

17.DyeTech

Thursday, April 11, 2013 3:55 PM

Last Day Lobby Show Weds 5/2 11 to 1. Snacks provided, help needed
ITLL Design Expo? Sat April 28
Turnitin activated- rubric on the way

SPECIFIC FV techniques

Boundary techniques. Boundary between 'seeded' and unseeded fluid.

Choice depends on physics desired

1 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:

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

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.

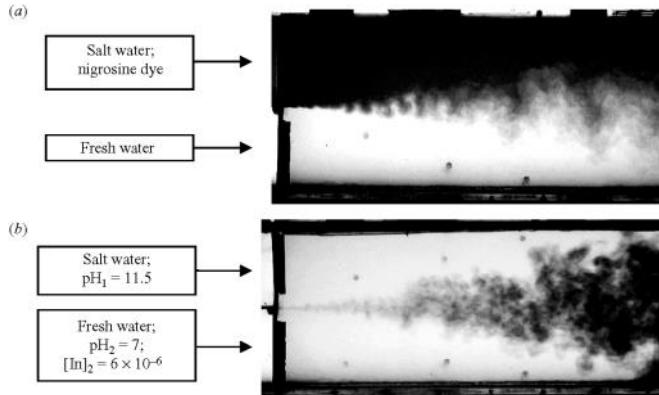


FIGURE 4. Photographs (contrast enhanced for visualization) of the buoyancy-generated mixing layer in a typical water channel experiment. (a) Nigrosine dye was added to the top stream. (b) Phenolphthalein was added to the bottom stream, which changes to its pink form as the two streams molecularly mix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

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-3/>

2) Want dye to show up - HIGH VISIBILITY

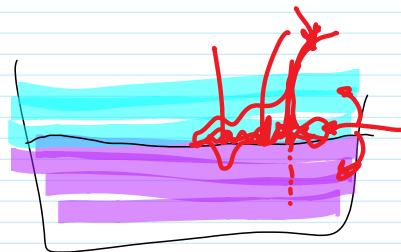
High Visibility: Want good contrast between dyed and ambient fluid.

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)

- Absorption
- Reflection
- Diffusion
- Refraction



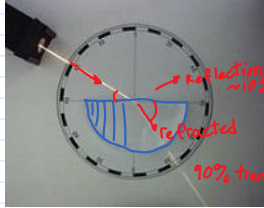
Scattering
 Rayleigh and Mie scattering
 Photoelectric effect

Refraction
 Absorption
 Diffraction
 Reflection
 Scattering/diffusion
 Transmission

Emission
 Fluorescence
 Excitation

1) Transmission

- o Refraction, at change of refractive index

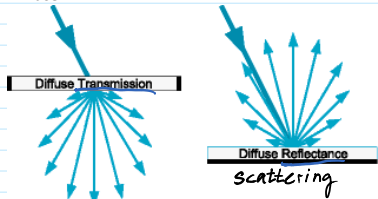


Lecture 02 Overview2
 Snell's law

<http://upload.wikimedia.org/wikipedia/commons/thumb/1/13/F%C3%A9ny%C3%B6r%C3%A9s.jpg/220px-F%C3%A9ny%C3%B6r%C3%A9s.jpg>

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

- o Diffuse



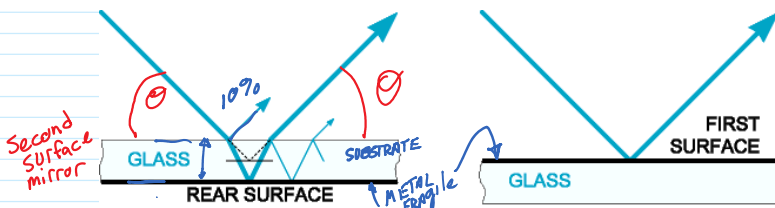
Diffuse transmission and reflectance.

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

2) Reflectance

- o Diffuse, scatter
- o Specular

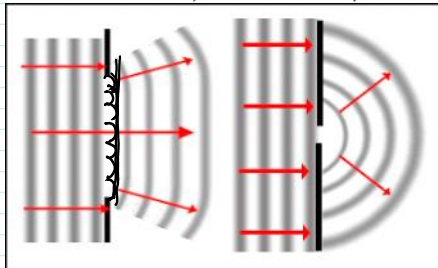
Edmund Scientific



Reflection from a second surface and first surface mirror.

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

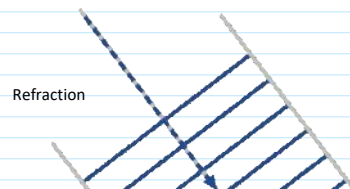
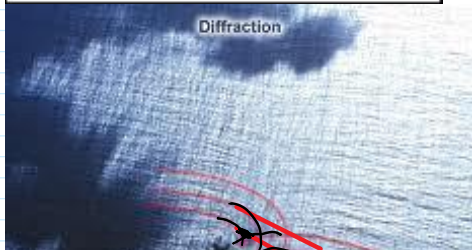
3) Diffraction: Like refraction, but with constructive/destructive interference



HUYGENS

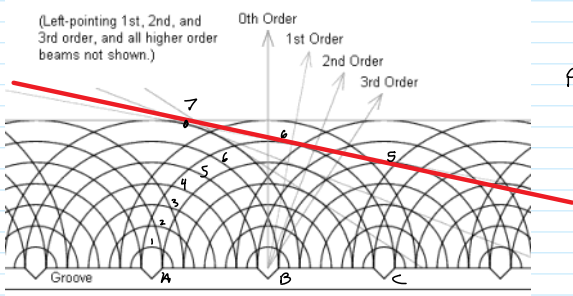
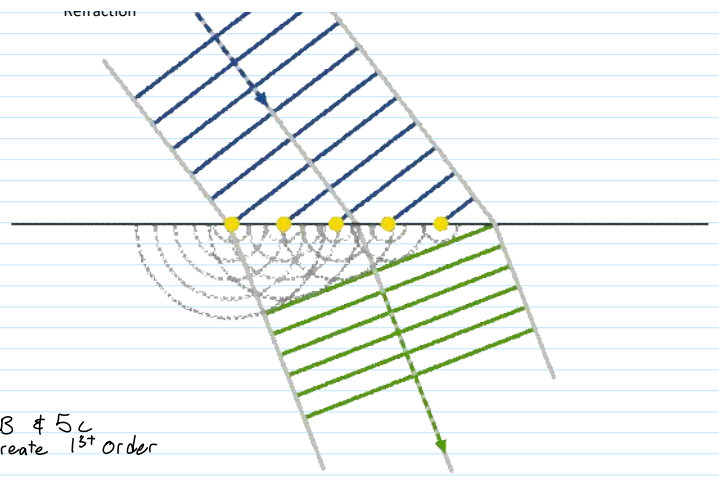
http://www.tufts.edu/as/tampl/projects/micro_rs/theory.html

http://www.med.utah.edu/marine/ripcurrents/NSF/media_gallery.php





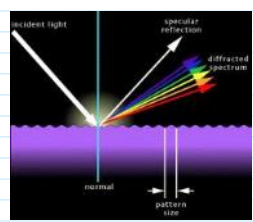
http://www.meted.ucar.edu/marine/ripcurrents/NSF/media_gallery.php



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

Incident Plane Wave ($\lambda = 2/11 \cdot \text{Grating Pitch}$)
Diffraction Grating

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



1st orders