

Jamming/flowing transition of non-Brownian particles through a restriction in a quasi-2D channel.

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We present experimental results on the jamming/flowing transition of a suspension of particles forced to flow through a restriction of variable size. Non-Brownian particles are immersed in an iso-density liquid and entrained by viscous drag in an horizontal channel. The key feature of the setup is to be two-dimensional, thus allowing a precise characterization by a fast camera ...

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I. INTRODUCTION

Suspensions of solid particles in a fluid are of interest in many practical situations encountered in mining, polymer and oil/gas industries, just to name a few. A number of models allow predicting pressure losses and velocity fields in pipes and reactors with sufficient accuracy to perform a full process design (pump capacity, pipe size and material ([1], [2]). ...

II. MATERIALS AND METHOD

The experimental setup is mainly composed of a feeder, a rectangular duct and a separator. ...

The operating protocol is graphically described on Figure xxx. Initially, the feeder is filled with particles and liquid in its lower half, and the horizontal channel is filled with liquid at rest. A typical experimental run is composed of the following steps: (1) The roller is turned on at 200 rpm. This creates a dense 2D granular packing that is pushed towards the restriction until the system jams (ark formation). Then, the roller is stopped. ...

Figure 1 shows that the density probability decays exponentially with the avalanche size. In other words, the probability to have an avalanche of size T is proportional to $\exp(-T/T^*)$, where T^* is a characteristic avalanche size. ...

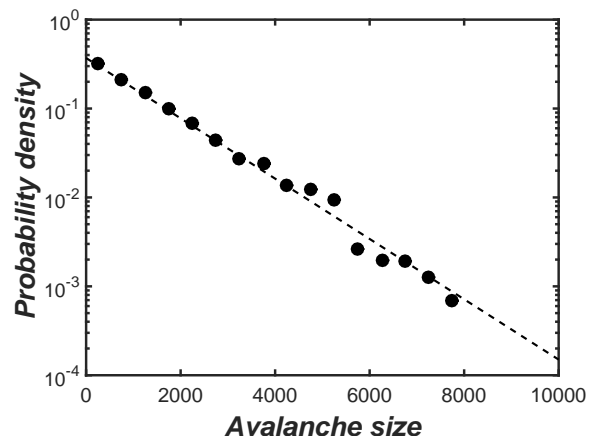


FIG. 1: Exponential distribution law of the avalanche size.

III. EXPERIMENTAL RESULTS

A. Overview

Figure V shows two typical top views of the rectangular duct containing suspended particles. The liquid flows continuously from left to right. On the left hand side, ...

B. Power-law divergence

In this section, we present experimental results highlighting the influence of the restriction size, the liquid flow rate, and the particle morphology on the suspension flow, characterized by the avalanche size, the velocity field of the solid phase, and the solid volume fraction upstream of the restriction. ...

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TABLE I: Divergence parameters.

Q_f	Spheres				Polyhedra			
	A	R_c	γ		A	R_c	γ	
0.73	1.4×10^3	4.4	5.3		1.4×10^7	5.9	7.9	
2.93	1.9×10^3	4.6	6.3		1.9×10^5	5.6	6.3	
5.86	2.0×10^2	4.4	4.5		2.0×10^6	5.9	6.8	

TABLE II: Comparison with the literature.

Authors	Particles	Fluid	Geometry	R_c	γ
This work	PE spheres 5.92 mm	Water Glycerol	\approx 2D Hor Visc. driven	4.5	5.4
This work	PE polyhedra 5-7 mm	Water Glycerol	\approx 2D Hor Visc. driven	5.8	7
Lafond	PS spheres 10-16 mm	Water Nacl	3D Horiz Visc. driven	3.6	
Garci- -martin	Glass spheres 0.423 mm	Air	2D Vertic Grav. driven	4.9	6.9
Thomas	Glass spheres 2 mm	Air	3D Vertic Grav. driven	4.7	5

The similarity with a classical phase transition suggests that it can be represented by a power law:

$$T^* = A.(R_c - R)^{-\gamma} \quad (1)$$

where A is ...

IV. DISCUSSION

A. Comparison with other systems

Table II compares the divergence velocity γ and the critical ratio R_c obtained in our work to the values given

by Garcimartin [3], Thomas [4] and Lafond [5]. Whatever the system dimension (2D or 3D), the particle morphology (spheres or polyhedra), the driving force (viscous drag or gravity), the suspending fluid (gas or liquid), and the flow direction (vertical or horizontal), we observe that the critical opening ratio R_c is 4.7 ± 1.2 and the divergence velocity γ is 6.0 ± 1.0

B. Statistical analysis

In this section, ...

V. CONCLUSIONS

In this paper, we investigated the behavior of suspensions of large solid particles suspended in an isodensity liquid flowing through a restriction. We performed ...

- The studies identified in the literature ...
- In the literature, we found ...

As a perspective, it is certainly very interesting to study the influence of cohesion forces on the jamming probability. In a near future, the authors plan to publish results from an ongoing work on this topic.

ACKNOWLEDGMENTS

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