

Silo Hacks

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Based on the inspection of thousands of silos, it has been noted that some owners make changes to their silos without consultation. This presentation will cover a number of them, with the goal of informing the audience to be aware of potential problems, and to look for them at their facilities.

Plant Air

Silos routinely use aeration pads in the bottom of silos to assist in making material flow more easily. These pressures routinely are in the four to six pounds per square inch (psi) range. But when material plugs, or the material doesn't flow well, many times facility personnel will increase the air pressure to try to make the material flow better. But this increase in pressure can fluidize the entire column of material, changing how it loads the silo structure, and increasing it up to five times the original design pressure. The effect can be catastrophic, and typically is very expensive to repair.

Adding Reclaim Outlets

It has been observed that owners have added nonconcentric outlets. These take the form of truck outlet spouts on the side walls, to added spouts on existing hoppers. The reasons make sense: an owner has a new process and needs to feed it from a new outlet in the hopper, or they want to start to feed trucks directly from the side of a silo. But these added outlets can lead to asymmetric flow.

Asymmetric flow happens in cases like this because when material is being reclaimed, a flow channel of moving material develops. In this flow channels, the pressures are lower than in the static material around it. If this flow channel intersects the silo wall, the lower pressures have a tendency to suck the wall in / create a bending or flexure of the wall. The results of this bending nearly always exceeds that of the uniform pressure that the silo was originally designed for. This causes an overstress in the silo wall, leading to permanent damage.

Before any outlets are added to a silo, an experienced structural engineer should analyze the silo to determine if the existing silo can withstand the changes and, if necessary, design the strengthening required.

Using interstice space

The use of interstices (the star shaped bins in between four round silos) is not free storage. When material is stored in an interstice, it exerts an outward pressure on the wall that creates a flexure / bending. This effect typically is greater than that of the uniform pressure on the round silo outward.

It has been observed that older silos were not designed with this in mind, and typically can prematurely damage the walls of a silo group and cause other damage. Unfortunately, at times a reduction in capacity or complete abandonment of the interstice is recommended as a result. This can also cause the walls to shift outward, and result in damage to roof support beam bearings, which can lead to roof collapse.

Changing material stored

Silos are designed for a specific material. This material has specific properties. Most owners at least know that materials have varying densities, and that a silo designed for a material with a density of 45 pounds per cubic foot (pcf) cannot be relied upon to store material with a density of 90 pcf.

But many people don't understand that other properties, such as coefficient of lateral pressure, angles of internal friction, friction factor of the material against the silo wall material (typically concrete or steel) also have an effect. While sometimes these properties are sufficiently similar between materials, that's not always the case. These can vary greatly and can lead to problems if a proper analysis isn't performed.

Modifying hopper / outlet arrangement

The above topic of adding an outlet is a subset of this one. But more broadly, it has been observed that owners are concerned with material not flowing evenly and adding flow retarders to discourage concentric mass flow, add airpads, or increase the length of airpads, add wear/liner plate constructed of stainless steel or other material, or myriad other changes can affect how material in a silo flows. These changes in flow can affect the silo structure by changing from funnel flow to mass flow, creating asymmetric flow channels, promote stagnant material to build up (that could spontaneously combust). Generally speaking, it is recommended not to modify a silo without consulting an experienced engineering firm to understand the possible ramifications of those proposed modifications.

This presentation will review these cases, show photographs of actual situations such as these, and give owners tips for what to watch out for when returning to their facilities.