Dry Granulation of Fertilizers by Compaction

Köppern is a medium size family owned company and for more than 100 years fully dedicated to the design of roller presses and process technology around the roller press. One major field for the application of roller presses (compactors) is the fertilizer industry.

By compaction a fine grain material is compacted into the so called flake, a ribbon of defined thickness. The flake is crushed and screened to produce a course grain material ***(Figure 1)****. A typical use of compaction is the production of agricultural fertilizers. Fertilizer is granulated in order to avoid dust during dispersion onto the ground and for better (reduced) solubility.*

When mined in large quantities potassium chloride (MOP) and other salts have particle sizes below 1 mm after concentration. With progressing mechanization and the use of bulk blending techniques the agricultural industry is demanding coarser grain sizes between 1 and 4 mm, or 2 to 4 mm as of late.

NPK granules can also be produces by the compaction technology. A mixture of the nutrient carriers for nitrogen (N), phosphate (P), and potassium (K) is compacted to a flake. Here as well the flake is crushed, and the desired fraction is screened out.

Because in contrast to conventional wet methods, the granulation of fertilizers by compaction is using dry feed materials from an almost unlimited number of sources and without special requirements on particle size or distribution, this technology is gaining increasing importance in the industry in particular with the raising energy costs (which is a major factor in wet granulation processes).

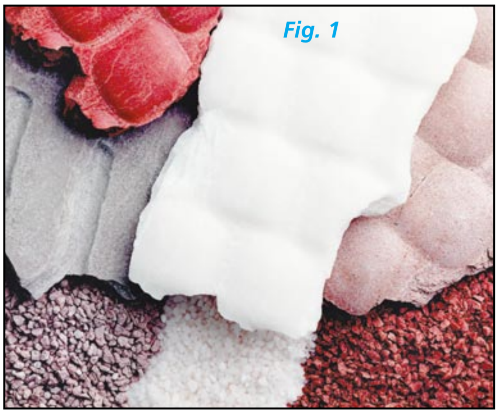

Fig. 1

So the advantages of the process are:

- *Dry process, no additives*
- *No water, no drying*
- *Stable NPK distribution in the particles*
- *Utilization of low-price fines*
- *Quick change of NPK formulae*
- *Flexibility in raw material selection*

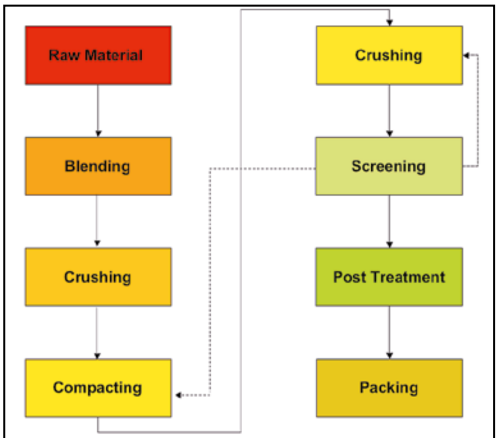

Fig. 2

Description of an operating plant

Although the principle of the compaction process is always the same ***(Figure 2)****, the development of each plant layout starts with the analysis of the customer's individual requirements. That analysis covers the entire process from the arrival of the materials to packing and shipping. Planning a green field plant is a rare case. Most of our prospective customers are already engaged in some form of fertilizer production activity. Thus the planning exercise needs to take account of existing conditions. This may have an influence even on the design of buildings, depending on the choice of the material handlings system – either horizontal or vertical.*

In a typical plant for approx. 25 t/h granular product, the blend of virgin materials is fed to the primary bin by belt conveyers and bucket elevator. The primary bin filling level is measured by means of level probes, and the measured values are transmitted to the compaction line's programmable controller. The material blend for press granulation is volumetrically metered by a vibrating feeder. In this way the material flow is precisely controlled, taking account of material recycled into the process.

A primary crusher fed by the vibrating feeder serves to homogenize materials of different hardness and/or particle size to a uniform fraction of < 1 mm. The virgin material and the recycled undersize material from the screening process are homogenized in a twin-shaft mixer. A magnet separator arranged at the twin-shaft mixer inlet serves to remove tramp iron from the material flow to avoid damage to the roller press and the crusher.

The roller press ***(Figure 3)*** *is fed by a trough chain conveyor. The material is guided to the roller press through an opening in the chain conveyor. At the end of the trough conveyor, there is a further overflow that makes sure that a sufficient flow of material is constantly supplied to the operating press. A flow meter provided in the overflow chute controls the flow of material supplied to the system that feeds the press.*

Below the roller press there is a flake breaker which reduces the flake to an initial fraction of < 30 mm for handling purposes. The entire material from the flake breaker is conveyed via belt conveyor and bucket elevator to a three-deck screen. The major portion of the material from the flake breaker is > 4 mm in size; this fraction is transferred to a bin for curing. The 2-4 mm granules are transferred to the post treatment section and the < 2 mm undersize fraction goes to the recycle bin; from where it is added to the virgin material flow in dosed quantities.

After curing, the oversize material is reduced in a granulate crusher to a defined grain size. The crusher speed must be adjustable to ensure that the optimum size reduction for the specific raw material used can be obtained. The crusher oversize material is returned to the multiple-deck screen.

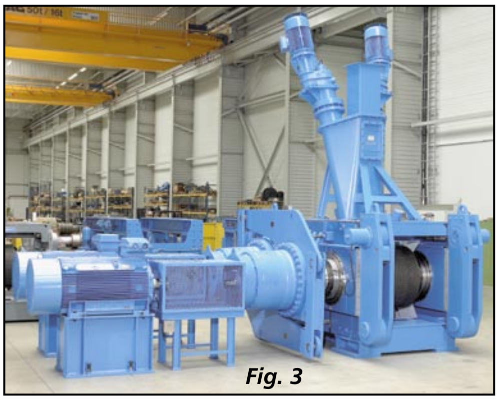

Fig. 3

The granules from the compacting line are fed into an abrasion drum where sharp edges are rounded off. This operation is followed by a final screening step that serves to remove the separated fines. The granules, after having been subjected to high loads in the drum, will undergo less abrasion during shipment and handling at the customers. If necessary, the granules are coated with an anti-caking agent in a coating drum to keep the grains from caking together during long storage times.

The product yield (2-4 mm) of a typical MOP circuit is 35-40% while for NPK it may be between 30 and 50% depending on the feed material mix.

The power requirement for a MOP compaction line is in the range of 40-45 kWh/t while for NPK it again depends on the type of feed material and the necessary specific press force. So for NPK the power requirement is between 35 and 55 kWh/t.

Unique compactor design

Anyone involved with fertilizer compaction in general, and with potassium compaction in particular, is familiar with operating conditions where vibrations and even hard blows occur in the press. Such phenomena are generally regarded as deaeration problems. From a mechanical point of view, however, they are direct exciters for resonant vibrations of the overall system. A continuous load of this type may lead to failures, mainly of components in the drive train. Damages can be avoided in most cases by compromising on press throughput, i.e. by reducing roll speed or feed rate to the press. Major factors contributing to vibrations are feed material properties (mainly fineness) and excessive roll speed.

With increasing press size the natural frequency is reduced. The risk to have the natural frequency within a critical range can be reduced by designing a stiffer system (instead of reducing the throughput). Stiffening/enlarging shafts and couplings, however, are limited with the commonly used twin shaft drive trains. A better way to achieve effective systems stiffening (press frame and drive train) is to use a different drive concept.

*Since the late 1980ies Köppern has been manufacturing large roller presses for high pressure comminution. These presses are equipped with planetary gear reducers, which are mounted directly onto the roll shafts **(Figure 4)**. It seemed to be appropriate to utilize this drive system also for large NPK/potash presses.*

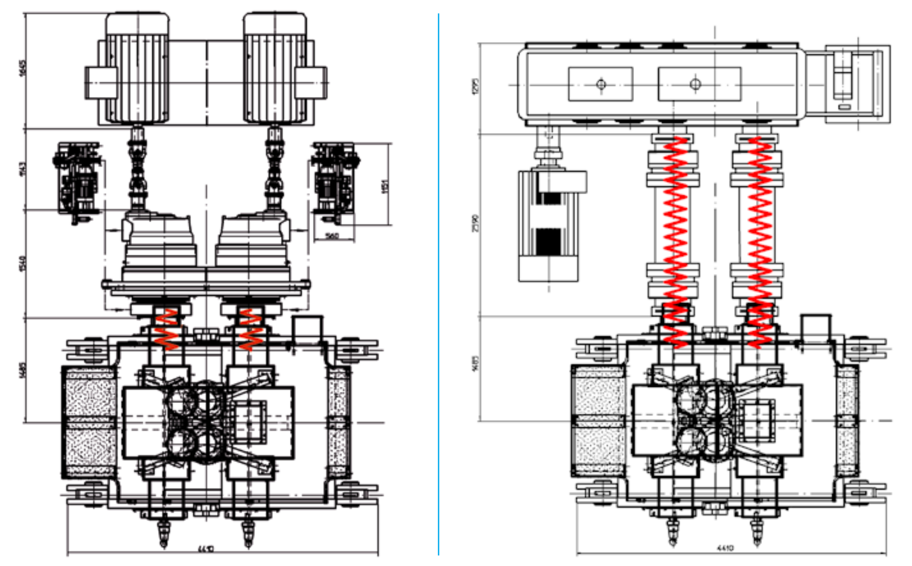

Fig. 5

*The stiffening effect on the system can be explained best by the following comparison between the two concepts **(Figure 5)**. It shows the traditional twin shaft drive and the individual roll drives with planetary gear reducers.*

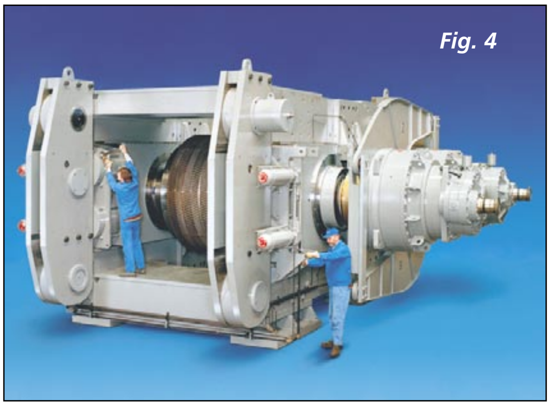

Fig. 4

Conclusion

By the end of 1998 Köppern delivered the first large potash compactor for a German potash mine for 130 tph flake capacity with the single shaft drive concept via planetary gears.

*Since this first introduction for a potash press the new technology has found worldwide recognition for NPK and MOP compaction. Clients in Canada **(Figure 6)**, China, Brazil, Hungary, Italy, Jordan and Serbia have since ordered roller presses for fertilizer compaction with the new drive concept.*

Within less than 10 years there is a total number of more than 40 compactors supplied or on order with a combined flake capacity of 28 Million annual tons (as of November 2007). Along with the hinged frame design, a new feeder design and other developments like the pendulum piston Köppern has further developed the performance and availability of large fertilizer compactors.

Fig. 6

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