



LIGNIN

*Customised processes for refining
the natural raw material*



**HOSOKAWA
MICRON GROUP**



At Hosokawa Micron Group, you get innovative technology and customised solutions from a single source. Thanks to our many years of experience, you benefit from system solutions with machines of the highest quality. Customers all over the world trust in our technologies and in the know-how of our experts.

**»» CUSTOMISED SOLUTIONS TO SUIT
YOUR LIGNIN**

**»» HIGHEST QUALITY POWDER
OR GRANULATE**

»» HIGH PROCESS AND PLANT RELIABILITY

**»» COMPLETE SYSTEM FOR THE ENTIRE
MANUFACTURING PROCESS**

TRIPLE COMPETENCE

We create synergies

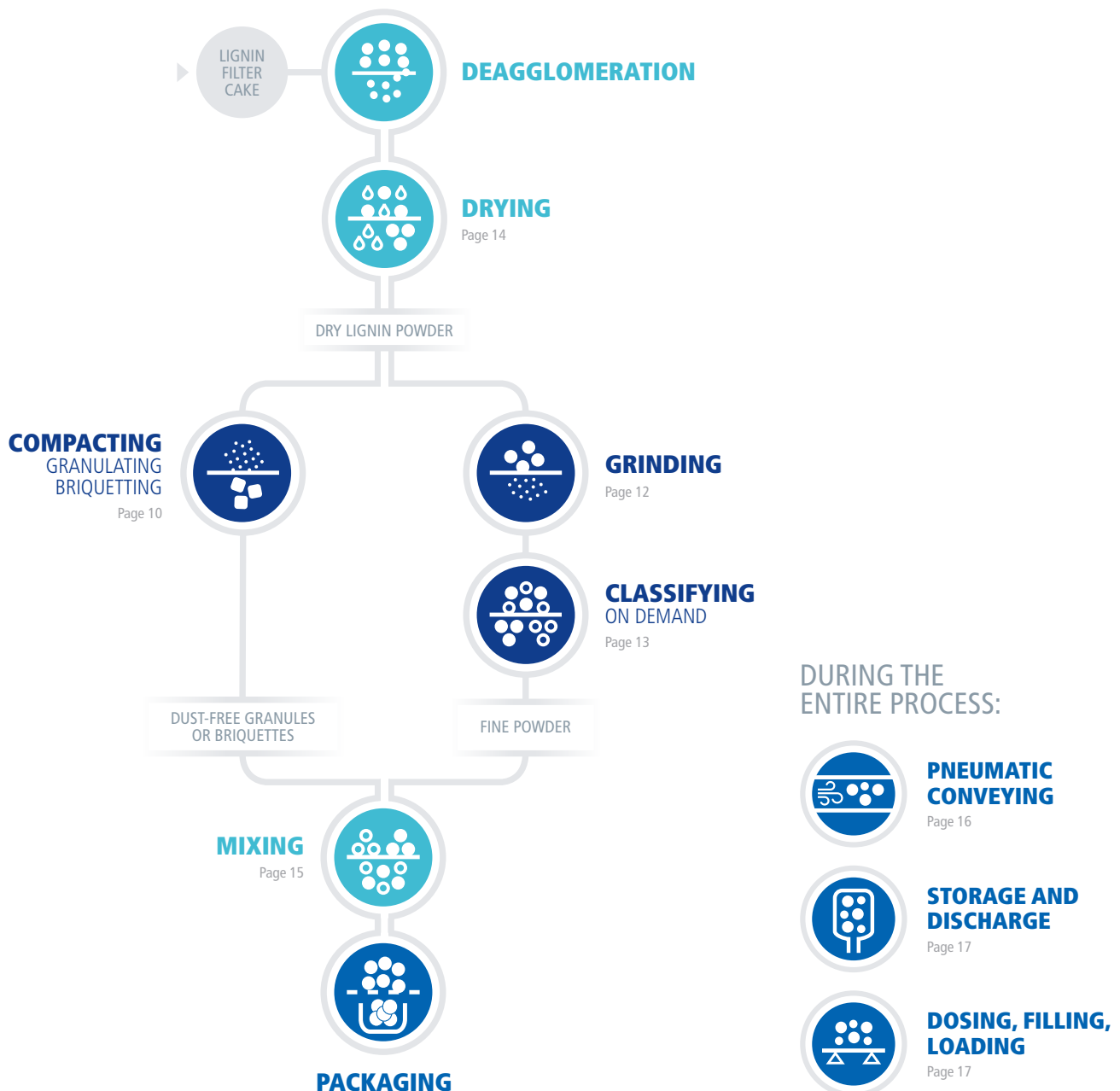
The Hosokawa Micron Group, headquartered in Japan, is represented at various locations around the world. Our know-how is pooled together in competence centres and provides complete process solutions from grinding to packaging. This allows you to process the natural raw material lignin in line with your market requirements.



EVERYTHING FROM ONE MANUFACTURER

Complete solutions for processing of lignin

With our machines and systems, you can process lignin from filter cake to finished product. This means that the by-product, can be utilised for numerous industrial applications.

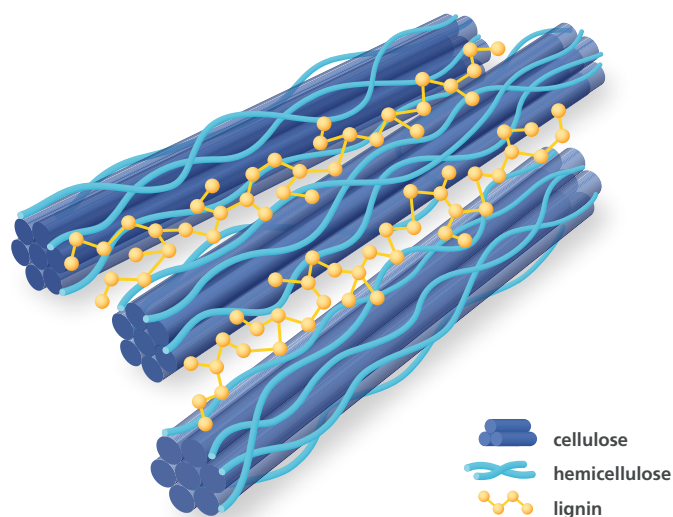




WHAT IS LIGNIN?

Renewable raw material with versatile properties

Lignin is an organic polymer and, alongside cellulose and hemicellulose, a component in wood. Here it has an impact on the lignification of the cell and the compressive strength and durability of the plant tissue. Overall lignin accounts for around 20 to 30 percent of the dry matter of ligneous plants. Previously, this natural raw material was regarded as a by-product produced during the manufacture of pulp or bioethanol and has scarcely been used industrially to date. In fact lignin is versatile and can actually be used for the various end products – from batteries to cosmetics.



PROPERTIES OF LIGNIN

Lignin is not a uniform substance, but composed of different monomer components. Depending on whether the raw material is hardwood or softwood, straw or biomass, the types of lignin differ considerably.

However, they do have certain characteristics in common:

- Low density
- Almost complete absorption of UV light
- Hydrophobic, not water soluble
- Insoluble in many solvents

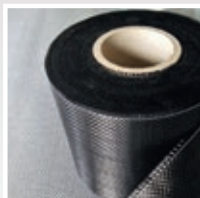


VERSATILE MATERIAL FOR NUMEROUS APPLICATIONS

Lignin can be acquired by means of various different chemical procedures including the sulphate and sulphite process, the soda process, Acetocell process or the organosolv process. Depending on the process, the lignin acquired has different chemical and procedural properties. For the subsequent processing, a primary distinction is

made between kraft lignin from the sulphate and sulphite process and sulphur-free lignin from other procedures. Depending on the manufacturing process and quality of the lignin, it can be used in the following application areas.

Kraft-Lignin from pulp production



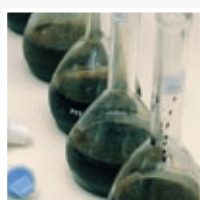
Carbon fibres



Hard Carbon
for Batteries



Carbon Black Replace-
ment for rubber



Basic material for the
chemical industry



Feed



Resins

Sulfur-free Lignin from organic refineries



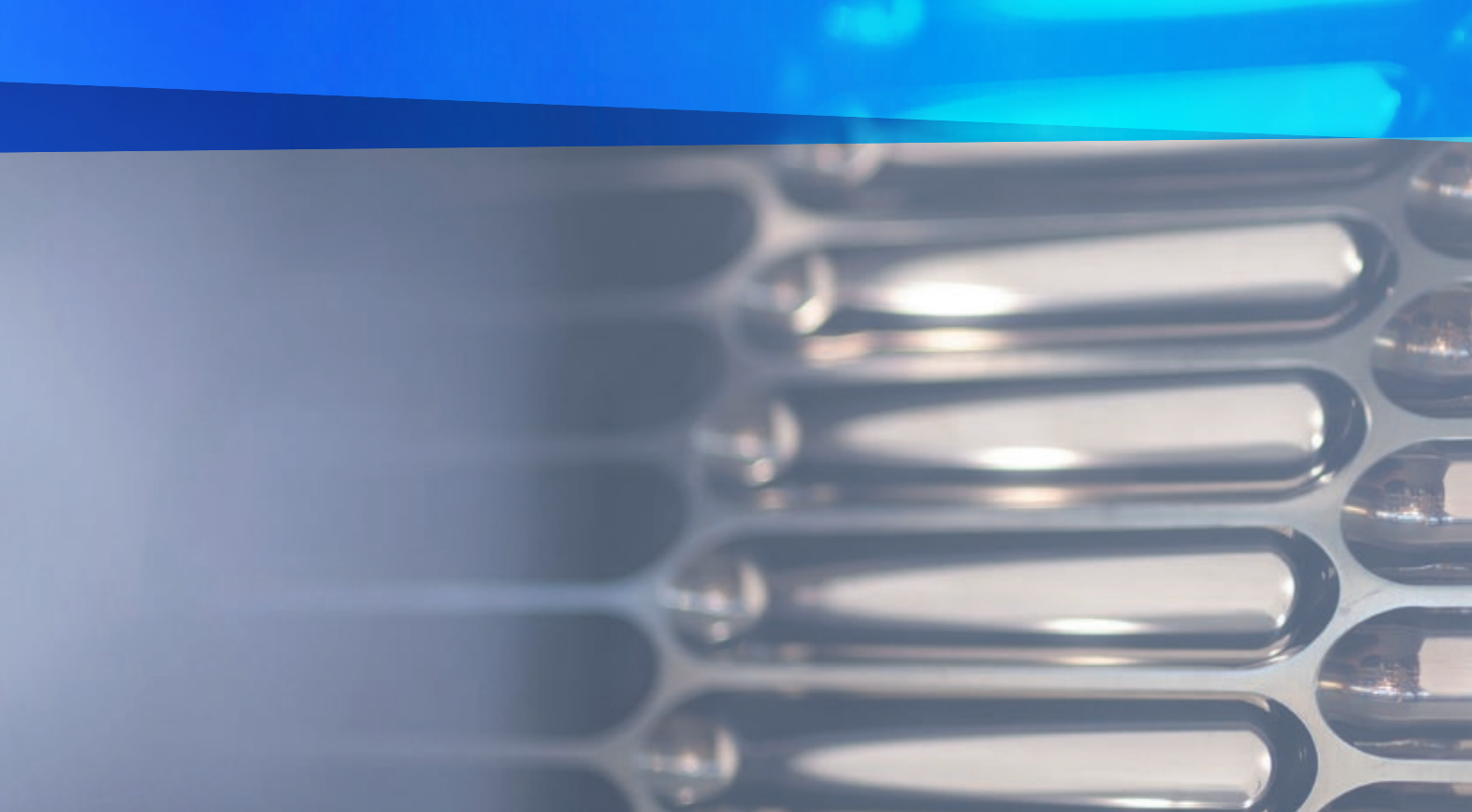
Use in Plastics
• Thermoplastics
• Elastomers
• Waxes



Additive for foams
• PU-foam
• Aero gels



Cosmetics



REFINING THE RAW MATERIAL

Customised solutions required

Lignin is an extremely versatile raw material. Its natural source, however, means that its quality is subject to strong fluctuations – since not all woods are identical. The manufacturing process also influences the properties of the raw material: Its properties will vary depending on whether the lignin is acquired during the manufacture of pulp and paper or in bio refineries.

For the processing of lignin this means: There is no standard solution for the grinding or compacting of lignin. Depending on the initial product and end usage, an individual process is therefore required and we would be delighted to develop it for you.

For the processing of raw lignin, there are various processes, which lead to different lignin qualities and depend not just on the desired application but on the type of lignin too: By grinding with a classifier mill or jet mill and subsequent classification, you will obtain a premium quality lignin powder. Compacting will result in dust-free granules or briquettes with good flowability and high bulk density.

alpinere rentals.de

» RENTING – INSTEAD OF BUYING

*Renting saves equity and keeps you financially independent. Whether for a few days or several years, you are always on the safe side with Hosokawa Alpine's rentals. Benefit from our constantly growing rental equipment and rent your system directly from the manufacturer. **Any questions? Come by and see us!***



HOSOKAWA ALPINE & LIGNOPURE TWO STRONG PARTNERS FOR YOUR SUCCESS



**HOSOKAWA
ALPINE**

The Hamburg start-up Lignopure GmbH is a pioneer for the incorporation of lignin into consumer products. We are bundling our knowledge together with this application expert and will develop a specific process for you for your required application

For this, Lignopure analyses the initial material but also the requirements of its end use. Based on this, they will determine how lignin has to be modified in terms of its particles in order to obtain an optimal end product. In turn, Hosokawa Alpine, as a machine and system builder, possesses the required know-how and technologies to process lignin with the required properties as best as possible.

We will support you in finding the right technology for your requirements and produce an optimal lignin granulate or powder. This primarily includes the process development of customised process and plant layouts based on the quality of the available lignin and the market potential. Through product and process tests in Hosokawa Alpine's test centre, we develop the right solution for you.



COMPACTING & BRIQUETTING

Optimised handling, better processing

Fine lignin powder is potentially explosive, has poor flow characteristics and a low bulk density. For this reason product handling is complex, occupational health and safety is cost-intensive and large storage areas are required. The solution to these challenges lies in the granulation or briquetting of lignin powder.



➤ Compressed lignin

GRANULATION OF LIGNIN: WE GET LIGNIN INTO SHAPE

By using a roller press, you will obtain a dust-free lignin granulate or briquettes with a constant, very high product quality, higher bulk density and good flow characteristics. This is subsequently not only better for further processing but for storage and transport too. In addition, the risk of a dust explosion or dust exposure is reduced, so that the necessary measures for employee and environmental protection can

be minimised. By refining the lignin in this way, a higher market price can be achieved. During granulation, the material is initially dosed evenly into the compactor. In the compactor, it is compressed to a flake by two counter-rotating rollers. Subsequently the flake is crushed into the desired particle size by a pre-crusher and a roller crusher.



BRIQUETTING LIGNIN

During briquetting, the raw material is compressed to the desired shape. Subsequently, dust and bars are sieved out and fed back into the process. Should water or other additives be necessary to manufacture stable briquettes, a mixing unit will have to be switched upstream of the compactor.

WHY HOSOKAWA ALPINE COMPACTING SYSTEMS?

With our compactor systems, you obtain the best from product and system. Since all system components are obtained from a single source, machines and processes are perfectly coordinated to one another.

APPLICATION-RELATED ADVANTAGES

- Flexible setting of granulate size possible
- Stable granulates
- Very low proportion of dust in the granulate

SYSTEM-RELATED BENEFITS

- Stable process
- No addition of additives required
- Energy efficient
- High system availability



➤ Compactor ARC MS



GRINDING OF LIGNIN

Powder with outstanding properties

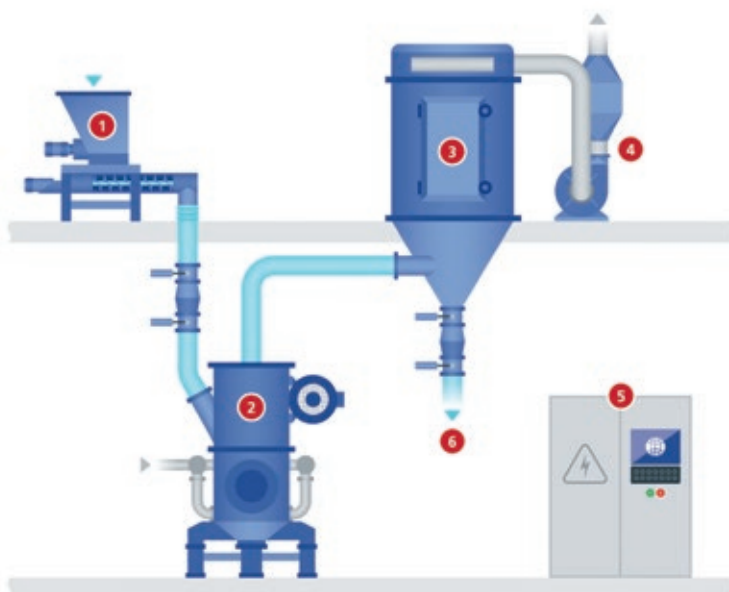
To grind lignin, there are two types of suitable mills: With the jet mill AFG, you will obtain a high degree of fineness where $d_{97} = 5 - 15 \mu\text{m}$. By the use of this jet mill with high grinding energy, fibrous raw materials can also be milled. With a classifier mill like the ACM, you will obtain a coarser target product with a fineness of $d_{97} = 10 - 25 \mu\text{m}$. Mechanical milling is a highly energy-efficient process.

- 1 Material infeed
- 2 AFG fluidised bed opposed jet mill
- 3 Filter
- 4 Blower
- 5 System control
- 6 End product

GRINDING WITH JET MILL AFG

YOUR ADVANTAGES AT A GLANCE

- High degree of fineness
- Sharp and easily adjustable separation line
- Fibrous materials can be ground
- Low wear
- Contamination-free product handling possible due to the ceramic lining of the complete system



➤ Example process: Grinding of lignin with the jet mill AFG

GRINDING WITH CLASSIFIER MILL ACM

YOUR ADVANTAGES AT A GLANCE

- Low specific grinding energy
- Sharp and easily adjustable separation line
- Flexible production parameters for setting the grinding fineness
- Compact, space-saving design



➤ Classifier mill ACM

GRINDING WITH THE JET MILL AMB

The Microburst AMB jet mill is ideal for use in laboratories and can also grind coarse or fibrous products to extremely fine levels without any preliminary crushing.

YOUR ADVANTAGES AT A GLANCE

- Also suitable for coarse and fibrous products
- Extra fine grinding is possible without any preliminary crushing
- High degree of fineness
- Simple explosion protection concept
- Modular set-up
- Easy to clean
- Baseline version* also available for stand-alone use

* A baseline variant is a compact, stand-alone system.



➤ Jet mill AMB

DE-DUSTING WITH AIR CLASSIFIER ATP

In order to obtain a steeper particle size distribution, classification with air classifier ATP is recommended for:

- De-dusting at 2–3 µm
- Top grain classification at 20–30 µm

De-dusting ensures you obtain a dust-free product with optimised flow capabilities. In addition you can ensure a sharp separation line by classification of top grain and remove the agglomerates. The steep separation curve also leads to a high product yield. This premium value powder is ideal, among other things, for premium quality plastics, foams or cosmetics.



➤ Air classifier ATP



DRYING

Efficient & fast



BATCH DRYING

Hosokawa Micron vacuum dryers are suitable for gentle low temperature drying. They can also be applied to other phases in the process such as reaction/crystallisation, heating/cooling, sterilisation, liquid/solid separation and mixing.

- Efficient and fast drying
- Batch sizes from 5 to 20,000 litres
- Solvents/water evaporation and recovery
- Multi-purpose processing
- Fully compliant with FDA, cGMP and EHEDG
- Automated CIP/SIP cleaning possible



➤ Conical paddle dryer (CPD)

CONTINUOUS DRYING

The Hosokawa Drymeister (DMR-H) continuous flash dryer combines drying, milling and classifying in one operation. It can handle moisture fluctuations from a few % up to more than 80% and dry temperature-sensitive products, safely, in a matter of seconds!

- Drying, milling and classification in one operation
- Turns pasty products into ultra-fine powders in one processing step
- High evaporation capacity (up to 2,000 kg/hr)
- Short residence time / low product temperatures



➤ Drymeister (DMR-H)



BLENDING

As lignin has a natural source, there are often variations in composition, structure and particle size. These variations can often be neutralized by introducing a blending operation. Besides mixing accuracy, important points of attention for mixing are aspects such as heat generation, product distortion and yield. All mixers are flexible in operation and can be used for various batch sizes from 10 to 100% filling without compromising the quality.

NAUTA CONICAL SCREW MIXER (LOW SHEAR)

The Nauta conical screw mixer is especially suited to processing delicate products, offering gentle mixing without product distortion and constant product quality.

- Batch sizes from 5 to 80,000 litres
- Perfect mixing quality and accuracy
- Fast and complete discharge from a bottom discharge

CONICAL PADDLE MIXER (MID SHEAR)

The conical paddle mixer is a multi-purpose mixer for processes where high accuracy and fast mixing with limited product distortion are important.

- Gentle and fast mixing
- Batch sizes from 20 to 20,000 litres
- Compact and simple design
- Suitable for mixing, drying and reaction processes

CYCLOMIX (HIGH SHEAR)

The Cyclomix is a revolutionary high speed paddle mixer designed for intensive mixing of cohesive powders. The mixing principle is based on a combination of high shear and high impact forces which can be used for different applications. The Cyclomix combines different processes in one single machine.

- Intensive mixing of cohesive powders, slurries and liquids
- Coating of powders with powders or liquids
- Spheronisation of particles
- Grinding or de-agglomeration
- Heating or cooling



➤ Nauta conical screw mixer



➤ Conical paddle mixer



➤ Cyclomix



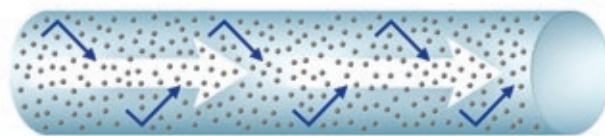
PNEUMATIC CONVEYING

of powder and lignin granules

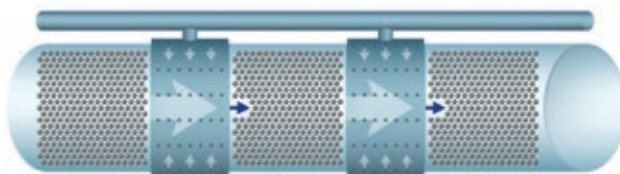
In order to guarantee optimum product quality, different conveying methods have to be used in different process stages. While simple dilute phase conveying is possible with the lignin powder, the sensitive lignin granules after the granulation process have to be conveyed more gently. This is done via Puls Pneu plug conveying or Step Pneu push conveying.

THE ADVANTAGES OF SOLIDS PULS PNEU AT A GLANCE

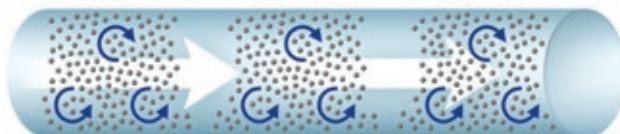
- Slow and gentle conveying starting at approx. 0.5 m/s
- Loading 20–60 kg product/kg gas
- No blockage at low speed and high loads
- Virtually no grain destruction, minimal abrasion and low dust generation
- Low energy costs thanks to efficient use of pressure energy



➤ *Solids Fly Pneu: With lignin powders, dilute phase conveying is possible.*



➤ *Solids Puls Pneu: For lignin granules, plugs are created and gently pushed through the conveyor lines.*



➤ *Solids Step Pneu: gentle conveying of powdered lignin*



STORAGE AND DISCHARGE

Product specific stocking of lignin

In the production process for lignin granules, it is necessary to stock raw materials, to buffer intermediate products and to store finished products. The subsystems have to match the bulk material and the process requirements. For example, a mass flow silo with the appropriate discharge aids is required for storing lignin granules.

THE ADVANTAGES AT A GLANCE

- No adhesion or clumping of fine dusts
- No bridging
- Gentle treatment of the material to be discharged without grain destruction
- Low maintenance and low noise
- Complete silo systems with constructive explosion protection



➤ Complete silo systems



DOSING, FILLING, LOADING

Recording the filled quantities

Finished lignin products are filled into big bags or sacks or transported in silo vehicles. The filling process is often combined with weighing and dosing in order to record and reproduce the filled quantity.

THE ADVANTAGES AT A GLANCE

- Dust-free loading
- User-friendly suspension device
- Integrated control for high operational reliability
- Incl. product compaction for volume reduction and increase in stability with big bags
- Low maintenance



➤ Big bag filling station



MATERIAL AND PROCESS DEVELOPMENT

Are you currently working on a new product idea or planning a new powder processing method? Process Consulting helps you to plan and realise your ideas for the grinding, classification, compaction or agglomeration of powders, granulates and bulk solids. With us, you can significantly shorten your development process and find solutions that you may not have thought of yourself. Interested? Get in touch with us!

SYSTEM DESIGN

Explosion and fire protection

Lignin is an explosive material, which means that there is a risk of explosion during processing. The following three measures are suitable for protecting personnel and the system.



INERTISATION

During inertisation, the oxygen content inside the system is reduced to such an extent that it falls below the explosion limits of the material (oxygen limit concentration). The oxygen concentration is continuously monitored. By means of a circulating gas process, nitrogen consumption can be reduced.

AVOIDANCE OF EFFECTIVE IGNITION SOURCES

With this measuring equipment and engineering measures are deployed with the system such that sources of ignition cannot occur. These measures essentially depend on the material, the equipment used and the process parameters. The protection concept for the entire system must always be checked on a case-by-case basis to determine whether the protective measure can be applied.

PRESSURE-SHOCK-RESISTANT DESIGN

With the pressure shock-resistant design, the system is designed to be so stable that the devices can withstand the maximum explosion pressure in the event of an explosion and do not cause any dangerous effects on the environment. It is also possible to design for a reduced explosion pressure via a pressure relief or extinguishing agent system. This has the advantage that no nitrogen is required and consequently the running costs can be reduced.



INNOVATIVE TEST CENTRES

Our worldwide research and testing facilities can offer you a wide range of machines and complete systems for the most diverse system configurations. Precision, quality and innovative technologies: Conduct your tests with us.



MANY YEARS OF EXPERIENCE

Benefit from our many years of experience in providing solutions and mastering demanding processes. Renowned customers across the globe rely on the technology and know-how of the Hosokawa Micron Group.



WORLDWIDE SERVICE

Our service teams take care of repairs and maintenance both on site as well as in our modern workshops equipped with the latest technology – swiftly, seamlessly and worldwide! The Hosokawa Micron Group – a partner you can rely on. See for yourself, you are sure to be impressed.



RENTAL AND USED MACHINES

With our rental and used machines, you benefit from shorter delivery times at attractive conditions and at the same time receive the usual Hosokawa Alpine quality.



BENEFICIAL SYNERGIES

The Hosokawa Micron Group combines the expertise and experience of numerous specialists to create perfect solutions. Experience from various customer segments of mechanical process engineering ensures that you as a user receive optimum solutions for practically every product - from individual components to complete systems.



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