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Design of Screw Feeders

Introduction

Screw feeders are employed wherever reliable and controlled discharge of a bin is of particular importance. Screw feeders are used in conjunction with plane-flow hoppers. They have the advantage of providing a well-controlled volumetric discharge rate, which for a given screw geometry and a given material, depends only on the set rotational speed. Screw feeders run with high fullness (they are usually assumed to be 100% full) but rather low speed. This is contrast with screw conveyors, which run less than 50% full but with high screw rotational speed [1].

The design of a screw feeder is realised for a given bulk material and a range of desired discharge rates. In fact, the interactions between the bulk material and the screw shaft, helix and casing surface play a major role in the performance of a screw feeder. Therefore, the flow properties of the bulk material must be determined prior to design.

The design of a screw feeder usually focuses on determining the best combination of parameters including:

- Screw diameter,
- Casing diameter, i.e. clearance between screw and casing,
- Shaft geometry, and
- Pitch length.

Particular attention is also given to ensuring that the drawdown from the feed hoppers will be uniform, which means that preferential feed from the rear should be avoided. This is to avoid formation of dead zones resulting in areas of increased material consolidation (Fig. 1).

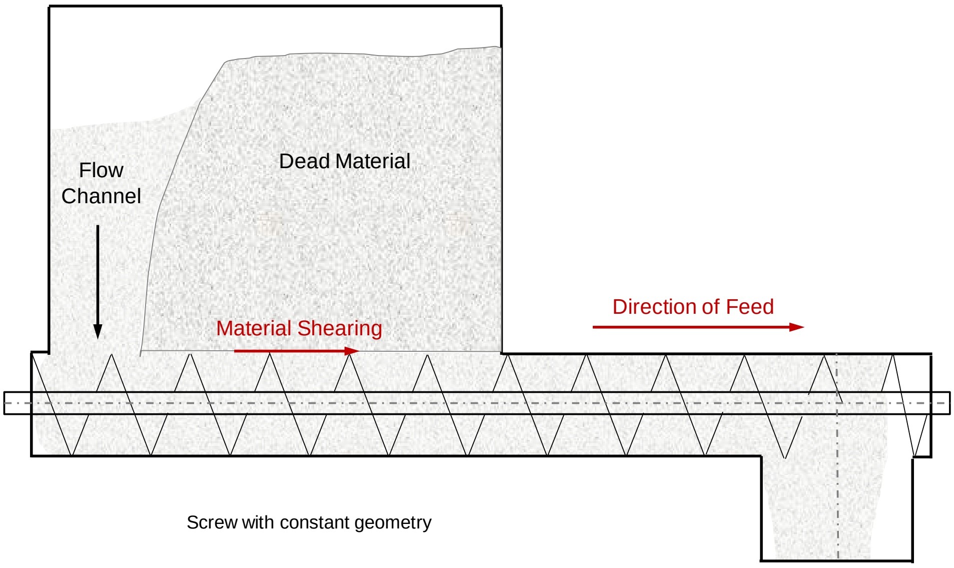

Figure 1: Flow issues due to inadequate screw geometry.

Design aspects

The following aspects should be considered while designing a screw feeder:

Screw diameter:

The screw diameter shall be chosen as to allow the required range of throughput to be achieved at low screw rotational speeds for which best conveying performance is achieved. Consideration in the choice of the screw diameter should also be given to the arching dimension of the material to be conveyed. The arching dimension is obtained from the knowledge of the bulk material flow properties. Not considering the arching dimension may result in flow issues and screw blockage.

Shaft diameter:

The screw diameter and the arching dimension of the bulk material will impact on the selection of the shaft diameter. The size of the shaft diameter shall also be chosen so as to avoid bending during material transport and in case of screw blockage. To permit uniform drawdown, the shaft diameter can be chosen to be tapered in the section located below the hopper.

Clearance:

The clearance between screw and casing is the result of a compromise between a possible decrease in conveying efficiency in case of a large clearance and the risk of particle jamming or contact between screw and casing if the clearance is too small.

Pitch length:

The pitch length should be great enough to avoid material arching. In addition, the pitch length should be selected so as to allow uniform draw-down in hopper. In fact, poor design usually leads to the formation of a flow channel at the back of the screw and the presence of dead material in the hopper (Fig. 1). Non-optimal design also frequently results in a non-uniform draw-down in the hopper, the feed occurring preferentially from the rear of hopper (Fig. 2). Correct design is achieved when the required feed rate is achieved and the drawn-down in the hopper occurs uniformly (Fig. 3). A uniform drawdown is usually achieved by combining a tapered shaft and increasing pitch length from the rear towards the front of the screw.

Screw blades thickness:

The thickness of the screw blades impacts on the structural strength of the screw and the volume available for the material in the screw. The greater the thickness of the screw blades, the stronger they are but the smaller the remaining volume available for the bulk material.

Construction materials:

Beside fulfilling the strength requirements, the choice of the construction materials should consider the interaction with the bulk materials as determined by the flow properties. It should also be considered that depending on the bulk material and its abrasiveness, the screw and the casing will wear over time and be polished. As a result, the friction between solid particles and construction material will change, leading to change in conveying efficiency and power consumption.

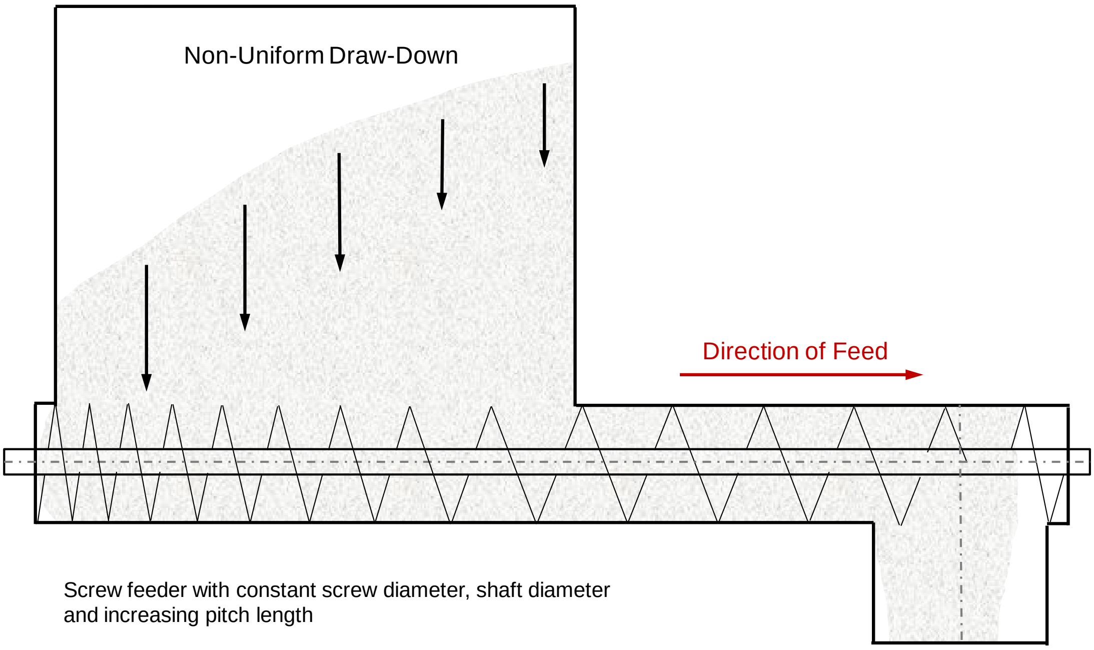

Figure 2: Poor screw feeder design resulting in preferential feeding from the rear of hopper.

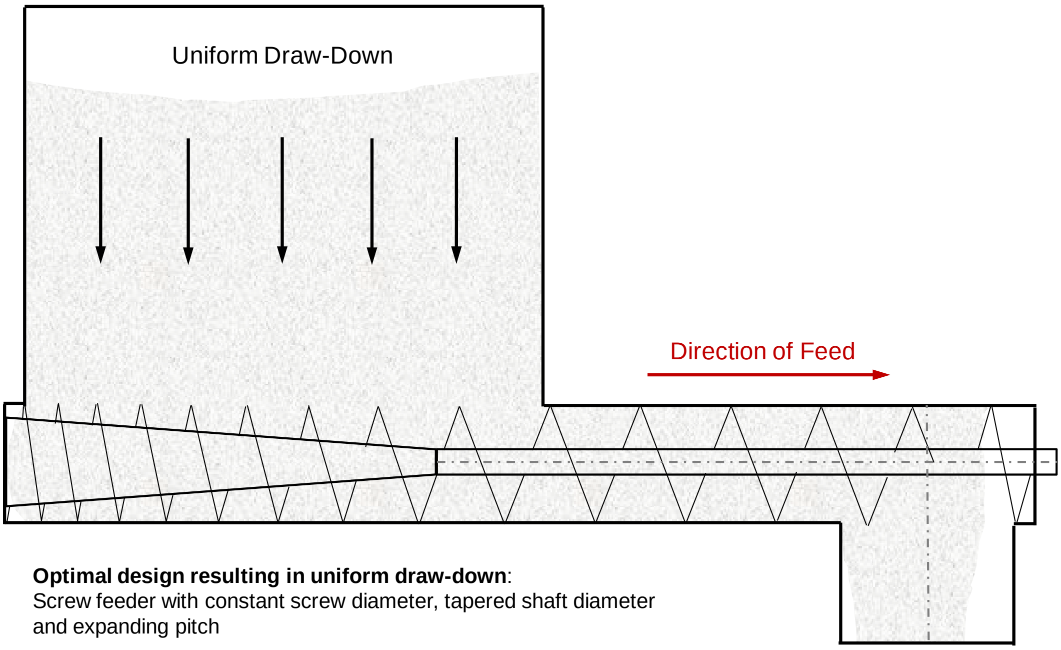

Figure 3: Optimal screw feeder design resulting in uniform hopper draw-down.

Reference

[1] A. Roberts, Predicting the volumetric and torque characteristics of screw feeders. In: Bulk solids storage, flow and handling, Vol.1, Reference notes from the Centre for Bulk Solids and Particulate Technologies, The University of Newcastle.