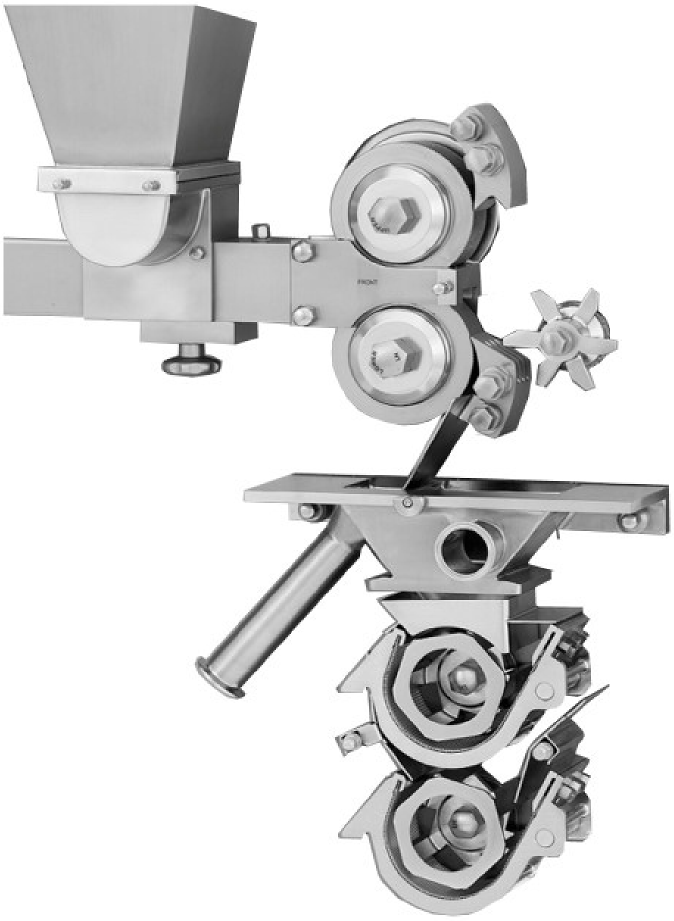
Five Common Questions About Roller Compaction/ Dry Granulation

1. What is the science behind powder processing during roller compaction operations?
2. What powder processing techniques are there and what advantages does roller compaction have over other powder processing techniques and technologies?
3. What are the significant control parameters in roller compaction operations?
4. What does a typical roller compaction operation and system look like?
5. What products can be compacted, and how is material flow addressed?

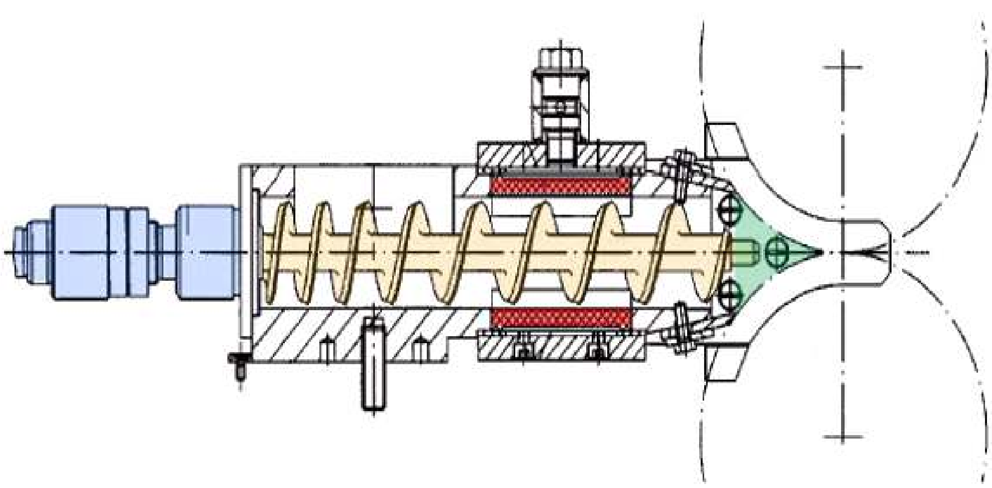


At Alexanderwerk, we are the world's leading provider of roller compaction and dry granulation solutions. We offer high-quality standard and custom machines that support critical processing applications in the chemical, pharmaceutical, food, life science, and nuclear fields. In this eBook, we provide answers to five of the most commonly asked questions regarding the roller compaction process, including how it works, what advantages it offers, what the significance of parameter controls is, what a typical roller compaction operation and system look like, and what products it accommodates.

1. What is the science behind powder processing during roller compaction operations?

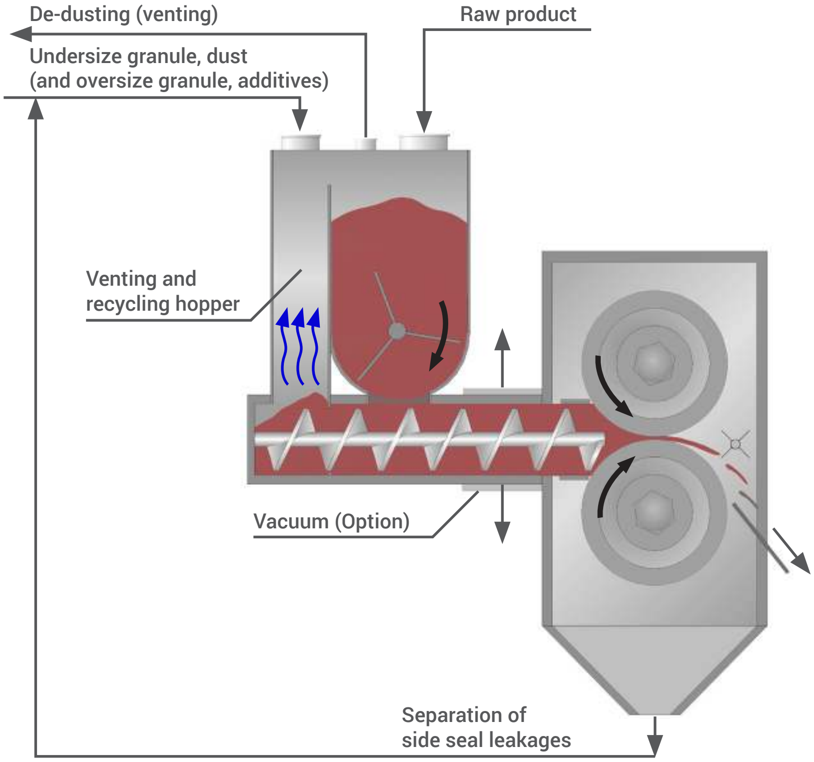
In manufacturing process operations, powder flowability—i.e., the ease with which powder flows through a system—affects the behavior of the material. As a result, it can have a significant impact on both the efficiency of the process and the quality of the finished product. Powder flow properties can very often be improved through the use of roller compaction/dry granulation technology. This is achieved by applying very high compression forces to densify a powder and then using a compression milling step to turn that densified material into granules of the desired size. The science of the physical changes that transform a powder can be described as follows: Raw material powder in the form of a single component or homogenous powder blend is fed into a roller compactor and delivered by means of a feedscrew to two counter rotating rollers for compaction. The rollers will apply hydraulic pressure to the powder that comes between them.

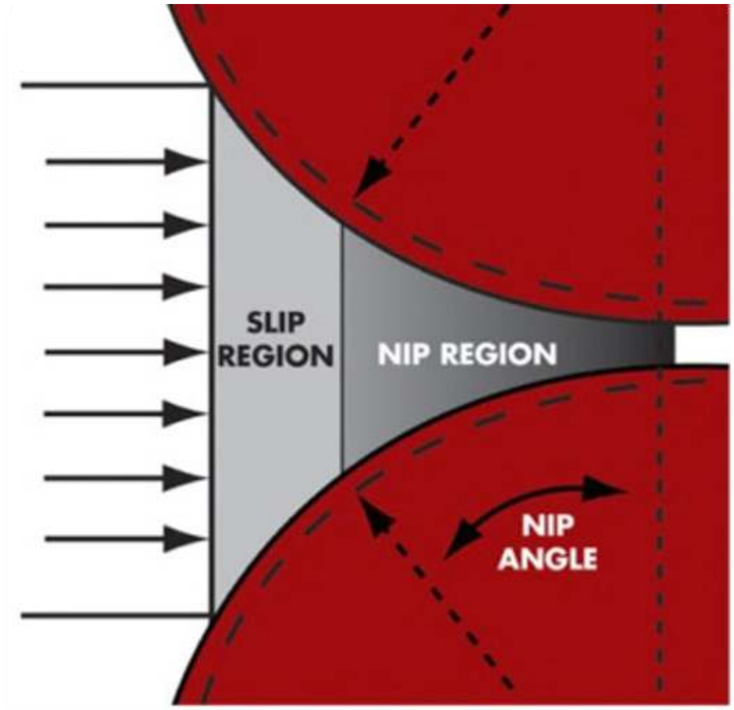
The material advances to the compaction zone using the friction of the powder against a spiral feedscrew. For very light or low bulk density powders, the addition of a vacuum filter helps to move the material into the process.



The material first begins to move into the compaction zone in the "Slip" region between the rollers. The powder particles are now moving closer together. In this area the friction of the roller surface interacting with the powder pulls the powder into the process.

In the next phase known as the "Nip" zone, the powder particles stop moving with reference to one another and begin moving with the same speed and position relative to the rollers. It is at this point that the particles begin to bend in a process known as "Plastic deformation".

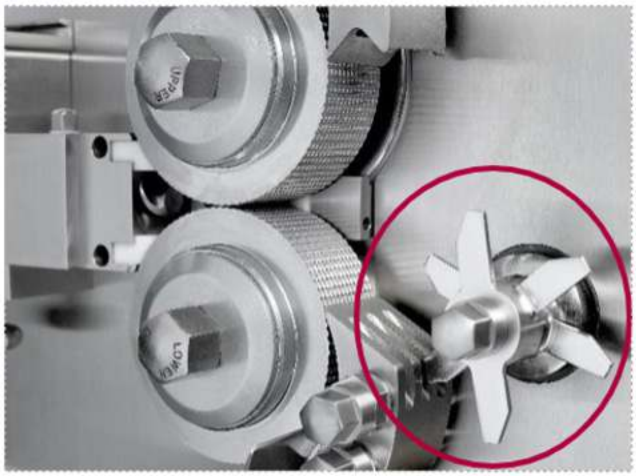




Material in nip region on actual machine

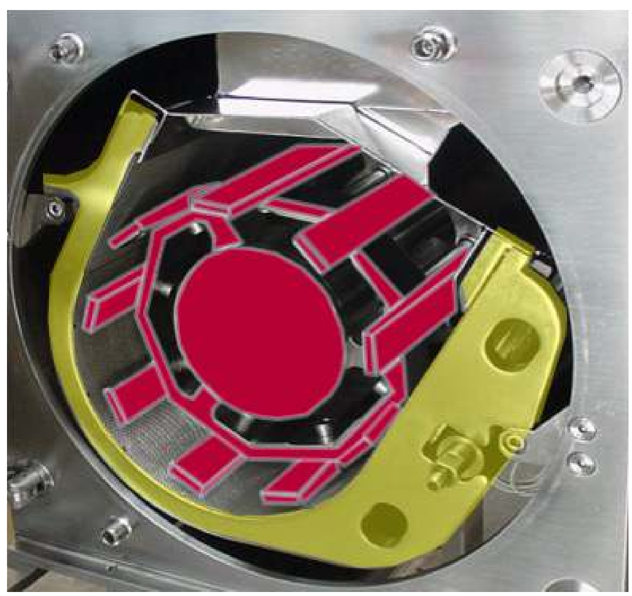
The further the particles are pulled into the process, the greater the pressure being exerted on them by the rollers. When particle bending cannot withstand the increasing pressure being exerted by the process, the particles will fracture.

As the fractured particles near the point of maximum pressure, Van der Waals forces will form new bonds between the fractured particles creating a densified “flake” or “ribbon” that exits the rollers as compacted material.



The next step in the process is the granulation step wherein the densified material is sequentially broken into smaller pieces and then is pressed through a screen of a defined size with a rotating bar.

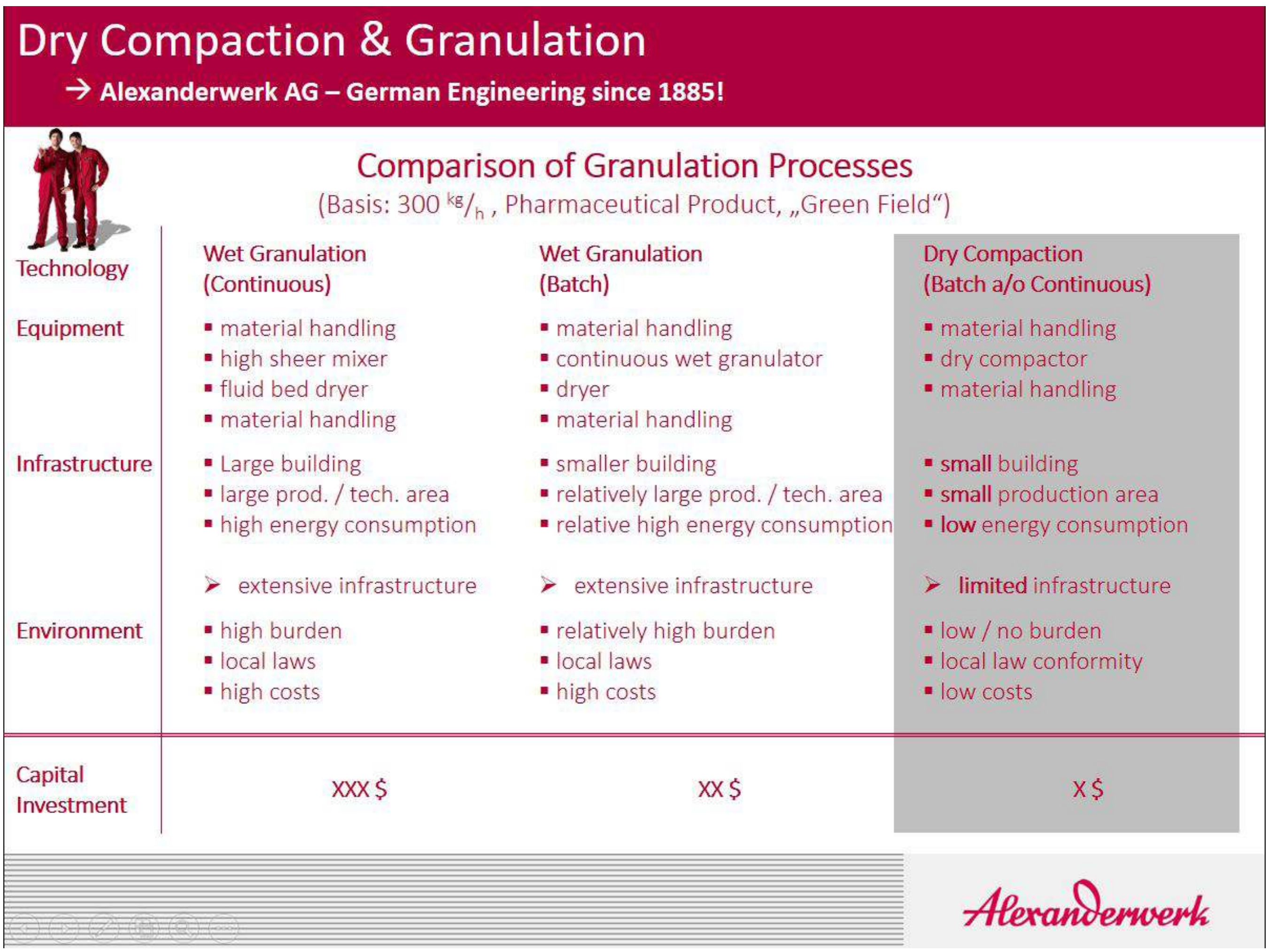
What results from this process is a material that has undergone a mechanical process to physically densify the material. In most cases, no additional binders, lubricants, or moisture need to be added to the process. The chemical nature of the original powder will remain unchanged.



Rotor with blades – Screen basket with screen insert

2. What powder processing techniques are there and what advantages does roller compaction have over other powder processing techniques and technologies?

There exists several different technologies to process powders into granules. The most common among these are direct compression, sometimes known as "slugging", roller compaction where a powder is densified between two counter-rotating rollers and then granulated by pressing that material through a sized screen, fluid bed powder processing wherein a powder is fluidized in an air stream and a "binder" is added to agglomerate the powder into a larger particle size, and moist and wet granulation which utilize varying degrees of moisture to help bind powder particles into larger sizes which can then be dried or extruded to create the final product. Each of these processes are used successfully in product specific application.



Dry Compaction & Granulation

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Comparison of Granulation Processes

(Basis: 300 kg/h, Pharmaceutical Product, „Green Field")

Technology	Wet Granulation (Continuous)	Wet Granulation (Batch)	Dry Compaction (Batch a/o Continuous)
Equipment	▪ material handling ▪ high sheer mixer ▪ fluid bed dryer ▪ material handling	▪ material handling ▪ continuous wet granulator ▪ dryer ▪ material handling	▪ material handling ▪ dry compactor ▪ material handling
Infrastructure	▪ Large building ▪ large prod. / tech. area ▪ high energy consumption ➢ extensive infrastructure	▪ smaller building ▪ relatively large prod. / tech. area ▪ relative high energy consumption ➢ extensive infrastructure	▪ **small** building ▪ **small** production area ▪ **low** energy consumption ➢ **limited** infrastructure
Environment	▪ high burden ▪ local laws ▪ high costs	▪ relatively high burden ▪ local laws ▪ high costs	▪ low / no burden ▪ local law conformity ▪ low costs
Capital Investment	XXX $	XX $	X $

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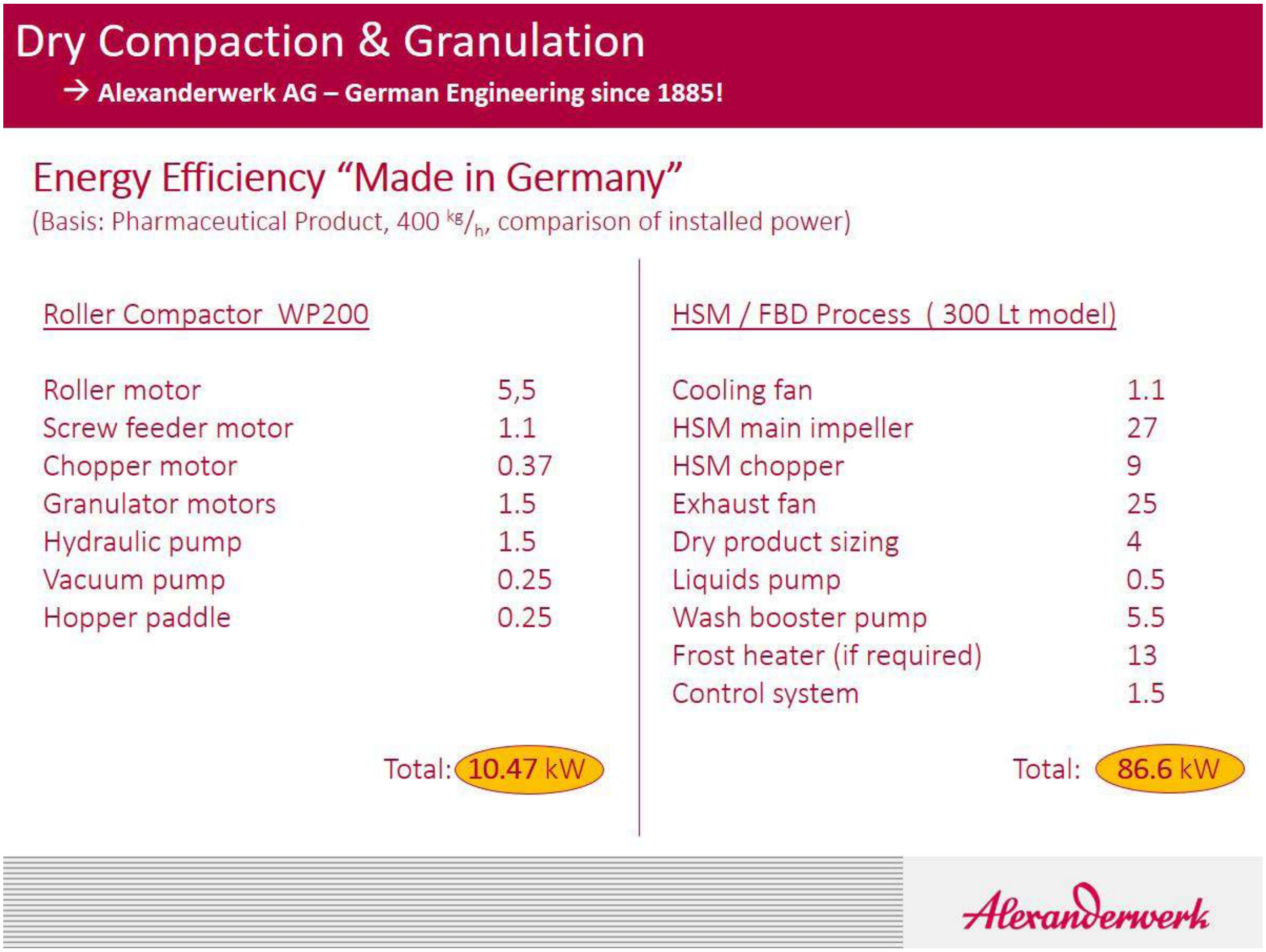


Dry granulation by roller compaction typically requires less material handling, less energy cost to operate, less physical footprint, less process risk, and less capital investment than competing technologies.

3. What are the significant control parameters in roller compaction operations?

Roller compaction/dry granulation is not a complex process to understand at the basic level. Raw material powder is densified by compressing it through two rollers under great pressure. That densified material is reduced in sized by pressing the material through a screen of a designated size which produces granules with desirable flow properties.

At a more detailed level, this elegant process is influenced and controlled by a variety of process parameters that respond to the operator's command to produce a powder with the appropriate characteristics. All of these parameters work together to influence the final product.

- The hydraulic pressure exerted on the rollers is the compressing force that densifies the material. The greater the force – the greater the densification α

Constant	Variable Let's change	Result	Additional Result	Comment
• Roll Speed • Feed Screw • Vacuum	Hydraulic press force INCREASE	α will increase	Gap will decrease (less volume out)	If press force is increased – gap will decrease and flakes will be harder. α is larger

- The feedscrew speed and the roller speed work together to determine how much material is presented to the rollers to be compacted and how long (residence time) the material will be exposed to that compaction force. These two parameters determine the throughput capacity of the machine.

Constant	Variable Let's change	Result	Additional Result	Comment
• Roll Speed • Hydraulic force (press force) • Vacuum	Increase feed screw RPM	Larger volume into RC	Gap will increase (more volume out)	If press force is constant – gap will increase to allow more volume to be compacted. α is maintained

- The "gap" which is the distance between the rollers determines the thickness of the flake or ribbon of densified material as it leaves the compaction zone. Selection of the correct gap size directly impacts the ability of the process to produce granules of the desired size. Increasing the gap size while maintaining the other process parameter will produce less densified material. Conversely, decreasing the gap will produce material that is more densified.

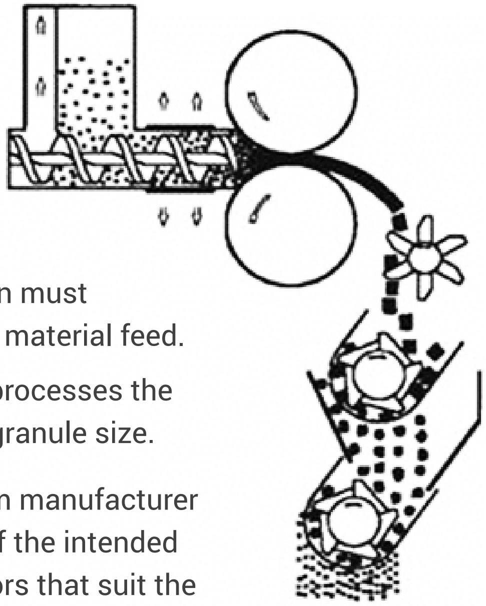
Constant	Variable Let's change	Result	Additional Result	Comment
• Roll Speed • Press Force • Vacuum	Gap increase	Volume out will increase	Feed screw speed will also increase	If gap is increased volume out will be larger α is maintained

- The screen size (size of opening between the screen wires) selection in the granulation step determines the maximum particle size to exit the process. The gap between the screen and the rotating bar can be optimized to generate the greatest percentage of particles in the correct size range without generating a large percentage of material that is undersized due to overprocessing.

All of the parameters discussed here are able to be set by a machine operator to influence the manufacturing process.

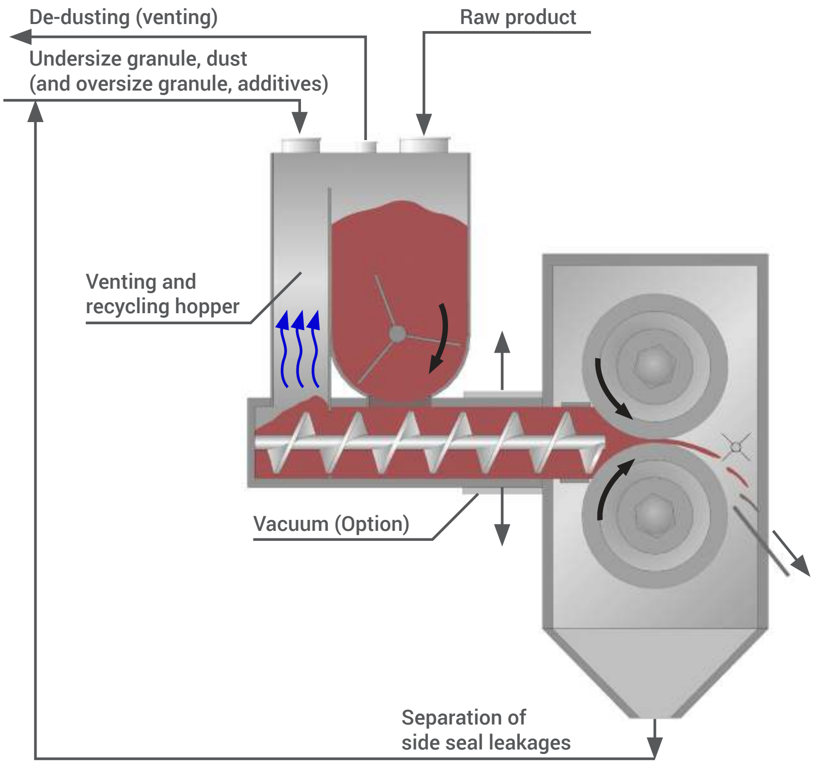
4. What does a typical roller compaction operation and system look like?

A typical roller compaction and granulation operation consists of three stages:



1. **Powder Feeding:** The raw material (powder) feeds into the roller compaction machine. The feeder unit must feature a control mechanism that allows for constant delivery of precise and accurate dosages to the rollers.
2. **Compaction:** The counter-rotating rollers compact the powder into a solid flake with an increased bulk density. The air displaced from between the particles during compaction must be given a path to exit the process without interrupting the raw material feed.
3. **Granulation:** A single-stage or multi-stage granulation system processes the flakes produced during the compaction stage into the desired granule size.

The design and construction of the roller compactors can vary from manufacturer to manufacturer, depending on the requirements and restrictions of the intended processing application. At Alexanderwerk, we offer roller compactors that suit the needs of various industries. Our WP Pharma Series units have the following features:



- Feed Hopper with a stirrer
- Combi-Vent-Feeder system to allow the air released in the compression process to exit the system and to provide a process point where fugitive materials that are captured in the process can be re-introduced to the feed stream
- Feeding unit with a vacuum zone (to improve material feed into the rollers)
- Vertical rollers (for compressing the material) which ameliorate the negative effects of gravity on the process
- Separator (for isolating and removing uncompressed material from the final product stream)
- Flake crusher (for controlled downsizing of flakes)
- Integrated two-stage granulating unit with two rotor fine granulators (RFGs)

5. What products can be compacted, and how is material flow addressed?

The roller compaction process plays a critical role in a wide range of powder processing operations. Some of the industries that regularly use it include:

- **The chemical industry** for fine chemicals, additives, battery compounds, feedstuff, fertilizers, salts, silica, soda ash, and textile dyes
- **The food industry** for flavorings, instant powders, and instant sweeteners
- **The pharmaceutical industry** for tablets, capsules, and life science products

For any powder processing application, it is essential to understand the properties of the raw material and how they affect the efficiency and effectiveness of the process. As indicated above, one of the most important factors to consider is flowability. Powders with poor flow characteristics can cake or stick to the walls of equipment, resulting in poor processing quality and inconsistency. By employing the roller compaction /dry granulation processes, industry professionals can improve the flowability of material, improving its ability to progress smoothly through downstream processing equipment.

Contact the Roller Compaction Experts at Alexanderwerk Today

The roller compaction process helps improve flow, reduce segregation, and increase uniformity in powder materials used in processing operations. For customers looking for a high-quality roller compaction solution, Alexanderwerk is the ideal supplier.

At Alexanderwerk, we design and manufacture high-performance powder processing equipment suitable for use in even the most demanding industries. Our product selection includes roller compaction and granulation units that are engineered with advanced feeding and control strategies for maximizing process efficiency and product quality. In addition to our standard lines of equipment, we also work with customers to design customized processing solutions for unique or specialized applications.

To learn more about our standard and custom compaction and granulation solutions, **contact us** today.

About Us

Alexanderwerk offers extended roller compaction & granulation services including lab testing, commissioning, training, calibration, preventive maintenance and repair services. A fully equipped warehouse enables quick spare part deliveries and ensures that your key process equipment has no downtime.

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