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# Effective Maintenance of Multi-frequency Sieving Machines

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## Introduction

In this report I shall review the maintenance of Sandvik Osprey's multi-frequency sieving machines and evaluate potential improvements, resource implications, and limitations.

## Process Background

Sandvik Osprey specialises in the production of fine alloy metal powders primarily for use in the Metal Injection Moulding (MIM) and Additive Manufacturing (AM) industries. The alloy materials range from Stainless Steel powders to Cobalt alloy powders and pure Copper powders, with hundreds of different chemical makeups.

The process involves building a charge of the required chemistry. A charge is a combination of the right quantities of different raw materials used to make the required alloy. The charge is melted together and then poured it into a high velocity gas stream through a ceramic nozzle to atomise it into a powder.

The atomised/powdered metal has a wide variety of particle sizes known as its Particle Size Distribution (PSD) ranging from roughly 0-500  $\mu\text{m}$ , which is too wide a range for any customer's application, so the powder must be sized. The process of sizing is using a mechanical means to cut the powder into fractions, removing the unwanted powder sizes.

Sizing is done using either a sieving machine for cuts greater than 32  $\mu\text{m}$ , or an air classifier for cuts less than 45  $\mu\text{m}$ . Sieving machines are the preferred sizing method as they provide a higher cut efficiency with less waste material, but they are not capable of fine cuts, so anything less than 32  $\mu\text{m}$  is done by air classification. The sieving machines are hence a critical piece of process equipment.

## Multi-frequency Sieving Machines

Amongst the sieving machines there are two main types in use at Sandvik Osprey:

- Traditional rotary sieving machines which use a rotating offset weight on a vertical shaft to vibrate the mesh. These sieving machines are very simple in concept and easy to maintain.
- Multi-frequency sieving machines which use two side mounted motors at opposing 45° angles to create the circular vibration, and a "beater ring" which is a stationary rubber coated ring that the mesh sits on, so when the mesh vibrates it knocks the mesh creating a second oscillation and cleaning the mesh. These sieves are far more advanced, but also far more complex and require more maintenance.

The multi-frequency style sieving machines will be the focus of this report as due to their complexity the maintenance systems are in need of improvement. However, to properly explain the current maintenance situation the rotary sieves will also need to be used.

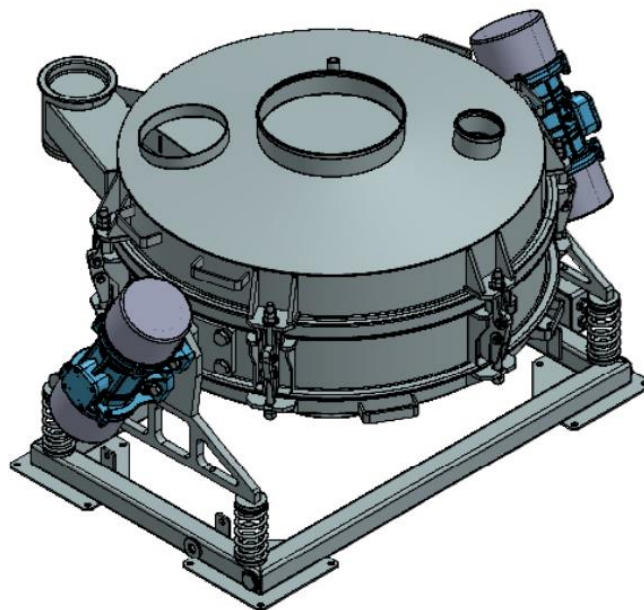


Figure 1 – Multi-frequency Sieving Machine (Virto, 2017)

## Current Method of Maintenance

The existing maintenance practices were carried over from the old traditional rotary sieving machines when the new multi-frequency type was brought in, with little thought to the different mechanism that drives the sieving machine.

The maintenance of the rotary sieving machines is a combination of Preventative Maintenance (PM) strategies, Total Productive Maintenance (TPM) strategies, and Reactive Maintenance (RM) strategies.

- PM - Visual inspection of the shaft, couplings, weights assembly, and framework on a monthly basis.
- PM - Re-greasing of the shaft bearing on a quarterly basis.
- TPM - Inspection and replacement of any meshes, flexible connections, gaskets, clips, and clamps on a daily basis by trained production operators.
- RM - Replacement and repair of other components through the company Engineering Request (ER) system. The operators are trained in troubleshooting the systems and reporting any issues they find through the ER system, the engineering/maintenance teams see the request and can work on the problem.

This system worked well for the rotary sieves, however when the multi-frequency were brought in with a different operating principle and maintenance requirements, the PM's were not updated to reflect this, and stock items for replacements were not set up. This has left the new sieving machines almost entirely to RM with large delays due to a lack of spares.

## Improvements of Maintenance and their Implementation

In order to improve the maintenance of the multi-frequency sieving machines the PM's and spares will need to be brought back up to standard. This will require a review of the recommended spares from the manufacturers manual as well as any other spares that are identified as required to reduce potential delays. The manual also suggests PM's and frequencies, these will need to be reviewed in line with maintenance and production resources to determine what the new PM's are and when they need to be done.

### PM Requirements

The PM recommendations from the multi-frequency sieve manufacturers manual are shown below.

| Component                          | Operations to be performed                                                                                         | Every day | Every 50 hours | every week | Every 200 hours/at each replacement of metal part | Every 250 hours | Each month | Every 15000 hours | Every 22000 hours |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------|-----------|----------------|------------|---------------------------------------------------|-----------------|------------|-------------------|-------------------|
| Screen                             | Check the conditions through the inspection windows                                                                | x         |                |            |                                                   |                 |            |                   |                   |
| Motor vibrator                     | Check the noise coming from the vibrator bearings (the bearings must not produce intermittent or metallic noises). | x         |                |            |                                                   |                 |            |                   |                   |
| Machine                            | Clean the machine to prevent the formation of a layer of dust greater than 5 mm.                                   |           | x              |            |                                                   |                 |            |                   |                   |
| Thread closing bars                | Check the tightness with a torque wrench.                                                                          | x         |                |            |                                                   |                 |            |                   |                   |
| Equipotential connections          | Check the equipotential connections between the metal parts shown in Figure A, Figure B, Figure C.                 |           |                |            |                                                   | x               |            |                   |                   |
| Fixing screws vibrator             | Check that the screws are not loose.                                                                               |           |                |            |                                                   |                 | x          |                   |                   |
| Buttons and cables                 | Condition check                                                                                                    | x         |                |            |                                                   |                 |            |                   |                   |
| Metal plates for ground connection | Check the presence of the special metal plates to ensure the equipotentiality between the parts that could result. |           |                |            | x                                                 |                 |            |                   |                   |
| Springs                            | Replacement of springs                                                                                             |           |                |            |                                                   |                 |            |                   | x                 |
| Bolts placed outside the screen    | Check the tightness with a torque wrench.                                                                          |           |                |            |                                                   |                 | x          |                   |                   |
| Motor vibrator fixing bolts        | Check the tightness with a torque wrench.                                                                          |           |                |            |                                                   |                 | x          |                   |                   |

Figure 2 – Manufacturers PM Guide (Virto, 2017)

These recommendations are based on an expected usage with light products such as pharmaceutical or food products and may not reflect the way the machine is used in production, so they need to be reviewed with this in mind. Sandvik Osprey may high density metal powders so there is generally more wear.

The following considerations have been made to review any changes to the suggested PM's:

- The Screen (mesh) is changed based on known usage and is checked on a batch by batch basis, with a batch taking anywhere between 10 and 30 hours to process, so the first PM is not necessary.
- Daily checks are done by the operators, so they would be trained to do the daily inspections as they do with the rotary sieves. This means any issues would be handled by the ER system or by less frequent PM's.
- Good household cleaning is in place on all systems so the Machine PM is not required.
- The thread closing bars (known in-house as Tie Bars) are taken off frequently due to the batch operation of the sieving machine, so a check is done per batch. As the PM check will be removed, the Tie Bar hinges and threads should still be inspected.
- The inspection of gaskets and seals has been missed off the recommended PM's.
- The inspection of the Beater Ring has been missed off the recommended PM's.

Taking these into consideration allows for a new personalised PM list to be made. The following preventative maintenance actions are planned to be carried out at the intervals shown.

| Component                          | Operation to be Performed                                                                                                                                                                                                                                                                | Weekly | 200 Running Hours/<br>Metal Part Change | 250 Running Hours | Monthly | 22000 Running Hours |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-----------------------------------------|-------------------|---------|---------------------|
| Motor vibrator                     | Check the noise coming from the vibrator bearings (the bearings must not produce intermittent or metallic noises).                                                                                                                                                                       | x      |                                         |                   |         |                     |
| Buttons and cables                 | Condition check. Replace if necessary.                                                                                                                                                                                                                                                   | x      |                                         |                   |         |                     |
| Gaskets and seals                  | Condition check. Replace if necessary.                                                                                                                                                                                                                                                   | x      |                                         |                   |         |                     |
| Tie bar hinges and threads         | Condition check. Replace if necessary.                                                                                                                                                                                                                                                   | x      |                                         |                   |         |                     |
| Metal plates for ground connection | Check the metal plates to ensure they are earthed correctly.                                                                                                                                                                                                                             |        | x                                       |                   |         |                     |
| Equipotential connections          | Check the earthing connections between the metal parts of the sieve.                                                                                                                                                                                                                     |        |                                         | x                 |         |                     |
| External bolts                     | Check the tightness with a torque wrench.                                                                                                                                                                                                                                                |        |                                         |                   | x       |                     |
| Motor vibrator fixing bolts        | Check the tightness with a torque wrench.                                                                                                                                                                                                                                                |        |                                         |                   | x       |                     |
| Beater ring                        | Check the distance from the beater ring to the bottom of the support mesh using a blank support mesh ring and a gasket. The support mesh is 2mm thick. The gap should be 1-2mm. If the plastic material on top is in good condition, adjust with spacers, otherwise replace beater ring. |        |                                         |                   | x       |                     |
| Springs                            | Replacement of Springs.                                                                                                                                                                                                                                                                  |        |                                         |                   |         | x                   |

Figure 3 – Sandvik Osprey PM's

As well as these PM's there needs to be a number of production checks that are done on a daily basis throughout the day. These are the TPM or production maintenance tasks and they include:

- Inspection and replacement of gaskets.
- Inspection and replacement of mesh support rings.
- Inspection and replacement of working mesh.
- Inspection and replacement of flexible connections.
- Inspection and adjustment/replacement of rubber deflectors (wipers).
- Inspection of earth bonding.

With these checks in place, the sieving machines would be in a much better maintenance situation, however for these checks to be beneficial there would need to be a stock of critical spares available.

### Spares

Spare parts are critical for maintaining production equipment while keeping downtime low. Downtime (time where the machine is not running) is a direct cost to production, as if the machine is down the product that would normally be processed on it is delayed and total capacity is reduced. Downtime with spare parts is usually only a matter of a few hours, while downtime without spare parts is a matter of days or even weeks.

As well as the spares required for the PM's, there are also a number of production spares that are required such as meshes and flexible connections to the sieving machine. These must all be considered when creating a spares list.

As spares are currently bought as and when needed as part of RM procedures, there is no stock control. Once the parts are held as spares stock control would need putting in place. A Kanban system is the best system for onsite inventory management for maintenance storage, this means that there are always parts available as there is a minimum stock quantity before more parts are ordered and a minimum order quantity.

*"Kanban strives to save companies time, money, and other resources by ensuring there is minimal downtime between tasks." (Halton, 2022)*

The minimum and maximum stock levels for each spare are based on usage. If parts are used more often then a larger stock level is required.

### Resource Considerations

In order to implement these maintenance changes resources such as cost and manpower are needed. The initial cost of this change would be the cost of spares as a stock of spares first needs to be generated. After this point the usage of parts should not change so there would be no change to the cost. There is also a benefit to cost in a reduction of downtime as the repair work would be done a lot quicker and hence the reduction in production capacity is removed.

Manpower must also be considered in the cost, as manning is one of the largest costs in a production facility. Implementing this change would require additional labour in the production area as well as in the stores area where the spares are managed. There would however be a reduction in labour from the maintenance team who would no longer need to spend a long time working on one system due to a lack of spares.

There is also an additional manpower consideration in the engineering area from an engineer needing to investigate the maintenance requirements to implement these changes.

Overall the resources would be mostly balanced out as there are potential savings as well as new costs.

Some of the engineering support could have been reduced through proper planning when these sieves were installed. If proper management of change was done when they were purchased then the PM's and spares required would have been finalised at the time, leading to a much smoother introduction of the sieving machines, and much less downtime.

### Conclusions and Recommendations

In conclusion, due to insufficient change management the multi-frequency sieving machines were brought in without proper PM's or spares, which has led to large downtime and poor maintenance.

To prevent similar failures to implement sufficient maintenance of new equipment the Management of Change (MoC) procedure around new equipment needs to be tightened up to include checking existing PM's, reviewing and setting up any new PM's, and identifying suitable spares and stock levels.

In the short term for the existing sieving machines, the PM's and spares list above should be implemented ensuring that the stock levels of the spares are checked.

## References

Virto. (2017). *X-Line User and Maintenance Manual*.

Halton, Clay. (2022). *What Is the Kanban System?*. Available at: <https://www.investopedia.com/terms/k/kanban.asp>. Accessed 07/04/2024.