Vibratory Feeding Technology Gets Sophisticated

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FREE-FLOWING BULK-SOLIDS handling can be tricky. You need to ensure a uniform discharge while maintaining the integrity of fragile, friable, abrasive or fibrous materials. Coperion K-Tron has thoughtfully engineered a line of vibratory feeders that achieve high accuracy via patent-pending technology.

Chemical Processing spoke with Urs Helfenstein, R&D mechanical engineer, Coperion K-Tron, regarding what makes the K3 vibratory feeders different from other feeding technologies.

Q. What factors affect the selection?

A. With vibratory devices, there are very different technologies available. For example, there are electric drives, which create a lot of noise. There are pneumatic devices, but pressurized air is an expensive power source. There are rotating masses to create vibration or oscillation. In this case you have moving parts, which means maintenance issues. We went down a new road and examined how masses are balanced.

Shock absorbers are essential when it comes to vibratory technology because you need to separate the vibration of the device from the environment or the structure where it is fixed. Without it, everything would vibrate and make a lot of noise and would be very inefficient. Most vibratory drives use shock-absorbing elements that are springs or rubber. We found that if it is on springs or on the rubber element, the vibratory drive can move in all directions. This has disadvantages. The oscillation can be very unpredictable. For example, if you have one material you have a certain center of gravity. But with another material that has a different density, the center of gravity may change and it causes trouble because it starts to oscillate differently. This is why some people think vibratory technology is not as reliable or predictable.

Q. How does K3 technology address that?

A. We use pendulums. They move only in one direction. And that's the direction where we want to absorb these vibrations. But all other degrees of freedom are restricted. We achieve shock absorption but we restrict all the other effects.

Q. What are other advantages?

A. A big advantage is improved accuracy because we have the same motion for every section of the vibratory tray and the same speed of material, which with the other technologies, you have different speeds on the tray and material height changes over the tray. With our technology, the material moves straight so you have a constant height. This means the material flow is much more controllable and responds to change much faster. We did tests with different materials and with different feed rates and achieved 35% better accuracy on average.

Another important advantage is weighing. If we have less vibration on the scale, we have less errors through this vibration. And together with this adaptive digital filter technology we have in the scale, we don't see any effect of vibration on the accuracy results. In general, it's a pretty simple device when it is designed right. And it has very low maintenance requirements and is much easier to clean than a screw feeder.

Q. Are there any underappreciated aspects?

A. One thing that is not very obvious is the balance. We have a top part where the tray is mounted and there is a counter motion. So, if one moves up the other moves down and vice versa. And the centers of gravity of these two masses are oscillating in counter directions. If they are in line with the motion, you can reduce the vibration to the environment and scale a lot.

Q. What mistakes are made when selecting vibratory feeders?

A. It's not an all-purpose device. It is only for free-flowing material. We do not have an enforced material motion like in a screw feeder. But sometimes facilities want to compromise on this because of the advantages.

Q. Are there special design considerations?

A. One point to be considered is we don't have agitators inside, so it is more sensitive to blocking. To remedy this, we have a technology called ActiFlow™, which uses vibration to break bridges in the hopper.

It's a smart device. If the vibration is not strong enough, it will not break the bridges. And if it is too strong, it will compact the material and then it bridges even more than before. The device measures how much material is on the tray and calculates from there. Many people prefer this over a mechanical agitator since you don't have to clean something inside because it's already outside of the hopper.

Q. How does the K3 differ from other alternatives?

A. We've talked about the pendulum shock-absorber technology. There is nothing like this on the market. What we haven't talked about is the hygienic design. We have a device that needs to vibrate. Usually to allow these vibrations, you have gaps. But for hygienic environments you try to avoid gaps. We designed a silicone boot, which covers the whole drive. There are no gaps. It is completely enclosed.

Another is the controller itself. It is a closed-loop control. We measure the motion 1,500 times per second. And by measuring the motion, we can adapt the excitation signal of the coil in real time. Others do not measure any vibration, they only increase the signal or lower it. We measure the motion and compare it to the excitation and then we see if we are in resonance, and we drive our vibratory in resonance frequency. Most of the devices on the market avoid resonance frequency.

For example, if you are on a swing and you are moving in the right frequency, with a little motion you get a big oscillation. This means you're in resonance. But if you move in a much faster frequency, you get almost no oscillation. This is what most devices on the market do. We measure the current 25,000 times per second and make adjustments to ensure a clean sine curve and very smooth motion. This reduces noise and vibration.

Compared to other devices, which are pretty simple, it's very complicated, but it gives us a lot of controllability as well as efficiency. To give you an example, we measured power consumption at a feed rate of 12,566 pounds (5,700 kilograms) an hour. We used only 20 watts of power to feed that amount. That's a third of a light bulb. Because we drive it in resonance, we only need a little bit of energy to keep it moving.

Q. Anything you'd like to add?

A. We should talk about the weighing technology, which is a core competence of our company. We build our own scales and controls. If you apply more force to the scale, the vibrating wire is more loaded and the resonance frequency increases. By measuring this resonance frequency, we know how much weight is on the scale. We measure over 100 times a second.

We achieve higher accuracy because the scale is adapted to the environment. We have a demo video (https://bit.ly/k3-feeder) that shows one scale with the filter and one without, both subjected to vibrations. On one you see a noisy signal and on the other one, you see a straight signal. On the one with filter you can actually see the change in weight signal due to drops falling out and on the other you see nothing because the signal is very noisy. So that's very impressive.

The Coperion K-Tron K3 line of vibratory feeders features improved high accuracy thanks to innovative patent-pending drive technology. They are available in a standard design or a hygienic easy-to-clean design.

Something else we haven't discussed is pressure in the system. Pressure fluctuations can seriously impact the weighing accuracy of a feeding system. This leads to incorrect weight signals, causing erroneous mass flow and poor feeding accuracy. We've developed EPC -- electronic pressure compensation. We measure the pressure on the outlet and in the hopper. And if the pressure changes, we compensate this error on the scale electronically.

Coperion K-Tron has over 100 patents for mechanical components and control technologies to our feeding and weighing solutions. This experience allows us to tailor our products and services to the needs of various industries.

For more information, send an email to info@coperion.com or visit www.coperion.com.