Vibratory tray feeders: Ten common problems and how to fix them

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This article explains how to troubleshoot problems with a vibratory tray feeder. After a brief review of the feeder's components and operation, the article lists 10 common feeder problems and explains how to find and fix them. A troubleshooting table provides a quick reference for matching problems with potential causes.

A vibratory tray feeder (also called a *vibratory pan feeder* or *oscillating feeder*) consists of a tray that moves rapidly back and forth to meter material into a process. As the tray vibrates, each particle is thrown up and forward from one point on the tray and drops down at a point farther along the tray.

While this operating mode may sound relatively simple, problems can affect the feeder's performance if the feeder isn't carefully chosen for your application or if it's not properly operated or maintained. Understanding how your vibratory tray feeder works will go a long way toward helping you spot problems before they can upset your process and result in major production losses. Let's start by reviewing some vibratory tray feeder essentials.

Feeder basics

Primary components in a vibratory tray feeder are the tray, a drive unit, and a spring system between the tray and the drive unit, as shown in Figure 1. The tray's receiving end is mounted under a supply hopper outlet, and the discharge end is located above receiving equipment. In operation, material discharges from the supply hopper onto the tray. The drive unit generates vibration, which is transmitted by the spring system to the tray. As the tray vibrates, particles are thrown up and forward from one point on the tray and drop down at a point farther along the tray. The distance the drive unit moves back and forth is called the feeder's *amplitude*. How high the particles are thrown compared with their forward movement is called the *angle of deflection,* and the number of times per minute this action is repeated is the feeder's *frequency* (measured in hertz). The drive unit can be linked to a controller that increases or decreases the tray amplitude to adjust the feedrate.

More about the tray. The tray (also called a *pan* or *trough*) can have any of several shapes — such as flat (Figure 1a), curved, V-shaped, or tubular (Figure 1b) — and can be of almost any length or width to meet your application requirements. It can also be constructed of various materials to suit your material's characteristics. For instance, a mild steel tray is suited to most materials in nonsanitary applications, while a stainless steel tray is typically used for foods and pharmaceuticals. The tray can also be lined with abrasion-resistant steel, polyethylene, epoxy, rubber, or another material to handle solids with difficult characteristics.

To function properly, the tray's center of gravity must be mounted slightly above the drive unit's *driveline* — that is, the centerline of the unit's housing or casting. Any alterations to the tray after the feeder is installed will likely change the location of the tray's center of gravity and alter the feeder's performance. For this reason, consult your feeder manufacturer's engineering service before replacing or modifying the feeder's original tray. In fact, failing to ask for the manufacturer's help in designing and constructing a new tray can void the feeder warranty.

More about the drive unit. The drive unit is mounted on isolation supports (called *shockmounts*) to prevent the feeder from transmitting vibration to other equipment. Most drive units for vibratory tray feeders are electromagnetic or mechanical. An *electromagnetic drive unit* generates vibration by sending electric current through an electromagnet and creating a series of interrupted pulls on an armature or other mechanism. This drive unit is available in standard and high-deflection versions and has no belts, bearings, or other moving parts, minimizing the need for routine maintenance. A *mechanical drive unit* generates vibration by driving eccentric weights. The standard electromagnetic drive unit provides more precise feeding control, while the high-deflection electromagnetic unit and the mechanical unit both offer greater capacity.

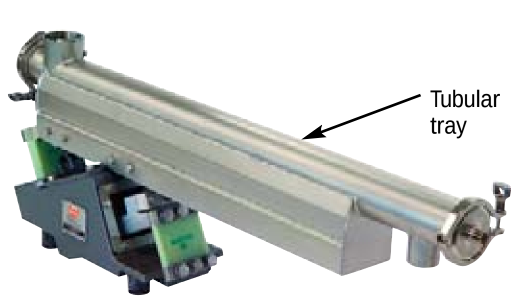
Which drive unit is right for your application depends on your material's particle size or bulk density. A standard electromagnetic drive unit with a 0.045- to 0.060-inch (1.143- to 1.524-millimeter) amplitude at a frequency of 60 hertz is best for handling materials with particle sizes from +50 mesh up to 2 to 3 inches (50.8 to 76.2 millimeters). A high-deflection electromagnetic drive unit, which has a 0.187-inch (4.76-millimeter) amplitude at a frequency of 30 hertz, is suited to feeding fragile materials that can be damaged by the high g forces created by the standard unit's full 60-hertz cycle. The high-deflection unit also handles low-capacity feeding of materials with particle sizes from –50 to –400 mesh, which tend to fluidize and flood on standard units. The high-deflection unit handles higher-capacity feeding of materials with particle sizes from +50 mesh up to 2 to 3 inches (50.8 to 76.2 millimeters). It can also feed lightweight particles with bulk densities less than 10 lb/ft^3 (4.53 Kg/ft^3).

Figure 1

Vibratory tray feeders

a. With flat tray

b. With tubular tray



A mechanical drive unit has a 0.25- to 0.44-inch (6.35- to 11.11-millimeter) amplitude at a frequency of 20 hertz and is suited to high-capacity feeding of materials with particle sizes from –50 to –400 mesh and from +50 mesh up to 2 to 3 inches (50.8 to 76.2 millimeters). The mechanical unit is best for materials with particle sizes larger than 2 inches (50.8 millimeters) and also can effectively feed lightweight materials (with bulk densities less than 10 lb/ft^3 [4.53 Kg/ft^3]).

More about the spring system. The feeder's spring system, as shown in Figure 2, consists of multiple springs, typically arranged in stacks. The springs are available in several materials, shapes, and sizes to effectively transmit vibration to the feeder's tray. For instance, the springs may take the form of thin fiberglass sheets (Figure 2), dense rubber-compound pads, or thick steel coils. The spring system must be mechanically *tuned* to the tray's size, shape, and weight so the tray can achieve the desired vibration displacement when the drive unit is operating at full voltage. The tuning — which varies with the tray's size, shape, and weight — requires changing the stiffness of the system's *tuning springs*. The tuning springs are typically under the tray's receiving end (Figure 2). Changing their stiffness requires increasing or decreasing the number of springs in each stack or increasing or decreasing the spring thickness, or both.

In a feeder with a factory-installed tray, the spring system is typically tuned at the manufacturer's facility before delivery to your plant. Replacing or altering the original tray on your feeder will require tuning the spring system to achieve the right vibration displacement for the new or

Figure 2

Spring system

modified tray. [***Editor's note:*** Find more information in the sidebar "Making sure your feeder sings in tune."]

Ten common performance problems

As the preceding information makes clear, it's important to select a vibratory tray feeder with the right components for your application. Choosing the right feeder not only will help it feed your material accurately, but will keep the unit running reliably over the long term.

But as with any machine, problems come up: Parts can fail. Fasteners can loosen. Your material characteristics or process conditions can change. To prevent problems like these from bringing your process to a halt, pay close attention to your feeder's performance to spot signs of trouble.

Spotting a problem. Some of problems that can affect your vibratory tray feeder can occur right after the feeder is installed, and others are more likely to show up down the road.

When operating the feeder at initial installation, you may notice any of these problems:

1. The feeder doesn't achieve the desired output or the output drops after being at the desired level. The feeder has low or reduced output.
2. The feeder operates noisily but achieves normal output.
3. The feeder operates noisily only during certain periods.

These problems can develop later, after your feeder operated satisfactorily at initial installation:

4. The feeder won't operate.
5. The feeder operates but has reduced output.
6. The feeder operates noisily but achieves normal output.
7. The feeder's amplitude gradually fades or slowly decreases.
8. The tray is excessively worn.
9. The flow of material discharging from the feeder is turbulent, creating inconsistent flow to the process.
10. The feeder output is inconsistent, creating feedrate fluctuations.

Finding and fixing the underlying cause. Each problem can have one or more cause. The problems and their potential causes (labeled A through S) are listed in Table I. The following information details each cause and lists troubleshooting steps for remedying the problem.

A. Feeder misapplication. In this case, your feeder model doesn't match your application requirements. For instance, the feeder may be too small for your desired feedrate; your material may be difficult or impossible to handle in the feeder you've selected; the feeder may not be able to operate in your application's extreme temperature (either cold or hot) or atmosphere (such as high pressure); or your feeding requirements may be too precise or excessive for the feeder you've selected. Consult your feeder manufacturer for advice on correcting any of these problems, such as by replacing the tray, selecting another drive unit, or choosing another feeder type that's better suited to your application.

B. Improperly disassembled or modified feeder base or tray. Changes to the base supporting your feeder's drive unit or to the tray can cause performance problems. For instance, improperly disassembling and reassembling the feeder can affect the unit's vibration displacement. In this case, reassemble the feeder according to the manufacturer's instructions. Modifying the base or drive unit, such as cutting it down from its original height, can make it less stable, also affecting the feeder's ability to generate the desired vibration displacement. Adding any weight to the tray — such as by adding extensions to a flat tray's sides to contain material, adding a cover to contain dust, adding a screen to the tray's discharge to classify the material before it's discharged to the process, or otherwise modifying the feeder's tray — can also impair performance. Avoid these problems by consulting the feeder manufacturer before attempting any base or tray alterations, and consult the manufacturer for help correcting problems caused by such alterations.

If the spring clamps or bolts become loose or the lockwashers are missing, the result can be too much vibration displacement.

C. Loose spring clamps or tray-mounting fasteners. In most vibratory tray feeders with flat fiberglass springs, three bolt holes at the top and bottom of each tuning spring allow the springs to be bolted to flat bars, called *spring clamps,* that hold the springs in place. In any vibratory tray feeder, bolts and lockwashers are used to mount the tray on the spring system. If the spring clamps or bolts become loose or the lockwashers are missing, the result can be too much vibration displacement. To remedy the problem, tighten all spring clamps and fasteners and make sure lockwashers are in place. Avoid the problem by regularly checking clamp and bolt tightness according to the manufacturer's specs, and see that all lockwashers are in place.

D. Failed electrical coil or motor in drive unit. This is an extremely rare problem. When it occurs with an electromagnetic drive unit, you need to replace the coil or the coil-and-electrical-frame assembly, which can be ordered from your feeder manufacturer. For a mechanical drive

Making sure your feeder sings in tune

To keep your vibratory tray feeder operating correctly, the feeder's spring system must transmit vibration from the drive unit to the tray so that the tray achieves the right vibration displacement for your application. The amount of displacement is controlled by mechanically tuning the feeder's spring system to your tray.

Checking vibration displacement

A vibratory tray feeder with a factory-installed tray is typically properly tuned at the factory before it's delivered to your plant. So after your feeder is installed, as long as your material's characteristics don't change and you don't make any changes to the tray, you most likely won't need to tune the feeder. However, it's important to occasionally check the tray's vibration displacement to detect any changes and adjust for them. Too much or too little displacement can signal problems such as failed springs or a worn tray.

Most vibratory tray feeders come with a sticker (or another similar tool) on the tray's outer surface that allows you to easily and quickly check the tray's vibration displacement. A typical displacement sticker, as shown in Figure A, displays a large *V* labeled with measurement increments, and the sticker is positioned so that the *V*'s centerline is perpendicular to the drive unit's centerline. As you observe the sticker during feeder operation, the rapid vibration will cause the *V* to appear as an *X*. Where the lines cross at the *X*'s centerpoint indicates the tray's actual vibration displacement, indicated by the measurement increment at the centerpoint. If this reveals that the feeder's actual vibration displacement has changed from the desired displacement, you'll need to adjust the feeder's tuning.

Adjusting tuning for a factory-installed tray

Before adjusting the tuning for the factory-installed tray, check your feeder manufacturer's maintenance instructions. Make sure that the feeder is turned off, and double-check that all tray lockwashers are in place and all tray fasteners are tight. Then follow these general rules:

Rule 1: To *reduce* the displacement, *increase* the tuning springs' stiffness by increasing the number of springs in each tuning-spring stack or by replacing the tuning springs with thicker ones, or both. Then check the displacement by energizing the feeder at the full voltage and frequency listed on the drive unit's nameplate.

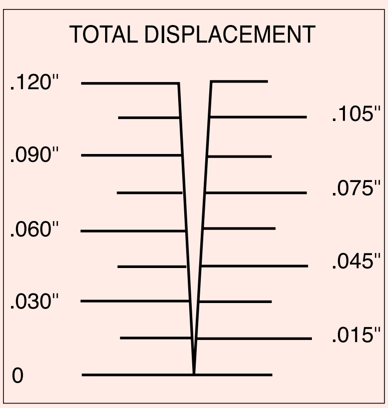
Rule 2: To *increase* the displacement, *reduce* the tuning springs' stiffness by reducing the number of springs in each tuning-spring stack or by replacing the tuning springs with thinner springs, or both. Then check the displacement by energizing the feeder at full voltage.

After the tray reaches approximately normal displacement at full voltage, use the feeder's controller (if so equipped) for fine or variable-speed control of the displacement.

One caution: If after you make either of the rule 1 or 2 adjustments you notice that the adjustment creates the opposite effect of what you intend, it means that the feeder is operating opposite to the normal side of its *tuning curve*. This happens when the tuning spring stiffness isn't great enough to achieve normal operation. In this case, you'll need to increase the stiffness until, when you adjust the tuning springs as outlined in rule 1 or 2, the adjustment begins to correct the tray's displacement. Then continue to tune the tray to the precise displacement your tray requires, again following rule 1 or 2.

Figure A

Displacement sticker



Tuning for a nonstandard tray

If you replace the factory-installed tray with another tray or modify the tray — by extending the tray sides, adding a cover, adding a screen to its discharge end, or otherwise changing the tray size or weight — you'll need to tune the feeder. Tuning can also be required if the tray's weight has changed over time, such as when a very abrasive material eventually wears the tray surface, making it lighter and increasing the tray's displacement.

In these cases, tune the feeder following these steps:

1. Turn the feeder off, then double-check that all tray lockwashers are in place and all tray fasteners are tight.
2. Energize the feeder at the full voltage and frequency listed on the drive unit's nameplate.
3. As the feeder warms up during tuning, listen for a striking (hammering) noise. This noise, which can also occur when the feeder is turned off and on quickly, is from the drive unit and indicates that the displacement at full voltage is well above the normal level for the tray size. But excessive displacement doesn't always create a striking noise, so you also need to check the feeder's displacement sticker (or other tool) to check the displacement level. To reduce the tray's displacement, turn the feeder off and follow the steps in rule 1 in the previous section; then turn the feeder back on and watch until the tray reaches approximately normal displacement at full voltage. Then use the feeder's controller for fine or variable-speed control of the displacement.

—J. Mitchell

Table I

Ten common problems and their potential causes

	Problems	A. Feeder misapplication	B. Improperly disassembled or modified feeder base or tray	C. Loose spring clamps or tray-mounting fasteners	D. Failed electrical coil or motor in drive unit	E. Failed controller	F. Incorrect voltage	G. Failed tuning springs	H. Foreign material in spring system	I. Incorrect tuning	J. Poor or broken tray welds	K. Incorrect factory adjustment	L. Sympathetic vibration in nearby equipment	M. Feeder contact with other equipment	N. Variation in power supply voltage or frequency	O. Blown fuse or circuit breaker	P. Incorrect electrical connections	Q. Shockmount deterioration	R. Corroded or worn tray	S. Variation in material characteristics
At initial installation	1. Feeder doesn't achieve desired output or output drops after being at desired level. Feeder has low or reduced output.	√	√	√		√	√	√	√	√			√	√	√		√			√
	2. Feeder operates noisily but achieves normal output.			√					√	√	√	√	√	√						√
	3. Feeder operates noisily only during certain periods.													√	√					√
After satisfactory initial operation	4. Feeder won't operate.		√		√	√		√		√				√		√	√			
	5. Feeder operates but has reduced output.		√	√		√	√	√	√	√	√		√	√	√		√			√
	6. Feeder operates noisily but achieves normal output.							√	√	√	√			√	√					√
	7. Feeder's amplitude gradually fades or slowly decreases.		√			√		√	√		√						√			√
	8. Tray is excessively worn.																		√	
	9. Flow of material discharging from feeder is turbulent, creating inconsistent flow to process.									√	√				√			√		
	10. Feeder output is inconsistent, creating feedrate fluctuations.		√	√		√	√	√	√	√	√		√	√	√		√			√

unit, you need to replace the drive motor, which is also available from the manufacturer. After replacing the coil, assembly, or motor, carefully follow the manufacturer's instructions for maintaining it.

E. Failed controller. If your feeder is equipped with a controller, check the controller for proper wiring and function. Inspect the unit for defective components. If necessary, rewire the unit and replace any defective parts.

F. Incorrect voltage. Check that the plant's power supply has sufficient voltage for the feeder, as specified on the feeder motor's nameplate.

G. Failed tuning springs. A failed fiberglass sheet tuning spring will have obvious white areas, while a failed steel coil spring may have a minute crack that can be discovered only by closely examining it. Order new tuning springs from the feeder manufacturer and replace them according to the manufacturer's instructions.

H. Foreign material in spring system. Examine the feeder's spring system for material and dust buildup in the spaces between springs. Clean off any buildup and take steps to enclose the area or contain dust and material sources.

I. Incorrect tuning. See the feeder manufacturer's maintenance instructions before adjusting the tuning. To increase the tray's vibration displacement and the feeder output, use fewer or thinner tuning springs. To reduce tray displacement , which — when excessive — can cause the drive unit to create a striking (hammering) noise, use more or thicker tuning springs. [***Editor's note:*** For detailed information on spring tuning, see the sidebar "Making sure your feeder sings in tune."]

J. Poor or broken tray welds. A poorly welded seam on the tray can crack or break, and even a solid weld can eventually fail after years of vibration. Check the tray welds and repair any that are poor or broken.

K. Incorrect factory adjustment. This problem, which applies only to a feeder with an electromagnetic drive unit, indicates that the feeder manufacturer may have incorrectly adjusted the gap between the drive unit's electrical assembly and the armature. Consult the manufacturer for determining how to correct the gap adjustment.

L. Sympathetic vibration in nearby equipment. Your feeder can transmit vibration to other nearby equipment if the feeder isn't properly isolated from its support structure (typically the floor or ceiling) or the other equipment is mounted on the same support structure, particularly if the structure isn't strong or stable enough. The same problems can allow vibration from other oscillating equipment, like grinders, to transmit vibration to your feeder. Before correcting the problem, make sure you know the vibration's source. Then isolate the feeder (or other vibration source) using adequate shockmounts, or reinforce the support structure to prevent vibration transmission.

M. Feeder contact with other equipment. Any contact with other equipment can prevent the feeder from operating correctly. Worn areas on the feeder will indicate where it's contacting other equipment. Adjust the equipment's position or modify the equipment to eliminate the contact.

N. Variation in power supply voltage or frequency. Check for variation in the power supply voltage and, if necessary, install a voltage regulator between the main line and the feeder. If your plant operates at a remote site and uses a generator to provide power, the generator motor's cycling can create frequency (hertz) variations in the power supply. Check for this variation and, if necessary, install a hertz regulator between the generator and the feeder.

O. Blown fuse or circuit breaker. Check for short circuits in the feeder's wiring connections and motor protection devices, including the fuses and circuit breakers. Replace any blown fuses, and reset any tripped circuit breakers.

P. Incorrect electrical connections. Check that all electrical connections are correct and tight. Fix any incorrect connections and tighten loose connections.

Q. Shockmount deterioration. Shockmounts must be in good condition to adequately isolate the feeder and prevent it from transmitting vibration to (or receiving vibration from) other equipment. Check that the shockmounts under the feeder's base are in good shape, and replace them if they've deteriorated.

R. Corroded or worn tray. A tray that has deteriorated can prevent material from moving across the tray surface as designed. The tray will also be lighter than it was originally, affecting the feeder's vibration displacement. Replace the tray with one made of special corrosion- or abrasion-resistant materials. Consult the feeder manufacturer for help in selecting a tray suited to your material characteristics, and make sure that your tuning springs are tuned to the new tray.

S. Variation in material characteristics. If your material's bulk density, moisture content, or other characteristics vary, the feeder can't provide top performance. Check your material's characteristics and take corrective measures to control any variation in them by ensuring that the raw materials arriving at your plant meet your specs and that you store and handle the materials properly so that their characteristics don't change before feeding.

A final word

You may want to keep Table I handy as a quick reference tool for diagnosing and fixing problems with your vibratory tray feeder. And to ensure top feeding performance, don't overlook your feeder manufacturer as a source of practical information on properly installing, operating, and servicing your feeder. **PBE**

For further reading

Find more information on vibratory tray feeders in articles listed under "Feeders" in *Powder and Bulk Engineering*'s comprehensive article index at www.powderbulk.com and elsewhere in this issue.

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