ., 1968

HYDROGEN BUBBLES



Best if very thin. Bubble diameter $\sim \frac{1}{2}$ - 1 wire diameter

25-50 μm dia platinum. Other wires oxidize, don't provide clean sheet

Want small enough for slow rise time $< 100 \mu\text{m}$

Why not use O_2 ?

(V) || Need 50-70 VDC

Get $\frac{1}{2}$ as much for same current

Why not use O_2 ?

(V)

Need 50-70 VDC, 1 amp min

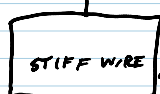
For long wires (200 mm) 250 V 2 amps
8 inches > \$500 power supply

SHOCK DANGER

Water must conduct: need salt - ~~Sodium Sulfate~~
better than NaCl

or
weak acid or base
eats wires?

Too much salt → bigger bubbles



Probe

insulate. Will disturb flow

any bubbles
form

PL & TIGHT, smooth

IONS are attracted to electrodes, stuff plates out,
fouls wire.

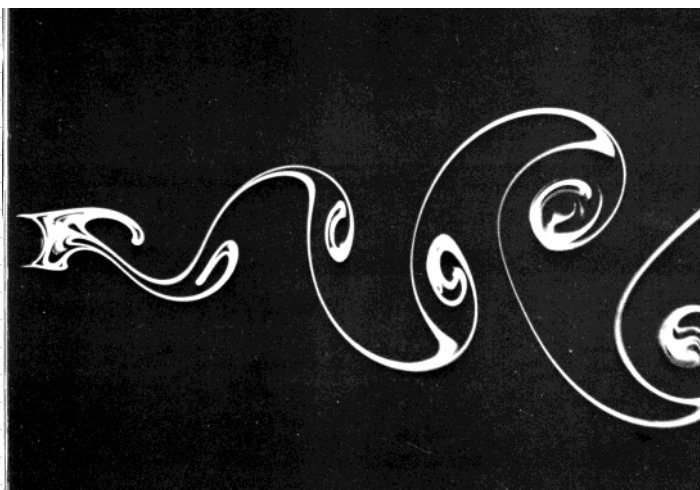
"cleaning" = Reverse polarity briefly now and then
2-3 sec

ELECTROLYTIC PRECIPITATION

Same circuitry as H₂ bubbles, but 10VDC, 10 mA much more reasonable requirements

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



94. Kármán vortex street behind a circular cylinder at $Re=140$. 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 Sada-toshi Taneda

MIT5.Electr
olytic_Tec...

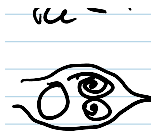
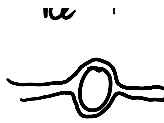
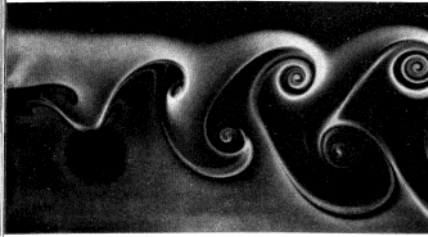
$$\frac{\phi D}{U} = \text{STROUHAL} \#$$

$$= St$$

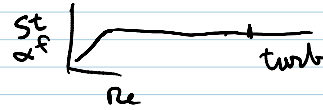
$$Re = 1$$

$$Re < 40$$





95. Kármán vortex street behind a circular cylinder at $Re \approx 200$. 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 Koopman



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Microbubbles \sim LATEX skins $100\mu m$

"Cooked" \rightarrow neutrally buoyant

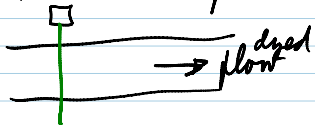
Fluorescent Polystyrene glass microspheres \leftarrow not buoyant

NON Buoyant

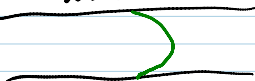
Al_2O_3
Corn starch non toxic
Pine Pollen
Rust particles - filtered

Molecular tagging velocimetry

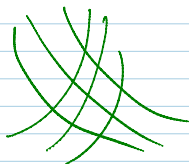
Laser beam "uncages" dye along a line which then deforms



Later



Many beams



can be
QUANTIFIED
to measure velocity
FIELD

Dye is molecular
no seed problems

<http://www.eer.msu.edu/tmual/MTV.html>