The influence of the bulk solid properties of Neuburg Siliceous Earth on its dosing performance

Eric Stuckert[1], Ivan Kibet[1,2], Anna Lai[1], Alexander Knieper[1], Jürgen Wieser[1]

[1] Darmstadt Institute for Plastics Processing (ikd), Hochschule Darmstadt

[2] Doctoral Centre for Sustainability Sciences, Hochschule Darmstadt, Hochschule Darmstadt

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Abstract

Ensuring consistent product properties over time is a constant challenge in compounding processes. A key component of a robust compounding process is reliable and predictable dosing and conveying of the bulk material into the compounding machine, which is usually a twin-screw extruder (TSE). Due to the central importance of the TSE in compounding processes, most recent technological advancements in this field have been predominantly focused on increasing its maximum possible throughput. At the same time, relatively little effort has gone into researching the ideal configuration and design of peripheral equipment such as feeders. With an ever-increasing amount of diverse compound recipes, the bottleneck in plastics compounding processes is gradually shifting to the dosing and feeding operations. The dosing of mineral fillers such as Neuburg Siliceous Earth (NSE) is often associated with periodic variations that present a significant process engineering challenge. This is caused by quality variations in the produced compounds are directly attributable to their respective dosing operations. This study investigates the relationship between the macroscopic bulk properties of three NSE test samples and their flow behavior in subsequent dosing experiments. The bulk properties of the samples are determined in powder rheological tests while the dosing accuracy and consistency values are obtained from experiments using a single screw loss-in-weight feeder.

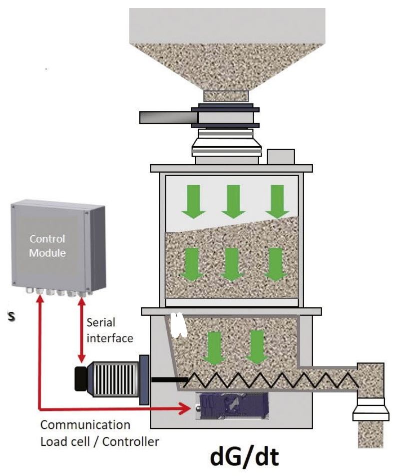


Figure 1. Feeder with particulate bulk material

Introduction

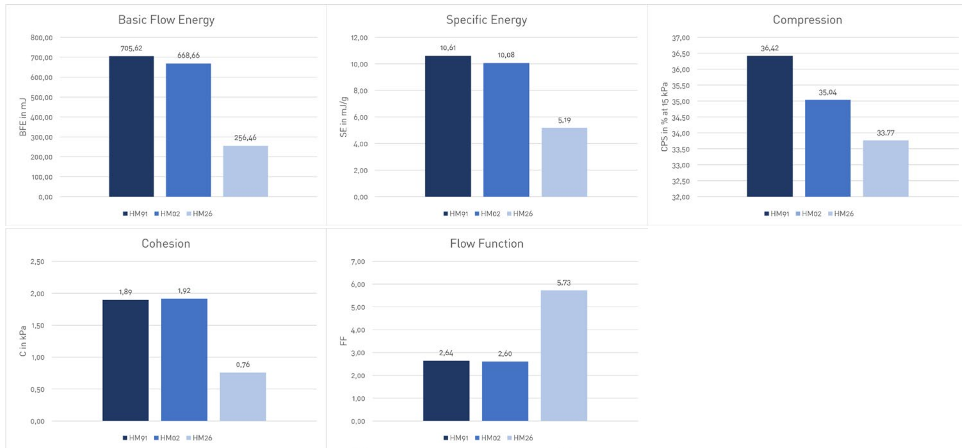
In the past, technological advances with TSE were made mostly to increase the highest possible throughput. This led to a dramatic fall of dwell times and results in a growing demand of precise dosing of added materials. Despite the experience of manufacturers, problems arise during processing due to complex flow properties. These problems can result in discard of material, low quality material or even process downtime. In the case of plastic processing, mineral filler materials such as silicious earth have shown difficulties in dosing. This study will investigate possible correlation of bulk properties and dosing accuracy and consistency.

Figure 2. Scheme of powder testing

Methodologies and Materials

To characterize the material, optical and rheological analysis were performed. To determine particle shapes, a VHX-500F reflected-light microscope was used. Furthermore, to determine particle size distribution, a Bluewave S3500 particle analyzer from Microtrac was utilized. To study dynamic flow behavior, a powder rheometer from Freeman Technologies was used. To correlate the measurements with dosing tests, a ProFlexx C100 single screw loss-in-weight feeder from Schenck was used. The powders used for characterization were three different kinds of silicious earths provided by Hoffmann Mineral.

Results



It was found, that dosing constancy correlate with the measured properties basic flow energy (BFE), specific energy (SE), compressibility (CPS), flow function (FF) and Cohesion (C). Higher levels of were found out to correlate with lower dosing constancy.

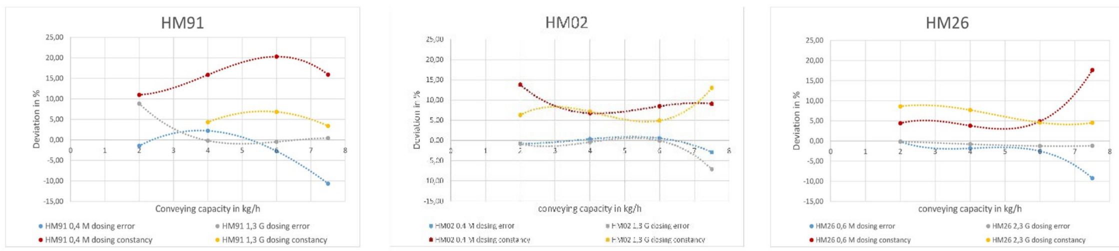


Figure 3. Dosing error and dosing constancy of HM91, HM02 and HM26

Conclusion

It can be seen that different rheological quantities as basic flow energy, specific energy, compressibility, flow function and compression correlate with the feeding behavior in constancy, but further research is needed to understand the dosing and feeding behavior of powders.

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h_da
hochschule darmstadt
institut für kunststofftechnik darmstadt

member of EUT+ European University of Technology

Contact

Prof. Dr. Jürgen Wieser
Darmstadt Institute for Plastics Processing (ikd)
Hochschule Darmstadt h_da
Haardtring 100, 64295 Darmstadt
mail: juergen.wieser@h-da.de

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