PROTECTING BEARINGS FROM DUST AND WATER.

ABSTRACT
Protecting bearing from dust and water. Protection methods like labyrinth rings, rubber seals, felt seals and shaft mechanical seals are described. Choice of the appropriate shaft seal and seal configurations to protect against dust and water ingress is critical. Numerous shaft seal designs suited to contaminated conditions are reviewed.
Keywords: Particles, contamination, bearing, shaft, grease barrier, breather.

Dusty surroundings are one of the most difficult environments for bearings. In equipment handling powders or in processes generating dust the protection of bearings against contamination by fine particles requires special consideration.

BEARING HOUSINGS

Bearings are contained within a housing from which a shaft extends. The shaft entry into the housing offers opportunity for dust (and moisture) to enter the bearing. The shaft seal performs sealing of the gap between the housing and shaft. Choice of the appropriate shaft seal and seal configurations to protect against dust ingress is critical.

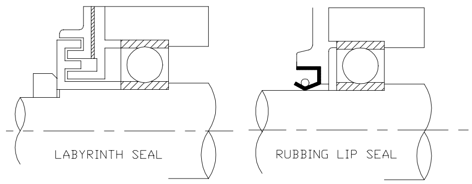


Figure No. 1. Shaft Bearing Housing Seals

Bearing housing seals for dusty environments may be either a labyrinth type or a rubbing seal type. The labyrinth type requires a straight shaft running true. Rubbing seals are the more common and allow for some flexing of the shaft. The sketches below are conceptual examples of each type of seal. When setting a lip seal into place to prevent dust ingress insure the sealing lip faces outward.

In situations of high dust contamination there may be a need to redesign the shaft seal arrangement for better dust protection than provided in standard housings. Some ideas which can reduce dust ingress into bearing housings are to :

i. provide two or more seals in parallel. Bearing housings can usually be purchased with combination seals as standard.
ii. retain the housing shaft seals but change from a greased bearing in the housing to one which is sealed and greased for life. If contamination were to get past the shaft seals, the bearing's internal seals would protect it.
iii. stand the bearing off the equipment to create a gap between the end of the equipment and the bearing housing while sealing the shaft at the equipment.
iv. put in a felt seal wipe between the housing and the wall of the equipment to rub the shaft clean. Install of a mechanical seal in very harsh environments.
v. install a grease barrier chamber sandwiched between two seals. This barrier is separate to the bearing housing and acts as the primary seal for the bearing. Grease pumped into the chamber will flush out past the seals.
vi. replace the grease barrier chamber instead with an air pressurised chamber.
vii. shield the bearing housing from dust with use of a specially fabricated rubber shroud encapsulating the housing and wiping the shaft or fit a rubber screen with a hole wiping the shaft over the opening emitting the dust.
viii. flush the bearing with grease by pumping excess grease into the housing and allowing the grease to be forced past the shaft seals or through a purposely drilled 15 mm hole in the housing. The hole must be on the opposite side of the bearing to the grease nipple, at the bottom of the bearing housing when in service and between the bearing and seal.
ix. Mechanical seals can be fitted to the shaft with the stationary seal sitting toward the machine and the rotating seal mounted back along the shaft. Combinations of other seals and wipers can also be used in conjunction with the mechanical seal. Mount the auxiliary seals so they see the dust/water first and keep the mechanical seal as the last line of protection.

ASSEMBLY

The process of assembling a bearing into the housing must be spotlessly clean. If contamination occurs at the time the housing is assembled no amount of external protection will stop the bearing from premature failure. When assembling bearings into housings make sure that:

i. your hands have been washed.
ii. the work bench is clear and wiped down clean.
iii. no one creates dust or grinds nearby during assembly.
iv. fresh, clean grease is used to pack the housing.
v. the components are clean and all old grease has been thoroughly removed.

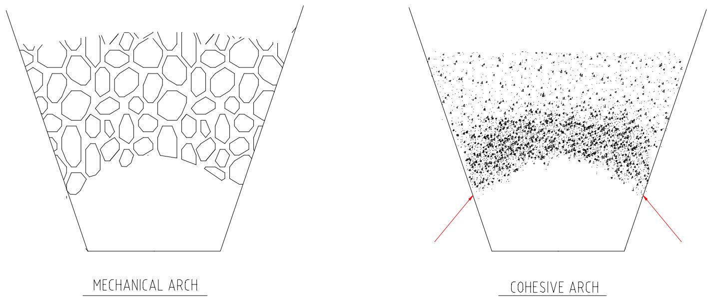
BREATHERS

When protecting bearings from dust you want to always consider another important area. A breather is used to let hot air out of a confined space and then to let the air back in when it cools down. Enclosed bearings get hot when operating and cool down to ambient temperature when not in use. The air drawn back into the space needs to be clean of dust and moisture. A breather on a bearing housing or bearing housing enclosure allows ingress of moisture and dust into the bearings causing premature life failure.

Bridging in Silos and Hoppers

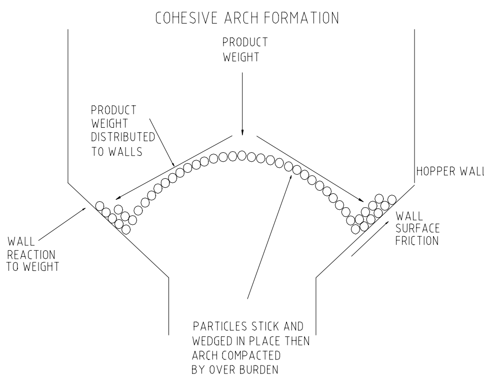
ABSTRACT
Bridging in silos and hoppers. Bridging is the name given to the self-created arch that develops just above the outlet of a bulk material silo or hopper as it empties. A bridge forms when wall friction holds up the ends of the arch. To overcome bridging the wall friction must be reduced or prevented from occurring. Keywords: live bottom, cohesive, powder, hopper design, angle of repose.

There are two types of arch. One is mechanically formed by relatively large particles (above 3mm) interlocking, while the second is formed when powders bind together under compression (cohesive arch). The resulting arch can support the weight of the material above it and prevent flow. The sketch below shows the two types of arch.



It is easy to tell if a silo has a material flow problem by looking for 'hammer rash' on the wall. If the product is not moving freely through the silo and outlet the operator will strike the side walls to rattle the material free.

WHAT CAUSES BRIDGING?
Bridging starts when friction stops the product at the wall and a neighboring particle wedges in behind or sticks to it. The product binds to itself until an arch is formed. Product from above compacts it into place and makes the arch so strong that it supports the overburden. The sketch below shows a simplified view of the arch building process.



Whether bridging occurs depends on a number of factors.

a) The angle of the discharge section wall.
b) The material of which the silo or hopper walls is made.
c) The stickiness (cohesiveness) of the bulk material.
d) The amount of attraction between the particles of the bulk material.
e) The extent of settling (consolidation) within the bulk material.
f) The natural strength of the material forming the arch.
g) The amount of moisture in the bulk material.
h) The ease with which the bulk material slides over itself.

This list can be divided into two categories – effects that depend on the **bulk material properties** and effects that depend on the **silo and hopper design**.

OVERCOMING BRIDGING IN HOPPERS
Solutions to stop hopper bridging focus on reducing the stresses created in the bulk material at the bottom of the hopper. If wall friction can be reduced or removed then the arch cannot get a foothold against the wall. If the cohesiveness if the bulk material can be reduced, then the arch cannot span the gap before it collapses under the weight of the overburden. If the weight from the overburden can be directed away from the arch it will prevent compaction.

The best approach to prevent bridging is to correctly design the hopper and silo for the product being handled. Standard tests can be done on samples of the bulk material to determine the necessary hopper angle and opening size for the product or range of

Static Electricity Basics.

ABSTRACT
Static electricity basics. Static electricity is the build-up of opposite polarity (positive and negative) electrical charges on two different substances in contact by the movement of one surface across the other. The spark that can occur from static build-up is the result of the opposite charges neutralising themselves when the electrical field between them becomes strong enough to overcome the gap resistance. Static can occur on both conducting (such as metal pipes) and non-conducting (such as rubber) materials. Examples are moving liquids, gases carrying particulate, conveyor and vee-belts, printing equipment, on rubber and plastic items, during dry cleaning, on moving road vehicles and airplanes. Keywords: electrically neutral, recombining electrical charges, earthing points.

How does static occur?
Four requirements must be present to build-up static:

- Movement occurs between two surfaces in contact.
- Two individual substances are present.
- The contacting surfaces are chemically different.
- Charges of opposite polarity separate and stay apart.

Control of static
The natural tendency of opposite polarity electrical charges is to recombine and neutralise. The control of static involves using methods that allow opposite charges to recombine safely or that provide a pathway for the charges to drain away to an electrical earth (It really does go into the ground).

Conducting materials can be electrically connected either by bonding all parts together to provide a pathway for the charges to recombine or the separate parts are individually earthed to create a pathway for the charges to drain away. The best practice is to use both methods simultaneously by connecting all individual parts together and earthing the lot. Electrically earth at two points on each circuit – just in case.

Non-conducting materials, by the nature of their chemical make-up, do not allow the flow of electrical charges. In this case static is controlled by putting conducting materials in direct contact with a large surface area of the nonconductor. Conducting additives can be put into the nonconductor when it is made and the item bonded to earth. Metal can be applied to the nonconductor's surface and the metal connected to earth. Atmospheric humidity can be artificially increased which permits the static to dissipate through the water vapour in the air. Ionised (electrically charged) air can be created and the charges of opposite polarities in the air and on the nonconductor combine and neutralise.

On-going maintenance
At least annually, test that the electrical resistance of static bonding and earthing meets the requirements of the applicable electrical code. Keep your eyes open for disconnected earthing straps when walking about statically earthed plant and get any detached items reattached. No corrosion is permitted at the bonding and earthing points since rust may separate the contact faces. Make jumpers from heavy cable or straps with solid connectors so if disconnected often they will still last decades. Always ground equipment, more so if its parts can build-up static.

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The same abrasive material can have vastly different characteristics depending on the method of transport. For example lime paste slurry pumped through a pipe behaves very different to the same lime blown by pneumatic transport. The presence of the liquid in the slurry and the slower flow velocities reduces the wall friction. Whereas in pneumatic transport, particle velocities are much higher and surface impact forces are greater. A rubber liner in a lime slurry pump will last much longer than the same rubber lining in a pneumatic separating cyclone for lime.

NATURAL RUBBER LININGS

The performance of natural rubber lies in its unique properties of resistance, tear resistance, toughness and cross linking of the molecular structure. The rubber deforms under impact, absorbing the energy of motion at right angles with the surface and returning most of it to the particle as a rebound.

As a wear resistant lining care must be taken with regards the angle of impact, the particle size, shape and weight, the height of the fall and the velocity of impact.

The impact angle is of the greatest importance. At 90^o impact angle resilience is the major factor in wear resistance. As the impact angle reduces tear resistance becomes more important. At low angles of impact specially fabricated surfaces are used. In slurry service flat rubber sheeting is common.

Within certain limits, increasing particle size and height is handled by increasing the lining thickness. Table are available for suppliers of lined equipment and pipes.

There is a critical speed above which natural rubber is unable to recover from wear and impact. At above 10 m/sec (3.25 ft/sec) the rubber cannot absorb the energy of motion and starts to fail.

ABRASION RESISTANT COATINGS

Abrasion resistant coatings are typically smooth, having a homogenous (well mixed throughout), hard matrix loaded with small hard, round particles of various sizes. The smaller particles fill the gaps between the larger particles and support the larger particles when they take impact loads. The bonding agent must be a small proportion of the total volume, with the hard particle matrix making-up the vast proportion. The bonding agent is the weakest component and is protected from contact with the abrasive medium by being 'hidden' behind the exposed hard particles. Such a coating offers less resistance to the movement of particles across it.

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If particles become airborne then water sprays can be used to capture the particles by having the dust particle adhere to the water droplet. This principle is often applied but as particle sizes become smaller then it becomes less effective.

Vehicles

Whilst vehicles are generally not responsible for being the initial creator of dust they often result in being a significant dust source. When a vehicle travels over particles on a roadway several things may occur.

- The particles may be pulverised resulting in smaller particles that are more easily able to become airborne.
- The particles are picked up by tyres and scattered over a larger area and may become airborne by lifting into the air.
- The particles may become airborne from the airflow induced by the vehicle movement.

The amount of airflow is directly related to the speed of the vehicle. The degree of scatter and airborne particles are inversely related with moisture content. The greater the moisture the greater amount of pick up by tyres and the less airborne dust is produced.

Build up of particles on vehicles and machinery such as front-end loaders (FEL) and bobcats result in a significant amount particle scatter and particles becoming airborne through induced wind lift off.

Evan's Rabbit vs Sheep Theory of Dust Control

Often people try the rabbit theory on dust. Firstly they say it is just a couple of rabbits and nothing to worry about and certainly not worth spending money on. As the problems gets larger very quickly the method used to control the problem is shoot all rabbits on sight. This ends up being very time consuming, labour intensive and ends up costing lots of money in bullets. This is often occurs in dust collection by putting lots of dust take-offs on dust collectors.

There ends up being too many take-offs that don't work efficiently because the dust collector has a limited useful capacity, and then there is a call for a bigger dust collector. More dust take-offs and a bigger dust collector means collecting more dust, which must mean the dust problems, are being fixed. Wrong! The dust problem is what is on the outside of the dust collector. Once you collect more dust you then have the problem of what to do with it. Once you have more dust collectors the capital cost goes up, the maintenance cost goes up and the operating cost goes up. You need to minimise dust collection points to those that are most effective.

The sheep theory to dust control is containment, control and collection. Like sheep, dust is dumb and tends to have a mind of it's own wandering around aimlessly following each other. Sheep are kept in fenced paddocks and herded all together in a flock to a collection point. This is what to do with dust.

If there is a hole in the fence and sheep are getting out you fix it. If a small flock of sheep runs off bring them back to the main flock rather than try herding two flocks. Don't try to move them too quickly or they will break up. Have somebody watching the flock for stray sheep that run off at all times, get a dog. If a sheep falls on the ground pick it up put it in the ute and deliver with the remainder of the flock.