Initial Testing Of A Dual Activation and Deactivation Illumination System For Visualization Of Flow Using Phosphorescent Particles

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Introduction

Flow visualization

1. Qualitatively improves physical understanding
2. Can be coupled with image processing to yield quantitative data about scalar and velocity fields.
3. We all love this stuff

Sieber et al. 2015
Gallery of Fluid Motion
Introduction

Classic Methods: More Quantitative & $$$$
Introduction

Classic Methods: $

Rouhnia and Strom 2016

M1

Dye injection at a point

http://tpapanicolaou.engr.utk.edu

Dye 1 fluid of a two fluid system - visualize the interface

Rouhnia and Strom 2015

M2a

M2b
Introduction

Drawbacks to typical methods

1. M1: Intrusive
2. M1 and M2: Saturation of the background
3. M2: only visualize the interface
Introduction

**Key Components**

1. Phosphorescent paint particles
   - Longer luminescence time than florescence
   - Activation/Deactivation?

2. Consumer-grade laser pointer

**Benefits**

1. Low cost
2. Non-intrusive [no disturbance + closed system]
3. Can potentially “clean” the background
4. Particle traces
Goal: Is this a viable method?

Questions to answer
1. Can you activate and deactivate?
2. Is it helpful for visualization?
3. Can it be imaged and used for quantitative analysis?
Methods

Materail

1. Glow in the dark powders from:
   • Techno Glow, Inc. (strontium aluminate)
   • Glow, Inc. (silicate aluminate)
   • GloNation (?)
   • Ebay (zinc sulfide)

2. Lasers:
   • 5 mW, 405 nm (violet)
   • 5 mW, 650 nm (red)
   • 5 mW, 808 nm (infrared)

Tests

3. Test activation/deactivation in air and water
4. Visualization and imaging in stagnant and moving water

Particle sizes
- 15-25 μm
- 30-40 μm
- 45-60 μm
Activation/Deactivation
Activation/Deactivation
Observations

1. Deactivation (or flash discharge) only occurs with zinc sulfide

2. Both the red and inferred wavelengths will deactivate… red does the best

3. Deactivation does not work in water… perhaps low?
Visualization: Stagnant Water
Visualization: Stagnant Water

Observations

1. Particles are not neutrally buoyant
2. Larger particles give off more light but sink faster
3. Particle dissolve after some time
4. Scatter is significant with smaller particles
Visualization: Moving Water
Visualization: Moving Water
Visualization: Moving Water
Visualization: Moving Water
Visualization: Moving Water
Visualization: Moving Water

Observations

1. Good visualization
2. Hard to image (long exposure)
Sediment Tracer?
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Sediment Tracer?
Concluding Remarks

1. Only zinc sulfide can be “deactivated”

2. However, zinc sulfide is hard to find… not as good as other phosphors for long glow times.

3. A laser pointer can be used to visualize the motion of glow particles for general visualization purposes. **However:**
   - Very hard to image
   - Cannot be “deactivated” (potentially due to scatter)
   - Path towards quantitative analysis is not clear

4. Perhaps more suited to track sediment movement.
Thanks