

Dye2

Monday, March 15, 2010
4:17 PM

Today

- Feedback: more minute papers, more interactive lectures, more feedback. Neater lecture notes. Guest lectures, facilities, demos creative aspects: good. Most teams OK.

If you missed last Friday, please submit feedback at

<http://www.surveymonkey.com/s/ZCGTFB3>

Image Self Assessments?

Plans for next Team Assignment? Only got a few.

SPECIFIC FV techniques

Choice depends on physics desired

1 DYES Today

2 Aerosols Particles

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

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

1) Not Disturb flow "How?"

Minute paper -Groups

Answers:

A) Match flow speed when injecting

Use small ports, minimize volume injected,

Consider location of injection; reveals different physics <http://media.efluids.com/galleries/laminar?medium=113>

Coat object with alcohol-dye mixture, let dry, then tow in tank: vorticity layer, wake, boundary layer

Or coat short strings on a rake. OK for low speed, short run times

B) Match fluid properties

- i. Density
- ii. Temperature
- iii. Viscosity
- iv. Surface tension (match intermolecular forces)

- v. Minimize chemical reactions (unless needed)
- vi. 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.

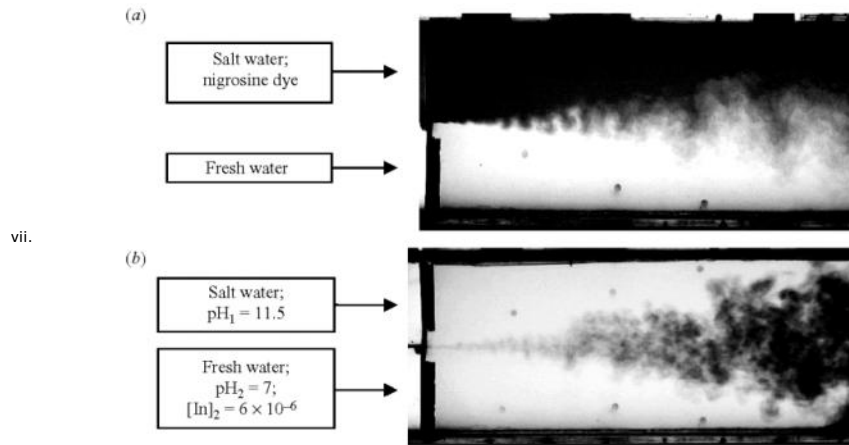


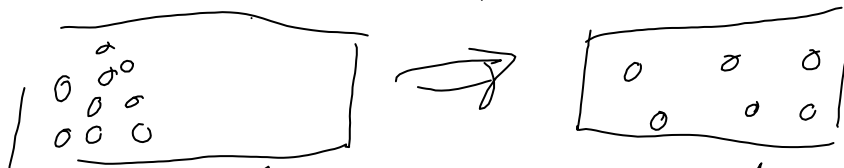
FIGURE 4. Photographs (contrast enhanced for visualization) of the buoyancy-generated mixing layer in a typical water channel experiment. (a) Nigrosine dye was added to the top stream. (b) Phenolphthalein was added to the bottom stream, which changes to its pink form as the two streams molecularly mix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

Tough to match all these properties- Dye properties are different from ambient fluid.
Mitigation Techniques:

1) Premix

For water mix dye + isopropanol
 DENSE light
 ~ ρ_{H2O}

Avg concentration gradient



Want dye to diffuse like ambient flow

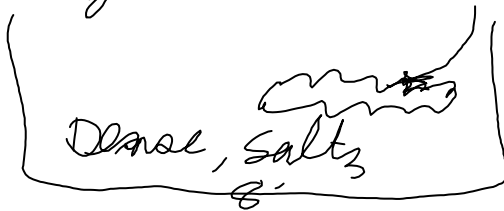
$$\text{Lewis \#} = \frac{D \rho C_p}{h_c} = \frac{\text{mass diffusivity}}{\text{thermal diffusivity}} = 1$$

D = mass diffusivity

$$\frac{\rho c_p D}{k_c} = \frac{\text{mass diffusivity}}{\text{thermal diffusivity}} = 1$$

D = mass diffusivity
 c_p = specific heat
 k_c = thermal conductivity

Reduce D using Milk or Latex
 lighter paint



Stratified
Milky Latex

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:

<http://www.youtube.com/watch?v=DwtobAve-18>

More info in [Special Effects article](#)

http://www.americanheritage.com/articles/magazine/it/2007/1/2007_1_10.shtml

High Visibility

increase concentration

Good contrast between dyed + Ambient

Reflect

Absorbed

Refract

Emit

Scatter

Max interaction

Transparent

Minimize interaction