Oscillation phenomena induced by flow of composite of particle and viscous fluid

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Introduction

Low frequency earthquakes and tremors are occurring at depths, where fluid is expected to exist. It is widely considered that the fluid phase plays a significant role in the generation of the oscillation although its physical picture of the process is poorly understood. We consider that present lack of the physical pictures of the generation process is fatal in further developments of this research. Object of this study is to explore a possible mechanism of the low frequency oscillation at depth.

In engineering field, various types of the oscillation phenomena associated with fluid flow are observed: fluid flow in collapsible tube, fluid flow in conduit with valves, granular flow in pipe and multiphase flow. In this study the granular flow in pipe is focused.

Experimental method

Plastic particle with diameter of 0.5 mm and viscous fluid are packed into cylindrical pipe with diameter of 6 cm. The pipe is connected to a tank with the viscous fluid and a tube with diameter of 2.2 mm. Pressures in the pipe and flow in the tube are measured.

Result

We found two distinct flow styles exist depending on the pressure difference. Permeable flow where only the fluid phase can flow is realized in low pressure regime. In high pressure suspension flow is realize. This suggests that the transition is controlled by a kind of yield strength of the porous structure composed of the particle in the pipe.

The variation of pressure at the exit of the conduit displays peculiar behaviors: the amplitude of this variation is highest near the transition between the permeable flow and the suspension flow and an oscillation with regular time interval is observed in this regime. Change of liquid fraction in the tube is synchronized with this pressure oscillation. Characteristic frequency of the oscillation is proportional to flux.

Discussion

In the case of suspension with large liquid fraction, low pressure difference can drive the flow, whereas in the case of low liquid fraction high pressure difference is required. Because of this the oscillation in the pressure corresponds to the oscillation in the liquid fraction of the suspension. We will construct a simple model to characterize this oscillation and propose a scaling to unite the labo-scale experiments to the field-scale with particle diffusivity and Poiseuille flux.