

Scaling laws for pneumatic and hydraulic conveying of granular material

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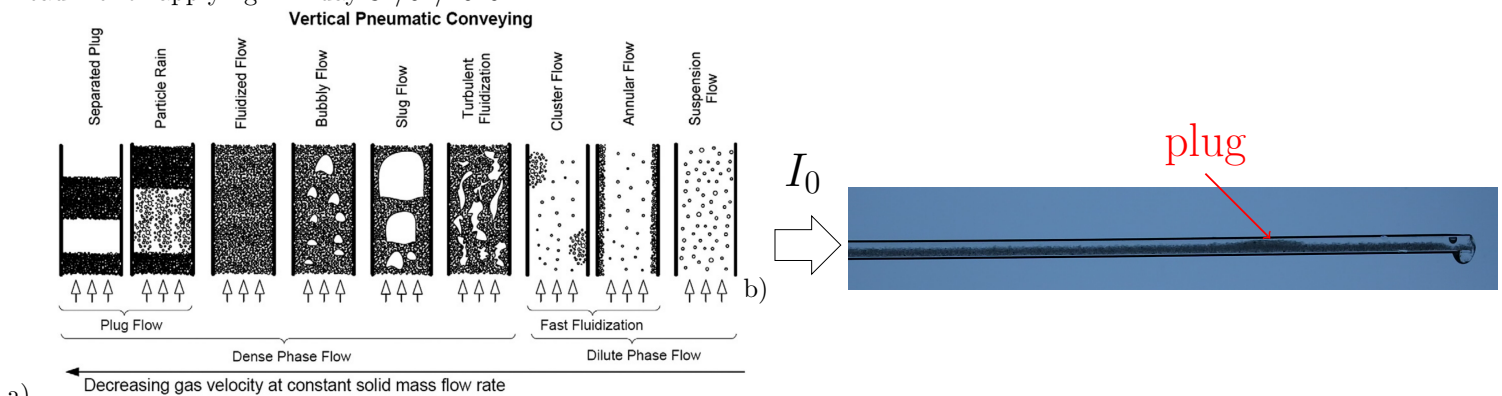
Master research project

Granular matter has an exotic flowing behaviour. It doesn't respond to pressure gradient as conventional Newtonian fluid, however it can flow by gravity as a liquid (see the similarity between an hourglass and a water clock, even though the physics is different).

When it comes to address the industrial transport of granular material (powder, grains, sand, etc) on a plant scale (or larger) pneumatic conveying can be suitable as it is flexible, fast and prevents product contamination. It consists in driving a granular phase with the viscous flow of a fluid along a discharge pipe line. Various industries such as chemistry, pharmacy, food, building or recycling sector have a strong interest for efficient transport techniques while processing their products. Several transport regimes can then develop by varying the concentration of the solid phase in the flow. Dilute kinetic regime develop when high flowing velocities are imposed. Reciprocally dense slugs or plugs of packed granular matter form with lower flow velocities. However this promising technique is yet limited by poor predicting laws for transport regimes in a conveying line. This 6 months payed Master research project aims at exploring the physical modelling of pneumatic conveying, and describe the exotic behaviour of such a complex fluid.

A very rich physics based on the complex interplay between viscous dissipation and solid friction is involved here. The candidate will be asked to model experimentally a conveying line at a laboratory scale reproducing typical pneumatic transport regimes. Comparison with industrial data will pave the way for the determination of general scaling laws able to predict the pneumatic transport regime. Perspectives can be considered with the statistical analysis of the flow behaviour, the numerical modelling of the system towards digital twins, or the interpretation of the observed features by means of artificial intelligence algorithms.

Deadline for applying : Friday 31/01/2020.



a) Schematics of the transport regimes observed in vertical pneumatic conveying of powders [1]. b) Millifluidic hydraulic conveying of glass beads reproducing a pneumatic *slug flow* regime.

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Bibliography :

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- [2] J.-P. Duroudier, *Divided Solids Transport*, iSTE Press, Elsevier (2016).

