A Review on modeling and Analysis of Circular Vibrating Screening machine

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Abstract: The vibratory screening machine is used in different industries like mining, pharmaceutical, food etc. In the past, the study of screening machine has been done on the basis of its design parameters like diameter of wire, length, mesh size, throwing index etc. The work regarding vibrational parameters is not widely done in the past. A little work on mathematical modelling has been done on the rectangular type vibratory screening machine. But the work related modelling and simulation is not sufficiently done on circular vibratory screen. In this paper the review on vibratory screen by modelling and simulation has been done. A mathematical model of vibratory screen and the motion equations are studied.

Keywords: Mathematic modelling, Chaotic Vibration, Screening characteristicsof Vibrating screening Machine

I. INTRODUCTION

Industrial screens are used in the minerals processing industry to separate solids from liquids and to separate particulate materials into different size ranges. Screening has been extensively used since the Greeks used horse hair-and-reed sieves to effect particle size separation. The first woven wire screens dates back to the 15th century Germany and remain largely unchanged today. Sieves and screens are used both industrially and in the laboratory to classify particulate material by particle size. The term "screening" is commonly used to mean a continuous sizing operation as distinct from sieving, which is a batch operation. The principles of size separation during screening and sieving are the same. Even in these early times, it was realized that shaking the screen by hand the efficiency of the screening process is improved.

Basically, the vibrating screening machine vibrates about its centre of mass. Vibration is accomplished by eccentric weights on the upper and lower ends of the motion-generator shaft. Rotation of the top weight creates vibration in the horizontal plane, which causes material to move across the screen cloth to the periphery. The lower weight acts to tilt the machine, causing vibration in the vertical and tangential planes.

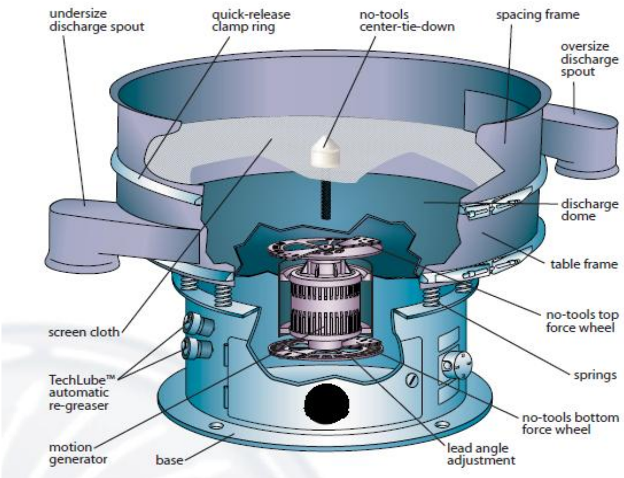

Fig 1.1 Vibratory Screening Machine

This is the reason why conventional systems cannot be used with slightly sticky and/or agglomerating materials, with heavy meshes (over 300 microns) or with large machines, especially rectangular screeners. On the contrary, the energy output capabilities of the Vibratory Screening Machine are so huge, that practically all kinds of materials are de-agglomerated and clogging of the mesh by any powder or slurry is avoided. Therefore the Vibratory Screening Machine can easily work with all meshes from 15 microns to 30 mm.

II.LITERATURE REVIEW

W. Vorster et al (2002) [1] have demonstrated that the throughputs of Sweco screens can be increased by at least an order of magnitude (at mesh sizes less than 100 µm) for dry material, without sacrificing efficiency, by retrofitting a device called a Kroosher.

- The Sweco separator is a screening device that vibrates about its centre of mass. Sweco claim greater capacity and screening efficiency with less blinding than other types of screening devices.
- The Kroosher is a mechanical converter, converting mono-harmonic oscillations to amplified poly-harmonic oscillations.

Fig 2.1 the Kroosher unit on a Sweco

Dry screening test work was conducted in order to identify and quantify changes in efficiency for the screening process. It was found that for the same screening efficiency, the throughput may be increased by more than 810% by fitting the Kroosher to a standard Sweco.

Song yam et al (2009) [2] has presented a new type of multi-degree-of-freedom and highly efficient vibrating screen based on multi-degree of freedom mechanics principle of dynamics. Its prominent character is to have an additionally high frequency and short amplitude vibration on long amplitude vibration. And it can efficiently increase probability of material crashing, eliminate blinding aperture, and get high screening efficiency.

According to the definition of classic institutions, the necessary and sufficient condition of the specified movement is that the number of the original is equal to the number of the degree of motion. If the number of freedom of motion is greater than the number of the original, we cannot call it mechanism.

HE Xiao-mei et al (2009) [3] An accurate mechanical model was constructed according to the required structural motion features. Applying multi-degree-of-freedom vibration theory, characteristics of the vibrating screen was analyzed.

Vibrating screens commonly work at fixed vibration intensity. Material on the screen surface moves by throwing, rolling or sliding motions. For common screeners, material granularity is widely distributed at the feed end. The energy imparted to the material particles from the vibrating screen is severely dissipated. Consequently, a large number of particles become laminated only a short distance from the feed end. The material penetrates the screen within the first 1/4 to 1/2 of the screen, which affects screening and lowers processing capacity. The decrease of fine-grained material causes the ratio of particles close in size to, or larger than, the mesh to increase. Thus, the screening efficiency declines dramatically. The material granularity simultaneously becomes uniform and the energy imparted from the vibrations to the material suffers little loss. Hence, the amplitude and velocity of the material particles increase. This causes the material bed depth at the feed end to be thick while at the discharge end it is thin. This kind of motion leads to an asymmetrical penetration along the screen surface, which influences the screening efficiency and processing capability.

LIU Chu-sheng et al (2012) [4] have presented a new concept of vibrating screen which has the same effect as traditional vibrating screen in a new way was put forward. The dynamic model of vibrating screen was established and its working principle was analysed when the action line of the exciting force did not act through the centroid of screen box. Moreover, the dynamic differential equations of centroid and screen surface were obtained. The motions of centroid and screen surface were simulated with actual parameters of the design example in MATLAB/Simulink.

Substituting parameters into the simulation-compute model, as shown in Fig., we get the motion time course for signals of displacement, velocity and acceleration of the centroid of screen box in directions of *x*-axis, *y*-axis and θ after the vibration is stable.

The periodic signals above essentially reflect the integrated information of exciting frequency of system and natural frequency in the three-DOF system. Detailed analysis requires frequency spectrum analysis of signals, implemented by fast Fourier transform (FFT), as shown in Fig.

Chen Yan-hua et al (2009) [5] have presented a numerical model for the study of a particle screening process using the discrete element method (DEM). Special attention was paid to the modeling of a vibrating screen that allows particles to pass through, or to rebound, when approaching the screen surface. Inferences concerning screen length and vibrating frequency as they relate to screening efficiency were studied. The conclusions were: three-dimensional simulation of screening efficiency along the screen length follows an exponential distribution; when the sieve vibrates over a certain frequency range the screening efficiency is stable; and, higher vibration frequencies can improve the handling capacity of the screening machine.

Chen Yan-hua et al (2010) [6] have studied the efficiency of particle screening over a range of vibrational parameters including amplitude, frequency and vibrational direction. The Discrete Element Method (DEM) was used to simulate the screening process. A functional relationship between efficiency and the parameters, both singly and combined, is established. The function is a complicated exponential. Optimal amplitude and frequency values are smaller for particles near the mesh and larger for other particles. The optimum vibration angle is 45° for nearly all kinds of particles. A transverse velocity, $V_{\perp}$, was defined and $V_{\perp}$=0.2 m/s was identified to be the most efficient operating point by both simulation and experimental observation. Comparison of these results with those reported by others is included.

Wang Guifeng et al (2011) [7] have established functional relationship between screening efficiency and screen length. It is shown that screening efficiency and screen length have a complicated exponential relationship. Relationships between them are profoundly discussed and conclusions are easily drawn: low values of the parameters do not benefit screening; screening efficiency generally increases with screen length; screening efficiency reaches a plateau when these parameters are in range frequently encountered in practical applications.

Xiao Jianz hang et al (2012) [8] have performed a simulation of stratification and penetration over a range of structural parameters that included screen width, aperture size, inclination angle, and wire diameter. The discrete element method (DEM) was used for the simulations. The terms stratification and penetration are defined and the change in fine particle concentration is discussed. Mathematical models relating fine particle ratio to time are established using the least squares method. The effect of structural parameters on fine particle ratio is analyzed. Stratification and penetration rate are discussed by considering the time derivative of the fine particle ratio. The conclusions are: an increase in inclination or wire diameter has a positive effect on particle stratifying. The optimal screen width is 40 mm for particle stratification; the inclination angle has a negative effect on the penetration; The effect of wire diameter and screen width on the penetration rate is negligible.

III. CONCLUSION

In this paper the work on vibratory screen by modelling and simulation will be done. A mathematical model of circular vibratory screen is prepared and the motion equations are derived. The natural frequency equations are derived. Different work is done by different authors in the context of different types of screening machines by different types of methodologies. In this review paper work a methodology is prepared on the basis of two degree of freedom mass couple system. The vibrating screening machine is considered as three degree of freedom force vibration system, which has motions in two directions translational and rotational.

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