The Ultimate Screener

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Paper written on project work carried out in partial fulfilment of B.Sc Eng (Extractive Metallurgy) degree

Introduction

Screening is an industrial process that splits material at a specific cut size into one fraction of particles larger than the cut size and another fraction of particles smaller than the cut size. Particles are vibrated to increase the probability of them being accurately classified and to move the oversize particles off the screen surface.

In conventional screening, the screen mesh vibrates with a single frequency and the particles on the screen are all exposed to this same frequency. The Ultimate Screener (see Figure 1) is a new screen technology that imparts multi-frequency vibrations to the screen mesh so that different parts of the screen surface vibrate at different frequencies.

The Ultimate Screener incorporates an additional deck that holds the multifrequency adapters as shown by Figure 2. These special adapters can transform single frequency vibrations into multifrequency vibrations. When the screen motors are switched on they begin to vibrate. This vibration is transmitted to the adapters via the body of the machine. The adapters then modify the vibration to have multiple frequencies, which are transmitted to the screen surface via resonating rings.

When the screen mesh is vibrating at a single frequency, all the particles exposed to the surface will be exposed to the same force. The particles will then vibrate on the screen with the same amplitude and frequency. When the screen experiences multiple frequencies, the particles on the surface will also vibrate at different amplitudes and frequencies. The frequency with which the motor on the Ultimate Screener vibrates can be set and varies between 40 and 60hz.

This project investigated the metallurgical performance of the Ultimate Screener. It also looked at the differences between screening with a single frequency vibration and screening with multifrequency vibrations. Screen performance is typically quantified by throughput, mesh blinding, and screening efficiencies. These parameters were used in evaluating the metallurgical performance of the Ultimate Screener.

The material that was screened was specified to be calcined anthracite. Calcined anthracite is often used in steel mill ladles and as a recarburizer in blast furnaces. It is can also be used as a substitute for calcined petroleum coke due to its high quality and cost effectiveness. www.luckydragon.com.cn/products/calcined anthracite

Experimental procedure

The following factors were investigated:

- Screen mesh size. Two mesh sizes (212 µm and 25 µm) were used to evaluate the screen performance
- The motor frequency was also varied and tests were conducted at 45, 50 and 55 hz. This was done to investigate the effect, if any, of the motor frequency on the screening kinetics and efficiencies

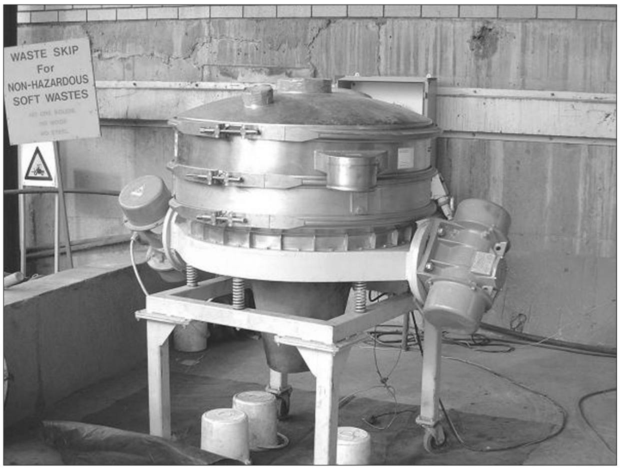

Figure 1—The Ultimate Screener

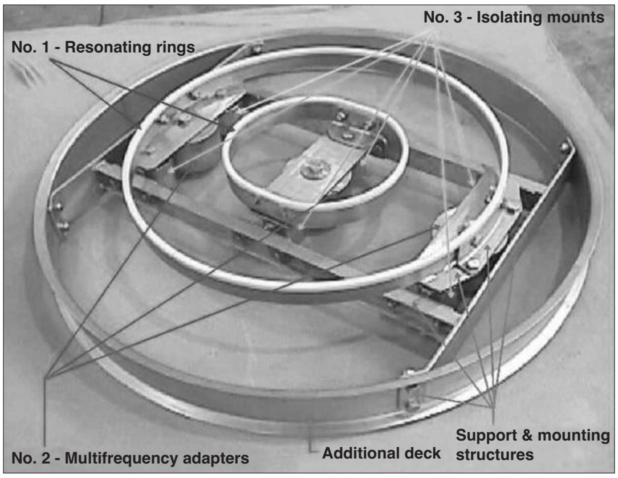

Figure 2—Additional deck showing intergral parts of the Ultimate Screener

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- Tests were also conducted on the Sweco screen for comparison purposes at 212 µm and 25 µm.

A 5 kg coal sample was placed on the centre of the screen mesh. The oversize outlet was blocked off and batch tests were conducted. Undersize samples were collected periodically for a total test duration of 30 minutes. The size distribution of the samples was determined via sieve analysis to assess the batch kinetics. This posed a problem when screening at 25 µm as the undersize particles were too fine to be analysed in this way. Attempts were made to evaluate the size distribution of these samples using light diffraction techniques. This failed due to a significant amount of agglomeration due to magnetic flocculation in the –25 µm fraction. This can be seen in Figure 3. As a result, screening at 25 µm was evaluated only according to the efficiency.

Batch tests were conducted and, to get an idea of the throughputs, batch kinetic curves were generated.

The screening efficiency was calculated according to Equation [1] below:

$$Efficiency = \frac{Mass\ of\ undersize}{Mass\ of\ undersize\ in\ feed} \times 100 \qquad [1]$$

A perfect separation is never obtained. There are always undersize particles that report to the oversize fraction. If the screen cloth is worn or has a tear, oversize particles will also be able to report to the undersize fraction. As a result, using the efficiency factor is simply not enough when describing the screening capabilities. A more representative description would be obtained via a partition curve. This is a curve that describes the fraction of each size class that does not pass the screen surface. The partition curve is usually modelled by Equation [2] below:

$$Ro = r_f + \frac{(1 - r_f)\left(1 - \exp\left(1 - a\left(d / d_{mesh}\right)^m\right)\right)}{1 - \exp(-a)} \qquad [2]$$

Where:

r_f = bypass factor

Ro = recovery to the oversize

d = particle size (µm)

a,m are shape parameters that are used to fix the shape of the curve.

For the purposes of this project, Equation [2] was solved by minimizing the sum of squares between the experimental data and the model in Excel.

Precautionary steps were taken to minimize the amount of coal dust produced during the test work. All the openings and joints on the screen were sealed with masking tape to prevent any of the dust produced from escaping the body of the machine. A large amount of static electricity was generated from the unit so hand protection gear needs to be used at all time.

All tests were duplicated to verify the results.

Results and discussion

Figure 4 illustrates the kinetic curves obtained for screening with the Ultimate Screener at 212 µm. It is evident that the screening was very easy at this mesh size as it took only one minute to screen out the undersize material. The higher motor frequencies produced faster kinetics at the start of the test.

When screening at 25 µm, the trends are more evident, as shown in Figure 5. The higher motor frequency resulted in a faster and more efficient separation.

When comparing the efficiencies of the various tests conducted at 25 µm and 212 µm on both screens, the Ultimate Screener was found to be significantly more efficient than the Sweco Screen (see Figure 6). Sweco 1 and Sweco 2 refer to the two tests conducted on the Sweco Screen.

Figure 7 clearly shows that screening at 25 µm can be easily accomplished using the Ultimate Screener with efficiencies ranging from 90 to 98% depending on the motor frequency where conventional screening failed completely.

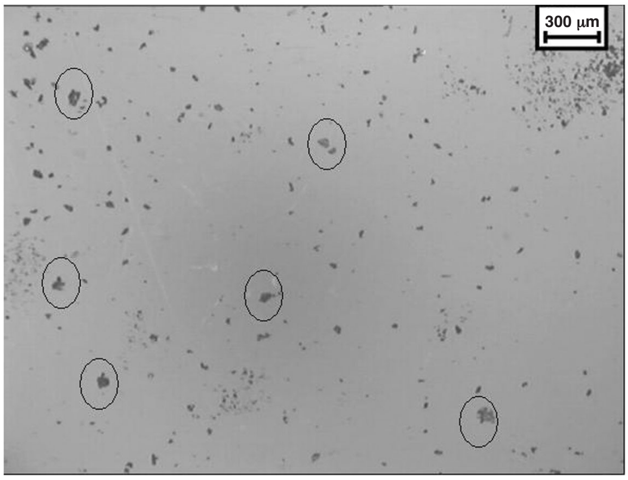

Figure 3—Agglomeration due to magnetic flocculant of –25 µm particles

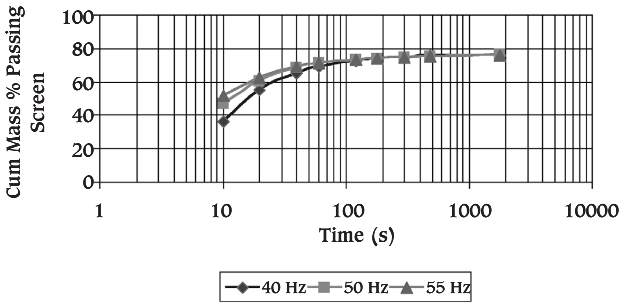

Figure 4—Batch kinetics with a mesh size of 212 µm

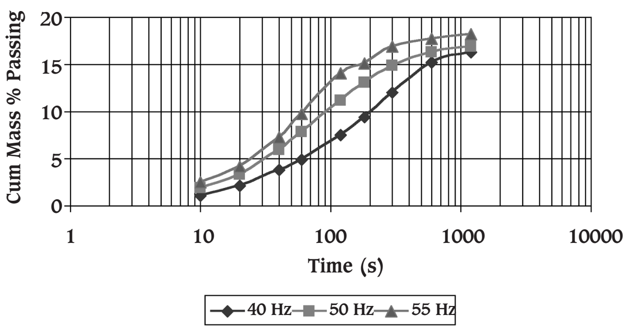

Figure 5—Batch kinetics with a mesh size of 25 µm

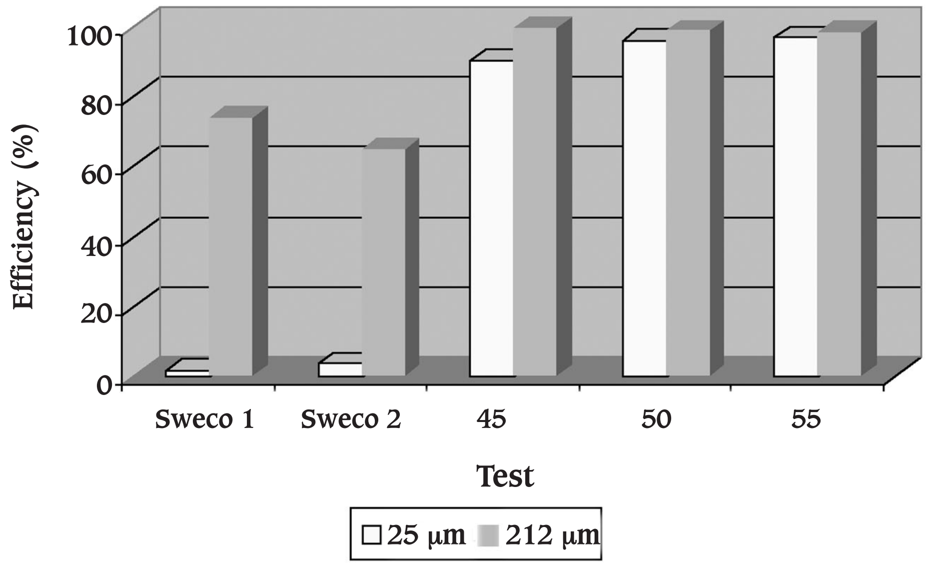

Figure 6—Comparative efficiencies

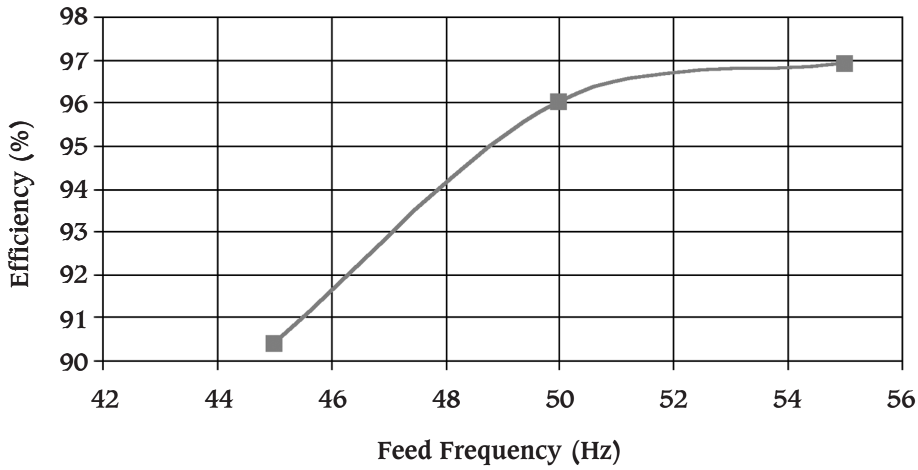

Figure 7—Relationship between screen efficiency and motor frequency when screening at 25 µm

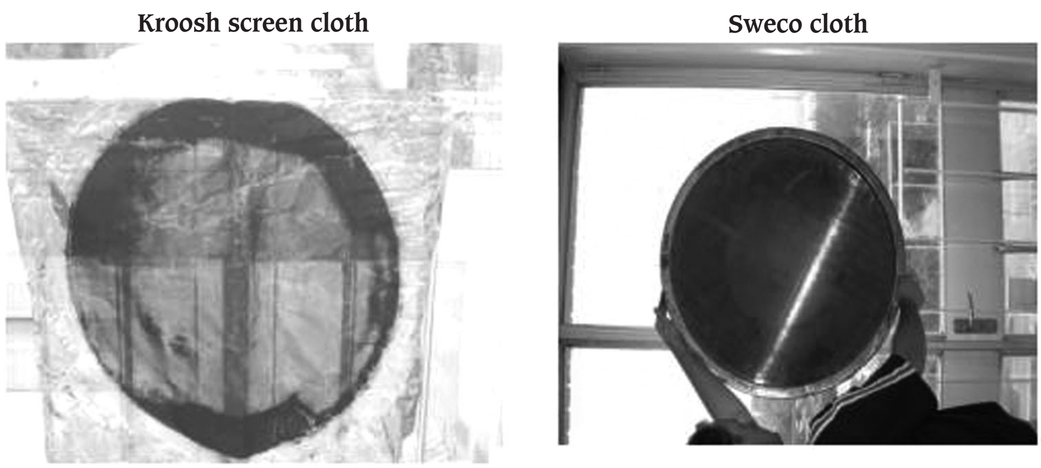

Figure 8—Mesh blinding on the 25 µm mesh

The effect of the motor frequency on the screen performance is significant when screening at the finer mesh sizes, as in this case.

The degree of mesh blinding was more severe on the Sweco screen cloth than the screen cloth used on the Ultimate Screener. Figure 8 shows the different degrees of mesh blinding on the two screen cloths. The outer edges of the screen cloth used on the Ultimate Screener showed more blinding than the inner region did. This was attributed to the flow pattern of the material on the screen whilst in operation. The material is fed onto the centre of the screen mesh and then migrates outward as it vibrates. Once it reaches the outside of the screen surface, the vibrations become very week and the material starts moving along the outside rim of the screen in an anticlockwise direction. The weak vibrational force and the circular flow pattern result in more blinding in this region

An important observation was that the screen wear on the Ultimate Screener is significant in the contact area between the resonating rings and the screen cloth.

Conclusion

There are distinct benefits and advantages to using the Ultimate Screener in dry fine screening applications. It exhibits very rapid kinetics and significantly reduces mesh blinding. It is capable of screening at sub-30 micron sizes for tasks that are impossible using conventional technologies. There is also a clear advantage in operating the motors at higher frequencies where the most rapid kinetics and best efficiencies are achieved. This indicates that higher throughputs would be achieved when the unit is operated at a higher motor frequency.

On the other hand, the unit produces higher screen wear rates and poses a health risk from the amount of static electricity generated.

Recommendations

To fully investigate the adapters benefits, it is recommended that the Ultimate Screener be tested with a more simple material. This project was complicated by having to deal with the additional constraints brought about by working with fine coal dust that posed a health hazard. The Ultimate Screener should also be evaluated in continuous and wet operations. ◆

Exposure draft on valuation in the extractive industries

The International Valuations Standards Committee (IVSC) is an NGO (Non-Government-Organization) member of the United Nations and works cooperatively with member States, organizations such as the World Bank, OECD, International Federation of Accountants, International Accounting Standards Board, and others including valuation societies throughout the world to harmonize and promote agreement and understanding of valuation standards.

It publishes the widely accepted International Valuations Standards book, the latest, sixth edition of which was published in May 2003.

These standards cover the valuation of all assets, whether real property, personal property, businesses or financial interests for any valuation purpose, and provide guidance against internationally accepted principles for the valuer.

In the minerals industry, in recognition of the need for better governance and transparency in the area of valuation, and after several noteworthy scandals, some countries, such as Canada and Australia developed their own Codes for valuation of mineral properties and/or assets, since the IVS applied mainly to real estate valuation, with an emphasis on market value as opposed to historic or fundamental value.

In the last year, IVS has developed a Guidance Note which is specific to the Extractive Industries, and which has now been released for public comment.

The importance of this development is emphasized by the adoption of market value in financial reporting as being 'in the best interests of the public, investors, government and business decision makers', according to the Toronto Accord.

This accord, held in October 2003, supported by the International Accounting Standards Board, the US Financial Accounting Standards Board and the American Society of Appraisers, amongst others, determined that the IVS was the appropriate set of international standards to be supported for these valuations.

It is still unclear as to precisely when, or if, this will apply to the Extractive Industries for financial reporting, but the IVSC Standards are applicable in South Africa, since South Africa is a member State of IVSC, and the Guidance Note now forms a good basis for comparison and/or incorporation into a South African Valuation Code.

The Task Group that formulated the Exposure Draft consisted of representatives from the USA, Australia, United Kingdom, Canada and South Africa, the latter representative being Alastair Macfarlane, who was nominated to attend the Group by the Council of the SAIMM.

The Exposure Draft and its associated Press Release can be read on the IVSC website, www.ivsc.org.

Comments are required via the internet by the end of March 2004, and then it is anticipated that Edition 7 of the IVS will be published in mid 2004, inclusive of the Extractive Industries Guidance Note.

Meanwhile work on developing a South African Code which deals with local and national variations is continuing under the auspices of the Council. ◆