

Vincent

In our eighth decade

CORPORATION

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SCREW PRESS OPERATING HINTS

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INTRODUCTION

Even if you have never seen one, most of you are at least aware that screw presses are used in citrus feedmills. Their use became common in the 1940's, to squeeze liquid out of orange peel in the process of making peel into animal feed.

A screw press is a rather simple machine. It is powered by an electric motor connected to a speed reduction gearbox. The output shaft of the gearbox causes a horizontal screw to turn at a low speed, generally in the range of 6 to 30 rpm. This screw is configured so that it squeezes the material that is dropped into the screw press. The length of the screw is surrounded by a cylindrical screen, and the liquid or juice squeezed out by the press is expelled through this screen. The residual fibers, which we call press cake, are pushed out of the far end of the machine by the screw. The machine works in a continuous, not batch, operation.

It takes compression to squeeze liquid out of materials. A screw press achieves this compression through three basic methods. One: the pitch and arrangement of the flights on the shaft of the screw can be manufactured so the material is squeezed. Two: the shaft of the screw can be manufactured so that it gets larger towards the cake discharge end of the machine. This increasing shaft diameter pushes the material in the press out towards the screen, pushing the press liquor through the screen. Three: there is a plug or door, which we call the cone, at the cake discharge end of the press. This cone is pushed shut by an air cylinder. In order for the press cake to get out of the press, it must first push open the cone. The higher the air pressure pushing the cone shut, the harder the screw must push the

material in the press. And, the harder the screw pushes the material, the more press liquor is squeezed out.

There is a collage of photos going by as I am speaking. In these you will see a wide range of materials being run through screw presses. You should be able to spot different kinds of screws, screens, cones, press liquor, press cake and so forth.

Other machines which do similar jobs to screw presses are decanter centrifuges and belt presses. In general, if a screw press can do the job, it will be preferred over either of these alternatives. For example, if a screw press can do the job, it would be preferred over a centrifuge because centrifuges have higher power consumption and maintenance expense. However, there are far more centrifuges sold than screw presses. Screw presses are good at some things but not all.

In the early days of the citrus industry, screw presses were supplied by firms whose primary markets then were sugar beet processors and beer breweries. These used presses to make animal feed. The sugar beet processors used presses to make meal from the waste left over after sugar was extracted from beets, and breweries converted their waste into spent brewer's grain.

Other major industries employing screw presses at the time were fish processors and rendering companies. In these, the application was to take the waste and convert it into animal feed. That is, waste from fish canneries and animal slaughter houses (mostly beef and poultry) was squeezed with screw presses in the process of producing things you may have heard of such as fish meal, bone meal and feather meal

A parallel industrial use for screw press was in the pulp and paper industry. Here the application was to remove moisture from reject fiber and sludge from wastewater treatment plants. The large virgin fiber mills wanted to squeeze water out of their waste to make either fuel for their boilers or, at least, material suitable for landfill. The smaller waste paper recycling mills needed to dewater their waste so that it could be economically disposed of in landfills.

More recently, environmental pressures and the development of more economical screw presses have resulted in their adaption by a plethora of industries. Plastic recyclers use them to dewater their wash tank sludge. Fresh Cut produce processors cut their landfill expenses in half by squeezing the free moisture from their waste. Bean, pea, and sweet corn canneries squeeze their waste to keep it from draining on the highway. Potato, carrot and onion peelers do the same. I could name at least twenty other industries, many of which you have never heard of, which use screw presses to dewater their waste.

Another important market requires vapor-tight presses. These are applications where alcohol is used in the production of things like citrus pectin, Xanthan gum, soybean protein

concentrate (hamburger helper), and even biodiesel fuel. The alcohol solution must be squeezed from organic material, and screw presses have proven ideal.

Manure dewatering is still another important emerging market. Dairy manure, from scrape barn, flush barn or biogas digesters, is dewatered both for nutrient management (where does the phosphate go?) and making bedding instead of using sawdust or straw. This has proven our most challenging application.

Vincent supplies screw presses to all of these industries. What is more, the company has a rental fleet of over one hundred fifty machines which are used for laboratory, pilot plant and even routine production. Since we have to not only make these machines work, but also maintain them, it has put the company in a unique position to improve the dewatering capability, to reduce the initial cost, and to reduce maintenance problems and their frequency. It has also put the company in a unique position to take the things we learn in one industry and apply them to another.

Every day we seem to be hit with new problems with our screw presses. All I hear is that this one does not squeeze out the water; that one does not have enough capacity; and the next one is broke.

The development of screw designs which squeeze tighter has caused a lot of the problems. So have the challenges of dewatering things previously all but impossible, like tomato and onion waste.

The part played by the common use of VFD's (variable speed drives) has been a key item in addressing many problems.

Most of these problems fall in four major categories. And that is what this presentation is about. The four categories are Jamming, Screen Blinding, Channeling and Purging.

NUMBER ONE: JAMMING

Generally jamming is caused by over-pressing excessively dry material. In the citrus industry, the jamming is usually caused by either over-liming the peel or by tramp metal.

Should a press become jammed, a series of steps can be taken to un-jam the press. Running the press backwards will usually break up jam material, so the first step is to reverse direction of the screw. This will either break up the jam or, hopefully, allow the retrieval of tramp material.

At older installations, generally the easiest thing to do is to reverse the leads on the electric motor drive. This will cause the screw to feed material backwards out of the press. Having

a reversing starter greatly facilitates this operation. These cost little more than a standard starter; they come with a forward-reverse switch.

At new installations, we recommend that a VFD be used to start and run the press. This can negate the need for an electrical starter or breaker. Not only does it provide superior protection against electrical overload, but it also adds a great deal more flexibility to the operation.

For example, a VFD can be programmed to automatically stop and run the press backwards for a few turns anytime high amp load is detected. In this manner a press can be operated nearly continuously at its peak torque and dewatering capability.

If a press has had extensive use in an abrasive application, the outer diameter of the flights will be worn away at the discharge of the press. Radial wear of 1" to 4" will lead to serious jamming and, possibly, a burst screen. Again, driving the press with a VFD offers protection against this form of jamming.

If reversing the press does not un-jam it, then, before going to the trouble of removing the screen, try inspecting the tips of the screw flights. This is done by shutting down the press, opening the cone, and cleaning out the end of the press with a long screwdriver or bar. This allows inspection of the end of the screw, which is the first part to show wear.

If running the press backwards several cycles does not clear the jam, chances are that the screen should be removed so that the cause of the jam can be determined. It is easy to spot rags or plastic wrapped around the screw. Most of all, look for a bent flight. If a flight has folded backwards toward the press inlet, the flow through the press will be blocked.

NUMBER TWO: SCREEN BLINDING

A common problem is for the screen of the press to become blinded (covered over). When this happens, the flow of press liquor coming through the screen diminishes. In the citrus industry this most commonly occurs when spoiled or under-limed peel is being processed.

In some cases, the screen can be cleared by periodically reversing the direction of rotation of the screw. This can be programmed into the VFD, so that the press runs forward for a given period of a few minutes and then briefly reverses direction when the screen starts to blind. This is one of the easiest possible solutions to test. Sometimes it is the only one that is effective.

Many people, especially in the pulp & paper industry, have voiced concern over having a press which continuously stops and momentarily runs backwards every few minutes. However, Nord and Sumitomo, our primary gearbox suppliers, have given assurances that it will not reduce the life expectancy of the gearbox. In one application, separating water

from emulsified chicken skin and fat, our presses have been operating this way for many years without gearbox or motor problems. The success is due in part to the soft start and stop programmed into the driving VFD's.

Many other methods are used to address blinding: (1) Adding notches to the screw, (2) Reducing or eliminating the pressure in the inlet hopper, (3) Adding press aid to the flow, (4) Changing to a different screen selection, (5) Reducing the screw-to-screen clearance, and/or (6) Employing a back-flush with caustic solution, acid, or high pressure spray.

Later on I will talk a little more about each of these six tricks.

If blinding occurs after an extended period of satisfactory operation, it is almost always due to a change in the material being fed into the press. However, it could be due to wear of the screw. Rounded edges of the flights will contribute to blinding.

NUMBER THREE: CHANNELING

A condition called channeling can occur with slimy materials, like washed or un-limed citrus peel, concord grapes, pineapple pulp, or spent brewer's grain. These will tend to channel through the press and squirt out of one side of the discharge cone. Two ways to eliminate channeling are to lower the pressure on the discharge cone, and to slow down the speed of the press. Again, a VFD can be invaluable for fine-tuning an operation.

Channeling can also be reduced by adding press aid to the material being dewatered, or by reducing the inbound flow to the press.

The rotating cone option is very useful in breaking up channeling. A pin on the face of the cone will break up the stream shooting from the press.

To break up channeling in citrus applications, pieces called wing feeders are welded to the end tips of the last two flights of the screw. These have been standard for many years.

NUMBER FOUR: PURGING

A condition similar to channeling occurs when the material being admitted to the press purges, without any liquid-solid separation, from the cake discharge. This can occur especially if pressure exists in the inlet hopper. The only time I have seen purging in a citrus application was in pumping peel to the press with a closed piping system.

Mechanically, purging usually occurs when a dry lump of press cake holds open the discharge cone. Un-pressed material will flow around this partial plug.

At installations where purging might occur, spill containment should be taken into consideration. Should a press begin to purge while operating unattended, the waste spill can be considerable. Spill containment usually consists of diversionary dikes or channels.

Purging may occur when there is a small, much reduced, flow of cake coming from the press. Usually this is a sign of a blinded (covered over) screen. Commonly this is caused by a worn screw. Liquid from the inlet hopper will wick into the press cake, making it soft enough to blow out.

In applications where purging is likely to occur, the screw press is always supplied with the rotating cone feature. The pin in the face of the cone will strip away hard material which might hold the cone open.

Mounting the press at about 3° above horizontal will help avoid purging because it keeps moisture from loosening the plug of cake at the discharge. The simplest way to incline the press is to place a block under the cone end of the press.

As with channeling, wing feeders can be welded to the tips of the last two flights of the screw in order to break up dry cake which might hold the cone open.

A drop in operating amps can be an indicator that a purging condition has begun. An ammeter circuit can be installed to alarm, or trip, the system when a reduction in motor amps occurs.

TRICKS

The six things I mentioned a while ago in regards to screen blinding are worthy of elaboration.

One, Notches: Most of the presses we supply today are supplied with 1/8" notches ground into the edges of the screw. This feature was first used to replace wipers in a manure application. Slimy manure was causing screens to blind.

Fibrous material accumulates in the notches and wipes away slimy material which blinds the screen. As fast as the fibers wear away, they are replenished.

An additional benefit is that the fiber in the notches can help prevent a screw from rubbing the screen. Since they can do no harm, but might on occasion help, notches are standard in modern citrus presses.

Two, Supercharging: Years ago I gave a presentation like this in which I described the use of superchargers to pressurize the material going into a screw press. I said that by forcing

material into the press, with a screw feeder or positive displacement pump, improved performance could be achieved. Unfortunately, this turned out to be true in a very limited number of applications. Because of the unpredictability and cost of superchargers, Vincent no longer offers them.

In fact, we recommend the opposite: minimize the static head of the material in the inlet hopper. This will minimize the chance of blinding the screen with a mat layer of fiber. We ran into applications where pressurizing the material in the inlet hopper plastered it in an impervious layer against the screen. The only time liquid came through the screen was momentarily when the flight of the screw came by and rubbed this layer away.

Three, Screw-To-Screen Clearance: Screw-to-screen clearance is critical in many applications. It can be loose in some applications: the citrus standard has been 1/16"; corn silage is 1/8". However in things like pulp wash, pectin peel, and pineapple juice, a tighter 1/32" becomes critical.

The reason that screw-to screen clearance is important is this: With a wider clearance, the screen partially blinds and performance deteriorates. As the flight of the screw turns past the screen, this layer of blinding material is rubbed off. However if this layer is thick and made of fine particles, the screen is not cleared by the passing flight.

Many things have allowed us to tighten the standard screw-to-screen clearance. Important items include laser alignment when welding the press frame; better welding fixtures and sequences; mounting the screens in machined pockets; and the use of one-piece, instead of two-piece, screens. Today the average screw-to-screen clearance in our presses is half of what it was fifteen years ago.

Four, Press Aid: We always say that if you put apples into a press, apple sauce will come through the screen. But, if you add press aid, apple juice will come through the screen. Commercial press aids have been used by the apple and grape industries for many years. These are inexpensive fibrous materials such as rice hulls, cotton seed hulls, and ground wood (cellulose fiber). When dewatering some sludges in the pulp and paper industry, they know that they will need to add "sweetener", in the form of reject fibers, before the press will work. The fiber gives body to the material so that the screw press can get a grip on it, and at the same time the fibers tend to wipe the screen clear of blinding material.

In the citrus industry, the use of press aid proved indispensable in dewatering spent peel generated in the process of making ethanol from orange peel.

Five, Screen Selection: The standard screen in a citrus feedmill is made of perforated sheetmetal with holes that are 3/32" in diameter. In contrast, almost all presses in the pulp and paper industry have screens made of wedgewire bars with slots that are 0.015" wide. Because it is hard to predict the results, our presses are built to take interchangeable perf

and bar screens. In addition, variations of both are common, such as 1/32 or 5/32 perforations or slots that are 0.040 wide.

One unusual thing about perforated screens is this: if a screen with 3/32" holes is being blinded, is it quite possible that performance will be improved by going to a smaller, 1/32" perforation. There are two possible explanations for this improvement. It may be that the particles which plug a 3/32" hole will roll right over and past a 1/32" hole. Or the improvement could arise from the fact that the 3/32" screen is a lot thicker than the 1/32" screen. This means that the press liquor needs to travel about three times the distance before it falls free on the outside of the screen. Either way, do not be surprised if someone recommends going to a screen with smaller diameter screen holes if your press is not performing as desired.

Six, Flushing: It is infrequent that a screw press needs a flush system. However, two are available: internal and external. Internal flushing is done by injecting water, steam or solvent through holes drilled through the resistor teeth of the press. In the juice industry, this feature is being used in CIP applications.

Admittedly, it is rare that internal flushing of a press is important to clearing the screen and getting the press working.

External flushing systems are used to avoid manual pressure washing of the screens: the press is supplied with traveling spray rings which are moved back and forth by air cylinders, controlled by a timer and assisted with a pressure boosting pump. In citrus, these are used where pectin accumulates on the outside of the screen. In this instance, the cleaning action achieved by spraying the screen can be important in sustaining peak operating performance of the screw press.

Those of you who know me know that I can go on for several hours like this. Instead, let me summarize what we have here.

SUMMARY

Screw presses in one form or another have been used since the nineteenth century to separate liquid from wet masses of animal and plant material. As the use of screw presses has spread to different industries, new designs and operating conditions have led to improvements in dewatering and throughput capacity. Knowledge and experience is being carried from one industry to another.

At the same time, the wider use of presses and the development of tighter squeezing machines has led to the need for addressing problems such as jamming, screen blinding,

channeling, and purging. The key to addressing jamming is to run the press backwards a few turns. A new technique for addressing screen blinding is also to periodically run the press backwards for a few turns. Channeling can always be reduced by reducing the screw speed or the air pressure on the discharge cone. Unfortunately this means moving down from peak press performance. Using the rotating cone feature, however, is more effective because peak press performance can be sustained. Purging is generally a result of running a press too long without inspecting it for screw wear. In applications where this is apt to occur, it is best to plan for spill containment.

Mechanical improvements in screw press design have lead to their adoption in a number of new industries and applications. As often as not, new screw press problems have arisen in these new applications. The flexibility and features being offered in VFD's have played an important part in addressing these problems. The programming features and low cost of VFD's have been a boost to our machine business.