

# Refinement of solid matters by means of agglomeration by compression with flat die pelleting presses

The processing of solid matters plays an important part in the material converting industries. The process design always causes problems, if the solid matter composition is very heterogeneous with regard to the type of material, density, and particle size, or varies with time, if the average granular size and density of the product are very low or if the product tends to agglutinate and agglomerate. Due to these disadvantageous product characteristics the following process steps, such as proportioning, conveying, mixing, and storage, are made more difficult and in many cases even impossible.

In order to compensate the mentioned product disadvantages, a process for the production of a granulate, i.e. a bulk charge of uniform particle size with a minimum of fines, should be applied.

For this purpose process engineering offers three essential methods: agglomeration by agitation, lump agglomeration (briquetting), and extrusion agglomeration (pelleting). These methods are called agglomeration processes, as they join individual particles.

In contrast to agglomeration by agitation starting from fine powders with the addition of liquids as binders and working without exterior pressure gradients, agglomeration by compression is a process with which the solid matters to be treated can be agglomerated and compacted break and abrasion-proof without the addition of binders due to very high exterior pressure gradients. Pelleting is a process, where the granulometric state of the products to be treated, i.e. shape and size distribution, can vary to a large extent, whereas briquetting is normally limited to the processing of powdery material. Machines of the type "flat die pelleting press" are particularly advantageous in this connection, as the product is crushed additionally in the interior of this machine by shearing forces.

The pelleting process allows – in combination with preceding conditioning processes – apart from the above-mentioned product changes increasing mainly the mechanical stability of the solid matters a number of further product improvements. By means of a modification of the process parameters (pressure, temperature, retention time) and the machine construction as well as the addition of functional auxiliary agents to the products to be treated it is possible to adjust the specific values, such as density and calorific value, to cause structural changes (e.g. protein and starch modification), and to reduce the germ load. From the point of view of the marketing the outward appearance of the final products is also rather important in many cases. Under certain conditions (product, process conditions) it is possible to create a smooth bright surface when pelleting the product.



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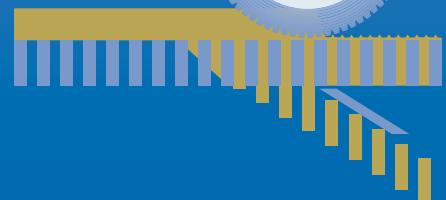
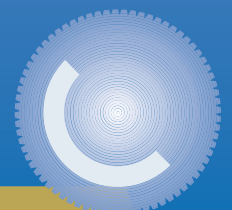
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# Refinement of solid matters by means of agglomeration by compression with flat die pelleting presses

## Possible applications of the pelleting process

Pelleting processes are used for various purposes:

- Conditioning of raw materials
- Shaping
- Blending with filling materials
- Dressing of wastes for recycling
- Production and refinement of finished products

## Ranges of application of the pelleting process

- Breweries
- Chemical factories
- Ironworks
- Compound feed factories
- Power stations
- Plastics industry
- Agriculture
- Mineral industry
- Food industry
- Oil mills
- Pharmaceutical industry
- Drying plants
- Pulp mills
- Sugar factories etc.

## Extrusion agglomeration using a flat die

Extrusion agglomeration using a flat die has proved to be a universally acceptable and economic method for compacting any lumpy, long-fibred, powdery, and pasty materials which have not been pre-ground. Depending on the industry the end product is called pellet, granulate, cob, or briquette. Pan grinder rollers and perforated dies are the important elements in the pelleting process. Compaction takes place in the open effective bores of the die (see fig. 1 and 2).

The coarsely pre-crushed products are fed to the press vertically from above and form a product layer on the die. The pan grinder rollers run over this layer and compact it (see fig. 3). The pressure is continuously increasing whilst the material is being rolled towards the effective bores, thereby pushing the product cylinder (plug) in the bores slightly forward. To achieve this, the frictional force of the pellets inside the bores must not exceed the effective pressure force of the rollers.

This means a small slice of material is forced into the bore to unite with the pellet already inside and at the same time pushing it slightly forward and through the reverse side of the die hole.

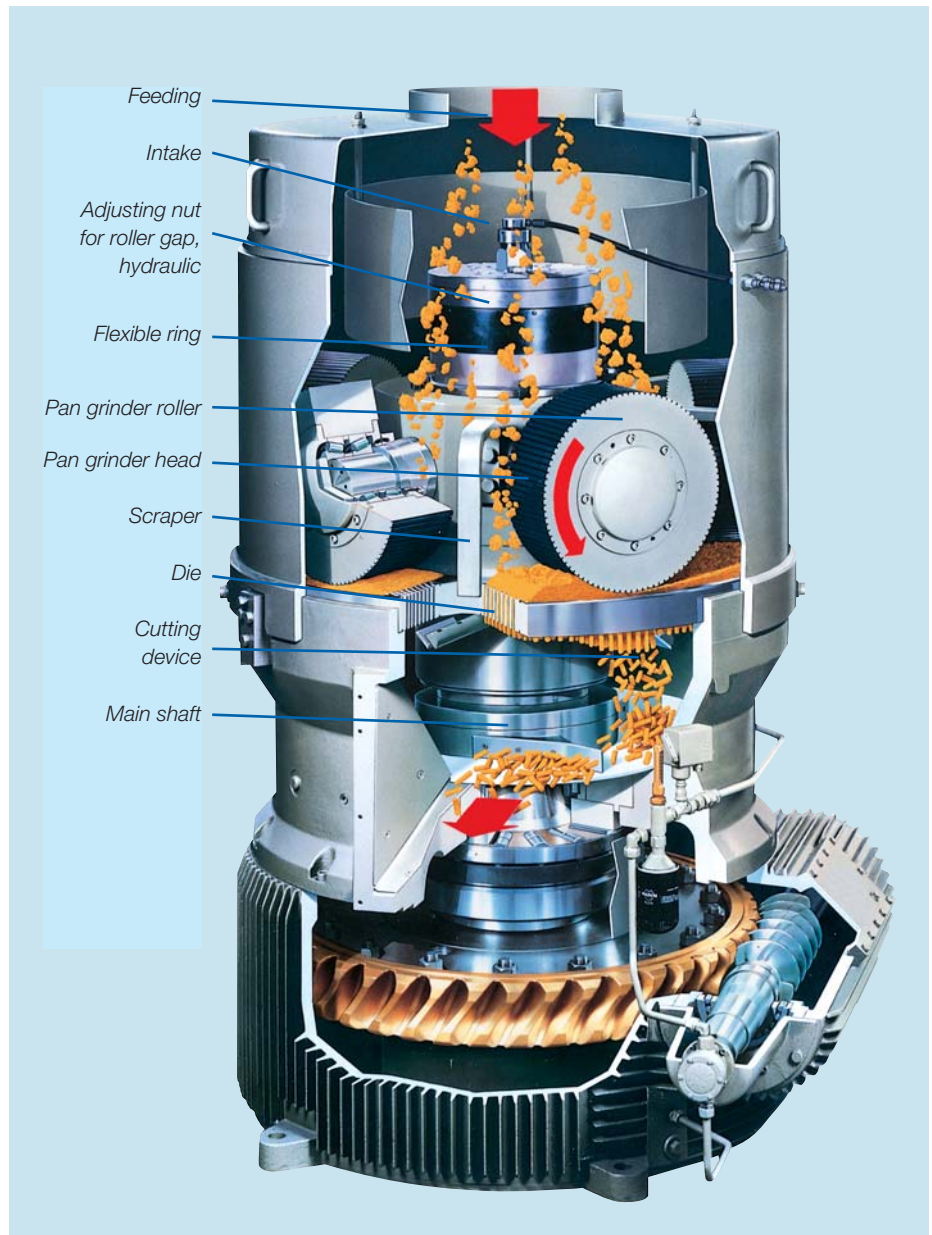


Fig. 1: Main parts of the flat die pelleting press:

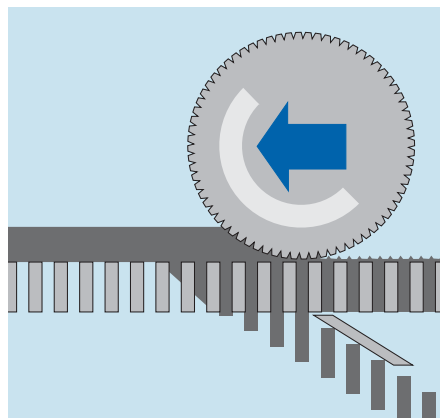


Fig. 2: Pelleting process with flat die pelleting

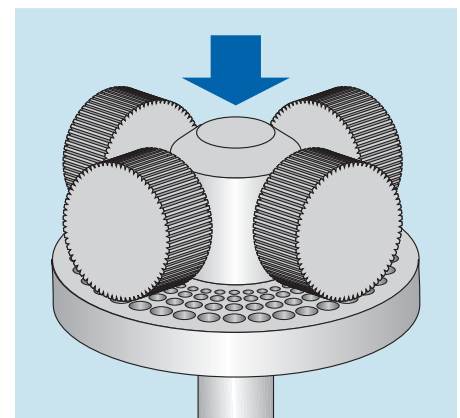


Fig. 3: Flat die pelleting press

By intent a residual product layer remains between the die and the rollers in order to achieve better pre-compaction and product binding and to avoid metal-to-metal contact which could cause unnecessary wear of the pelleting tools.

The rollers pass over each hole several times per second so that the pelleting process is discontinuous contrary to the extruder. The individual layers of material forced into the effective bores of the die form an endless strand which is cut to the desired pellet length from below using adjustable knives.

The object is to produce a homogeneous pellet which does not show the layered production with stability left mainly intact even after having been subjected to mechanical stress.

Accomplishment of this objective can be influenced by many factors such as:

1. Crushing ratio of the material to be pelleted
2. Composition of the product mixtures
3. Moisture content of the material to be pelleted
4. Addition of binders, steam addition, conditioning of the material to be pelleted
5. Number and dimensions of pan grinder rollers
6. Diameter of die and number of effective bores
7. Length, diameter, and physical shape of effective bores
8. Distance between rollers and die
9. Pellet drying
10. Pellet cooling

Die diameter, free perforated surface, track width, diameter, width, and number of rollers can be varied according to the pelleting characteristics of the material to be pelleted. A hydraulic system makes it possible to change the distance between rollers and die during operation. In this way the thickness of the product layer can be influenced and adapted to the requirements of each product. In case of wear of the pelleting tools the pan grinder head is readjusted without interruption of operation.

### Advantages of the flat die pelleting press

#### Material feeding

The material is directly fed to the press vertically from above by gravity without passing any deflectors and without the use of mechanical aids (forced feeding). Thus the danger of blocking or bridging due to inad-

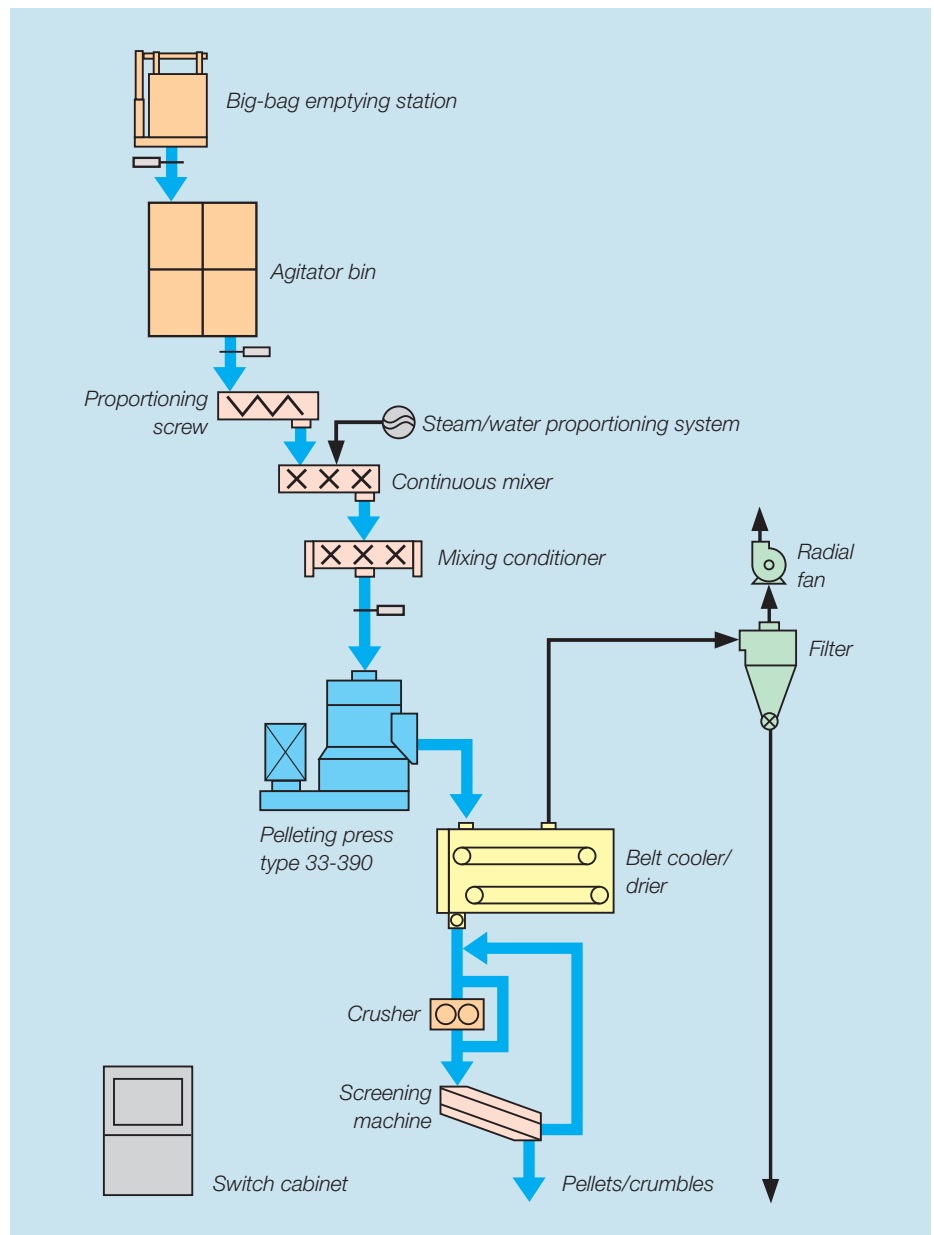


Fig. 4: Typical flow chart of a pelleting plant

vertent compaction, particularly with materials having a low bulk density, is excluded.

For material feeding and acceptance by the pelleting tools a large press interior is available. The maximum effective diameter of our dies is 1,250 mm. A large feeding area is especially necessary for materials with a low bulk density. The compaction ratio of waste paper and straw, for example, is 15:1, i.e. about 15 m<sup>3</sup> of input material must be processed to achieve 1 ton of pellets.

#### Pan grinder head

The pan grinder head forms one unit comprising roller axles and rotating pan grinder

rollers. Number, diameter, width, shape (cylindrical or conical), and surface of rollers are selected to best suit the material to be pelleted. Materials with a low bulk density are handled with fewer rollers to provide more space.

The circumferential roller speed of 2.5 m/s is relatively low which makes it easier to force the material between the rollers and the die. Furthermore the material can be deaerated more easily, the risk of roller slip is reduced and the press can operate under a noise level lower than that of the drive motor.

The hydraulic pan grinder head adjusting system (see fig. 5) makes it possible to opti-

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mise the distance between rollers and die during operation. The thickness of the material layer can therefore be influenced in such a way that the most economic press capacity is achieved.

### Dies

Die thickness plus the number, shape, and diameter of the holes as well as the roller track width can be varied according to the material to be processed. A high specific press output with low energy consumption per unit is among other things greatly influenced by the retention time of the material inside the effective bores.

The shorter the retention time, the softer the pellets, i.e. the higher the output, the poorer the pellet quality. To avoid this, the length of the effective bores can be extended until the full motor power has been consumed. However, the longer the bores, the greater the risk of the rollers being blocked. It is therefore preferable to increase the number of the die holes to the maximum by creating a larger roller track per driving and pelleting unit.

A large roller track is of particular importance when processing materials with a low bulk density and with maximum particle sizes of 100 x 100 mm, e.g. paper and plastic foil.

The specific roller track area varies between 25 and 30 cm<sup>2</sup> per kW of the installed power depending on the intended use and requested material compaction. Only with large specific perforated die areas can the installed power be completely converted into throughput.

### Shearing effect

The shearing forces produced by the pan grinder rollers when running on the product layer between rollers and die result in a better pre-compaction, less crumbling of the material, better intake characteristics, shorter length of the effective bores as well as smoother, harder, and tougher pellets with the same power consumption. Conical rollers can be used for materials whose nature does not allow them to be subjected to additional shearing forces or which causes excessive wear on the die. Due to the direct material feeding, the large press interior, and the shearing effect of the rollers even very coarse material can be processed. With some products, e.g. waste, one size reduction stage can be saved by operating the existing grinding plant using a bigger mesh size. The net result is a saving of energy, a reduction in investment costs, and a simplified sequence of operation.

### Change of pelleting tools

The dies are supported on the full circumference of the press case and are merely held in place by wedges. This minimises the risk of die breakage.

The pan grinder head is seated loosely on the main shaft and is connected to the latter by feather keys. From above the pan grinder head is held in place by the adjustable hydraulic nut.

Changing dies is therefore very easy and rapid, because except for the hydraulic nut no screws or clamps need to be loosened. The pan grinder head and die can easily be lifted by means of an electric chain hoist and be replaced without any need to clean the interior.

### Cooling and drying of pellets

If the moisture content of the pellets must be reduced in order to improve the storage stability, the calorific value, or the combustion properties, the pellets can be subjected to a second drying step using the Kahl belt drier which employs cheap waste heat.

### Product tests can be carried out in the KAHL pilot plant

In the last few years more than 5000 products have been pelleted successfully in the KAHL pilot plant (see fig. 6).

In the following some examples:

- Catalysts
  - Vulcanization accelerators
  - Tablets
  - Vitamin C instant products
  - Pharmaceutical substances
  - Graphite
  - Pigments
  - Stearates
  - Plastics powder, waste
  - Fertilizers
  - Washing agent additives
  - Activated carbon
  - Sludges
  - Talc
  - RDF
- etc.

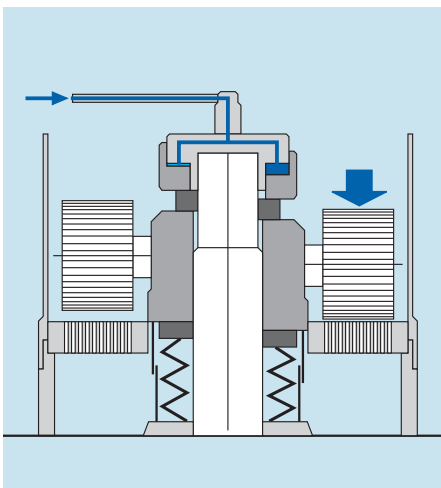


Fig. 5: Functioning of the hydraulic pan grinder roller adjusting system: on the left in the rest position, on the right in working position



Fig. 6: All products can be tested at the KAHL pilot plant