19.DyeTech

Wednesday, November 6, 2019   3:55 PM

SPECIFIC FV techniques

Boundary techniques. Boundary between 'seeded' and unseeded fluid.
Choice depends on physics desired
I DYES **Today**. Mostly in water.
                    Light/matter interactions in general
2 Index of refraction techniques
3 Light emitting fluids
4 Particles. In air (aerosols, fog, smoke)
5 Particles in water

In this class, often visualization technique determines physics examined, but usually
physics are determined by system under study, and FV technique applied should not
disturb the flow/physics

I Dye Considerations:

1)Want dye to NOT disturb flow
2)Want dye to show up - HIGH VISIBILITY
3) Special techniques

Minute paper: How to not disturb flows with dye?

Minute paper results: How to not disturb flows? Call out answers:

Match properties
Density
Viscosity
Temperature
Pressure
Velocity
Diffusion coefficient

Premix solution
Inject upstream
Maximize contrast, mimize dye volume
No chemical reaction
Use small syringe to reduce impact on flow; drag

previous answers:
- Match fluid properties, including
    - velocity(speed and direction)
    - Density
    - viscosity
    - Polarity; miscibility; (will it mix)
    - pressure
    - Temperature
    - contrast
    - Molecular weight
    - intermolecular forces (to minimize surface tension)
    - Diffusion coefficient
- No chemical reaction
- Match vorticity as well as velocity
- Inject upstream of test section
- Allow for equalization time
- Use small ports, minimize volume injected,
- Consider location of injection; reveals different physics
    - http://www.efluids.com/efluids/gallery/gallery_pages/HW004/text.jsp
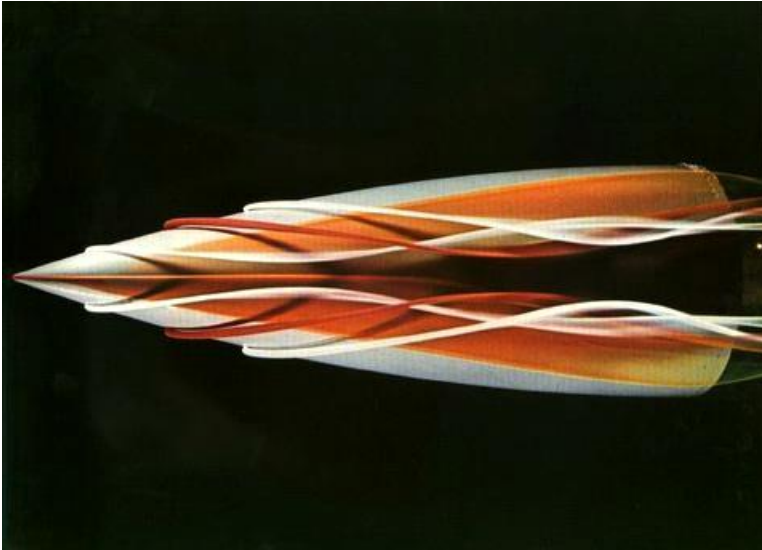
by Henri Werlé, at
ONERA = NASA of France
Master of colored dye streams

Tempera

- Avoid injection altogether: Coat object with alcohol-dye mixture or water soluble paint, let dry, then tow in tank. Shows vorticity layer, wake, boundary layer
        Or coat short strings on a rake. OK for low speed, short run times

Example of dye that visualizes physics without disturbance

N.J. Mueschke et al., "Measurements of molecular mixing in a high-Schmidt-number Rayleigh-Taylor mixing layer," *Journal of Fluid Mechanics* 632, J. Fluid Mech. (UK) (2009): 17-48.

(a)

Salt water; nigrosine dye →

Fresh water →

(b)

Salt water; $pH_1 = 11.5$ →

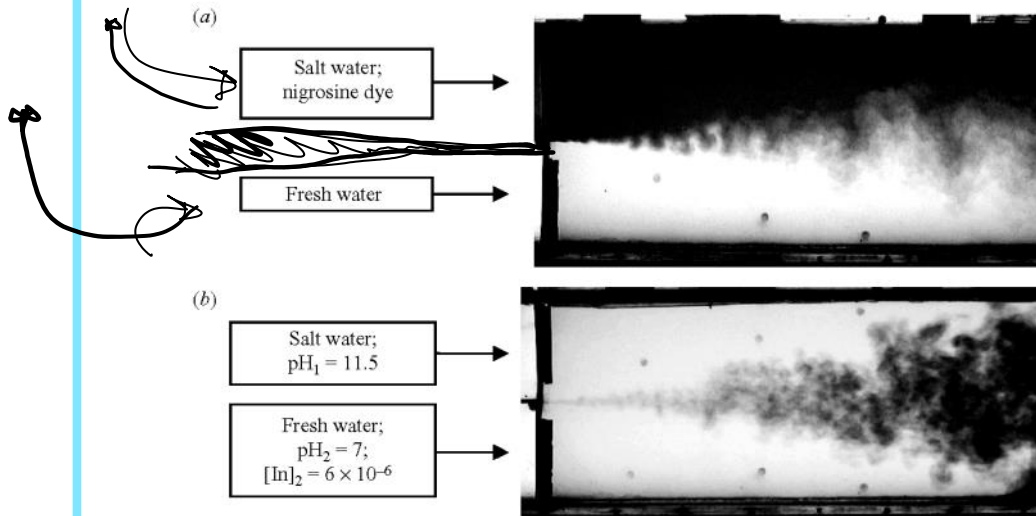Fresh water; $pH_2 = 7$; $[In]_2 = 6 \times 10^{-6}$ →

FIGURE 4. Photographs (contrast enhanced for visualization) of the buoyancy-generated mixing layer in a typical water channel experiment. (a) Nigrosine dye was added to the top stream. (b) Phenolphthalein was added to the bottom stream, which changes to its pink form as the two streams molecularly mix (here, "pink" is shown as dark regions within the mixing layer).

Indicator dye

Ph indicator, shows where mixing got to molecular level.

Tough to match all these properties! Dye properties are different from ambient fluid.
To match density, try a premix:

For food dye in water, premix dye (dense, sinks in water) and isopropyl alcohol (floats) to get neutral buoyancy in water

The concentration gradient between dyed and undyed fluid may cause dye to diffuse too rapidly, misleading when studying mixing. **Turbulence** also causes fast diffusion, making visualization of the overall flow structure difficult. **Try some milk or latex paint to slow turbulent diffusion.**

Famous example:

Cloud tank was invented by Douglas Trumbull to make realistic clouds in 'Close encounters of the third kind' (1980's sci fi). Used many times since
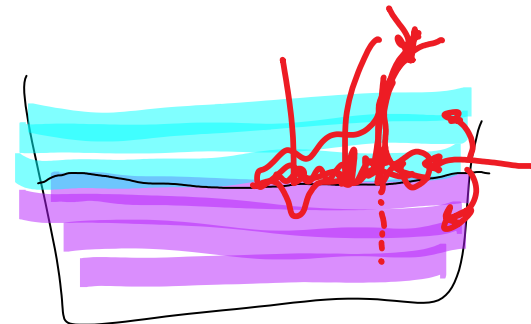https://www.youtube.com/watch?v=iX_EuN46Ad8 1:26

"The effect's process begins with filling a water tank halfway with saltwater which is then layered with a thin plastic sheet. Fresh water is poured over the thin layer of plastic to fill the rest of the tank. This leaves the visual effects artist to remove the thin layer of plastic to reveal what seems to be a single body of water, but is really two layers of different densities: salt water and fresh water. Finally, paint is injected into the tank and it flows through the water, forming an organic cloud figure…
A 2000 gallon glass tank was used that was approximately seven feet tall, seven feet wide and four feet deep which would have to be emptied and refilled after every shot."

From <https://donofriofilm.wordpress.com/2013/12/16/cloud-tank-effects/comment-page-1/> references
http://singlemindedmovieblog.blogspot.com/2010/04/old-school-effects-cloud-tank.html

DIY version: http://www.youtube.com/watch?v=hxgVKWe5Vm0

2)Want dye to show up - HIGH VISIBILITY

High Visibility: Want good contrast between dyed and ambient fluid.

Ambient fluid = transparent = NO interaction with light
Dyed fluid = want MAXIMUM interaction with light
      Example: Alberto Seveso:
http://www.burdu976.com/phs/portfolio/2-colori-disatro-medicina/

Minute paper: list the ways that dye (or any molecule) can interact with light (from external source, later will talk about emitted light)

Minute Paper:

Sketch two setups showing how light interacts with dye: One a scattering setup (the dye scatters light), and one an absorbance setup. Show a typical light path from light source to dye to camera for each