

The Fluidizer (A Sand Management Device)

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What is Fluidization?

Fluidization is the process of altering the state of a compact and solid-like granular material to a dynamic fluid state. This practice involves pumping a fluid (liquid or gas) into the granular material via pipes. It is useful in sand and inlet management and also has underwater archeology applications.

Design Concepts

Criteria :

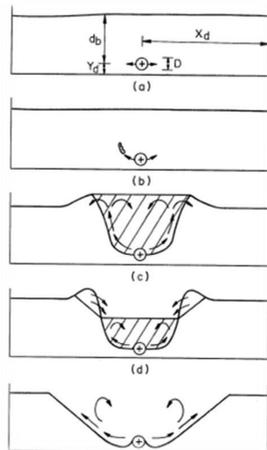
1. Self-bury to a depth of 9 feet
2. Use no assistance from other machinery (i.e. dredge)
3. Fluidize and remove at least 900 cubic feet of material
4. Portable
5. Enduring harsh marine conditions
5. Durable and resistant to corrosion
6. Operate multiple sub-systems at the same time

Components :

1. Several PVC pipes and fixtures (3')
2. 3 – 100 ft. contractible hoses
3. 350 GPM Trash Pump (3" diameter)
4. Aluminum frames

Sub-Systems:

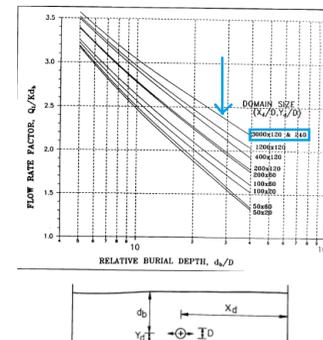
- **Self Burying Sub-system**
 - Purpose: Allows the fluidizer to bury itself
 - Unique feature, making the device portable.
 - Position: Two PVC pipes placed in parallel at the base
 - Holes: 1/8" in diameter along the bottom (facing the sand) spaced every 1.75"
- **Fluidization Sub-system**
 - Purpose: Fluidize a large amount of sand in a desired location
 - Position: One pipe situated on top of the self-burying system
 - Holes: 1/8" in diameter horizontally opposed and spaced every 1.75"
- **Venturi Suction Removal Sub-system**
 - Purpose: remove the fluidized sand slurry
 - Position: On top of the fluidizer pipe and
 - Method: Employs Venturi suction principles using a ratio of 3" to 0.5" to intake the sand and discharge it



Theory of Fluidization

Initial Flow Rates:

- Scientists Lennon, Chang, and Weisman developed a mathematical model to assist in find incipient flow rates necessary to initiate fluidization.
- From the graph, the flowrate factor, (QI'/Kd_b) , is found and used in the empirical equation for the initial flow rate found below.



$$Q_I = (QI'/Kd_b) * K * d_b * L$$

where:

- K is the coefficient of permeability
- d_b is the burial depth
- L is the length of the pipe

Self Burial System Calculations

$$QI = (QI'/Kd_b) * K * d_b * L$$

$$(QI'/Kd_b) = 2.25$$

$$K = 1.31 * 10^{-4} \text{ ft/s}$$

$$d_b = 8.875 \text{ ft}$$

$$L = 10 \text{ ft} * 2 = 20 \text{ ft}$$

$$QI = 0.0524 \text{ ft}^3/\text{s} = 23.525 \text{ g/min}$$

Fluidization System Calculations

$$QI = (QI'/Kd_b) * K * d_b * L$$

$$(QI'/Kd_b) = 2.28$$

$$K = 1.31 * 10^{-4} \text{ ft/s}$$

$$d_b = 8.625 \text{ ft}$$

$$L = 10 \text{ ft}$$

$$QI = 0.0258 \text{ ft}^3/\text{s} = 11.584 \text{ g/min}$$

Research Cruise

The deployment of the fluidization system consisted of a three day research cruise off the coast of Fort Pierce. The cruise included 3 different deployments of the system and 8 total dives.



Upon deployment, the fluidization system was loaded onto the stern of the research vessel and set in the water. The system was then floated, with the aid of lift bags, to a small boat, the Carolina Skiff. This vessel was used to house the pump which facilitated communication between dive team and the boat crew for pump operation directions. The system was then sunk and moored to the sea floor with the use of sand screws. After successfully mooring The Fluidizer in place, the burial subsystem was activated. Next the fluidization sub-system was engaged, followed by the removal sub-system.

Overview

Upon each deployment of The Fluidizer, the team found ways to improve the efficiency of deployment, function, and removal of the system. at that depth.

Improvements included:

- Removal of the main frame previously located at the pipe and hose connection elbow.
- Adding appropriate weights to stabilize and aid in the self burial of the device.



After 3 successful deployments, it was confirmed that fluidization is a viable method of burial and sand management. The Fluidizer was able to bury itself to a depth of 2 ft. At this depth, it was also able to fluidize and remove the sand, leaving a trench of absent material behind.

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