流動化現象が定常状態に達するまでの過程
A route to steady state of liquid fluidization

*金 芳隆[1]、栗田 敬[1]
*Yoshitaka Kon[1], Kei Kurita[1]

1.東京大学地震研究所
1.Earthquake Research Institute,The University of Tokyo

When fluid is injected with low flux into the saturated packed bed of particles, fluid flows through interstitial spaces. This is known as a permeable flow. In this situation an empirical relationship, the Darcy law is known to exist in laminar flow, where the fluid flux is proportional to the applied pressure difference. When the applied pressure difference is increased and hence, the fluid flux is increased and both fluid and particles begin to flow together as a suspension. This gross flow called fluidization is important because it can drastically change efficiency of material transport. In the field of hydrology, for an example, this is related to an initiation of debris flow. In the field of volcanology, this process is related to the rejuvenation of a dormant magma chamber where the injection of new magma into the crystal mush causes the replenishment. In the field of chemical engineering, fluidization is well investigated for the engineering applications. The transition between a permeable flow and a gross flow is a kind of phase change; This critical superficial velocity is known as a minimum fluidization velocity (v_{mf}). The dynamics of the change from a permeable flow state to a gross flow state is more important in the initiation of such as debris flow and rejuvenation of magma chamber. The process of the initiation of fluidization is as follows; Water start to flow with high velocity enough to fluidize, both upper and fluidized front are lifted from top and bottom of particles bed, respectively(Slis et al. (1959)). Gibilaro et al. (1984) derived that upper front velocity has constant value until it reaches steady state and depends on water flux, and Thelen and Ramirez(1997) confirmed it experimentally. Upper front velocity is discussed like above, however, fluidized front velocity is not observed experimentally. In this presentation, we focus on the dynamics of the initiation process of the fluidization and present experimental approaches.

To observe the initiation process of the fluidization, we employed a vertical fluidizing bed. Transparent acrylic pipe (inside diameter:30 mm, length: 40~120 cm) is used, where particles are packed at the bottom of 12.5 cm. From water-saturated state, water is injected from the bottom at constant flux(the superficial velocity of 0.5~4.7 cm/s). The hydrostatic pressures are monitored at 3 different positions at 0,5,10 cm hight from bottom. Glass beads(diameter:0.8 mm, density:2.5 g/cm^3) and polystyrene beads(diameter:0.8 mm, density:1.03 g/cm^3) are used as particles. The all move of beads are filmed, and inside area of this pipe is divided into fixed, fluidized and no particle area by differential of particles density.

We found that top of the particle bed and the fluidization area propagates from bottom to upward when the injected velocity is above the critical value v_{mf}. Because fluidization front velocity is larger than upper front velocity, the thickness of fixed bed becomes gradually small, and after that all beads become fluidized. On checking pressure and movie of the same time, it is revealed that hydrostatic pressure gradient of fixed bed are larger than fluidized bed during rise. Propagation of fluidized bed is divided into two types by flux; In case injected velocity is slightly larger than v_{mf}, the propagation ends when both upper and fluidization front reach same hight. In case injected velocity is enough high compared with v_{mf}, rise lasts after a while that. Fluidized front velocity depends on injected flux when it is low, however, fluidized front velocity saturates when it is high. Porosity of propagating fluidized bed is kept nearly equal value to one

of terminal fluidized bed.
We also compare the cases for soft gels are used as elastic particles and discuss the effect of modification of packing and particle shape during flow.

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