



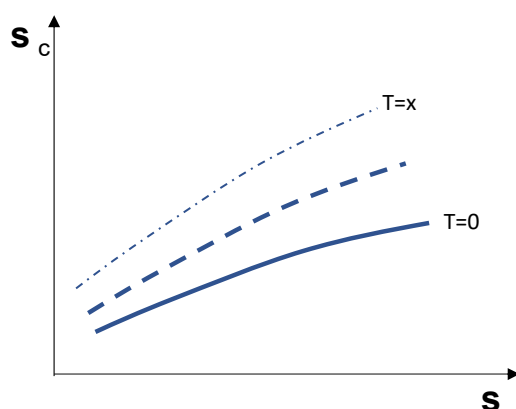
Basic knowledge: physical properties of bulk solids III; Time consolidation

The behavior of bulk solids may change over time when stored and are exposed to a compressive stress. With compressive stress, the weight of the particles in a silo or container is enough to change the properties of the bulk over time. This effect is called time consolidation, which can lead to caking.

What exactly happens in the bulk over time? Depending on the bulk's base material, many different effects have impact on the time consolidation, including:

- Physical, such as deaeration, plastic deformation or condensation
- Chemical, such as chemical binding on touching surfaces or crystallisation
- Biological, such as fungal growth

In some of these cases, the bulk density may also change. It is most likely increasing over time, which usually reduces the flowability. The following chart shows how the consolidation stress s_c effects the yield strength s over time. The different lines show different consolidation times, while $T=0$ is the yield strength behaviour without time consolidation.



This can create an issue if bulk solids are stored over a long time in a silo without movement -- especially if time consolidation wasn't considered in the design of the silo bottom or discharge device.

What can be done to mitigate time consolidation?

Time consolidation in principle cannot be avoided. However, the effect of time consolidation can be reduced by storage conditions such as moisture and silo levels. Another possibility is to move the product via a recycle loop in the silo. In any case, it is important to investigate the time consolidation behaviour in mind when sizing a silo, hopper or discharge device as this can help to avoid troubles in the future.

Next time, we will look at the angle of repose, which is a quite easy to determine figure for bulk solids. As always, please do not hesitate to message me with questions/comments.



Gerald Marinitsch, has broad and comprehensive background in management, mechanical and process engineering and since 2014 is working with a team of experts at Solex on heat exchangers for bulk solids.

'After several years of working with bulk solids heat exchangers, I realized that bulk solids knowledge is not widely spread throughout the engineering society. Consequently, I decided to summarize some basic knowledge in a series of articles '

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