

Shear device for measurement of wall friction in designing granular moving bed filters

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Abstract—A new measuring method and device for measurements of flow properties of filter granules and pellets of larger particle sizes, particularly for wall friction measurements, is proposed. A bidirectional stress gage is employed in the new shear device. The shear ring is 200 mm in internal diameter. The shear path of the specimen of particulate solids is long enough to measure wall friction coefficients of large granules and rocks considered as moving bed filter media. Several tests with different granular materials and using different shear rings have been performed.

Keywords: Granular bed filter; filter granules; wall friction device.

1. INTRODUCTION

Wall friction is a critical parameter when designing granular moving bed filters (GMBF) for hot gas cleanup with mass flow louvered walls **1**, **1'** and cross-flow of gas with fly ash **3** (Fig. 1). Mass flow provides a first in, first out flow pattern of moving bed at the bottom **4** of the filter, where all the filter granules **2** are in motion whenever the GMBF is operated. This is especially important when moving beds of filter granules with fly ash fine particles are cohesive and form stagnant zones **2-a** along louvered walls.

Two basic criteria must be met to achieve mass flow. The outlet span between opposite louvers must be large enough to prevent arching, and the convergent channel formed by couple of opposite louvers must be steep enough and have sufficiently low friction to allow the filter medium in the moving bed to flow along the louvered walls smoothly. The latter criterion is a function of friction between the granular filter media and the louver wall surface. Some factors which are known to affect wall friction include louver wall surface characteristics, filter media and fly

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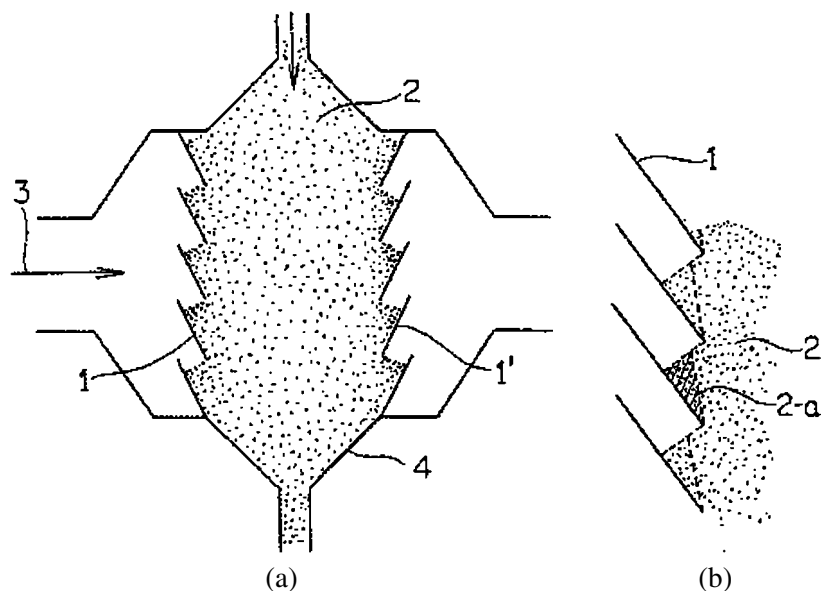


Figure 1. Filter moving bed. (a) Mass flow. (b) Stagnant zones.

ash flow characteristics, and the filter operating conditions (temperature, moisture, etc.).

Wall friction determines whether a channel between louvers is mass flow, which in turn affects louver loads, segregation of filter granules and fly ash fine particles, wear of the louver walls, filter panel vibrations, velocity profile of granular moving bed in convergent channel of louvers, and the size of outlet span between louvers to prevent arching. This paper will introduce a new method of wall friction measurement of large granules of filter media in GMBFs. The ring of the shear cell and the shear path of the new device are compatible with granules and pellets of larger sizes.

2. WALL FRICTION MEASUREMENTS

For a filter medium to slide on a surface of louver, friction between the two must be overcome. This friction is typically measured using a Jenike shear tester (JST) [1, 2] as shown in Fig. 2. First, the filter granules are placed in a retaining ring on a flat piece of louver wall material. Then, using weights, various forces are applied to the filter granules in a direction normal to the louver wall specimen. Filter granules in the ring are forced to slide along the stationary louver wall specimen and the resulting shear force is measured as a function of the applied normal force. The weights used should reflect the pressure range expected in the GMBF moving bed. Five to seven points of wall friction measurements are normally generated. To measure the wall friction, a flat sample of the louver wall material about 11-cm square is required.

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