16.DyeTech

Monday, October 29, 2018 3:55 PM

Last Day Lobby Show Weds 12/12 11 to 1. Snacks provided, help needed

SPECIFIC FV techniques

Boundary techniques. Boundary between 'seeded' and unseeded fluid.
Choice depends on physics desired
I DYES Today. Mostly in water.
2 Aerosols Particles. Mostly in air for boundary effect.

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:

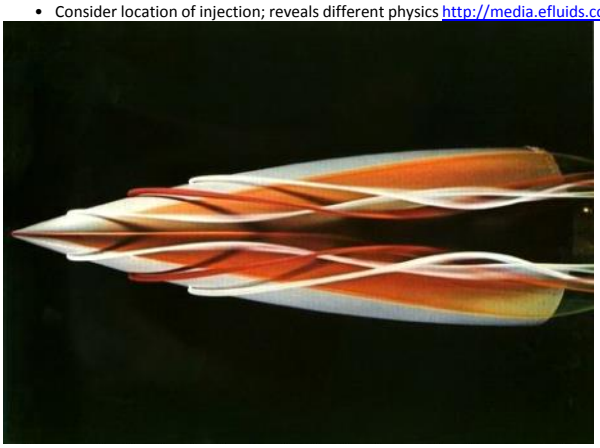
1)Want dye to NOT disturb flow
2)Want dye to show up - HIGH VISIBILITY
3) Special techniques

Minute paper results: How to not disturb flows? Call out answers:
Material properties; match density
Match velocity
Dye injection upstream of the physics
Minimize volume of dye

Match dye density to medium density
Avoid changes in momentum: inject at local velocity and direction

Answers:

- Match fluid properties, including velocity(speed and direction)
  - Density
  - viscosity
  - Polarity; miscibility; (will it mix)
  - pressure
  - Temperature
  - contrast
  - Molecular weight
- 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://media.efluids.com/galleries/laminar?medium=113



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

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

- Match fluid properties between dye and medium
  Density
  Temperature
  Viscosity
  Surface tension (match intermolecular forces)
  Minimize chemical reactions (unless needed)
  Diffusion coefficient

Tempera

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)

number Rayleigh-Taylor mixing layer," *Journal of Fluid Mechanics* 632, J. Fluid Mech. (UK) (2009): 17-48.

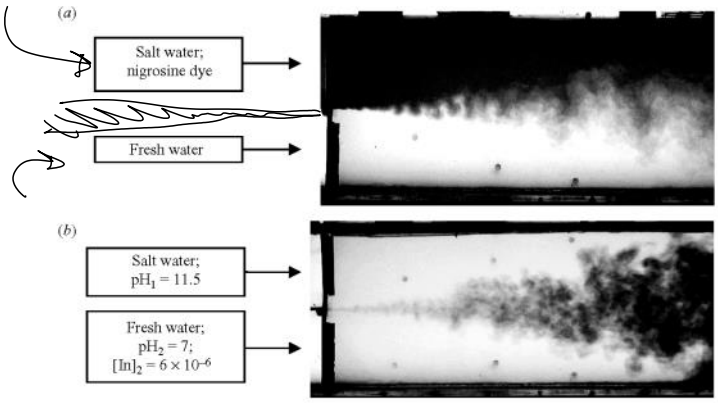


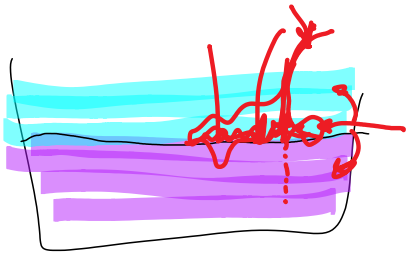
FIGURE 4. Photographs (contrast enhanced for visualization) of the buoyancy-generated mixing layer in a typical water channel experiment. (*a*) Nigrosine dye was added to the top stream. (*b*) Phenolphthalein was added to the bottom stream, which changes to its pink form as the two streams molecularly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

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 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

Alberto Seveso:
http://www.burdu976.com/phs/portfolio/2-colori-disatro-medicina/

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

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

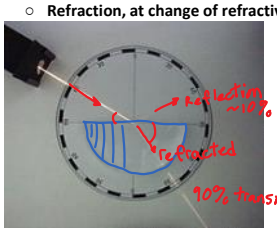
Reflection
Absorption
To higher energy levels; excitation
Diffraction
Refraction
Diffusion
Transmit
Radiate it
Scatter
photoelectric

Absorption
Reflection
Diffusion
Refraction
Scattering
Rayleigh and Mie scattering
Photoelectric effect

Refraction
Absorption
Diffraction
Reflection
Scattering/diffusion
Transmission

Emission
Fluorescence
Excitation

1) **Transmission**
   - **Refraction, at change of refractive index**

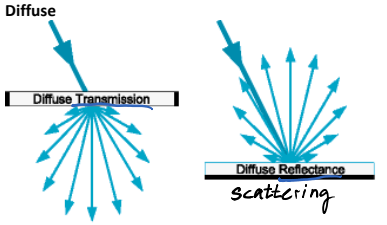


Lecture 02 Overview2
Snell's law

http://upload.wikimedia.org/wikipedia/commons/thumb/1/13/F%C3%A9nyt%C3%B6r%C3%A9s.jpg/220px-F%C3%A9nyt%C3%B6r%C3%A9s.jpg

There are many flow vis techniques based on refraction; will cover later.

   - **Diffuse**

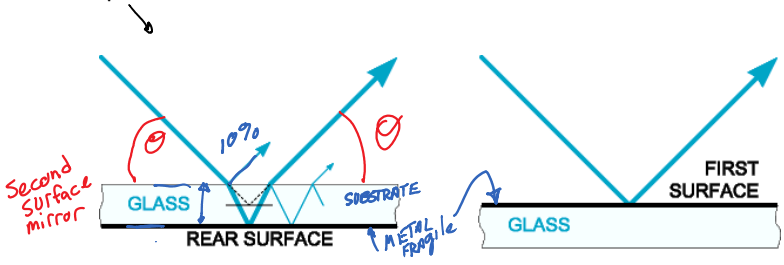


Diffuse transmission and reflectance.

http://library.thinkquest.org/26162/manili.htm

2) **Reflectance**
   - **Diffuse, scatter**
   - **Specular**

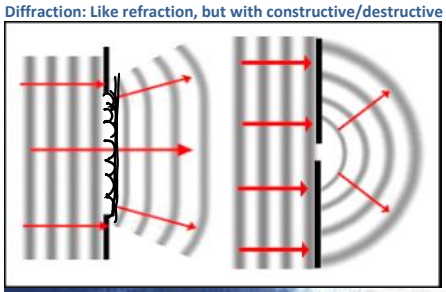
Edmund Scientific



Reflection from a second surface and first surface mirror.

http://library.thinkquest.org/26162/manili.htm

3) **Diffraction: Like refraction, but with constructive/destructive interference**



HUYGEN

http://www.tufts.edu/as/tampl/projects/micro_rs/theory.html

http://www.meted.ucar.edu/marine/ripcurrents/NSF/media_gallery.php

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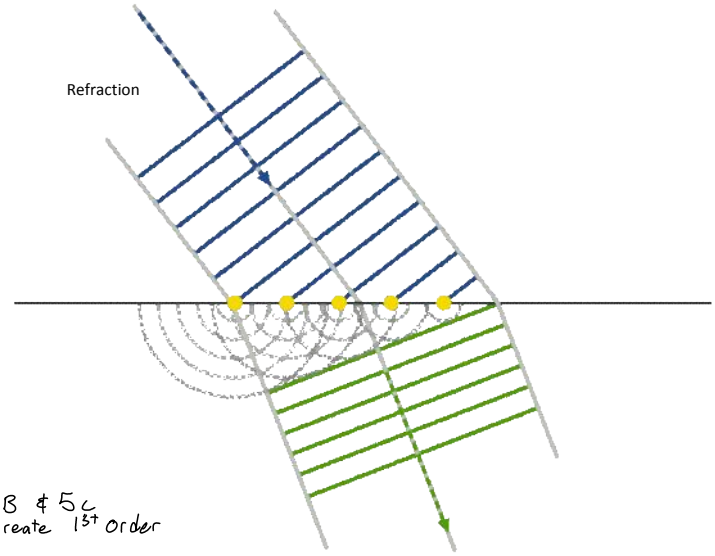
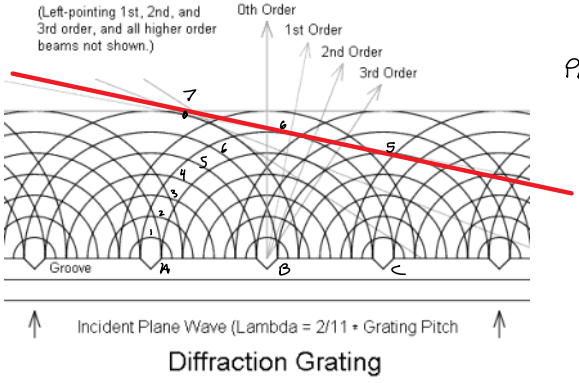
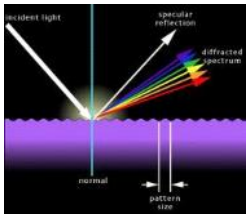




http://exoplanet.as.arizona.edu/~lclose/a302/lecture14/lecture_14.html

Peaks 7A, 6B & 5C line up to create 1st order



1ST orders