DIN - DEPARTMENT OF INDUSTRIAL ENGINEERING

PhD Course in Mechanics and Advanced Engineering Sciences (DIMSAI)

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MULTIPHASE FLOW ENGINEERING: DESIGN AND REALIZATION OF INDUSTRIAL PLANTS

Fig.1:Spray drier outlet and conveyor belts

Introduction

Nowadays, in the ceramic industry, atomized slip conveying is mainly carried out by conveyor belts (Fig.1). This kind of transport, without specific powder confinement devices, spread out fine particles, causing dust pollution and generating risk for workers' health.
Atomized slip pneumatic conveying fully solves dust pollution problem in the working environment. However, two technical parameters need to be controlled and kept constant to make a sustainable pneumatic conveying of atomized slip: product humidity and particles size.

Project description

The ultimate goal of the research project is to design and realize an industrial plant for pneumatic conveying of atomized slip in dense phase, avoiding critical problems of product damage and humidity. A finite element software simulator (TPSim Win) will be used to design the pipe diameter and the loading ratio, i.e. the ratio between the mass flow rate of solid and air.

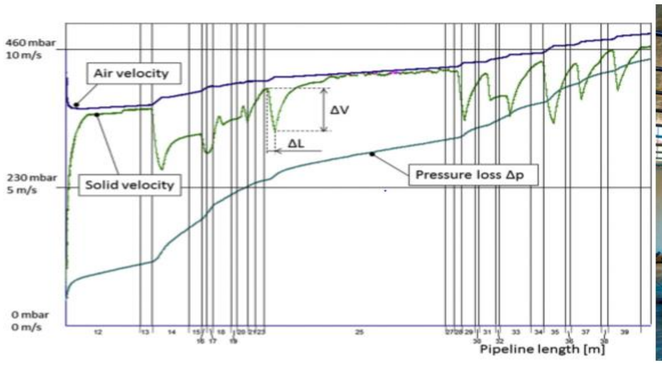

Fig.2: Typical TPSim Win output diagram

Fig.3: Pneumatic conveying test facility

TPSim Win needs three basic input data: bend friction coefficient, straight friction coefficient and product hydraulic diameter. A typical output diagram of TPSim Win is represented in Fig.2.
A pneumatic conveying test facility has been designed and realized in industrial size (Fig.3), to measure the above-mentioned characteristic values, which are necessary for industrial plant design. Moreover, on the pilot plant we can study the behaviour of atomized slip along the pipeline, evaluating the impact of the transport process on product features, and we can confirm fluid-dynamical parameters foreseen by the TPSim Win software simulator.
A number of tests have been carried out. Particles size distribution and humidity of conveyed material have been measured after each single test to define the best operating conditions.

Results

The results of the experimental tests prove that solid and air speed, which are closely linked, are the most relevant parameters in terms of product integrity. Fig. 4 shows the effects of a pneumatic transport process carried out both with low loading ratio (m=12) and with a higher loading ratio (m=32). In the first condition, pneumatic conveying tends to produce a considerable amount of fine material. Instead, when the mixture ratio is high, product wear is very limited.
As regard atomized slip humidity, this problem is less relevant with high loading ratio, where the lower compressed air flow rate has a smaller influence on thermo-hygrometric properties of the product. Furthermore, solid humidity fluctuation can be limited by controlling the temperature all along the full pipeline length.

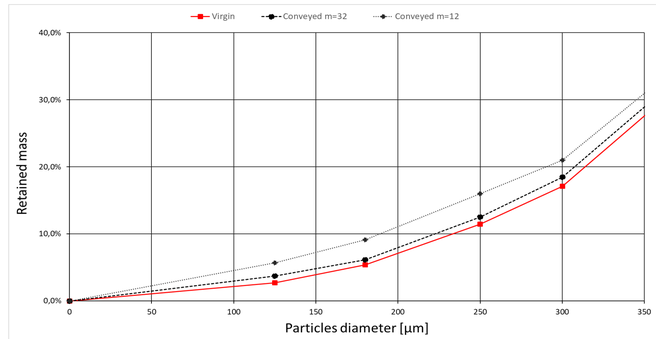

Fig.4: Grading curves of virgin atomized slip and conveyed atomized slip

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