2015

FLUME* – Recirculating Water Tank

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Multi-Project!

FLUME* – Recirculating Water Tank

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Objectives of the year

- Revisit the entire design and theory of the previous year
- Finalize the ¼ model to proof the workability of it
- be time limitless for testing
- Conduct first experimental results

Laminar and turbulent flow

The adequacy of the testing flume is predicated upon the ability to produce water flow that is either laminar or turbulent, and by limiting the inertial effects of the flow, ideal real-world seafaring conditions can be simulated.

Flows output are analyzed in terms of non-dimensional Froude & Reynolds numbers

- Reynolds number:
  - Similitude between model and prototype
  - Maximum free stream velocity to generate

$$Re = \frac{VL}{v}$$

- Froude number:
  - Similitude between model and prototype
  - Resistance of a partially submerged object

$$Fr = \frac{V}{\sqrt{gL}}$$

Tesla discs and motorization

Tesla discs

- In 1909, Nikola Tesla invented tesla turbine that creates laminar flow through boundary layer effects
  - Discs rotate creating drag that causes the water to travel in a smooth pulse-free flow.
  - The discs do not create turbulence during rotation

- 8 tesla discs used for the Flume, determined by

$$D = \pi\sqrt{\frac{n}{\omega}}$$

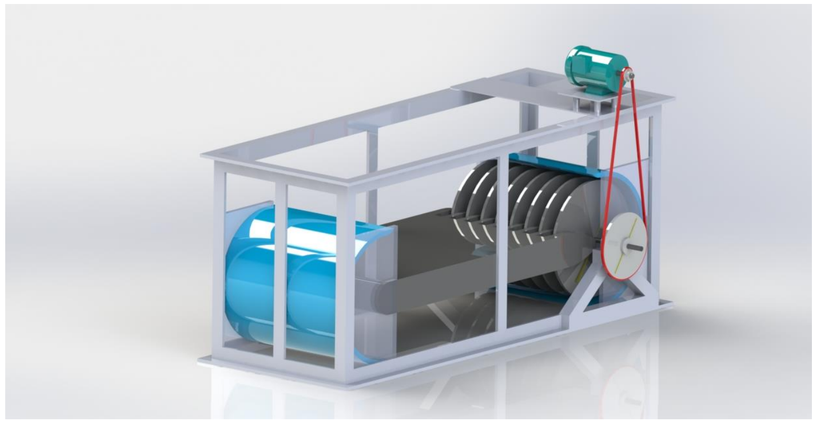
Motorization

Simulate a flow up to 12knots
=> 128rpm for tesla discs

- 1hp Electric motor (3470 max rpm)
  - Linked to a controller
  - Able to run the motor at different frequencies
  - Gear ratio between motor and Tesla discs 1/5

System Overview

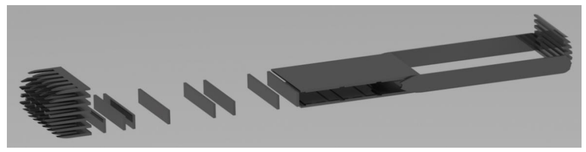
- Testing facility for Ocean engineering field
- Simulate natural flow around a moving vehicle
- ¼ model of the full scale Flume (72”x2’”x24”)
- Propulsion system: 8 tesla discs
- Available for students, instructors and researches
- operational everywhere (classroom, etc.)



Construction Process

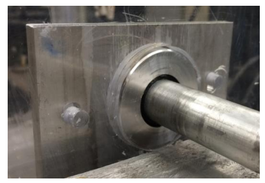
• Center divider

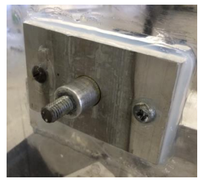
One of the most important part of the flume. Complex construction to save weight and easiness to handle it. Composed of 26 Starboard pieces.



• Rotational axle permeability

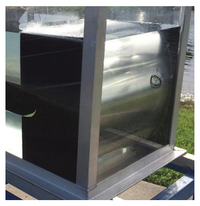
Machine shopped pieces to fit exactly the existing holes present in the acrylic glass





• Return Chute

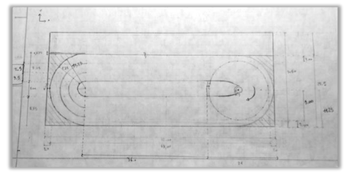
Return chute done in thin metal sheet (highly smooth) and supported by starboard plates.

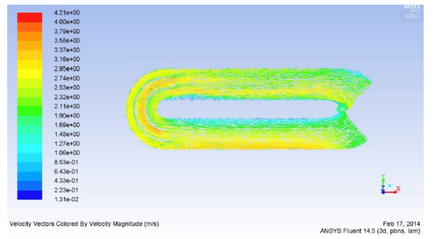


ANSYS Fluent analysis

Fluent analysis was done to test theoretically the new circular flow path design.

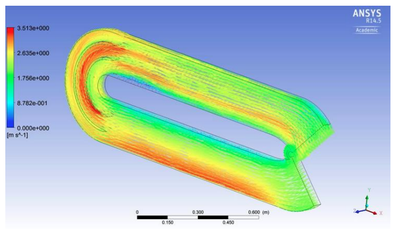
- hand drawings first made
- then converted in CAD drawings and analyzed





Results:

- Homogeneous speed conserved over time
- Homogeneous water velocity along layers in testing area
- Still some instability into the return chute



Results and future improvements

All objectives were successfully achieved and even more. It was seen that the model flume could simulate vessel going up to 22 knots instead of 12 knots.

Laminar flow was visually observed over time. Then, by increasing the water velocity, the flow became turbulent.

Future improvements:

- rebuild Return chute with stronger material
- Safety measures for electricity
- Protective case for gear assembly
- Set up tests: flow sensor, drag sensor

*Publication

OCEANS 2015 conference

Genoa Italy

NORTHROP GRUMMAN

Engineering & Science Student Design Showcase

at Florida Institute of Technology