Fluidization of Grains under Water

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I. Introduction

Granular fluidization under water is a common phenomenon in nature, and is also used in the industry. Understanding toward this phenomenon and the affecting factors help improving the related researches and applications. We are going to observe the fluidized zone formed by spherical glass microbeads (used in the essays) and the carborundum sand-blasting grit (closer to the natural sand and industrial grains). Due to the larger friction and the non-spherical shape of the carborundum grit, it is more likely to form chunks and is harder to fluidize. The comparison of these two grains will give us the idea about the current model's ability to describe underwater fluidizations in the real world.

II. Apparatus for Experiment

The setup is made up with a Hele-Shaw cell and a nuzzle below where fluid (air or water) is injected. We use the gap between two acrylic boards with the bottom and the edges sealed as our Hele-Shaw cell and put grains into it and set an air pump to put air into the gap. There we observed the phenomenon of fluidization and change the density of fluid by means of adding the salt.

We take video from the side of the fluidized zone and use OpenCV to get the brightness of the image as the index of granular density. The fluidized zone can be distinguished from the rate of change of granular density or the character of its margin.

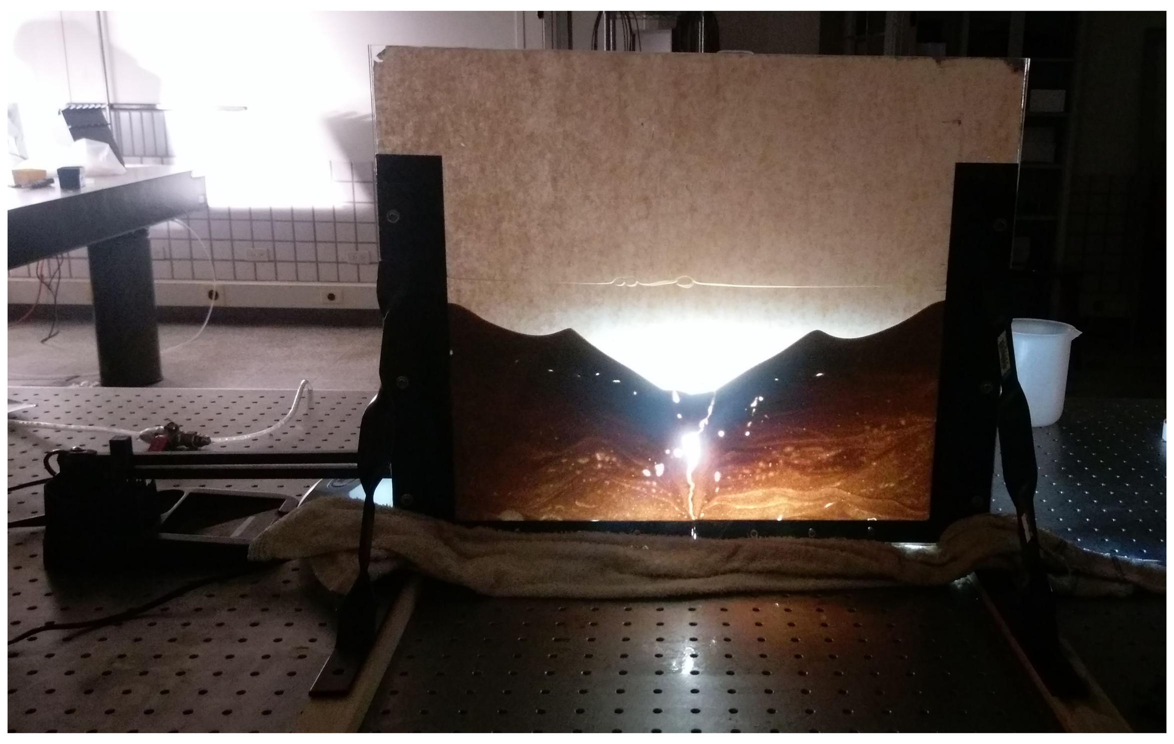

Fig. 1 Schematic diagram of apparatus

III. Experimental Results

1.half vs time (different flow rate)

Before the fluidized zone getting stabilized, the half-width may be floating. Until the fluidized zone be stabilized, the value will gradually getting steady.

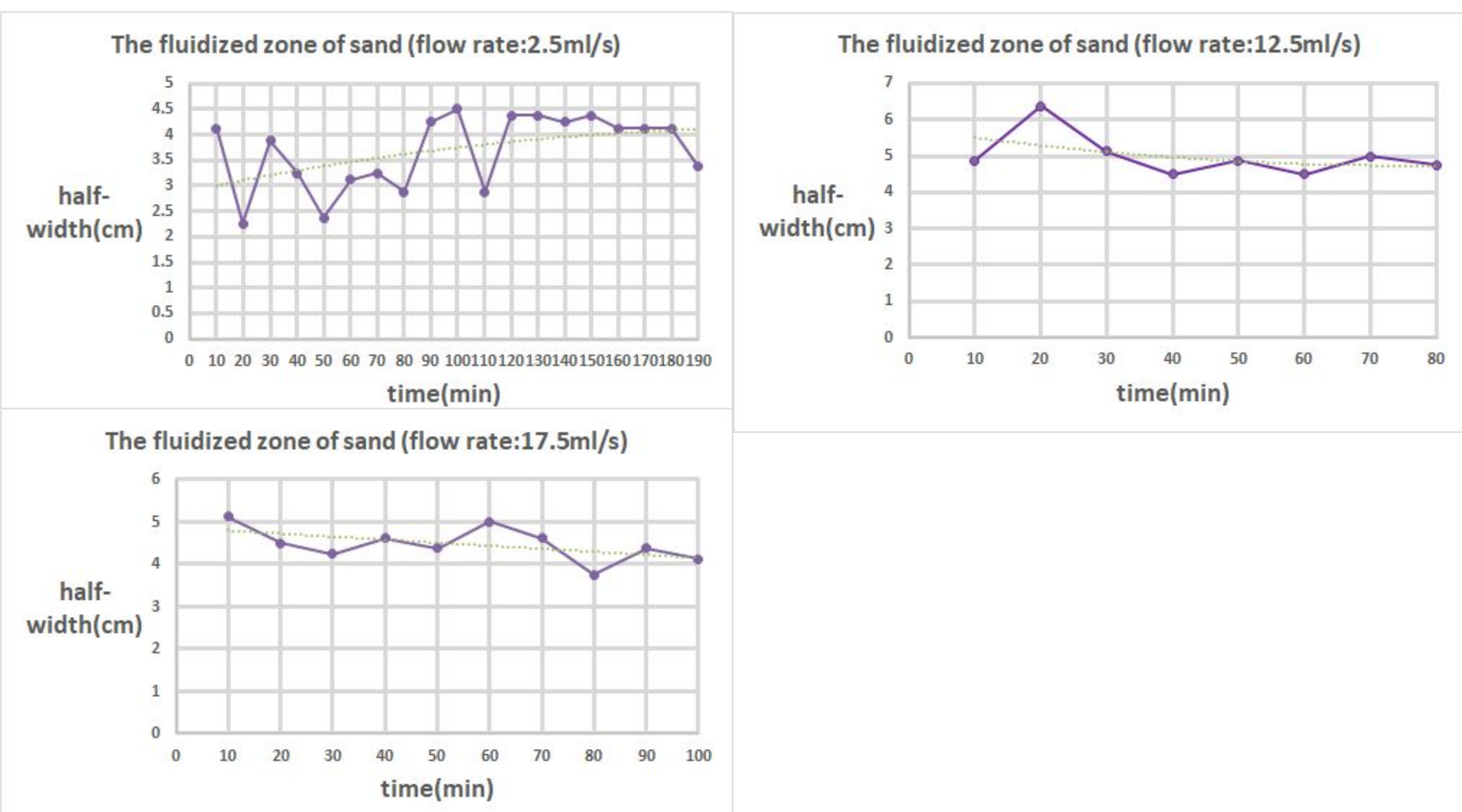

Fig2.The half-width of the fluidized zone as function of time prepared at several different flow rate.

2.area vs. time (different flow rate)

Theoretically, with time passed, the area of fluidized zone will get increased.

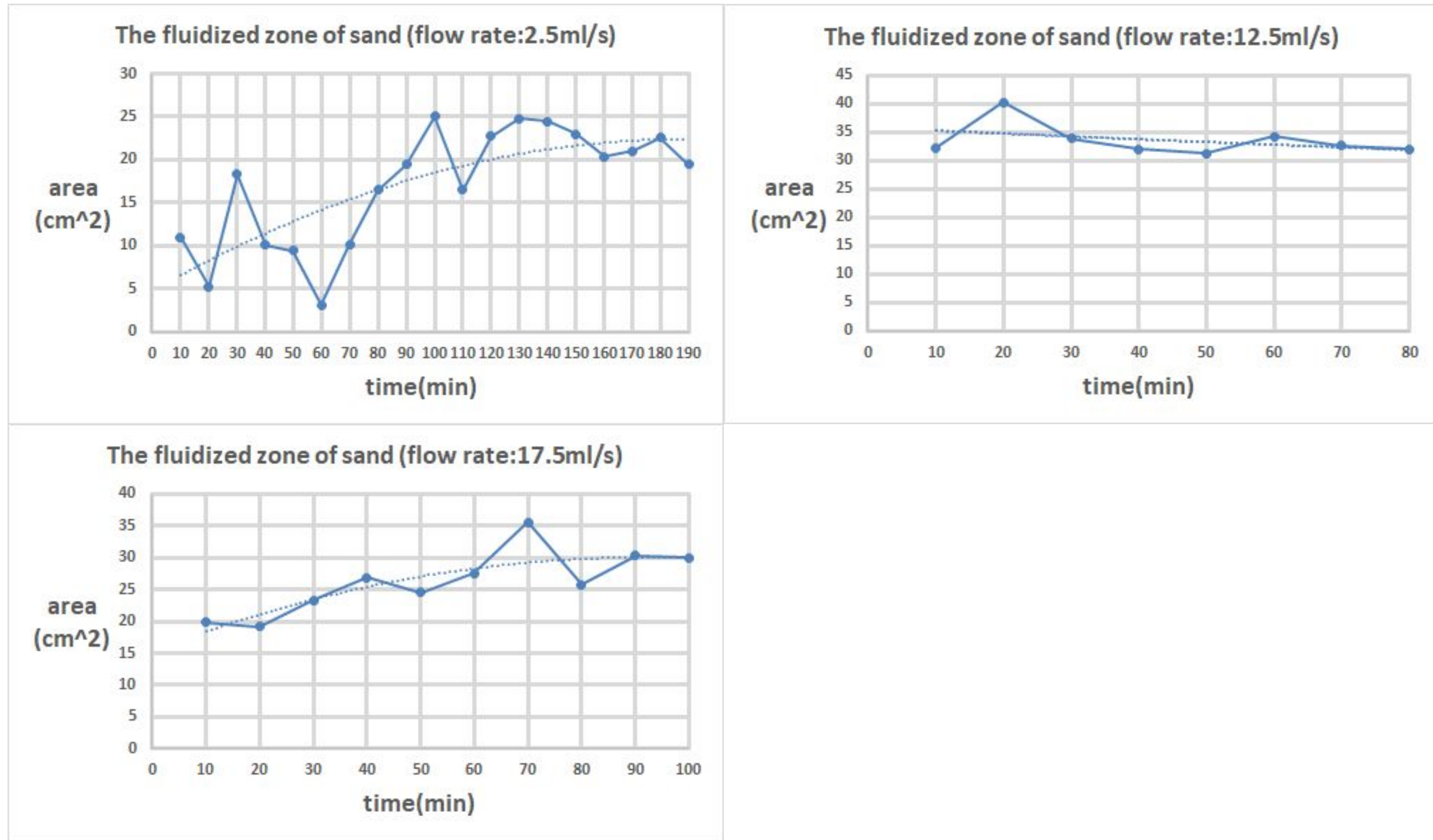

Fig3.The area the fluidized zone as function of time prepared at several different flow rate.

3.flow rate vs. half-width and flow rate vs. area

The area and half-width of the fluidized zone widened when the flow rate increased. Especially, the change of area is more obvious than half-width.

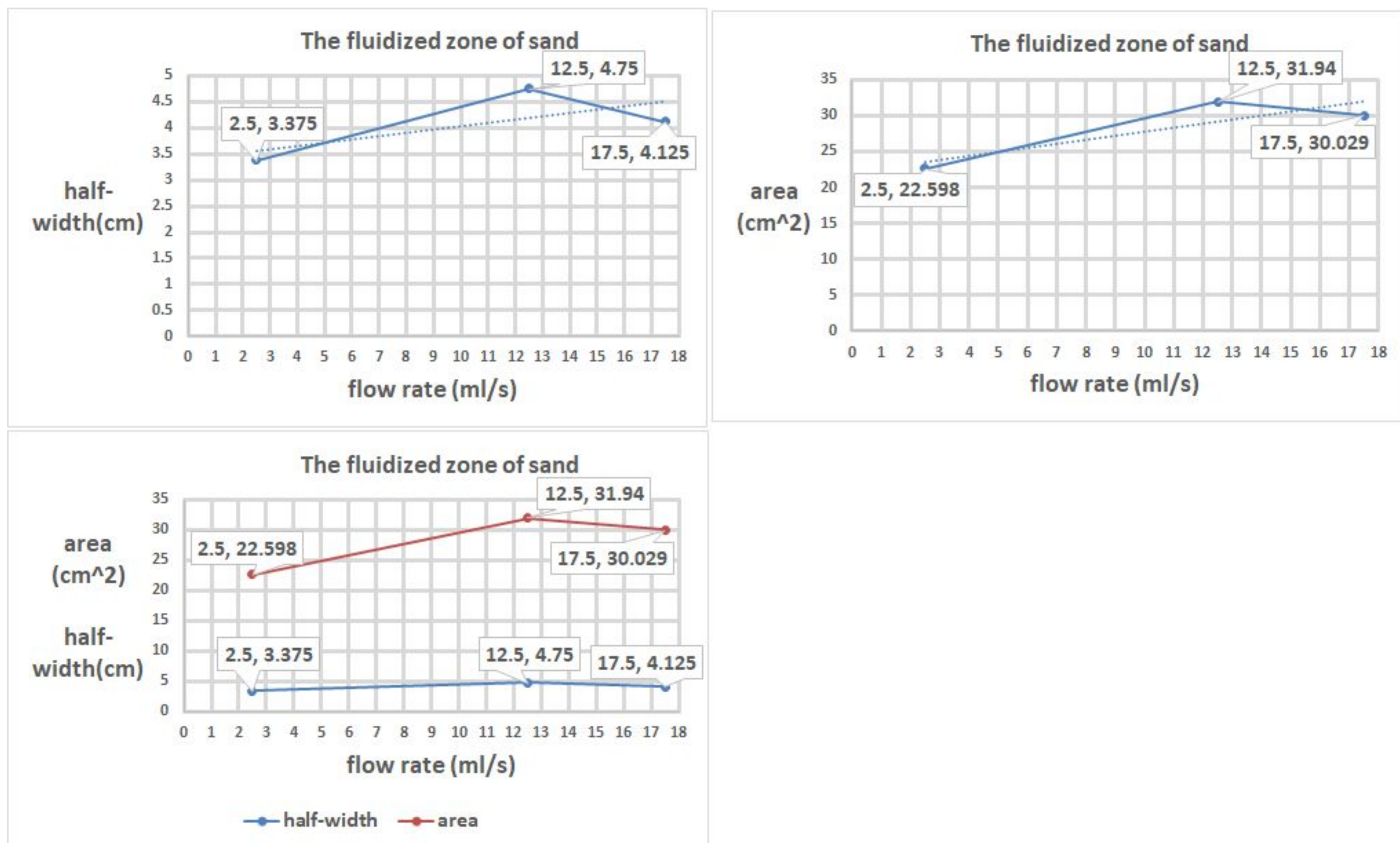

Fig4.The half-width and area of fluidized zone as function of flow rate

IV. Discussion

1.By comparing the data about fluidization of sand under water, we found that the area of the fluidized zone widened when the flow rate increased.

2.The boundary of the fluidized zone of sand is mostly close to the shape of the bullet, instead of the parabola shape mentioned at paper.

V. Conclusion

1.The area of fluidized zone increase and then get stable along time.

2.The area and the half width is positively related to the flow rate.

3.The change of the half width along time is relatively small because the fluidized zone grows from top to bottom, and the half width is thus determined at the early stage.

Reference:

[1]Venting dynamics of an immersed granular layer. German Varas, Valerie Vidal, and Jean-Christophe G ́eminard. PHYSICAL REVIEW E 83, 011302 (2011)
[2]Gas-induced fluidization of mobile liquid-saturated grains. Gabriel Ramos, German Varas, Jean-Christophe Geminard, and Valerie Vidal. PHYSICAL REVIEW E 92, 062210 (2015)