Reproducible Sieving in the Shortest Possible Time

Retsch Anwendungstechnik
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Despite the rapid development of modern optical particle measuring techniques, classical sieving analysis is still at the forefront for the practical quality assurance of bulk goods. In addition, sieving results are often used as the basis for comparison with other measuring techniques.
Above all, a quickly available particle size determination result is required for the quality assessment of bulk goods during production processes. In order to ensure proper production monitoring, it is frequently quite sufficient to determine a trend.
Standardized and reproducible working instruments are required in order to ensure the reliability of the results and to reduce the required working time to the absolute minimum. The necessary working steps should be laid out so that operator errors and random errors are excluded as far as is possible.

Requirements and working procedure for a sieve analysis

If short sieving times are selected for the particle size determination, then it must always be assumed that individual fractions will not be separated as sharply as is required, particularly when sieving is carried out in the fine particle size range. However, if the whole sieving process is carried out reproducibly, i.e. primarily when the machine parameters are always reproducible, then sieving results can also be compared with each other even when containing a systematic error.
Strict attention must be given to the following factors before the start of a sieving analysis:

- **Representative part-sample**

Sieve analysis starts with the selection and preparation of the amount of sample to be sieved. This must always be a representative part of the whole original sample. If this is not the case then the sieving result must be called into question.

- **Reliable sieve shaker**

When selecting a sieve shaker care must be taken that the sieving time and sieving movements can be set reproducibly and are also carried out reproducibly.

- **Standardized analytical test sieves**

Only test sieves in accordance with DIN ISO 3310 ff or similar standards are to be used for sieve analysis. Sieves that do not meet the requirements of these standards must not be used.

- **Evaluation and documentation**

PC-supported programs are used today in order to avoid random errors and, above all, operator errors in the evaluation of sieve analyses.

Carrying out reproducible sieving in the shortest possible time

There are several factors which have a persistent influence on the sieving process and therefore on the quality of the results. Apart from the technical requirements of the sieve shaker, the **oscillation amplitude and frequency parameters as well as the sieving time play a crucial role.**

In order to transport a solid particle through a sieve opening the sieve cloth, i.e. the sieve plate, and the particle must be moved relative to each other. This takes place indirectly by the type of drive of the sieve shaker. The probability of the particle passing through is determined by several factors: the ratio between particle size and sieve opening, the particle shape, the direction of movement and the orientation of the particle to the open sieving area. In short, the sieve movement and sieving time are the crucial factors for an exact and sharp separation of the individual fractions.

Demands placed on the sieve shaker

Throw-action sieving is often used for analytical sieving. In this case the highest probability of the particle passing through the sieve is given when the particle flight time corresponds to the time for a single sieve plate oscillation. This means that a comparison between particle and sieve opening can take place at each oscillation. However, this can only be achieved with a particular sieve shaker setting and is known as the "statistical resonance". For this to happen there must be an interaction between the oscillation amplitude and the oscillation frequency, i.e. a particular sieve plate acceleration must be achieved.

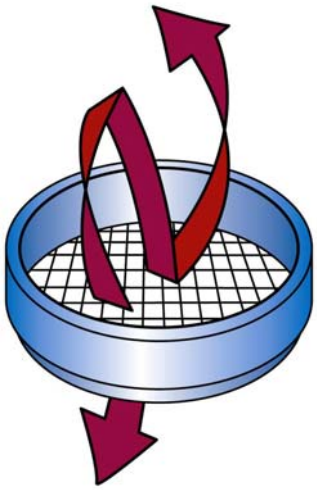


Fig.: The electromagnetic drive of the AS 200 and AS 300 "control" ensures a 3-dimensional throwing movement that allows the sample to wander uniformly across the whole surface of the sieve.

The Retsch Sieve Shakers AS 200 control and AS 300 control provide all the requirements for reproducible short-time sieving processes. The sieve shakers have an electromagnetic drive which causes the spring-mass system to oscillate. All operating parameters such as oscillation amplitude, sieving time and interval time can be selected digitally. In addition to the oscillation amplitude, the oscillation-frequency-independent sieve plate acceleration can also be set and displayed. The microprocessor-controlled measuring and control unit guarantees constant sieve movements and therefore absolutely reproducible sieving processes. All the relevant operating parameters of the sieve shaker that could influence the sieving result can be calibrated within the context of test agent monitoring.

Setting the oscillation amplitude

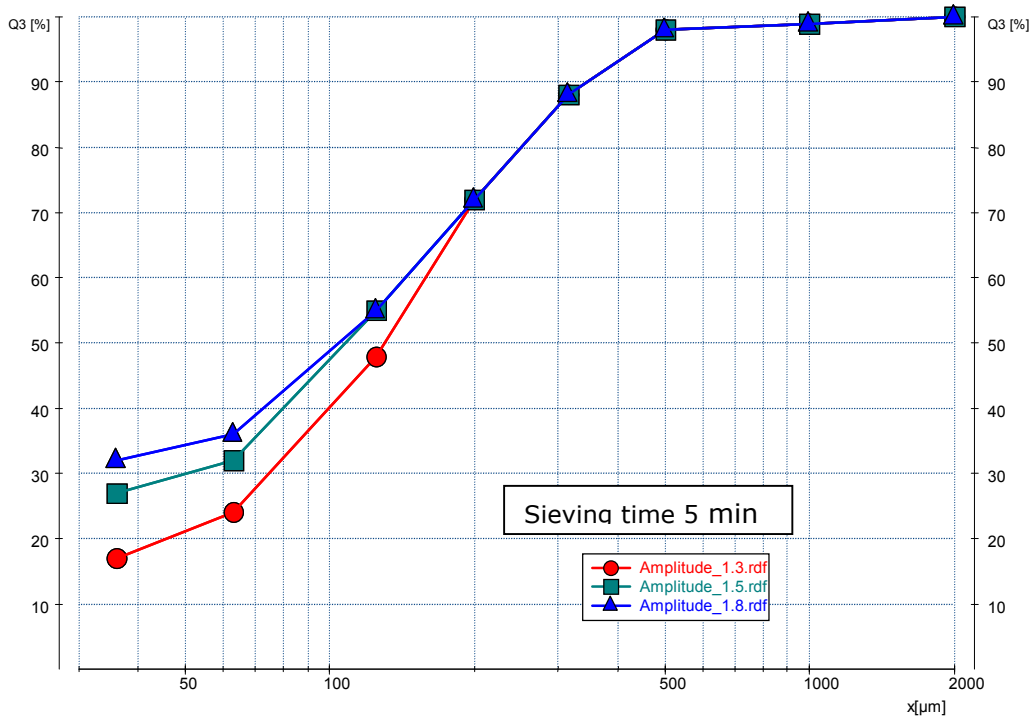
The sieving movement of the sieve shaker has the largest influence on the sieving quality factor. The intensity of the oscillation amplitude moves the sample around on the sieve plates.

The consequences of various manual settings of the oscillation amplitude are shown in the following example. An oscillation amplitude of 1.5 mm is to be selected on a conventional sieve shaker. A corresponding scale is used for setting, or rather "estimating", the oscillation amplitude; this is attached to the shaker plate of the sieve stack. The subjective observation involved could produce operator setting errors that could result in variations of up to 0.3 mm.

Fig.: Digital setting of the oscillation amplitude on the AS 200 "control" from Retsch

The graph (Fig. 1) shows an example of sieving results illustrating the possible degree of variation of the measured particle size distribution. The passage $Q_3(x)$ is shown as a function of the particle size. As can be clearly seen, the manual setting of the oscillation amplitude results in enormous differences, particularly in the range < 200 µm. **Differences of up to 20% are obtained for the passage values.**

This means that for short sieving times in particular the reproducible setting of the oscillation amplitude is of crucial importance. Sieve shakers AS 200 control and AS 300 control meet this requirement. The oscillation amplitude is selected digitally and is then maintained and displayed during the sieving process. This means that the setting and sieving process are absolutely reproducible.



(Fig.1)

The manual setting of an oscillation amplitude of 1.5 mm could result in the actual value varying between 1.3 mm and 1.8 mm because of operator error. The differences in particles size distribution are particularly noticeable in the range below 200 µm.

Different mains frequencies

Throw-action sieve shakers with a mains frequency excitation of 50 Hz and 60 Hz (as is usual in the USA) are both in use, as well as natural frequency excitation sieve shakers. Different frequencies and the same oscillation amplitudes naturally result in different particle throw heights. In addition, the forces acting on the particles in this case are different, and the number of comparisons between the particles and sieve openings is also different. If the optimal oscillation amplitude has been selected for a particular frequency then, at the same oscillation amplitude and a different frequency, other results will be obtained; with natural frequency excitation sieve shakers the results are non-reproducible. The forces occurring during the passage of the particle and the number of sieve plate oscillations also differ; e.g. at 50 Hz 3000 sieve movements are achieved and 3600 sieve movements at 60 Hz (Fig. 2).

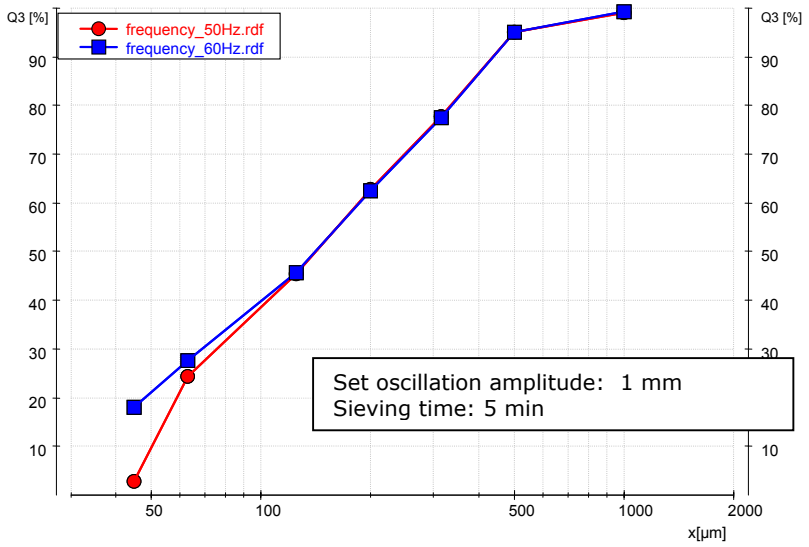


Fig. 2
Sieving results at the same oscillation amplitude (1.0 mm) at 50 Hz (red curve) and 60 Hz (blue curve). It is obvious that at the same oscillation amplitudes and different frequencies no reproducible results are obtained in the fine particle size range.

Such errors can be compensated by entering the same sieve plate acceleration instead of the oscillation amplitude (Fig.3). The Sieve Shakers AS 200 control and AS 300 control have this type of setting.
If the sieving time difference of 20% resulting from the number of swings at 50 Hz and 60 Hz is taken into consideration then **reproducible results can be obtained throughout the whole world.**

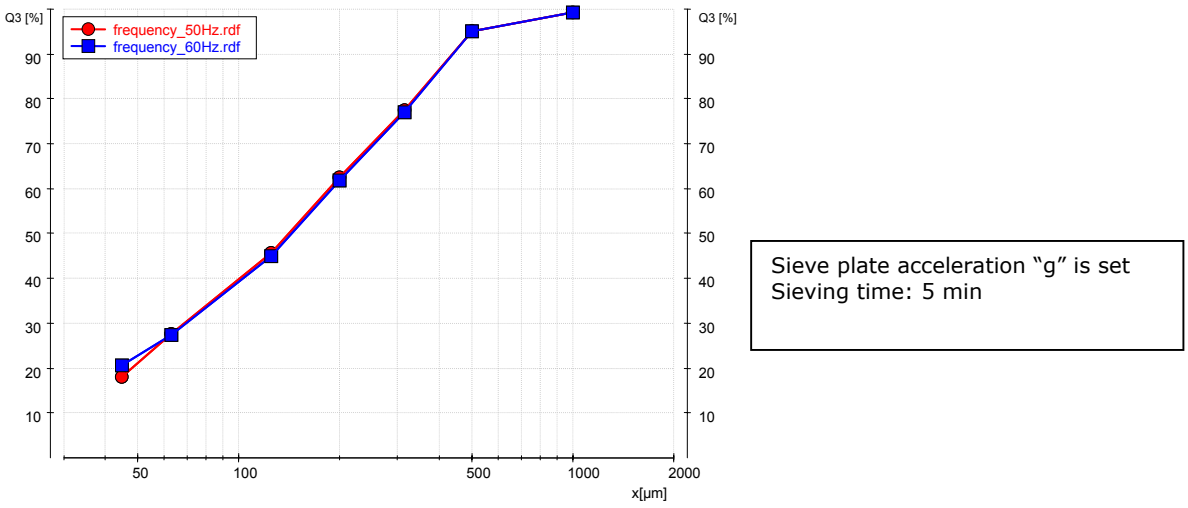


Fig. 3

Setting sieve plate acceleration " g = 7.2" at 50 Hz and 60 Hz, without taking the sieving time correction of 20% into account.

Sieving in the shortest possible time

In the production control of bulk goods short sieving times are the aim in order to be able to react as quickly as possible in the corresponding process control. Short sieving times are usually defined as being < 5 min and should be reproducible. Mechanical timers, which can still be found on many conventional sieve shakers, can have a relative setting error of +/- 10%. This error can frequently be traced to the inaccurate setting by using an analog scale and not to the lack of precision of the timer. For a sieving time of 5 min a variation of 10% means that sieving takes place for 30 seconds longer or shorter; this has consequences for the result. Electronic timers with digital time selection and quartz accuracy make such setting errors impossible. All Retsch "control" sieve shakers are equipped with these electronics.

Professional evaluation of sieve analyses

Once the sieving and weighing processes have been completed the mathematical evaluation and graphical presentation of the particle size distribution can be carried out.

In most cases a manual procedure is very time-consuming and systematic and operator errors cannot always be avoided, even if work is carried out conscientiously. Matters are different with a PC-supported evaluation program. In the Windows system the **EasySieve®2.0 software**, validated according to DIN ISO IEC 12 119, takes over operator guidance and provides instructions about the next working step to be carried out throughout the whole sieving process. The program communicates with the balance and sieve shaker and calculates the sieving result as a cumulative distribution (Fig.1-3) and frequency density. In addition, it permits the calculation of the relevant parameters. Graphic and tabular presentations of the sieving result are shown as well as the general sieving data in a well laid out standardized measuring protocol. Trend analyses, comparative presentations, mean value calculations and data export are also possible.

The use of the EasySieve® 2.0 evaluation program reduces the total time required for a sieve analysis by approx. 60 – 70% when compared with a manual method.

Summary

"Quickness is not witchcraft, even for sieving." The optimum between a short sieving time and a significant result is achieved when the parameters oscillation amplitude or sieve plate acceleration and time can be set reproducibly and controlled throughout the sieving process.

If short sieving times are the aim, as in the process control of bulk goods, then particular demands are placed on the sieve shaker regarding reproducibility. The Sieve Shakers AS 200 and AS 300 control from Retsch provide all the technical requirements for this.

By using these reliable machines and a defined procedure sieving results that are reproducible and allow worldwide comparisons can be achieved in a short time.

References

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