03 Overview A

Friday, August 30, 2024

Today: Overview A

Admin
Choices
Forces: why does it look like that
Start Vis Techniques

Admin

Your Name Table Tents. Every person, every class. Both sides, so people near you learn your name
Docusign or Flowvis.org login questions?
Reading assignment in Guidebook - First three pages: Introduction, Overview 1 (Phenomena, why does it look like that?) and 2 (Visualization Techniques)

iClicker: https://join.iclicker.com/DUYS

A) There's a textbook? 0
B) I forgot the reading assignment 1
C) I glanced at it 7
D) I read the first page or two 5
E) I read the whole assignment 4

Overview 1: Topics will be presented iteratively.

Previsualization: Have a goal, think about what you want it to look like.
Make CHOICES:

1. Flow phenomenon: Water boiling? Faucet dripping?
2. Visualization technique: Add dye? See light distorted by air/water surface?
3. Lighting: Continuous? Strobe? Sheet?
4. Image acquisition: Still? Video? Stereo? Time lapse? High speed?
5. Post processing, final output. Edit, at least crop the image and set contrast.

Choice 1 - Flow phenomenon: Why does it look like that?

What are the forces? = a framework for interpretation of the image

Minute paper. In groups (3 or so; random breakout rooms in zoom, clusters in person) list all the forces that can act on a fluid. Write them down, then we'll harvest from the class.

Buoyancy
External Surface force from physical surface
Pressure gradient
Gravity
Surface tension
Drag
Viscous forces
Potential energy, height
Kinetic energy gradient
Capillary force
Magnetism
Intermolecular forces
Shear force
Temperature
Coriolis

Previous Minute paper results:

Viscous
Shear
Gravitational
Buoyancy
Electromagnetic
Electrostatic
Inertial
Centripetal/centrifugal
Pressure
Body forces: gravity, buoyancy, EM
Viscosity, shear, friction
Thermal diffusivity
Interaction with other fluids
Surface tension
Intermolecular

Air resistance (drag)
Cohesion
Adhesion (capillary action)
Normal force
Stress
Strain
Thermodynamic
Heat
Convection
Osmosis
Solar radiation

Composition of fluids
Densities of fluids
Chemical reactions
Impact
Wind
Mass
Acceleration
Temperature
Phase change
Strong, weak nuclear forces
Cavitation
Vortex structures
vortex stretching
concentration gradient

Good, inclusive list. Not all are forces, but all can 'drive' a flow via a set of physics or mechanism.
Heat, for example.
Force - Any action applied to an object which would cause the object to move, change the way it is currently moving, or change its shape. A **force** can also be thought of as a push (compressive **force**) or pull (tensile **force**) acting on an object.
Engineering Terms
www.pre-engineering.com › resources › engineeringterms

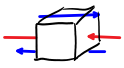
All *forces* can be categorized like this: 2 types of forces

Body

Acts directly on every molecule equally
a) Gravity
b) Electromagnetics

Surface

Acts on the surface of a volume of fluid

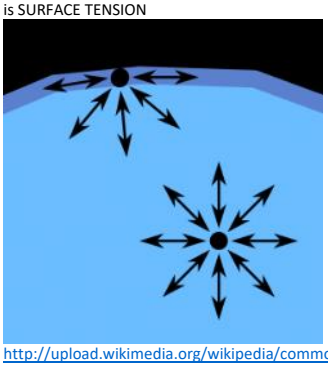


Pressure: always perpendicular to surface (red)
Shear: always parallel to surface (blue)

Any surface force can be decomposed into a shear plus pressure
Note: these are actually STRESSES = Force acting on an area.

The only force that is not so easily categorized

is SURFACE TENSION



It's the result of intermolecular forces, so it affects every molecule, like a body force

But it is only obvious at interfaces between fluids, kind of like a surface force.

Water and oil are ***immiscible***
Mustard ***emulsifies*** oil and vinegar(water)

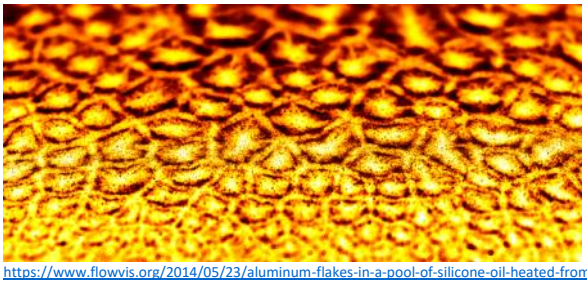
http://upload.wikimedia.org/wikipedia/commons/thumb/f/f9/Wassermolek%C3%BCleInTr%C3%B6pfchen.svg/300px-Wassermolek%C3%BCleInTr%C3%B6pfchen.svg.png

Marangoni Convection

When the chemical composition or temperature of a liquid varies from one location to another, the surface tension will vary. Fluid will be dragged from the low-surface-tension area into the higher: Marangoni convection.

The classic food dye/milk/detergent experiment shows this effect. There are a lot of other experiments to try!
https://www.flowvis.org/category/flow-categories/multiphase/surface-tension/

Axe glitter shampoo: https://vimeo.com/127504020 . Alex Meyer 2013 Spring Team Second. assignment



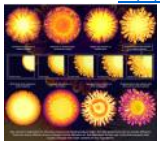
Millie Blackstun, with
Athena Ross, Vigneshwaran Selvaraju, and Amanda Kennedy, using equipment from Scott Kittleman, ATOC.
2014 Team First assignment

From <https://www.flowvis.org/media/2014/2014TeamFirst/Reports/Melissa_Blackstun.pdf>

https://www.flowvis.org/2014/05/23/aluminum-flakes-in-a-pool-of-silicone-oil-heated-from-below-displays-the-benard-marangoni-convection-instability-the-resemblance-to-the-sun-was-achieved-with-post-processing-of-color/

Rayleigh-Taylor or Rayleigh-Benard instability: cooler liquid is denser, and sinks. Warmer fluid also has lower surface tension.

'Mocha diffusion' https://gfm.aps.org/meetings/dfd-2023/65020bb4199e4c1475d6f12e



Conclusion: Whenever you are observing fluids, think about the forces that may be acting, ***that make it look like that.*** Yes, put in your reports.
Also, any other relevant physics besides forces.

2. Visualization Techniques

a. Seeded Boundary techniques
b. Index of refraction (light bending)
c. Particle tracking

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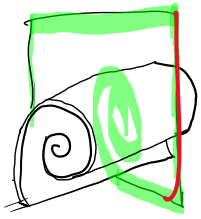
a. Seeded Boundary techniques:

One fluid is seeded with dye or particles which scatter or absorb light. The other fluid is transparent, not scattering or absorbing light. The boundary can be seen.



Stage fog illuminated by a sheet of laser light forms a suddenly started laminar planar jet at Re = 330. Tanner Ladtkow, Geneva Wilkesanders, Tim Read, Andrea Fabri. Team Project 3, 2006

India ink falling through water shows the Rayleigh-Taylor instability. Gordon Browning. Get Wet Fall 07.

Back-lit. Dark ink absorbs light.

http://www.colorado.edu/MCEN/flowvis/galleries/2009/Team-1/FV_popup1-21.htm

Lucy Dean, Joseph Duggan, Tim Jarrell, Melissa Lucht

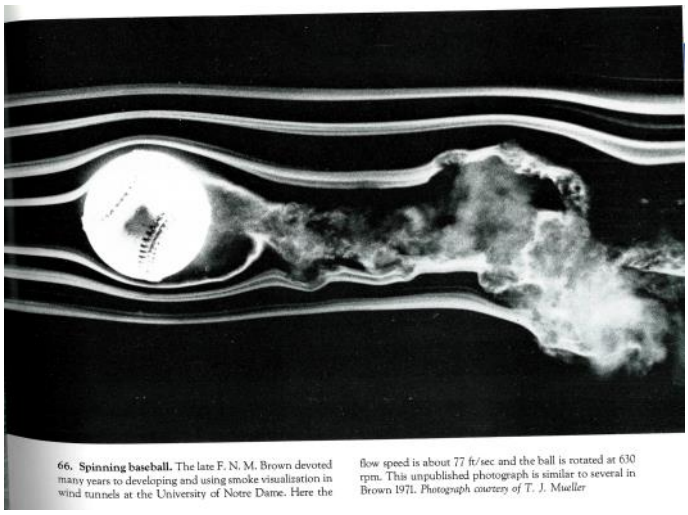
White gas (naptha) pool flame.
Team 1 Spring 2009

Light emission shows hot soot region
Black body radiation: Red to yellow to white

Blue = specific emission from C_2 or CH radicals

Seeded boundary technique is characterized by dense seeding, can't see individual particles:

Dye = food coloring, molecular scale
Hydrogen bubbles (in water), 2-3 micron particles
Smoke 1 micron particles
Water droplets (clouds, fog, vape) 1 micron, bigger can happen but won't track the flow as well.



66. **Spinning baseball.** The late F. N. M. Brown devoted many years to developing and using smoke visualization in wind tunnels at the University of Notre Dame. Here the flow speed is about 77 ft/sec and the ball is rotated at 630 rpm. This unpublished photograph is similar to several in Brown 1971. *Photograph courtesy of T. J. Mueller*

Van Dyke book: An Album of Fluid Motion

This is a relatively easy technique.
Remember, choose environmentally benign fluids: foods, personal care products. No chemicals down the drain here.