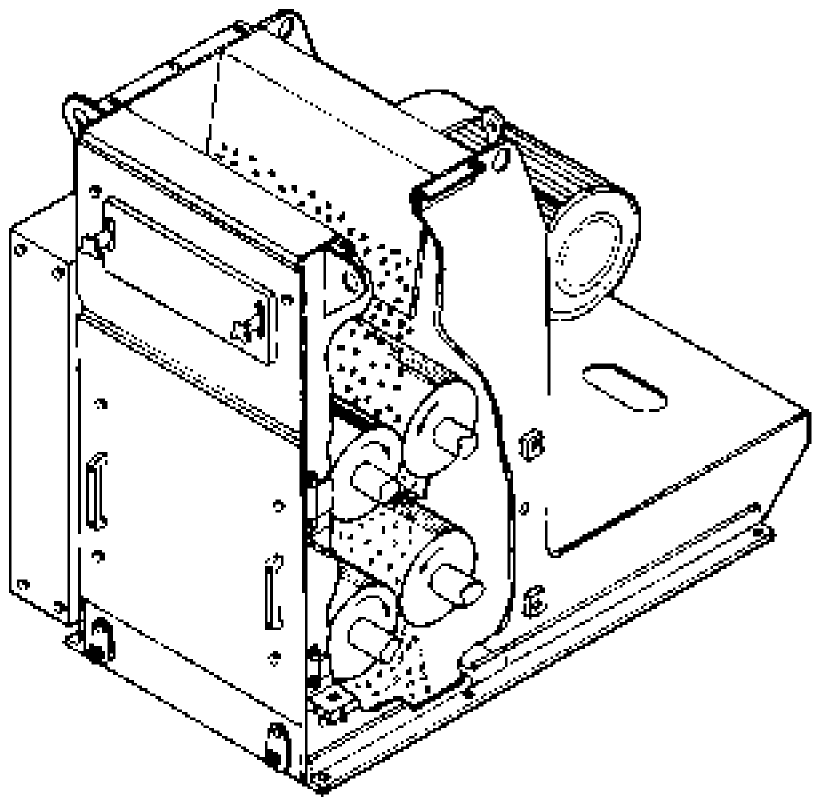
CPM.NET

Roller Mill Maintenance



Mark Heimann
Roskamp Champion
2975 Airline Circle
Waterloo, Iowa USA 50703
Tel 319 232 8444
Fax 319 236 0481
sales@cpmroskamp.com
www.cpmroskamp.com

Roller Mill Maintenance

Roller mills are used around the feed mill to perform a variety of tasks. Applications include crumbling pellets, cracking corn, dry rolling and steam flaking grain, and grinding corn, wheat, or milo for mash and pelleted feeds. While each application has some unique aspects, maintenance and operation of the equipment is remarkably similar.

Roller mill maintenance can be broken down into three general areas; rolls, bearings, and drives. Maintenance requirements may vary from application to application but are most directly linked to the horsepower connected to the equipment. Those machines with more horsepower connected will require more maintenance and attention. The materials processed will also influence the maintenance requirements of the roller mill system. When relatively clean #2 corn is processed, roll corrugation intervals will be extended and the machine operation will be smooth and trouble free. When materials containing more abrasive impurities like tapioca, Canola, or corn stored on the ground are to be processed, the likelihood of problems will be increased.

Horsepower and Machine Size

Double Pair Roller Mills

Roller Mill Size	Low	High
900-24	20	40
900-36	40	60
1200-24	40	60
1200-36	60	100
1200-52	75	150
1200-72	100	200

Roll Maintenance

Roll Life and Materials Processed

Easy to process / Long life

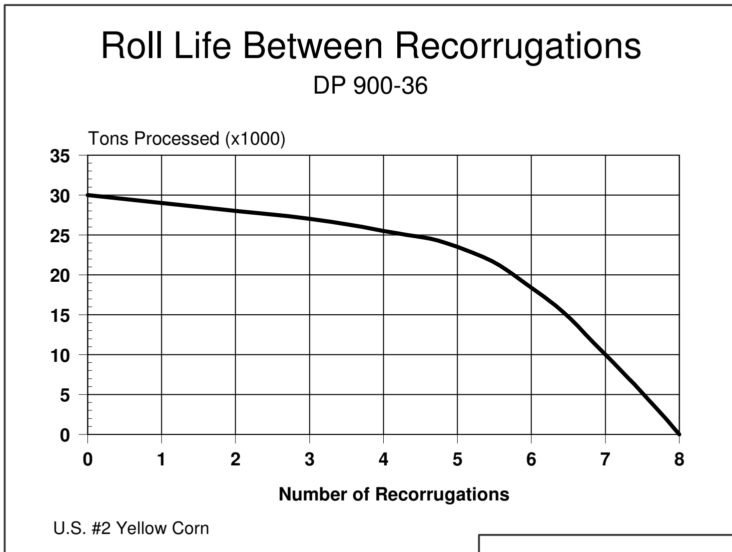
- Corn, 48% Soybean Meal
- Hard Wheat, Grain Sorghum
- Soft Wheat, Heavy Barley, 44% Soybean Meal
- Light Barley, Oats, Sunflower Meal
- Beet Pulp Pellets, Grass Pellets
- Screenings, Screenings Pellets
- Rape Seed / Canola

Tough to Process / Short Life

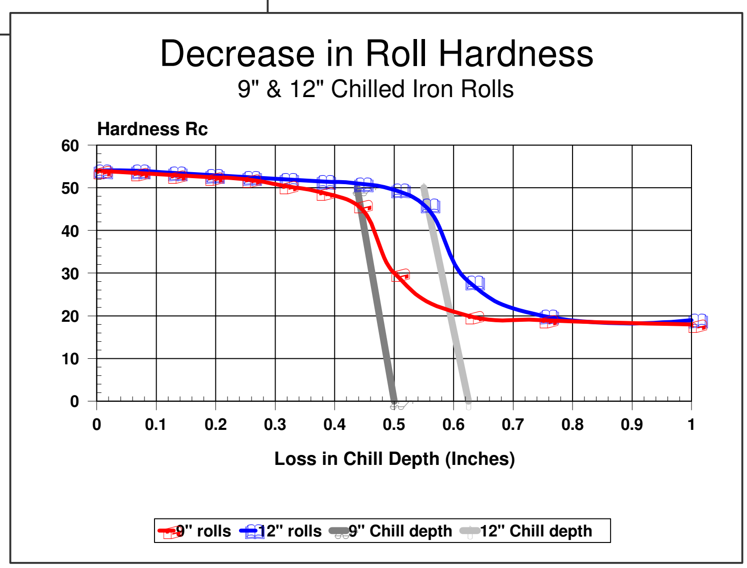
Over the life of the corrugations, some roll wear will occur due to normal processing, and some wear will occur due to extraneous conditions. As noted, the best roll corrugation life will be realized with easy to process materials like corn, soybean meal, and pellets made from similar products. As products become tougher or contain more abrasive impurities, roll life will be reduced. Producing finer ground products, smaller crumbles, or thinner flakes will also reduce the life of the roll corrugations.

Roll corrugations must be selected according to the materials to be processed, and the finished product requirements. Coarser grooving provides longer life and higher capacities but will produce coarse or thicker finished products. Finer corrugations do indeed lead to finer products and thinner flakes, but will reduce capacity and wear out faster.

Remember that each time the rolls are recorrugated, some roll diameter will be lost. Coarser grooving is deeper and so the loss in diameter will be greater each time the rolls are recorrugated. After several recorrugations the diameter of the rolls will become so small that the rolls are no longer useful either because of the small size (capacity loss) or the loss of roll hardness.



Larger diameter rolls will process more tons before recorrugation, and will have a deeper roll chill or hard working surface. Because of the better nip angle, large diameter rolls are often used in flaking operations where roll corrugations may be very fine to prevent cutting the grain while making thin, uniform flakes. Larger diameter rolls must also be used in machines with longer rolls to maintain the degree of stiffness required for holding the rolls in position.

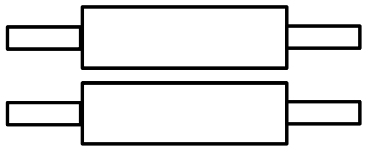


Larger diameter rolls have a better roll (corrugation) life since the increased diameter improves the nip angle, making it easier for the rolls to pull material into the nip. This reduces slippage in the roll, a major source of normal wear on the roll. For this reason, 10” and 12” diameter rolls will continue to process grain more effectively than 6-1/2” or 9” diameter rolls even when the corrugations begin to show significant wear.

Factors Affecting Roll Wear

Factors affecting roll wear might be categorized as normal and abnormal operating conditions and material characteristics. Normal operating conditions would include such details as maintaining the rolls parallel and tram, uniform feeding end to end, and keeping the rolls stops properly adjusted. Normal material characteristics would include the cleanliness of the grain or materials being processed, moisture, and test weight. Abnormal operating characteristics might be rolls operating out of parallel, uneven feeding from end to end, and roll stops that are incorrectly set allowing the rolls to touch metal to metal. Abnormal material characteristics would include low test weight grain (requires the rolls to be set extra close), or excessive impurities such as dirt, sand, stones, and tramp metal.

Roll Tram and Parallel



Rolls in Parallel

Rolls out of Parallel

In order to achieve best roll life and consistent performance from end to end the rolls must be parallel and tram. If rolls are allowed to operate out of parallel, not only is the product inconsistent (fine on one end, coarse on the other) but the roll wear will be uneven as well. The same is true for rolls operated out of tram. Normally the tram adjustment will be set only when rolls are changed, or in the event of some significant upset condition (such as lost elevator buckets and bolts appearing in the nip of the rolls).

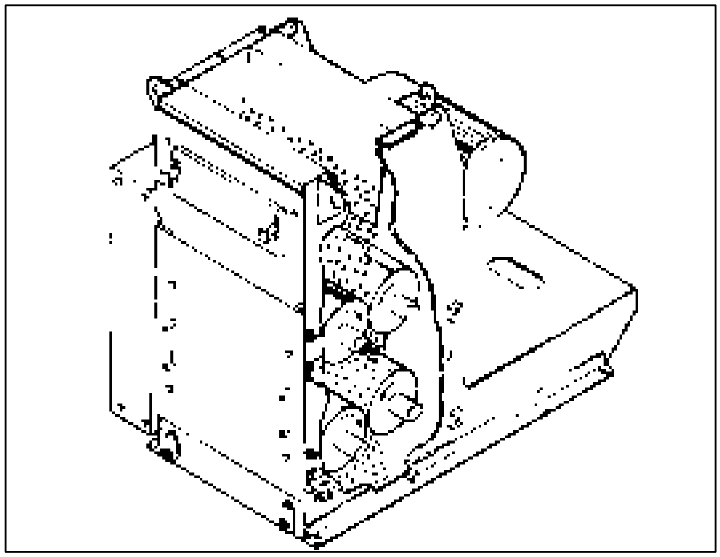
Rolls in Tram

Rolls out of Tram

When the rolls are not in tram or parallel, there is a tendency for the material being processed to "drift" in the nip of the rolls towards the open end(s). This excess material may over time actually begin to "pile up" in the nip of the rolls and cause accelerated wear. Operating out of tram or parallel and trying to make a fine grind or thin flakes may cause the "close" end (or center of the rolls if out of tram) to actually make metal to metal contact. If the roller mill is operated with the rolls out of tram or out of parallel, significant thrust loads may be exerted on the rolls and bearings. In machines with straight bore bearings, the forces may be enough to cause the rolls to shift sideways in the machine, even contacting the mill frame. This condition is aggravated if the bearings have been removed or replaced as the fit between the shafts and bearings will not be as secure as those originally supplied. It some extreme cases, it may be necessary to "dimple" the shaft under the set screws or add collars between the roll ends and the bearings to keep the rolls from shifting. A more progressive solution is to replace the straight bore bearings with new bearings using a tapered sleeve adapter to absolutely clamp the bearing to the roll shaft and prevent any such movement.

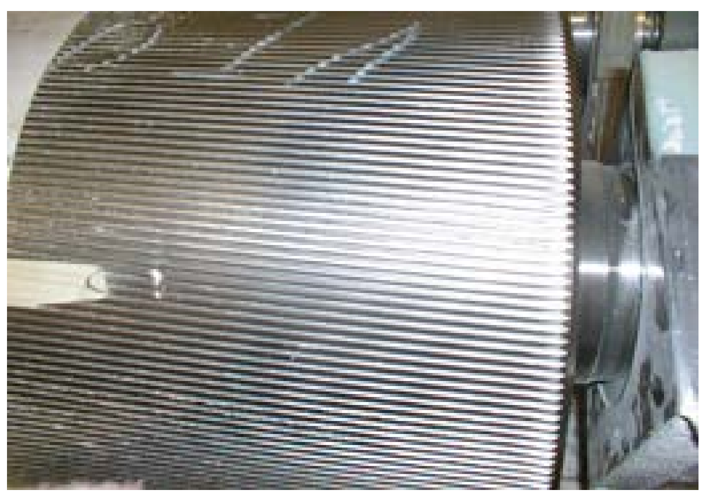
Test for roll parallel by routinely checking the spacing between the rolls from end using a metal feeler gauge. Many long time users may employ a technique of passing feed tag between the rolls and comparing the depth of the crease to determine whether the rolls are parallel or not. Check roll tram by visually sighting across the tops (or bottoms) of the rolls and compare how they line up with each other. On some machines it is possible to use a "tramming plate" to lay across the rolls to test for tram. Adjust the tram by raising and lowering one or both ends of the roll(s) until proper tram is obtained.

Even Feeding is Critical



Rolls must also be fed uniformly from end to end to promote consistent wear and to produce a consistent finished product. This normally requires a surge hopper over the machine to keep the feeder full all the way across, and use of the feed gate to keep materials distributed evenly from end to end. Inconsistent or uneven feeding will lead to greater roll wear in one portion of the roll producing an inconsistent product and requiring more frequent recorrugation. Cost for servicing rolls will typically be on the order of $0.02 - $0.03 per ton. If only 70% of the roll surface is actually worn, this cost per ton can easily go to $0.04 - $0.05 per ton. Multiplied over the life of the roll these added costs could be anywhere from $2,500 to more than $10,000 for 1200-52 and 1200-72 rolls. Inconsistent or uneven feeding can also contribute to rolls working out of parallel, with all of the associated maintenance and operational problems.

Roller mills are also more sensitive to instantaneous changes in the feed rate than are other pieces of process equipment. Feeding a roller mill directly from a screw conveyor or bucket elevator will cause surges in the feed rate that the roller mill “sees” instantaneously unless some damping system such as a surge hopper is used. Even though the feed rate averaged out over time may be within acceptable limits, the instant the surge hit the roll the feed rate will be much higher and will cause the same affects as overfeeding the mill. This kind of surging feed will ultimately reduce the capacity of the machine and may lead to catastrophic failures of drive or roll adjustment components.



Roll to Roll Contact

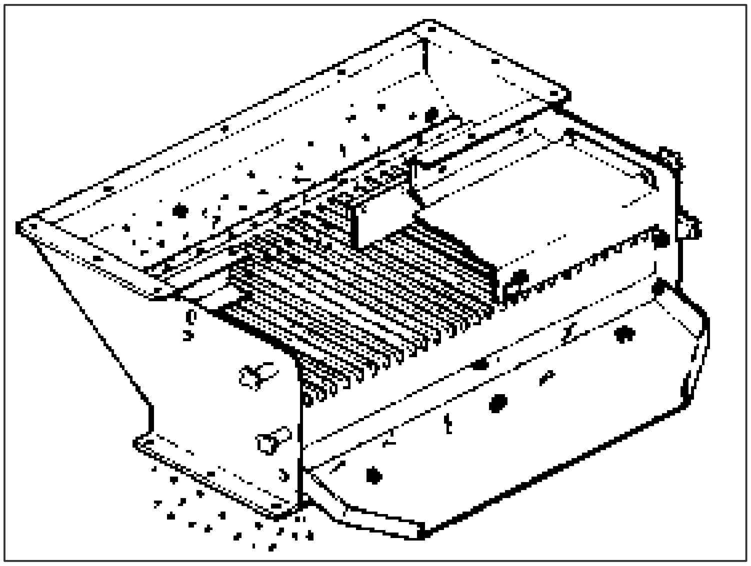
Roll to roll contact occurs when the roll stops are not properly set or maintained. When the rolls are allowed to run together, the wear rate can be so high that a set of rolls with corrugations in good condition can be destroyed in a matter of minutes or hours. While the rolls are very wear resistant and will tolerate some incidental contact such as when roll adjustments are made, running the rolls together with pressure and no feed will greatly accelerate roll wear. Evidence of roll to roll contact would be corrugations with tops that appear flat, with sharp or broken edges. There will normally be some circumferential grooving or scratches in the rolls as well. Roll to roll contact is most obvious due to the noise of the rolls grinding together however rolls with spiral grooving will tend to make less noise than rolls with horizontal grooving, so care must be exercised when setting rolls close together.

Abrasive Wear

Wear on the rolls may be due to processing materials that are naturally abrasive, or contain a high amount of abrasive impurities. Rape seed, tapioca chips, or beet pulp pellets are common examples of materials that tend to wear the rolls a high rate because of high levels of abrasive minerals included with the products. Some materials are simply naturally abrasive; 44% soybean meal, sunflower meal, and Canola meal (due to the hulls) and cocoa hulls are a few typical products that are naturally abrasive.

Rolls subjected to abrasive wear will show the corrugations rounded as in normal wear, and will often have a highly polished appearance. Normally there will be some circumferential scratches or grooving but the appearance and effects are quite minor. There is little that can be done to reduce the affects of processing materials with highly abrasive characteristics. Using the coarsest corrugations that will achieve an acceptable grind will produce the best results in term of roll life (tons processed before recorrugation).

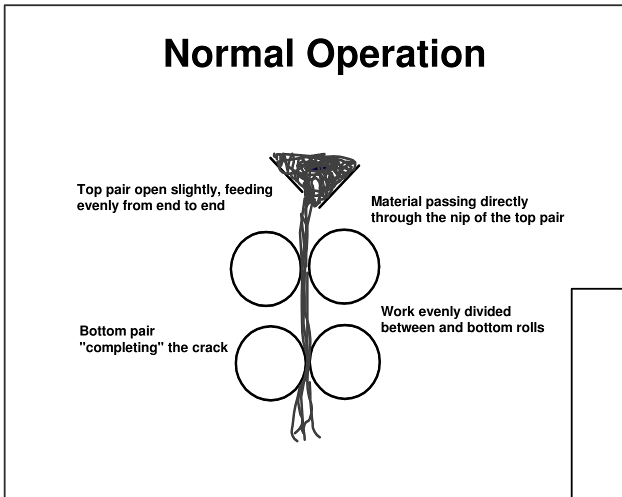
Oversize Materials

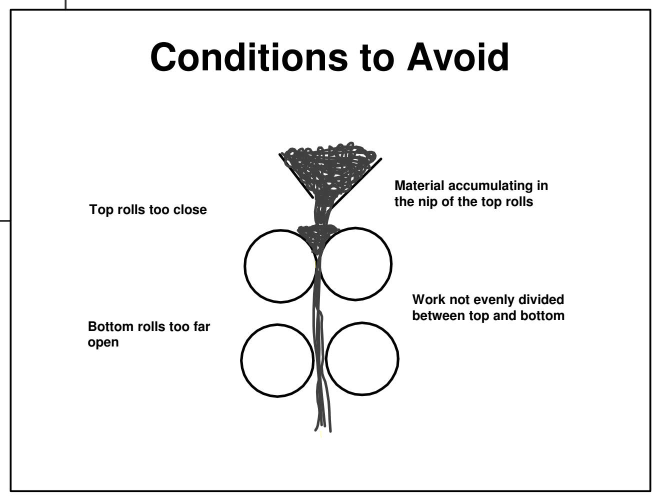


Oversize materials, such as corn cobs and stones can also cause accelerated roll wear and damage to the rolls or roll adjusting mechanism. Deep, circumferential grooves in the rolls are indicative of stones that were too large for the rolls to process that stayed in the nip of the rolls for a long period of time. These stones eventually wear away until they are small enough to pass through the roll nip and may not be found in the machine. In extreme cases such as soybean processing plants cracking whole soybeans (and stones the size of soybeans) the rolls may appear to be corrugated in both directions! A simple scalping device will in most cases remove most of the stones and other gross oversize materials that may cause these severe problems. Good magnetic protection to capture any tramp iron will further insure against damage to the rolls. It is always a good idea when cleaning the magnet to inspect the roll nip for any oversize pieces of material and remove them. Make sure the mill is off and power is locked out before reaching into the roll nip. A simple scalper or grain cleaner ahead of the roller mill will reduce damage caused by oversize materials, and will result in a better quality finished product with less objectionable bits of cob, stalk, etc. in the finished product.

Balance the Work Between Roll Pairs

In two and three pair high machines it is necessary to “balance” the work being done between the pairs of rolls to avoid uneven roll wear. When properly managed, a two pair high roller mill used for grinding corn or cracking soybeans will wear the top and bottom pairs of rolls at approximately the same rate. By using a “staggered” corrugation on the fast and slow rolls (coarser grooving on the fast roll) all four rolls will be ready for recorrugation at the same time. Changing all rolls at one time is usually the most efficient use of the time and effort required to make a roll change.





Roll must be operated in a way to avoid having the grain pile up in the nip when the mill is running at full capacity. This is not normally a problem when the rolls are in good condition, as the corrugations will easily pull the grain in and the motor load will limit the throughput. As the top roll especially become dull, they will loose their effectiveness at pulling the grain in, and the possibility exists that material may begin to “pile up” in the nip. This condition must absolutely be avoided since the grain slipping in the roll nip will cause greatly accelerated roll wear.

If the mill capacity is decreasing, or if the motor load does not go up when the feed gate is opened, it is very likely the grain is not passing through the top pair of rolls. To maximize capacity and extend the roll life, open the top pair of rolls slightly and/or reduce the feed rate to eliminate any accumulation in the nip of the rolls. If the finished product is too coarse, close the bottom rolls to obtain the desired finished particle size.

Roll Recorrugation

Eventually, it will be necessary to recorrugate the rolls to maintain maximum capacity and product quality. While the manufacturer always tries to specify the best possible roll corrugations with new equipment, new information is being added every day so sometimes improvements may be made. If there is ever any doubt as to whether or not the roll corrugations can be improved check with the equipment supplier for best suggestions.

For coarser corrugations (3, 4, 5, or 6 Gr/In) it is usually possible to follow the old corrugations when the rolls are serviced. This means the roll surface will only be ground as far as necessary to true up the diameter leaving some of the old corrugations visible. The roll is then recorrugated in the same grooves as previously cut on the roll face. By not grinding the rolls completely smooth every time they are recorrugated the total life of the roll will be extended. For finer corrugations, it will be necessary to grind the rolls completely smooth before cutting the new corrugations.

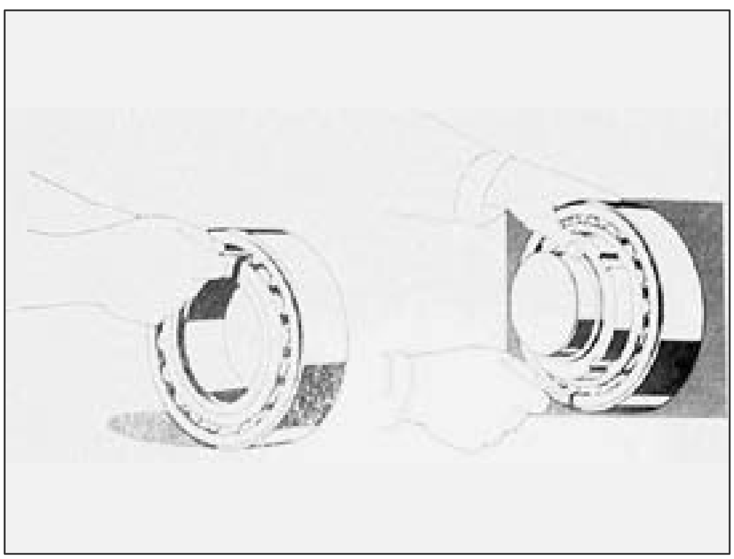
As noted, whenever the rolls are recorrugated, there will be some loss in diameter. After rolls have been recorrugated two or three times, the top pair will be smaller in diameter than the bottom pair in a two pair high machine. To maintain the best capacity and mill performance, it is a good idea to switch the top and bottom rolls after two, three, or four recorrugations. This will maintain a more uniform diameter among all the rolls, and insure that the complete set will continue to process grain most effectively through their entire service life.

Generally, spiral corrugations are preferred for grinding applications where more horizontal grooving will be used for cracking, dry rolling, and flaking applications. While many different roll corrugation styles and profiles are available, a simple Round Bottom Vee (RBV) style groove is best in most applications around the feed mill. Even for crumbling rolls where classic Le Page style corrugations had been used for years rolls with RBV corrugations cut longitudinally are proving themselves superior in terms of roll life and capacity. Le Page corrugations are still widely used when the shape of the finished product is important as Le Page corrugations make a more cubic shaped particle.

Bearings

Bearing maintenance is critical to proper long term roller mill operation. Normal maintenance would include frequent addition of small quantities of grease. ½ to 1 ounce of grease added every 40 hours of operation will be sufficient for most machines used for cracking, crumbling, or grinding. For steam flaking operations, higher quantities of grease are often added every day as the mill is shut down to displace any moisture that may have entered the bearing in the course of normal processing. Whenever excessive amounts of grease are added to any bearing, some grease will naturally bleed from the seals. This excess grease should be cleaned off at regular intervals to prevent accumulations that may hold dust or other impurities against the roll shaft. Excessive amounts of grease do not improve bearing lubrication, and may lead to bearing failures due to overheating of the bearing. Typically the bearing housing should be no more than 1/3 to 1/2 full.

When rolls are removed for service some shops will routinely remove the bearings and housings prior to grinding and corrugating. In a few cases this may be necessary due to the design of the bearing or bearing housing, but is not required in every case. Leaving the bearings in place on the roll reduces the chance of damaging a bearing through improper removal techniques, and saves considerable time. Most bearings will be sized to last the life of the rolls if proper lubrication is maintained so periodic removal is not required or recommended. This is especially true for rolls using straight bore bearings.



Whenever bearings with tapered sleeve adapters are used it is critical that the bearings be properly set. This will involve measuring the internal clearance of the bearing with a feeler gauge, and reducing the clearance by tightening the lock nut on the tapered adapter sleeve. If the bearing is too loose, the tapered sleeve may not grip the shaft and could cause the journal to slip or spin in the bearing damaging the bearing adapter and the roll shaft. If the bearing is too tight it will certainly run hotter than normal and can fail prematurely due to frictional heating and improper lubrication.

Always refer to the manufacturer's instructions when adjusting bearings mounted with tapered sleeve adapters.

Drives

Roller mills normally operate as less than motor RPM so some form of belt drive between the motor and the rolls will normally be employed. There are a few machines today that utilize either a direct coupler between the motor and the rolls or a gearbox and one or more drive shafts but these are the exceptions rather that the rule. A variety of V-belt configurations are used today including Classical Belts (A section, B section, C section, etc.) and V cross section (3V, 5V, etc.) Although the belts may appear similar, B section belts should never be used on 5V sheaves, and vice versa. “V” section belts have a steeper angle for more contact with the belt and higher horsepower capabilities in a narrower drive. Hardware store variety belts in 4L and 5L cross sections are designated “Fractional Horsepower” and should never be used in roller mill applications.

In some cases, as when higher horsepower is transmitted or when small diameter sheaves are used the belts may be notched, and carry an “X” designation such as 5VX or BX belts. Never substitute a standard belt for an “X” belt or short life and excessive heating will occur.

There are a few machines in use today that use an HTD (High Torque Drive) or timing belts for the main drive (flaking mills and cracking mills) or for the Inter-Roll Drive (cracking mills and roller mills for grinding). HTD drives are very low maintenance (no stretch) and have exceptional efficiency. HTD drives do not provide any slip whatsoever, and so have limited applications for differential Inter-Roll Drive applications. HTD belt drives do generate a lot of noise while in operation, and higher horsepower or higher speeds increase the noise levels. For flaking mill applications the HTD Main Drive will be enclosed in a guard with acoustical insulation to reduce the noise level in the vicinity of the machine.

Any belt drive must be properly aligned and tensioned in order to perform. Belt manufacturers provide excellent information and instructions on proper belt tensioning, and specialized tools to set the belt tension. It is still up to the user to make sure the proper belt tension is maintained in order to maximize belt life and optimize machine performance. Alignment of HTD drives can easily be checked by noting the way the belt tracks in the sprockets while the machine is in operation. Alignment of V-belt drives is normally achieved using a string or a straight edge to line up the sheaves. In any case, proper belt installation techniques must be employed (no screwdrivers or rolling V-belts on to sheaves with the tension on).

Finally, to insure the best performance and longest life of belt drives; they must be operated within acceptable load limitations. This will mean monitoring the motor amps while the machine is operating and keeping the work evenly distributed between pairs of rolls in two and three pair high machines. When starting a roller mill, always insure the rolls are clear, or open the rolls to allow any materials to pass through easily when the motor is started.

Steam Flaking

Steam flaking involves crushing or rolling grain that has been conditioned with live steam to make the kernels soft and pliable. Because the grain has been heated and the moisture level is elevated, some of the starch will be “damaged” in such a way that it looses its crystalline structure and will absorb water. This is known as gelatinization.

Steam Flaking Roll Maintenance

Rolls used in most steam flaking operations utilize relatively fine corrugations (14, 16, 18, or even 20 Gr/Inch and finer) to prevent cutting the kernels of grain being processed. Because of the temperature, moisture, and chemicals often used when steam flaking, special precautions must be taken to insure maximum roll life.

Proper aspiration on a steam flaking mill will help prevent moisture from condensing and potentially dripping on the rolls. Water dripping in one spot on a moving roll over time can actually cut into the roll surface leaving a pronounced groove. While this rarely creates a safety concern, it does affect the quality of the flaked grain produced by the damaged rolls. All steam flaking mills should be properly aspirated to remove condensation and moisture to protect the rolls, as well as all of the mill components that are not fabricated from stainless steel. Except for parts that may contact the moving rolls (cheek plates and scraper blades) all of the components within the roll housing should be fabricated from stainless steel.

When the steam flaking mill is shut down at the end of a day, it is a good practice to run a small amount of dry grain through the machine to remove excess moisture from the surface of the rolls. This is especially true if some form of chemical grain treatment is used to improve grain conditioning. Not only are many of the chemicals oxidizers, but all are “wetting agents” that reduce the surface tension of the water making it adhere even more closely to the roll surface.

Never allow the rolls to contact metal to metal. Rolls running together without feed will certainly experience very high pressure on the roll surface, eventually leading to a damage known as “spalling”. Spalling is material breaking off of the roll surface; normally this condition is associated with the roll ends, but spalling can occur anywhere on the face of the roll where high pressures exist. Once a roll experiences spalling damage the surface will likely continue to have problems until the area is complete worn away or breaks off.

In some cases, the corrugations in the center of the roll will wear faster than at the roll ends do to material flow in the system. To prevent the roll ends from contacting with high pressure, it may be necessary to “relieve” the roll ends by grinding. This can be done with a hand grinder or with a machine grinder set on the flaking mill. The rolls must be turning when grinding the ends to maintain a true running roll.

As the corrugations on steam flaking rolls wear and begin to loose their grip, the capacity of the flaking mill may be reduced. This can be especially troublesome during cold start-ups. To improve the operation of the machine when starting with worn corrugations keep the feed rate to a minimum to gradually warm the rolls or use a steam line to pre heat the rolls and increase the grip. If the material is allowed to accumulate in the roll nip while the machine is in operation the rate of wear on the rolls will increase very dramatically.

Bearings & Drives

Because steam flaking mills work in an hostile environment special care must be take to maintain the bearings found on the machine. Many users find that bearing life is improved by adding grease to the bearings every day when the mill is shut down. This will purge some of the old grease and moisture from the bearing and help reduce the corrosion that will occur if free moisture is available. Be sure to provide a path for the excess grease to pass from the bearing without getting into the belt drives or falling to the floor.

Where the bearings are exposed to live steam as in the feeder or roll housing an additional seal may be used to help prevent live steam from entering the bearing. This additional seal may be constructed from UHMW PE or neoprene rubber and is normally designed to fit tightly to the roll shaft and block the path into the bearing. This seal should be replaced as often as necessary to maintain a good fit to the shaft.

Again, because of the hostile environment the driving belts should be checked on a frequent basis and replaced as necessary to maintain peak performance.