19.DyeTech

Friday, October 28, 2022 2:55 PM

Today

Admin:

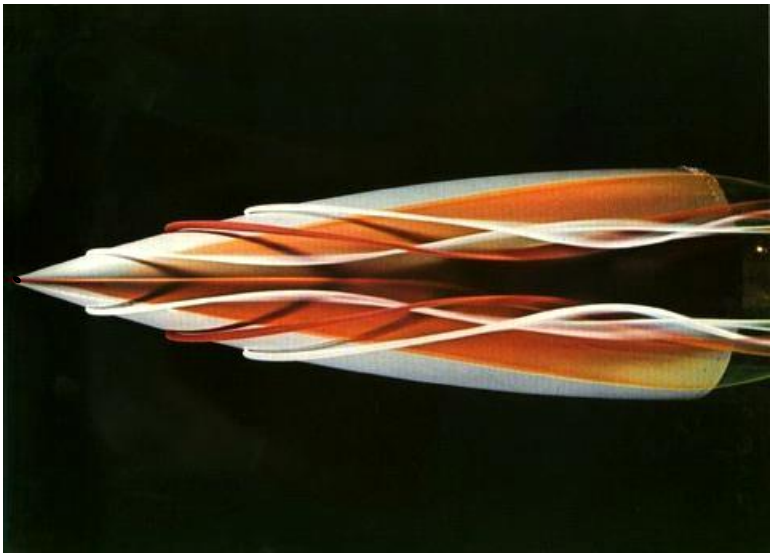
- Reading assignment: Guidebook, Dye Techniques 1 Do Not Disturb and 2 High Visibility

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 Light emitting fluids
3 Index of refraction techniques
4 Particles. In air (aerosols, fog, smoke)
5 Particles in water

Group Minute paper: How to not disturb flows with dye?

- Match fluid properties, including
  - velocity(speed and direction)
  - vorticity
  - density
  - viscosity
  - polarity; miscibility (will it mix)
  - pressure
  - temperature
  - molecular weight
  - intermolecular forces (to minimize surface tension effects)
  - diffusion coefficient
- Ensure there is no undesirable chemical reaction between the dye and ambient fluid
- Inject upstream of test section or region of interest (ROI)
- Use small ports
- Minimize volume injected
- Premix a dilute solution of dye with the ambient fluid to help match properties.



by Henri Werlé, at
ONERA = NASA of France
Master of colored dye streams

From Courants et Couleurs
https://www.dailymotion.com/video/x16dpof

This is an ogive shape =
gothic arch

Injection location has a
huge effect.

- Avoid injection altogether: Coat object with alcohol-dye mixture or water soluble paint (Tempera), 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.

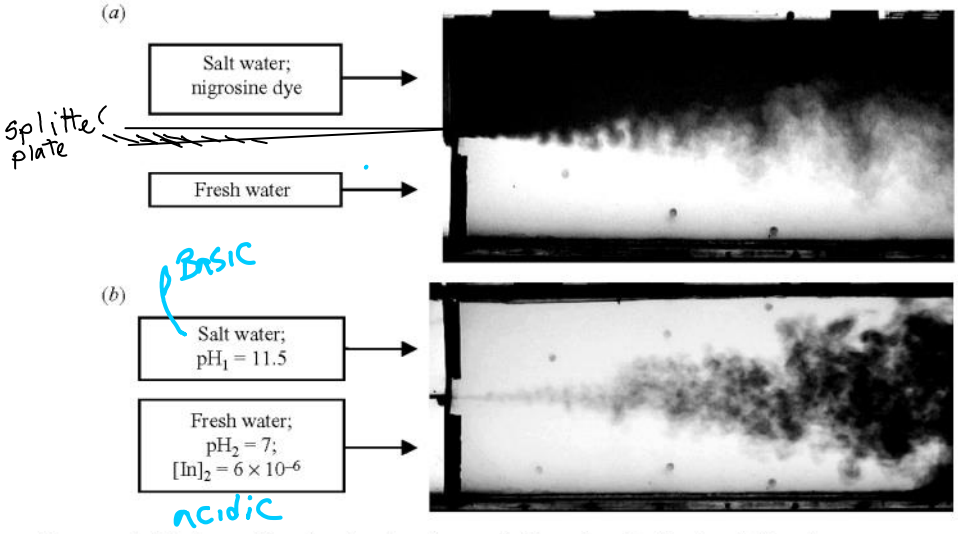


FIGURE 4. Photographs (contrast enhanced for visualization) of the buoyancy-generated mixing layer in a typical water channel experiment. (*a*) Nigrosine dye was added to the top stream. (*b*) Phenolphthalein was added to the bottom stream, which changes to its pink form as the two streams molecularly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

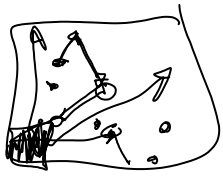
Indicator dye

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

Match diffusion coefficient?
Think Pair Share: What is diffusion? What causes it?

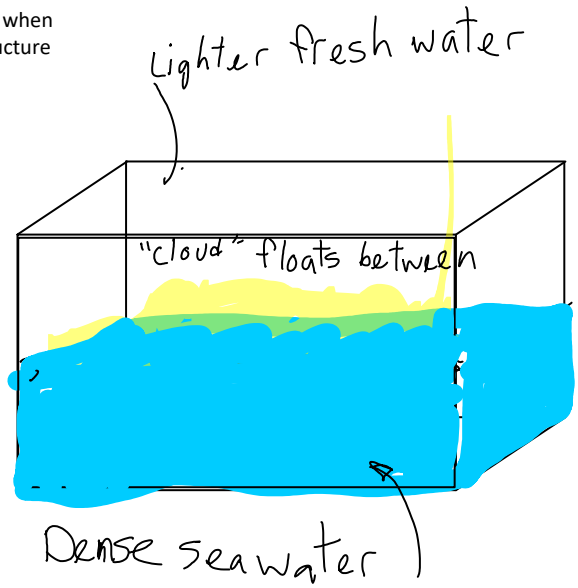


From the *atomistic point of view*, diffusion is considered as a result of the random walk of the diffusing particles. In molecular diffusion, the moving molecules are self-propelled by thermal energy. Random walk of small particles in suspension in a fluid was discovered in 1827 by Robert Brown, who found that minute particle suspended in a liquid medium and just large enough to be visible under an optical microscope exhibit a rapid and continually irregular motion of particles known as Brownian movement. The theory of the Brownian motion and the atomistic backgrounds of diffusion were developed by Albert Einstein.[5] The concept of diffusion is typically applied to any subject matter involving random walks in ensembles of individuals.

From <https://en.wikipedia.org/wiki/Diffusion>

Diffusion can be modeled and computed using concepts of concentration gradient, Gibbs free energy, Fick's Law, etc.

The diffusion coefficient of dye is higher than water, causing 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 boundary technique 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=pYVybOyMz-A

"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

Also used in
Raiders of the Lost Ark (1981), Star Trek: The Wrath of Khan (1982) and Independence Day (1996)

From <https://www.flowvis.org/Flow%20Vis%20Guide/do-not-disturb-dyes-in-liquids/>

Tree of Life (2011)
From
Cloud Tanks - Explain like I'm five, VFX edition: E01
Dimitris Katsafouros
https://www.youtube.com/watch?v=qIYAvHsojDk, a detailed vlog episode on cloud tanks

Would be great to try with our new city models from Mark Stock! See me for checkout.

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/

In groups: talk about what you are doing for the next assignment, IV3 due Weds Nov11
Then
Minute paper:

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

Refection
Diffraction
Refraction
Absorption
Florescence
Transmit
Interference (Destructive or Constructive, phases)