COMPARING THE LIFE-CYCLE COST OF A VIBRATORY FEEDER TO A SCREW FEEDER

When purchasing a loss-in-weight feeder, you want to make sure that the feeder is appropriate for your bulk solids application and you also want to ensure that the feeder is a good financial investment. This article looks at the life-cycle cost of a vibratory feeder in comparison to the life-cycle cost of a single screw feeder to determine which feeder type is a better long-term investment.

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Manufacturing processes involve a wide variety of raw materials, depending on the industry, and there's an equally wide variety of feeding options available on the market to bring these bulk materials into the process. In applications where free-flowing bulk solids need to be accurately fed to ensure an optimal end-product quality, single screw feeders are often the solution of choice. However, there are a variety of options that can get the job done besides single screw feeders, such as bulk solids pumps, belt feeders, and vibratory feeders. The feeding tool choice is generally based on various application aspects, including the bulk solid material's characteristics, the desired feedrate, hazardous location limitations, the material's flowability, and the space available for installing the equipment.

In many cases, both single screw and vibratory feeders would be appropriate for the same application. In the past, vibratory feeders often had a big disadvantage compared to screw feeders due to problems like feeding accuracy and vibration transmission to surrounding equipment, which can cause disturbances. However, equipment manufacturers have invested time and money in research and testing to optimize the technology. This investment has resulted in vibratory feeders that are more beneficial compared to screw feeders not only technically but also in terms of cost, particularly when looking at the feeder's total cost over its service life. In this article, we'll explore exactly how the *life-cycle cost* — the total accumulated cost of a piece of equipment over its entire service life — of a vibratory feeder compares to a single screw feeder.

Feeder basics

Before discussing the loss-in-weight (LIW) feeders' life-cycle costs, let's discuss the basics of each feeder type analyzed in this article.

Vibratory feeder. A vibratory feeder, as shown in Figure 1, is made up of a shallow, flat-bottomed tray that can be covered or open. Material flows from the feeder hopper above onto one end of the tray, where the material is moved along the tray via vibrations from an external drive connected to the tray's underside. The vibrations cause the material to be tossed upward and forward in short increments. Once the material reaches the tray's other end, the material discharges into the process below. Vibratory feeders are suitable for conveying material that's free-flowing and dry, such as tablets, table salt, or powdered flavorings like vanillin, which are easier to convey than non-free-flowing, sticky materials, such as brown sugar or powdered milk. Because the tray doesn't constrain the material flow, the vibratory feeder is also ideal for materials with irregular shapes such as cereal flakes or fiberglass.

Screw feeder. A screw feeder, as shown in Figure 2, is different from a vibratory feeder in that instead of a tray conveying the material, the screw feeder uses a rotating screw housed within a tube to move material from one end of the tube to the other. The screw rotates via a rotating drive shaft, drawing material from the feeder hopper above and moving the material down the length of the tube. At the screw feeder's other end, the material is discharged into the process below. Because the screw is what conveys the material, materials metered through a single screw feeder must be free-flowing, dry, and made up of small particulates, such as plastic pellets, cornmeal, or sugar.

What is life-cycle cost?

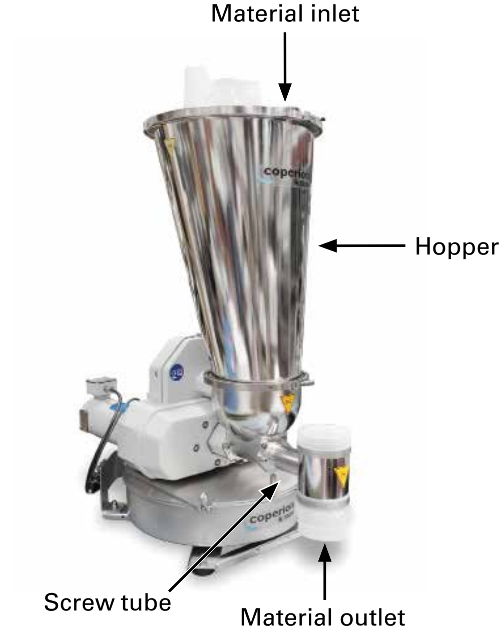
The life-cycle cost of a piece of equipment is generally divided into three phases: the procurement costs, the operating costs, and, finally, the recycling costs, as shown in Figure 3. In contrast to the total cost of ownership, the life-cycle cost doesn't take into account the

FIGURE 1

A vibratory feeder conveys material via vibrations created by an external drive, resulting in the material moving down the tray.

FIGURE 2

Screw feeders move material using a rotating screw encased in a tube.



interest rate for capital repayments or warehousing. This is mainly because each company works individually with different interest rates and storage costs.

For the purposes of this article, we'll define a LIW feeder's service life as 15 years. To understand how the individual costs develop for the two different feeder types, the three individual phases will be examined in more detail.

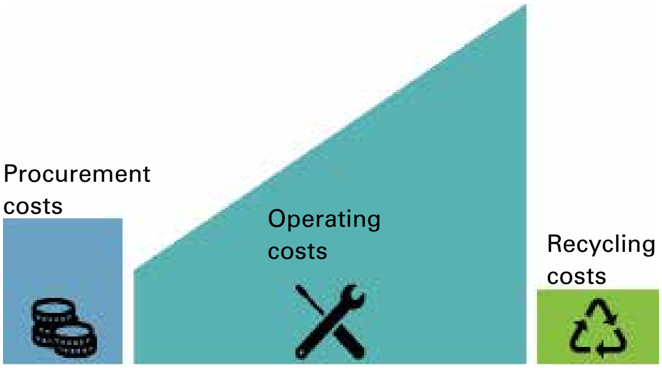
Procurement costs

Logically, the actual price paid for a vibratory feeder or screw feeder is the keystone of the procurement costs. However, there are other costs that must be figured in, such as transportation, customs tariffs, and installation, among others. In brief, these costs include all those incurred to get the feeder installed and running. In broad terms, the procurement costs can, of course, be kept low by negotiating a low purchase price. However, the lowest price isn't always the best offer.

To understand procurement costs better, we need to look more closely at how a price is actually calculated. You start with the material costs, which are necessary for feeder production, and add the labor costs incurred to build the feeder. Together with the overhead costs, this results in the manufacturing costs. The overhead costs include administration as well as research and development. Companies with their own research and development departments, which actively research new technologies and thereby achieve technological leadership, are more burdened on the cost side. Depending on the location, an equipment manufacturer may have a price advantage based on local labor costs, but, nevertheless, the material used is a major part of the manufacturing cost. In order to achieve a lower price, savings can be made by considering different material grades and quality, but this would likely have an impact on the equipment's operating costs and service life. In the last step, the manufacturer's profit margin is added to the cost. From the customer's point of view, it may seem that manufacturers can obtain high margins. Ultimately, however, demand is always

FIGURE 3

Life-cycle cost consists of three main phases: procurement costs, operating costs, and recycling costs.

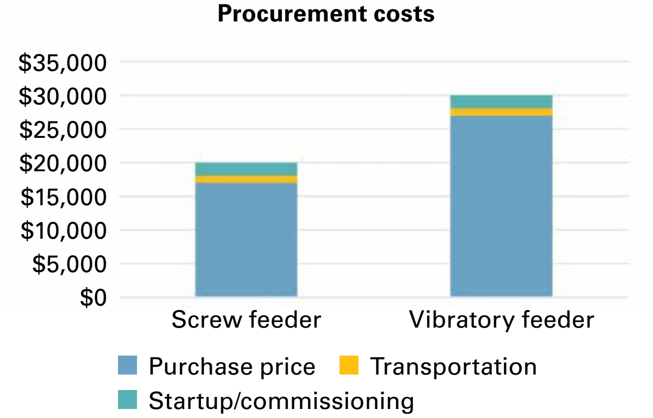


closely related to price, and a company that tries to achieve excessive margins, as opposed to companies with realistic margins, will hardly have any demand and won't be able to survive as a result.

What does all this information mean in our case? Screw feeders are available in many design standards in different qualities and prices. For the sake of this comparison, we'll assume that a new single screw feeder, with a throughput of about 1,000 kg/h, will have an average procurement price of $17,000. In contrast to this, a new vibratory feeder with similar throughput, with the advancements mentioned earlier, is about 50 percent more expensive at around $27,000. The transportation costs of $1,000 and the commissioning costs of $2,000 will be similar for the two feeders. As a result, with a $10,000 difference in procurement costs, the screw feeder is definitely in the lead in terms of lowest cost at this point, as shown in Figure 4.

FIGURE 4

Initially, the screw feeder is at an advantage with lower procurement costs.



Operating costs

Assuming both machines run fully automatically, the LIW feeder's operating costs include spare parts, maintenance, cleaning, and energy costs.

Spare parts costs. As previously mentioned, users often look for savings in lower prices during procurement, but lower prices often mean lower quality materials, which generally result in a shorter service life. Therefore, we can safely assume that a lower investment cost can lead to an increased requirement for spare parts later on. Screw feeders have a number of wear parts — such as ball bearings, motor brushes, shaft seals, or even the screws themselves — that need to be replaced at regular intervals. For a screw feeder in the intermediate price range, experience shows that spare parts costing $1,500 are required annually. Calculated over a 15-year service life, spare parts costs for a LIW screw feeder amount to about $22,500, which is probably still a conservative estimate.

Because a vibratory feeder has no rotating parts, operators can save money by not having to purchase and replace wear parts. In addition, LIW vibratory feeders are developed in such a way that all force is directed into the bulk material, eliminating the need for mechanical spare parts, such as those required for the screw feeder. But, of course, the vibratory feeder's electronics — the vibratory drive itself or its measurement technology — may fail or become outdated over the course of 15 years. Such a failure should be planned for during a vibratory feeder's service life and would result in replacement or repair costs of about $7,000.

Maintenance costs. Let's move on to the maintenance work, which, in this example, will be carried out by an in-house expert. Assuming an hourly rate of $50, maintenance work is normally carried out twice a year, during summer and winter holidays. For the screw feeder, this maintenance includes a scale check or calibration as well as a change of seals, ball bearings, and other wear parts. An accurate scale check takes about 30 minutes and the replacement of wear parts takes about 1 hour, which totals $150 for 3 hours of maintenance per year. And for 15 years of operation, that's about $2,250 in total maintenance costs for a screw feeder. In comparison, since the vibratory feeder doesn't require the replacement of wear parts, maintenance is limited mainly to a scale check or calibration. This corresponds to 1 hour of work per year or $50, and over 15 years of operation, that's about $750 for maintenance costs for a vibratory feeder.

Cleaning costs. The next item on the list is the cleaning costs. The disadvantage of screw feeders is that cleaning always requires mechanical work, such as removing the feeding screws and agitator, cleaning the screw shaft, and changing seals. Often, the many edges and corners in a screw feeder make cleaning difficult. A specialist can disassemble, clean, and reassemble a screw feeder in about 30 minutes. Looking at a vibratory feeder, we see that it can be easily cleaned with a cloth if the tray is the open type or has a quick-release cover that can be removed without tools. Since there are no rotating parts with seals that must be removed, vibratory feeder cleaning is uncomplicated and can be carried out quickly within a maximum of 15 minutes.

If we assume that either feeder type is cleaned at least once a week, we can calculate the amount of time spent cleaning each feeder for the whole year. A screw feeder takes 0.5 hours to be cleaned each week and assuming the feeder will be cleaned 50 weeks out of the year, that's 25 cleaning hours per year. A vibratory feeder would likely take 0.25 hours to be cleaned each week and cleaning the feeder 50 weeks in a year amounts to 12.5 cleaning hours per year. Already we can see that the vibratory feeder takes half the time to clean compared to a screw feeder. Factoring in an hourly cost of $30 for a cleaning professional, the annual cleaning costs for a screw feeder amount to around $750 and $375 for the vibratory feeder. And extrapolated to an assumed service life of 15 years, the cleaning costs for the life of a screw feeder amount to $11,250 compared to $5,625 for the life of a vibratory feeder.

Energy costs. In a production plant, the energy costs for a feeder are often ignored. After all, the feeders generally have relatively small motors with minimal energy requirements when compared to the whole plant. However, the energy requirements of various drives or motors can vary widely and have a noticeable impact on the feeder's life-cycle cost. In our example, the screw feeder, with a throughput of 1,000 kg/h, uses a 1.6-kilowatt motor. For the same throughput, a new vibratory feeder consumes 19 watts (or 0.019 kilowatts) of power. If we assume an average energy cost of 12 cents per kilowatt hour, a screw feeder costs 19.2 cents per hour of operation. In contrast, a vibratory feeder costs 0.2 cents per hour. If these values are applied to 2,500 production hours per year, the total annual energy costs for a screw feeder amount to $480 and $5.70 for a vibratory feeder. And then extend those results to a 15-year equipment service life, and the energy costs for a screw feeder total $7,200 and the vibratory feeder $85.50.

Total operating costs. When all operating costs in this example are added together, a screw feeder has an annual cost of $2,880, while a vibratory feeder can be operated at a considerably lower cost of $430.70. The difference in the two feeders' annual prices tells us that a vibratory feeder can be more economical than a screw feeder. And again, when we extend those annual amounts to a 15-year service life, the total operating costs for a screw feeder amount to $43,200 versus $13,460 for a vibratory feeder. Figure 5 illustrates the comparative operating costs over a 15-year period.

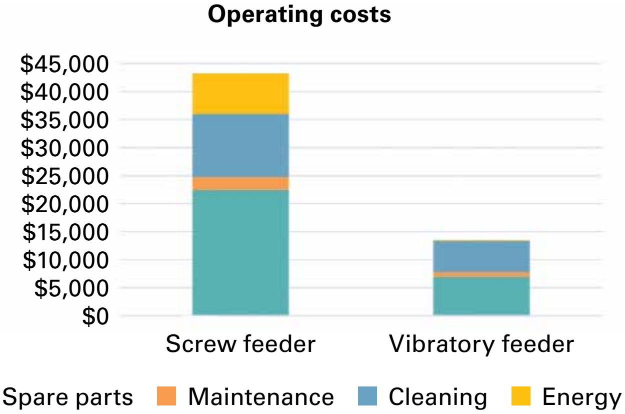
Recycling costs

In mechanical engineering, recycling costs are a combination of costs and revenues. On the cost side, this includes the costs of dismantling and disposing of nonrecyclable material. On the revenue side, selling equipment or recyclable raw materials would lead to income. For our example, let's assume that dismantling either feeder's system, similar to setup, costs about $2,000. From the sale of parts and raw materials, we'll earn about $1,000, which will result in a net cost of $1,000. Considering that in this example, both feeders cost approximately the same to recycle and bring in the same profit from used parts and raw material, the difference in recycling costs between a screw feeder and a vibratory feeder is negligible.

One option offered by some manufacturers for used equipment is *modernization*. This involves updating certain obsolete feeder components so that the equipment is once again like "brand new." Equipment modernization allows you to update a 15-year-old feeder with newer components so that the feeder can continue to be used for many years.

FIGURE 5

With no rotating parts and lower energy consumption, the vibratory feeder has an advantage in operating costs.

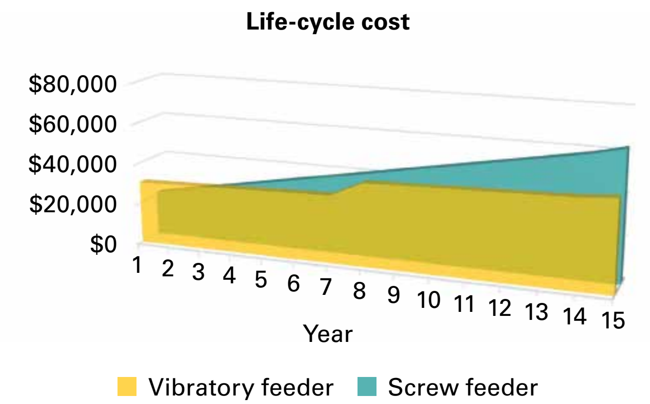


Total life-cycle cost

In summary, to determine the life-cycle cost of a screw feeder versus a vibratory feeder, we compared the total costs over 15 years for both feeders. The screw feeder's total life-cycle cost amounted to $62,550 compared to $44,410 for the vibratory feeder, as shown in Figure 6 and broken down by year in Table I. Both Figure 6 and Table I clearly show that the screw feeder's initial cost is lower than the vibratory feeder's for the first 3 years. This is mainly due to the vibratory feeder's higher investment costs in the beginning. However, from the fourth year of operation onward, we can clearly see that the screw feeder costs exceed those of the vibratory feeder. The marked increase in year 8 for the vibratory feeder stems from the assumption that we may need to replace the electronic components after 7 years of operation. There's a possibility that the drive may work just fine for the entire 15 years but factoring in the possible replacement cost is a good idea. While actual costs may vary depending on local markets, the overall proportion of costs will remain the same.

FIGURE 6

While the screw feeder has a lower initial cost, the vibratory feeder can end up being a more economical solution over the feeders' service lives.



If a LIW vibratory feeder is suitable for your bulk solids application, you can see that you can create product with equal or higher accuracy at lower costs compared to using a screw feeder. You can also achieve a higher *return on investment* — the amount of money spent on maintaining the feeder in relation to the feeder's original implementation costs — over the vibratory feeder's service life compared to a screw feeder. **PBE**

For further reading

Find more information on this topic in articles listed under "Feeders" in *Powder and Bulk Engineering*'s article index in the December 2019 issue or the article archive on *PBE*'s website, www.powderbulk.com.

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TABLE I

The annual cost of a screw feeder versus a vibratory feeder over a 15-year feeder service life.

Year	Costs	Screw feeder	Vibratory feeder
Year 1	Procurement	$17,000.00	$27,000.00
	Transportation & customs	$1,000.00	$1,000.00
	Commissioning and startup	$2,000.00	$2,000.00
	Cleaning	$750.00	$375.00
	Energy	$480.00	$5.70
Year 2	Spare parts	$1,500.00	N/A
	Maintenance	$150.00	$50.00
	Cleaning	$750.00	$375.00
	Energy	$480.00	$5.70
Year 3	Operating (spare parts, maintenance, cleaning, energy)	$2,880.00	$430.70
Year 4	Operating	$2,880.00	$430.70
Year 5	Operating	$2,880.00	$430.70
Year 6	Operating	$2,880.00	$430.70
Year 7	Operating	$2,880.00	$430.70
Year 8	Operating	$2,880.00	$430.70
	Electronics updates/replacements	N/A	$7,000.00
Year 9	Operating	$2,880.00	$430.70
Year 10	Annual operating costs	$2,880.00	$430.70
Year 11	Annual operating costs	$2,880.00	$430.70
Year 12	Annual operating costs	$2,880.00	$430.70
Year 13	Annual operating costs	$2,880.00	$430.70
Year 14	Annual operating costs	$2,880.00	$430.70
Year 15	Annual operating costs	$2,880.00	$430.70
	Recycling costs	$1,000.00	$1,000.00
	Total life-cycle cost:	**$62,550.00**	**$44,410.00**

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