NETZSCH

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# CASE STUDY

# Mechanical processing of cellulose

Business Unit
GRINDING & DISPERSING

# Mechanical processing of cellulose by comminuting, fine grinding and fine classification

## State of the art

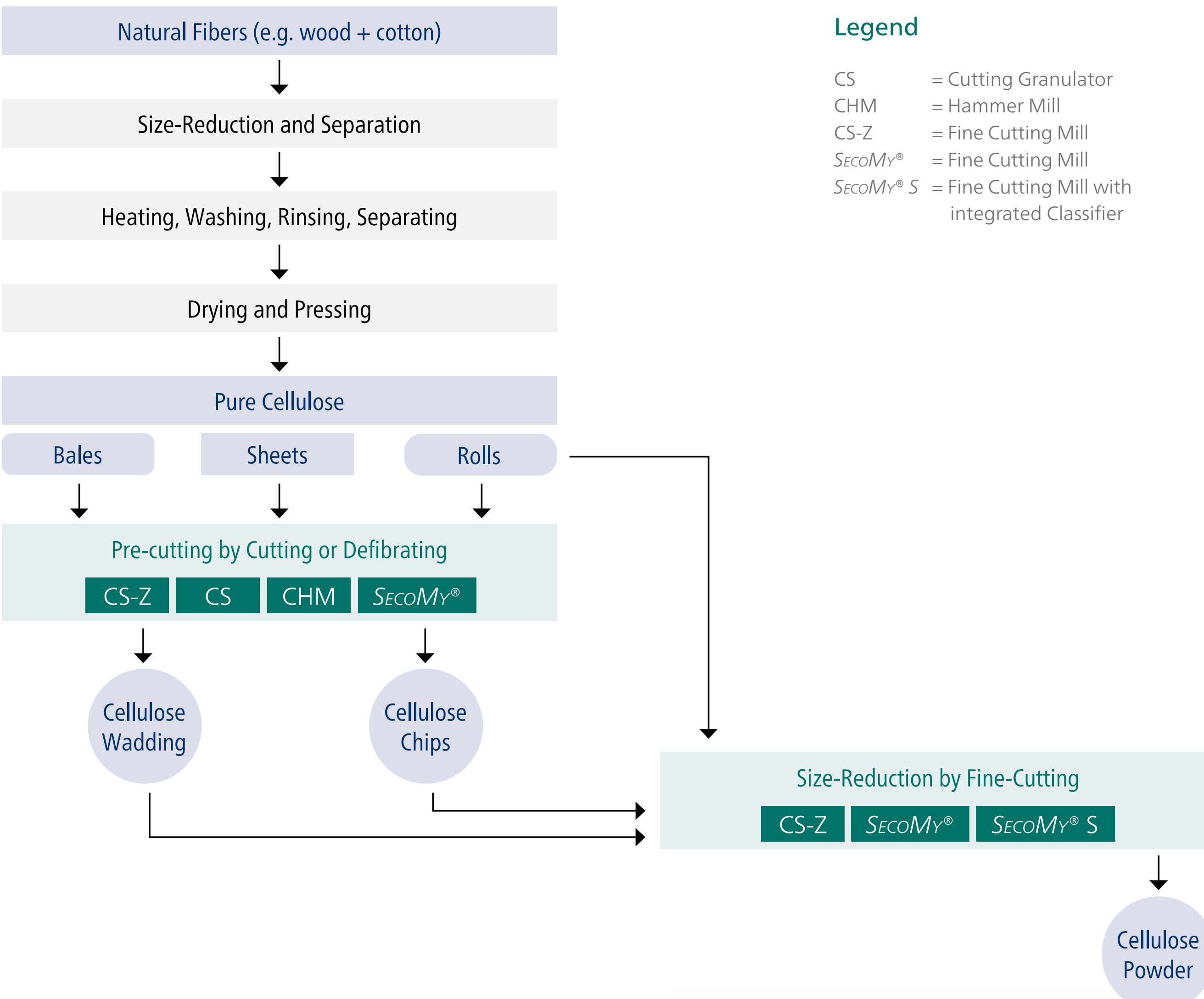
Paper is certainly the first thought that most people associate with the term "pulp" or "cellulose". Cellulose is an important raw material in paper production, but this is not the only area of application, as cellulose is of great technical and economic importance: the natural product is used in a variety of ways in the chemical, food and pharmaceutical industries. Both in its pure form and as a cellulose derivative, it is used as a thickening agent, carrier, filler, release agent, coating agent and foaming agent. As a food additive, cellulose and its derivatives bear the designations E 460 to E 466.

Cellulose is the main component of plant cell walls and therefore the most common organic compound. In 1838, the French chemist Anselme Payen succeeded for the first time in extracting cellulose from plants and determining its chemical formula. It was not until 1920 that the structure of the most common biomolecule found in nature could be determined. Hermann Staudinger was able to show that the unbranched polysaccharide is made up of several hundred to ten thousand glucose molecules. In 1992, the chemical synthesis of cellulose was achieved for the first time.

Cellulose is a white substance that is insoluble in water and is found in cotton in almost pure form (95%). However, it is mainly obtained from wood because this is the easiest of all cellulose sources to cultivate and process. The types of wood used contain significantly less cellulose than cotton (e.g. pine wood 44%; spruce wood 57.8%; beech 53.5%; poplar wood 50%). Overall, cellulose extraction is a complex process. A whole series of mechanical and chemical steps are necessary to separate cellulose from the natural by-products and then process it. At the end of the process, cellulose fibers are obtained that are approx. 1-3 mm long and are pressed and dried to form sheets (rolls or panels). The linters cellulose obtained from cotton is also often processed into bales.

For the various end applications, the cellulose or cellulose derivatives obtained in this way must be further processed by comminution, fine grinding and classification.

# Cellulose Processing




**Legend**

CS = Cutting Granulator
CHM = Hammer Mill
CS-Z = Fine Cutting Mill
SecoMy® = Fine Cutting Mill
SecoMy® S = Fine Cutting Mill with integrated Classifier

## NETZSCH Hammer Mills

The pulp web material, which is continuously fed above the rotating beater unit by means of a special roller feeder, is caught by the rotating beaters and thrown against grinding tracks and screens or slotted grids. This results in defibration of the pulp material with minimal specks or knots.

With an installed drive power of 90 kW, a mass throughput of 1000 kg/h is achieved with a CHM 1000/1200-L1-EV hammer mill with a rotor diameter of 1000 mm and a working width of 1200 mm.

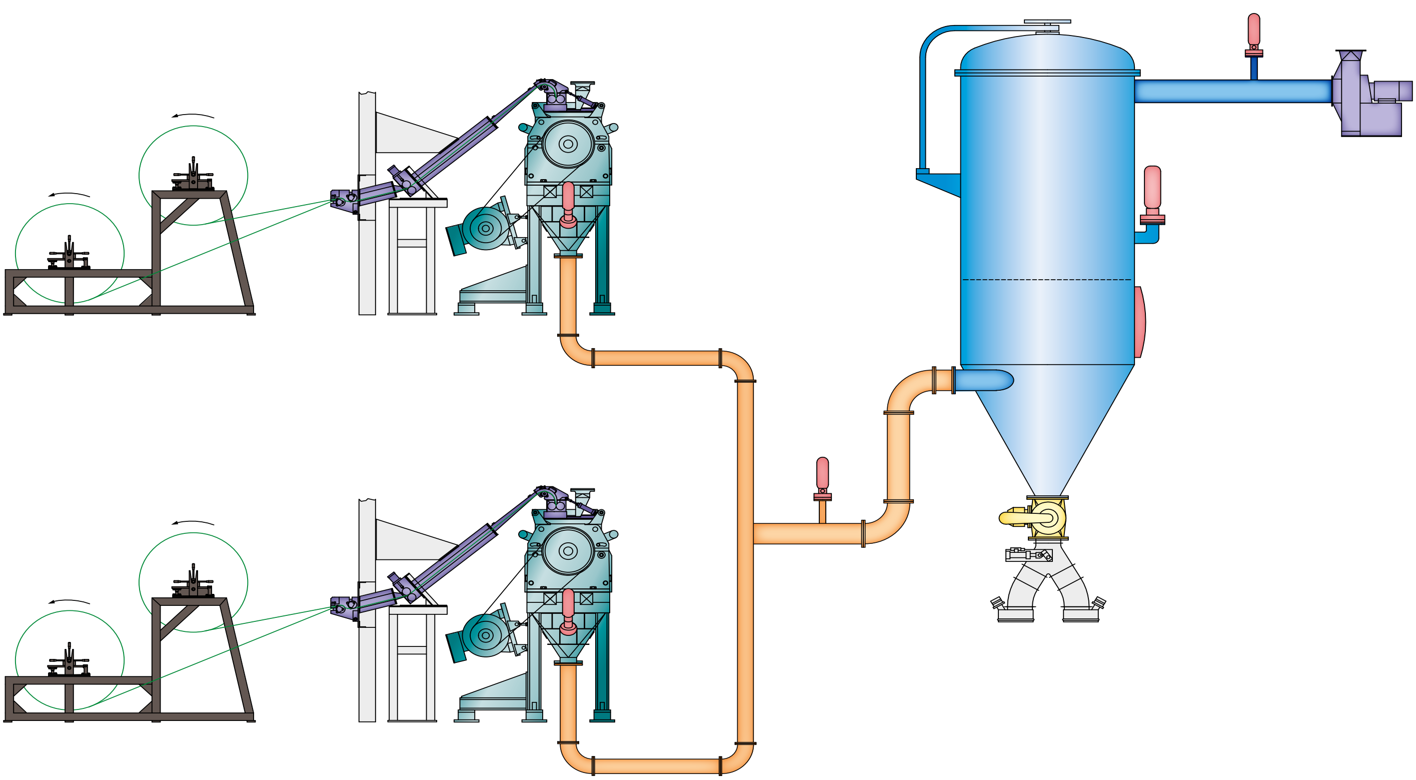
## Fine Cutting Mill CS 500/1000-Z

The specially developed Fine Cutting Mill CS 500/1000-Z is used. In this mill, the feed material is finely ground using a multi-knife rotor (16 cutting bars on the circumference) and a large number of fixed cutting knives as well as a special sieve insert. The achievable throughput rates of this fine cutting mill with a cutting circle diameter of 500 mm and a cutting width of 1000 mm depend on the quality of the pulp and the required final fineness, which is usually between 0.1 and 0.5 mm. With a drive power of 75 kW, product quantities of up to 500 kg/h per machine can be achieved. The machines now used in large numbers for this application are characterized by their low operating temperatures and the associated low viscosity loss of the product at high bulk densities of up to 150 g/l.

The feed of the pulp depends on the form of the feed product: The pulp (wood or linters) in the form of wound web material is fed into the cutting rotor via a feeding device, whereby the throughput rate can be adjusted via the feed speed of the roller feed. The pulp in the form of individual sheets or bales, which are frequently found in linters, is first pre-cut to a size of approx. 20 mm by means of an upstream cutting granulator before the actual pulverization and then fed to an intermediate silo or directly to the fine cutting mill via a pneumatic conveying system.

The end product of these special fine cutting mills is a cellulose powder with a small grain size and the highest possible bulk density - so-called alpha-cellulose. This is used as a filling and reinforcing material and is a good substitute for plastic or glass fibers.

| Product | Feed Shape | Fineness | Capacity [kg/h] |
|---|---|---|---|
| Cellulose | Sheet goods | < 25 mm | 1 500 -2 000 |
| Cellulose | Sheet goods | < 6 mm | 800 - 1 200 |
| Cellulose (wood) | Rolls | $d_{90}$ = 100 µm | 240 - 290 |
| Cellulose (wood) | Rolls | $d_{90}$ = 200 µm | 280 - 330 |
| Cellulose (wood) | Rolls | $d_{90}$ = 250 µm | 130 |
| Cellulose (wood) | Rolls | $d_{90}$ = 350 µm | 350 - 550 |
| Cellulose (wood) | Chips < 15 mm | $d_{90}$ = 250 µm | 320 - 450 |
| Cellulose (linters) | Rolls | $d_{90}$ = 100 µm | 190 - 230 |
| Cellulose (linters) | Rolls | $d_{90}$ = 200 µm | 240 - 280 |
| Cellulose (linters) | Pre-cut from bales | $d_{90}$ = 200 µm | 180 - 250 |
| Cellulose (linters) | Rolls | $d_{90}$ = 350 µm | 300 - 420 |
| Cellulose derivatives | Granulate < 8 mm | < 500 µm | 300 - 500 |



Pulp pulverization with two NETZSCH Fine Cutting Mills CS 500/1000-Z

## NETZSCH Fine Cutting Mill *SecoMy®*

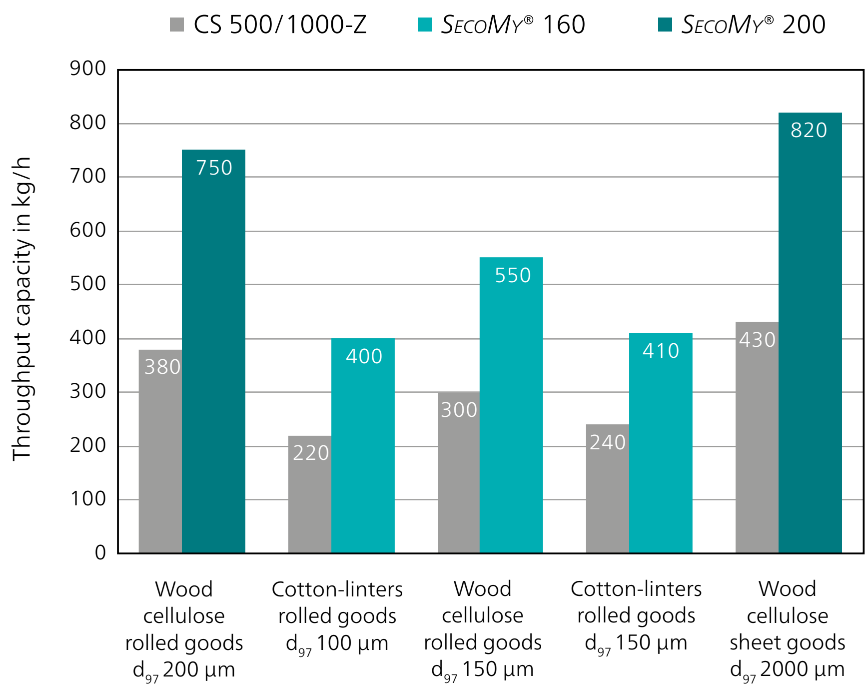
The NETZSCH Fine Cutting Mill *SecoMy®* is a further development of the proven CS 500/1000-Z cutting mill and can easily replace it. It has identical space requirements and can increase productivity of the plant with a little additional time and effort. Compared to the previous model, performance increases of up to 100% are possible. Only the operating media must be adapted, if necessary.

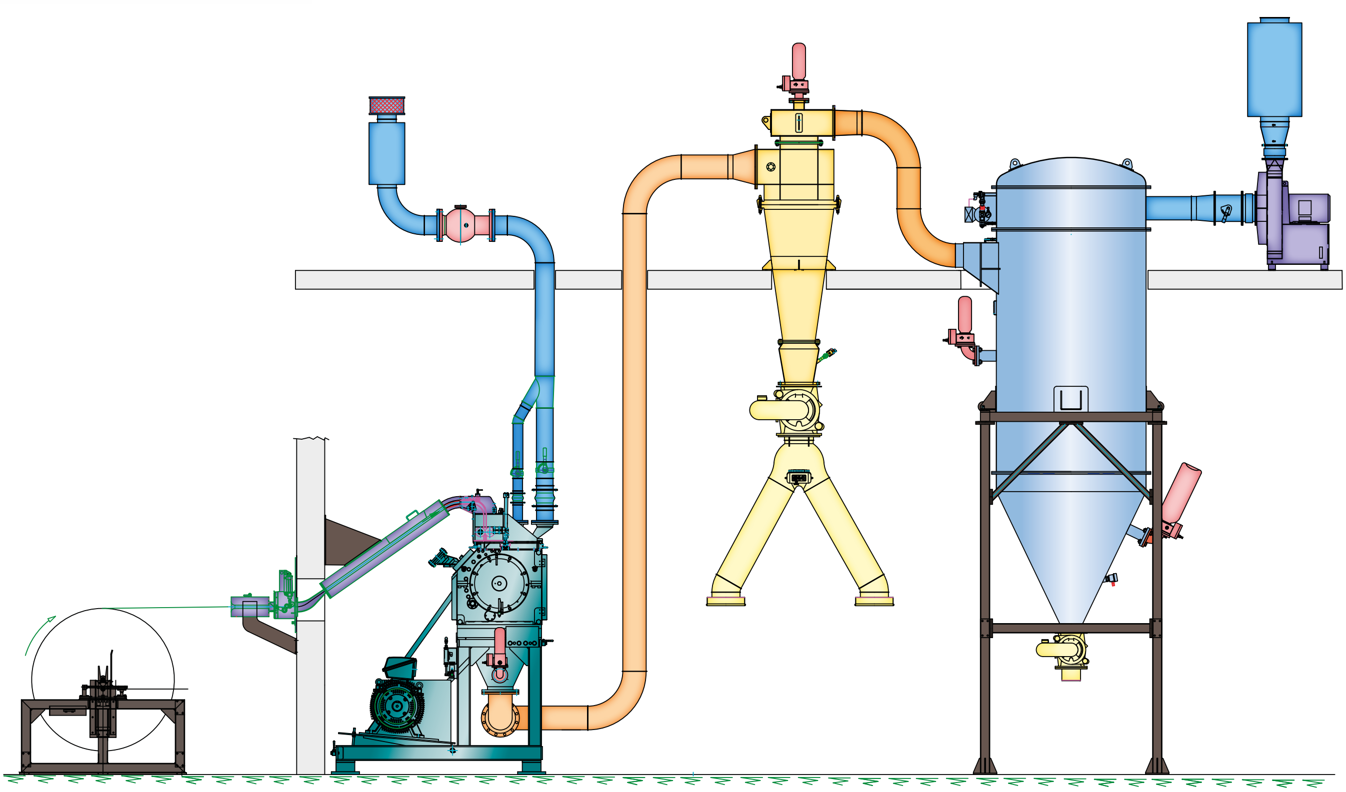
The feed material is fed into the cutting chamber either by gravity or via a nip roll system. The material is cut repeatedly between the rotor- and stator knives working against each other in a particular cutting sequence with a defined gap, until the material can pass through a special screen insert which closes off the bottom of the cutting chamber. The rotor is supported by precision bearings, which are separated from the chamber by special seals.

The product is discharged pneumatically via a suction trough. This simultaneously cools the product and the cutting chamber. Two nip-roll systems can be operated simultaneously, so the production of product mixtures is also possible.


| Product | Feed Shape | Fineness | Capacity [kg/h] |
|---|---|---|---|
| Cellulose | Sheet goods | < 25 mm | 2500 |
| Cellulose | Sheet goods | < 6 mm | 1400 - 2100 |
| Cellulose | Sheet goods | < 2 mm | 690 |
| Cellulose | Sheet goods | $d_{97}$ = 200 µm | 320 - 380 |
| Cellulose | Granules | $d_{97}$ = 200 µm | 260 - 290 |
| Cellulose (wood) | Rolls | $d_{97}$ = 250 µm | 110 - 175 |
| Cellulose (wood) | Rolls | $d_{97}$ = 100 µm | 390 - 520 |
| Cellulose (wood) | Rolls | $d_{97}$ = 200 µm | 500 - 600 |
| Cellulose (wood) | Rolls | $d_{90}$ = 350 µm | 630 - 920 |
| Cellulose (wood) | Flakes < 15 mm | $d_{90}$ = 250 µm | 570 - 800 |
| Cellulose (Linters) | Rolls | $d_{90}$ = 100 µm | 340 - 480 |
| Cellulose (Linters) | Rolls | $d_{90}$ = 200 µm | 720 - 880 |
| Cellulose (Linters) | Rolls | $d_{90}$ = 350 µm | 540 - 750 |
| Cellulose (Linters) | Pre-cut from bales | $d_{90}$ = 200 µm | 320 - 450 |

# Performance comparison of the Fine Cuttings Mills CS 500/1000-Z and SecoMy®



Schematic layout of an installation with Fine Cutting Mill SecoMy®

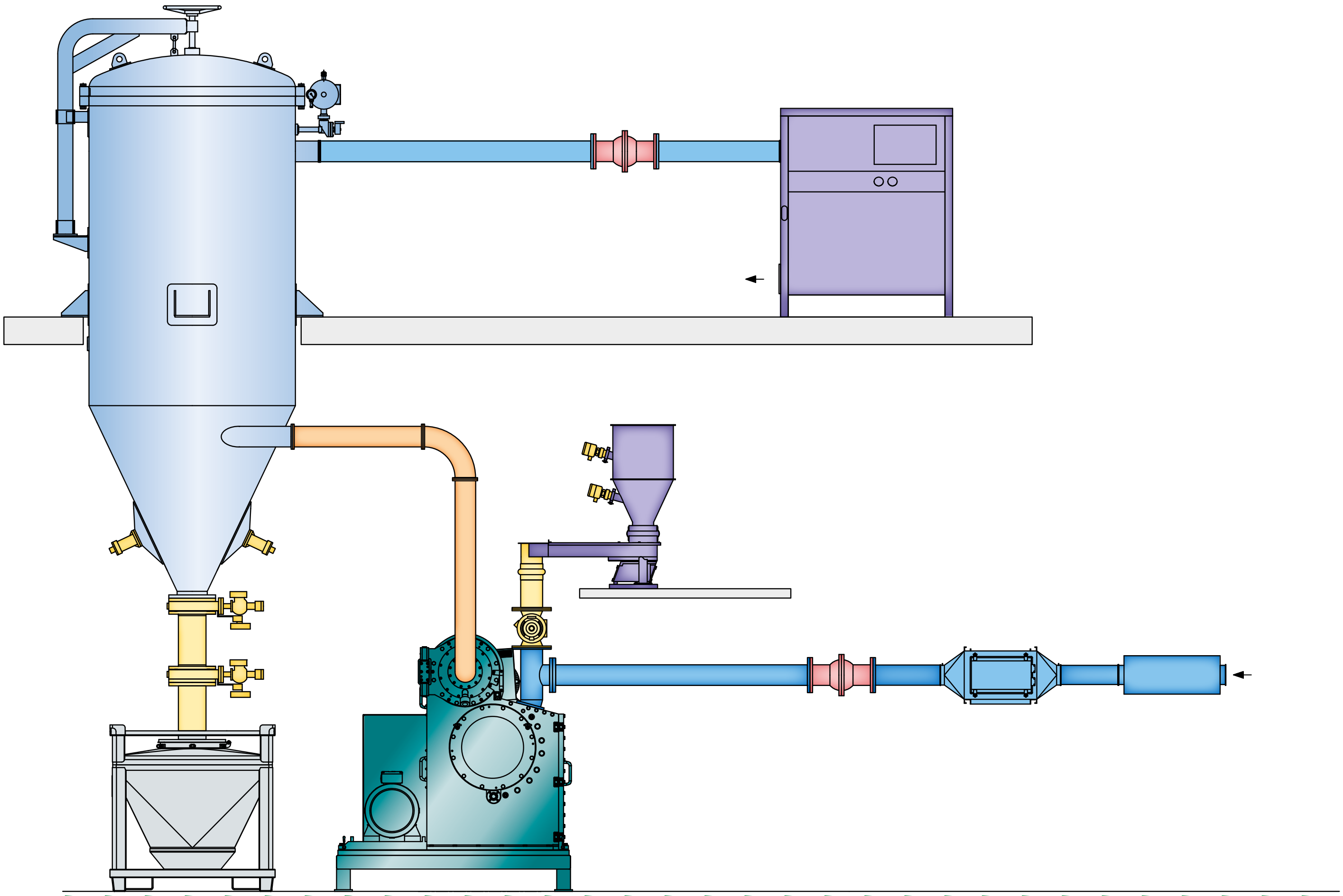
## Fine Cutting Mill *SecoMy® S* – finer qualities and increased bulk density

In contrast to conventional cutting mills, the *SecoMy® S* achieves final finenesses of less than 45 µm in a single-stage process. This is made possible by an air classifier integrated into the machine housing, which replaces the screen mesh usually used in such machines. A dynamic classifier wheel classifies the ground product within the mill and forms the product discharge for the fine fraction. Particles that are too coarse are rejected by the classifier wheel and subjected to a second grinding process. The actual target fineness for the final product is determined by adjusting the classifier wheel. This machine is ideally suited for materials that require good free-flowing properties, high bulk densities and gentle grinding.

With this design, high degrees of fineness can be achieved, which were previously not possible with the screen meshes used. In addition to this, thanks to the integrated classifier wheel, the well-known problems of blockage and clogging of fine screen meshes and their short service life have been eliminated with the newly developed *SecoMy® S*.

The feed product is conveyed into the cutting chamber by gravity or by a nip-roll device. The material is cut between the rotor- and stator knives of the *SecoMy® S*, which operate against each other in a special cutting sequence with a defined gap. The cutting continues until the material is fine enough to pass through the classifier wheel. As the product discharge is carried out pneumatically, this air can also be used for cooling purposes. In addition to this, when temperature-sensitive products are ground, water-cooling of the machine parts is possible.

| Product | Type of feed product | Feed size | Achieved Fineness |
|---|---|---|---|
| Cellulose | Rolls | 220 mm width | $d_{99}$ = 63 µm |
| Cellulose | Chips | 15 mm x 15 mm | $d_{97}$ = 63 µm |



Schematic layout of an installation with Fine Cutting Mill *SecoMy® S*

## Summary

Of course, mechanical process engineering machine manufacturers not only have to meet the requirements of the processing industry in terms of presenting new product-related tasks. The technical design of machines is also becoming increasingly important within this branch of industry. Machine designs or system concepts in gas-tight or pressure-shock resistant design are of course a common "necessity" to consider the product-specific properties and existing regulations. New product qualities and/or production methods constantly present new challenges for mechanical process engineering, which must be met by continuous further development. This is also the guarantee for innovation. An important factor for the chemical industry too!

New tasks and requirements in the chemical industry will certainly continue to lead to further innovation in mechanical engineering in the future. industry will certainly lead to further innovation in mechanical engineering.

The owner-managed NETZSCH Group is a leading global technology company specializing in mechanical, plant and instrument engineering.

Under the management of Erich NETZSCH B.V. & Co. Holding KG, the company consists of the three business units Analyzing & Testing, Grinding & Dispersing and Pumps & Systems, which are geared towards specific industries and products. A worldwide sales and service network has guaranteed customer proximity and competent service since 1873.

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