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Review Paper on Factors Affecting Efficiency of Vibration Screen

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***Abstract* - In this review paper some basic factor affecting performance of horizontal vibration screen are studied, in order to find out condition for which maximum screening efficiency can be achieved. .Efficiency of vibration screen generally depends upon different factor such as material loading, screen inclination, screen aperture, frequency of vibration, amplitude of vibration. Paper includes study of these factors in order to improve efficiency of vibration screen. In this paper 3D DEM method used for simulating flow of material on vibrating screen. Results are simulated with software and experimental results are also comparing to predict generalized result. Numerical finite element models were generated to investigate the structural and dynamic behavior of a standard vibrating screen. These analyses allowed the modification of the geometrical parameters of the traditional screen and to design the new one.**

I. INTRODUCTION

Mineral processing operations include three main parts of crushing, classification and separation. The classification stage is of importance from different aspects such as reducing energy consumption, suitability of the product for the next phase of the process, suitability of the product for sale and so on. If in the process of crushing, the materials are crushed more than what is suitable, in addition to power dissipation, fines particles are generated that valuable material in it that cannot be recycled at a later stage. Also, if the material is not crushed reason enough in crushing stage and enter phase separation, its valuable content is not released yet and cannot be separated, and thus enters into the waste stream, so investigating performance of this equipment in given periods of time is necessary. Vibration screen is important equipment of this step. Vibration screen is often used for scattered materials in most areas of mining, metallurgy, building materials, food, medicine, chemical industry, energy, and environment . Screening or sieving is widely used in industry as a unit operation for large-scale separation of particles, and the application fields include traditional mineral, metallurgical sectors, food sorting and infrastructure construction. In the high grade highway. The working performance of vibrating screen directly affects the economic benefit and production safety of enterprises. Sieving and screening are widely used in industry as a unit operation for large-scale separation of particles according to size and in the laboratory as a tool for the analysis of particle size distribution, usually at a small scale. Sieving is one of the oldest and most widely employed physical size separation methods. Although this very ancient technique may be dated back to thousands of years ago, an insightful understanding of this technique has never been realized due to the complicated size distribution, and composition of industrial particulate solid.

II .LITERATURE REVIEW

To realize the full potential of a production plant, cost effective strategies such as gravity classification must be exhausted before resorting to more energy intensive options (which may not necessarily be more efficient). Thus, detail understanding of the process is necessary. This research is built upon the models developed in an earlier work in which it was proposed the rate of particles classification is proportional to the rate of change in momentum (P), and the screen area, and inversely proportional to the particles diameters. Successful development of the approach would enable gravity-based systems e.g. deck screens, to be applied not only in the minerals industry but across process industry as a whole[1]. Knowledge of process flow conditions together with information about the flow properties of materials over different equipment surfaces will enable process engineers to optimize material handling operations by utilizing approximate empirical models for instance, to predict material flows. Possible applications also exist in other areas such as, coal beneficiation or biomass classification during pre/post combustion, municipal solid waste management, food cereals processing, pharmaceutical, agricultural products and farm inputs, crystals classifications, and many other related industries. In applying such systems, the main factors to consider are flowability (of material on equipment), deck screen inclination, angle of repose and mass throughputs or loading per total projected area of screen. Flowability is the ability of granular solids and powders to flow [2]. It is important to note that flowability is not an inherent material property, but rather a combination of the physical properties of a material (particles) that affect its flow on another material (equipment used for handling, storing or processing). It follows, therefore, that consideration must be given to both the material and the equipment. Consequently, flowability has been defined more accurately as ‘‘the ability of the powder to flow in a desired manner in/on a specific piece of equipment''.[3].

III. METHODOLOGY

A. Experimental Setup

Glass beads particles of mass, MT ranging from 10 to 160 g (16batches), and known particle sizes (0.75, 1, 2, 3 mm), were released from an elevation to an inclined sieve with increasing (known) aperture sizes downwards, Dap (1–4 mm), with channels below each sieve to collect the undersize. In this experiment, the same methodology as in Rotchi el(2013)was followed, with the exception that in the current study the process was repeated for six deck angles of inclinations (20^0, 15^0, 14^0, 12.5^0, 10^0, 5^0) for each batch (MT) of glass beads. The aim was to assess the effect of different inclinations and changes in feed throughputs on flowability (velocity), classification rates and efficiencies. The following measurements were taken and recorded: sample mass MT, mass of the undersize collected on the 1, 2, 3 and 4 mm sieves (m1, m2, m3, m4 and oversize Mi), and elapsed time t. The
Fig.1 DEM model of vibration screen for simulation following values were calculated directly from the collected data: total undersize masses (Mu), classification efficiency g, computed as the ratio of total mass of undersize Mu to the batch mass MT, epsilon e, computed as the ratio of mass of collected oversized particles to the total sample MT.

B. DEM simulation

The application of the Discrete Element Method (DEM) to vibratory screen analysis is a great improvement that was introduced by Cundall and Strack as a way to model the behavior of dense solid assemblies in soil. The sieving analysis initially employed a ''first-order rate law'' to analyze screening, e.g.; the random path model of Jansen and Glastonbury, which was only applicable to independent particles. Then ideas from Computational Fluid Dynamics (CFD) were adopted and the solids were treated as a continuum. Finally, multiphase flow models using the, so called, Lagrangian approach or the DEM are now being developed where the motion of each individual particle is determined as a consequence of all the forces acting on it. The basic advantage of this method over continuum techniques is that it simulates effects at the particle level and there is no need for global assumptions about the assembly response, which is directly output from the simulation. The fundamental theory of particulate simulation uses the ''springs and dash pots'' model to represent particle interactions, as shown in fig. This has been adopted in most of the current DEM applications to particulate flows. Particles are assumed to be cohesion-less elastic bodies and the microscopic particle–particle and particle–boundary interactions are calculated along with the evolution of the particle trajectories.

C. Conditions of the simulation

A 3D DEM model as shown in fig.3 was set up to simulate the screening process for an angle of 21 degree as the screen inclination. The screen box is 160 mm long, 30.5 mm wide, and 80 mm high. The boundary consists of a woven mesh with a wire diameter of 0.7 mm and a square aperture 1 mm on a side. This provides an aperture that allows undersize particles to pass through it. Particles fed onto the front section of the screen by gravity, via the particle factory.

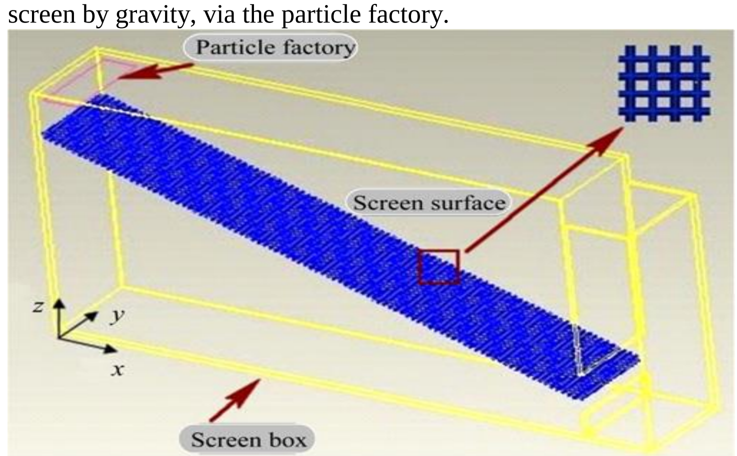

Fig.1 DEM model of vibration screen for simulation experiment

The particles falls through apertures and become an underflow stream. Other particles rebound along the screen surface and become the overflow stream. This study employs a mixture of two different sized particles, which consists of bimodal normal distribution with individual mean diameters of 0.5 and 1.0 mm. The standard deviation in diameter is 0.45. The spherical particle density is 2687 kg/m3, which have similar properties to sands. The initial velocity calculated from the feed was assigned to all the particles. At the moment of generation the particle velocity is assumed to be vx = vy = 0 and vz = –0.01 m/s. As a result of vibration the velocities in all three dimensions changes because the particles contact each other and the screen surface. The conditions and parameters of the model are listed in Table 1. Simulations have been divided into four groups according to the parameters used. The first group was conducted using various amplitudes: 0.5, 1.5, 2.55, 3.5, 4.49, 5.0, and 7.0 mm, while the other conditions were held constant. For the second the frequency was varied: 10, 15, 20, 30, 40, 50, 60, and 70 Hz. Different vibration angles of 10, 21, 32, 44, 51, 61, 71, 81, 90, and 100 degrees were used for series three. Series four involved different inclinations: 0, 10, 15, 20, 25, 30, 35, and 45 degrees. The length of the screen surface was 160 mm and it was evenly divided into eight parts so the relationship between screen length and screening efficiency could be analysed.

IV.RESULT AND DISCUSSION

Screening efficiency versus screen length: varied frequency and vibration angle Frequency mainly influences the bounce state of particles on the screen surface. High frequency is benefit to penetration and to avoid blinding of particles. The vibration angle is defined as the angle between the vibration direction and the screen surface. An appropriate vibration angle not only can improve well-proportioned bounce but also raise the screening efficiency.

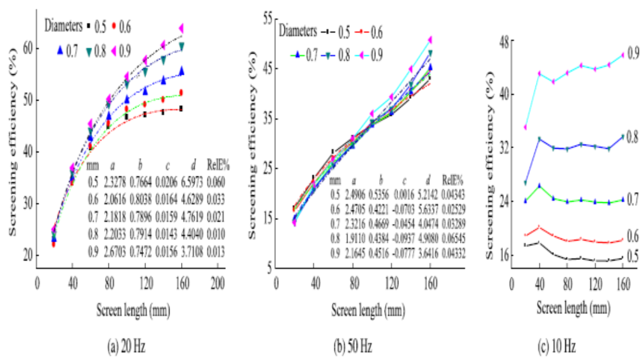

Fig 2.Effect of screen length on efficiencies [1]

The screening efficiency curves for different frequencies appear and efficiency curves for different screen inclinations appear in fig 2. As the frequency increases there are obvious changes in the curves. Between 20 and 30 Hz, a commonly used range, the screening efficiency increases at longer screen lengths one of which was shown as fig 2a at 20 Hz. Fig. 2b shows that efficiency is almost proportional to screen length when the frequency is very high, over 50 Hz. Lower frequencies, less than 10 Hz, give curves that are almost horizontal, see fig.2c. In this case a low peak emerged at a screen length of 60 mm mainly due to the moment of the particles falling on the screen surface. The vibration angle simulations are not exactly the same as those where frequency was varied. At excessively high frequencies the particles had high kinetic energy and touched the screen surface for a shorter period of time. Larger vibration angles extend the time of the particles stay on the screen surface and raise penetration efficiency. When the vibration angle is over 100 degrees the particles have a tendency to rebound, which then results in the ‘‘pollution’’ of oversize particles in the underflow area.

Screening efficiency versus screen length: varied amplitude and screen inclination Vibration amplitude mainly influences the kinetic energy of the particles. Large amplitudes contribute to energy transportation and stratification and also make the particles bounce higher and further. This is also an important influence on the required structural strength of the vibrating screen. Increased amplitude requires the structural strength to be taken into account. Inclination of the screen is defined as the angle between a horizontal line and the screen surface.

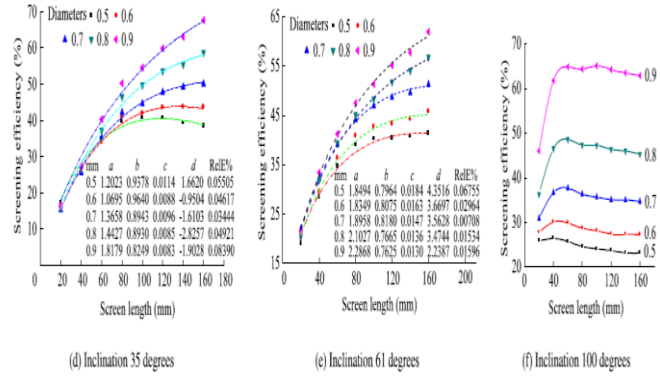

Fig 3 Effect of Screen inclination angle and length on efficiency [1]

Changes in inclination directly influence the horizontal projection of the holes in the screen cloth and the velocity of the particles moving, or bounding, on the inclined surface.Large inclinations shrink the horizontal projection of the aperture almost horizontal. This can be seen in Fig 3. The screen length of 60 mm is critical because at this point there is a peak and the screening efficiency becomes stable at longer lengths. In industrial screening applications only wet sieving of particles containing a mass of water employs a large vibration angle.

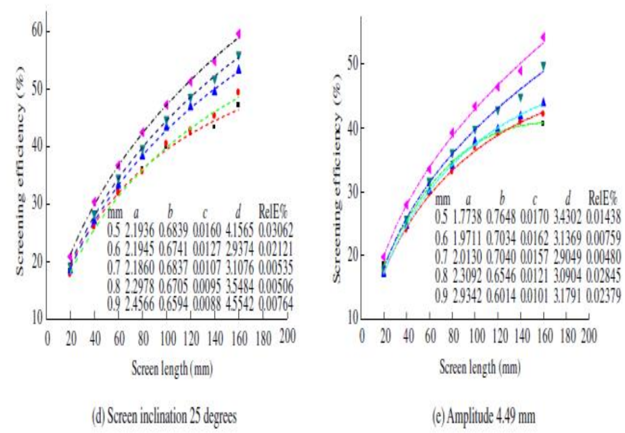

Fig.4 Effect of Amplitude and screen length on efficiency[2]

Screening efficiency versus screen length: varied amplitude and screen inclination Vibration amplitude mainly influences the kinetic energy of the particles. Large amplitudes contribute to energy transportation and stratification and also make the particles bounce higher and further. This is also an important influence on the required structural strength of the vibrating screen. Increased amplitude requires the structural strength to be taken into account. Inclination of the screen is defined as the angle between a horizontal line and the screen surface. Changes in inclination directly influence the horizontal projection of the holes in the screen cloth and the velocity of the particles moving, or bounding, on the inclined surface. Large inclinations shrink the horizontal projection of the aperture and the horizontal component of velocity rises. Penetration probabilities of the particles decrease in the normal direction and as a result this contributes to an increase in productivity. Fig 4 shows the situation of small amplitude and screen inclination amplitude of 0.5 mm and an inclination of 0 degrees).

REFERENCES

[1] N. Rotich, R. Tuunila, M. Louhi-Kultanen, “Empirical study on the effects of screen inclination and feed loading on size classification of solids by gravity”, Mineral Engineering 70 (2015) pp.162-169.

[2] Dong Hailin , Liu Chusheng , Zhao Yuemin , Zhao Lala, “Influence of vibration mode on the screening process”,International Journal of Mining Science and Technology 23 (2013) pp.95–98

[3] Wang Guifeng, Tong Xin, “Screening efficiency and screen length of a linear vibrating screen using Dem 3D simulation,”Mining Science and Technology (China) 21 (2011) pp.451–455.

[4] Zhao Lala, Zhao Yuemin, Liu Chusheng, Li Jun, Dong Hailin, “Simulation of the screening process on a circularly vibrating screen using 3D-DEM”,Joural of mineral engineering pp.342-349

[5] M. Jahani, A. Farzanegan , M. Noaparast,” performance of Banana screen using LIGGGHTS DEM solver”, International Journal of Mining Science and Technology 23 (2013) 95–98.

[6] Leonid I. Slepyan, Victor I. Slepyan,**”** coupled mode parametric resonance in vibrating screen**”** Mechanical SystemsandSignalProcessing43(2014)295–304

[7] Changlong Du,Kuidong Gao,Jiamping Li and Hao Jiang,” Dynamics Behavior Research on Variable Linear Vibration Screen with Flexible Screen Face”, Advances in Mechanical Engineering Volume 2014