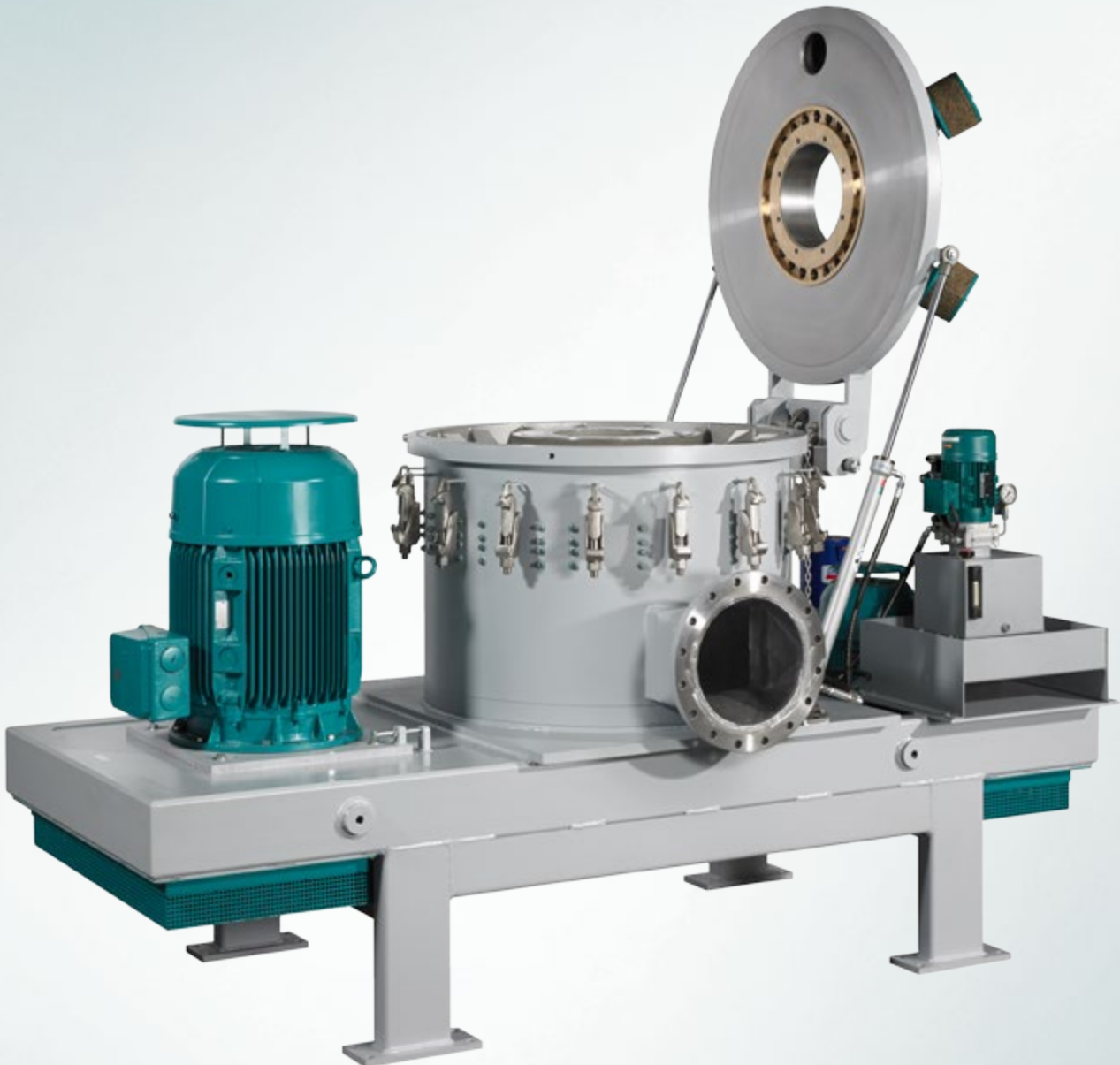


NETZSCH

Proven Excellence.



Process Technology for the Rounding of Graphite

NETZSCH *GYRHO* – Efficient and Economical Spheroidization

SPHEROIDIZATION OF GRAPHITE

Graphite is the stable modification of carbon under normal conditions and has been used for many years in various sectors such as the steel- and automotive industries. In the next few years, the area of renewable energy, which is experiencing extremely rapid growth in the context of electromobility, will offer the highest growth potential for graphite, as it is used as a raw material for anodes in lithium-ion-batteries. Approximately 10 – 15 times more graphite than lithium is required for one lithium-ion-battery.

Globally, graphite occurs most commonly as so-called flake graphite, which are graphite flakes containing only a small proportion (maximum 20 %) of actual graphite finely distributed in rock. This natural graphite must be processed using various methods in order to obtain the final product which is used for battery applications and has a purity of over 99.95 %. As well as the chemical purity, the morphology of the graphite also plays a decisive role. Spherical graphite (SPG) is ideal for the application as a raw material for anodes. Its smooth, small surface prevents flaking and means low irreversible capacity loss and long service life. Thanks to the high tap density, high charging is achieved and consequently a higher energy density.

NETZSCH & ANZAPLAN

dorfner group

The NETZSCH business unit Grinding & Dispersing and Dorfner ANZAPLAN have joined forces to exploit their individual strengths and the wealth of experience of both companies to find an efficient solution for graphite rounding.

NETZSCH contributes its competence as an expert for ultra-fine grinding and classifying with a comprehensive experience potential and diverse machine program ranging from laboratory- and production-scale machines to complete production lines. Dorfner ANZAPLAN GmbH is the leading consultancy and engineering company for the technical evaluation of industrial, specialty minerals and metals projects (e.g. graphite, lithium cobalt, vanadium, rare earths, high-purity quartz). ANZAPLAN's full service portfolio includes processing solutions, evaluation and engineering services across all phases of project development.

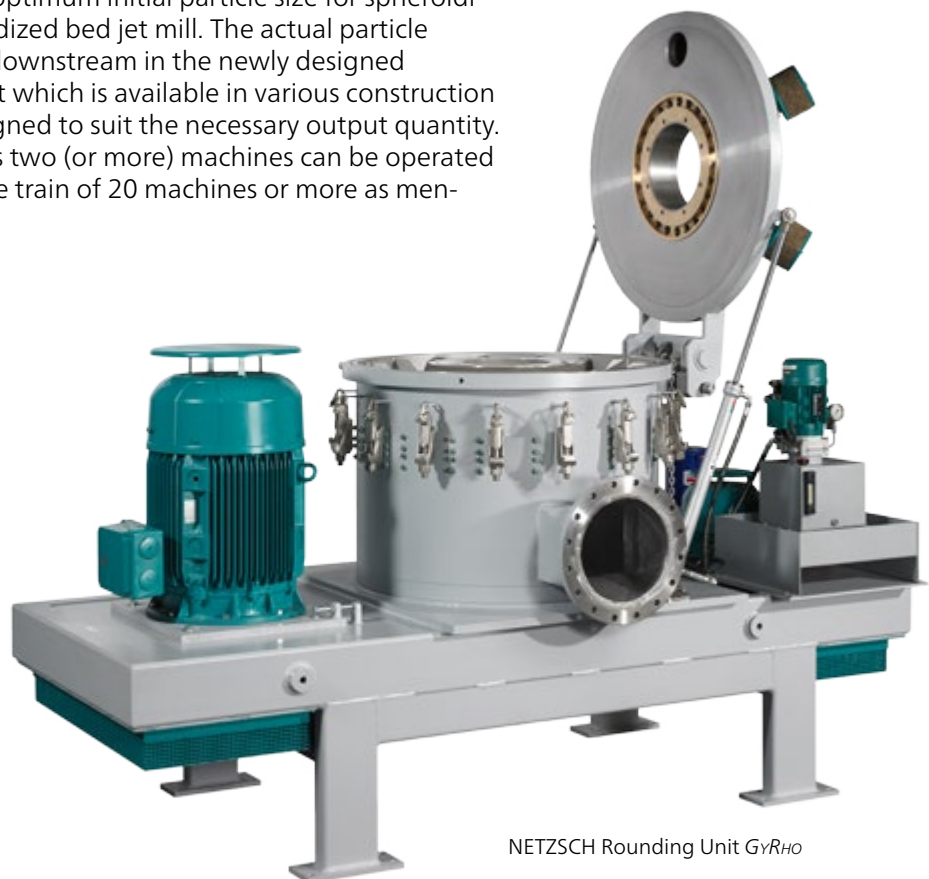


THE NETZSCH PROCESS

During the previously most frequently used cascade process for the spheroidization of graphite, the graphite concentrate passes through a "machine train" of more than 20 classifier mills installed in rows with external classifiers. As well as the enormous amount of space required, there are further disadvantages, i.e. each mill must be adjusted separately, and a scale-up of the production capacity is only possible by adding further, more complex machine trains. This assembly offers a complete lack of flexibility and a rapid change between individual product particle sizes is practically unrealizable in such a setup, as the complete machine train is optimized to suit one specific particle size.

The solution from NETZSCH

The system developed has overcome all the disadvantages of the standard technology and delivers an elegant solution for efficient, process-technology optimized graphite rounding. In a first step the flake graphite is pre-ground to the optimum initial particle size for spheroidization in a classifier mill or fluidized bed jet mill. The actual particle rounding takes place directly downstream in the newly designed NETZSCH *GyRHO* Rounding Unit which is available in various construction sizes and can be specially designed to suit the necessary output quantity. For larger throughput volumes two (or more) machines can be operated simultaneously and replace the train of 20 machines or more as mentioned above.

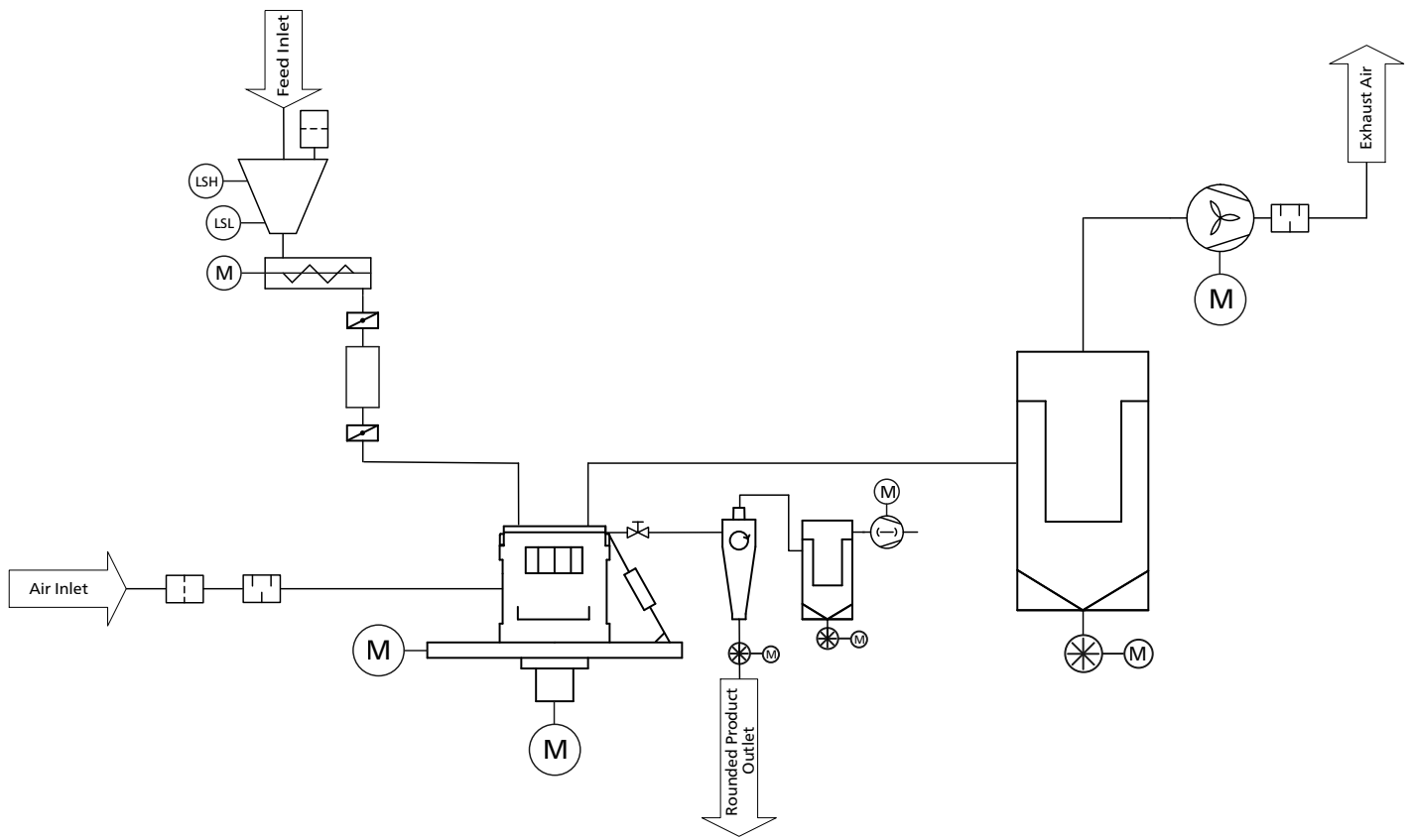


NETZSCH Rounding Unit *GyRHO*

Process Description

Setting the desired product parameters is significantly simpler due to the reduced plant complexity and at the same time availability also increases.

In principle the process is divided into three phases: Filling, rounding and discharging. During the filling phase, the maximum product volume is conveyed into the processing chamber. During the rounding phase, the particles are stressed until rounded by optimum geometry and process parameters. In the discharging phase, the processing chamber is emptied by a suction unit with cyclone and separated.

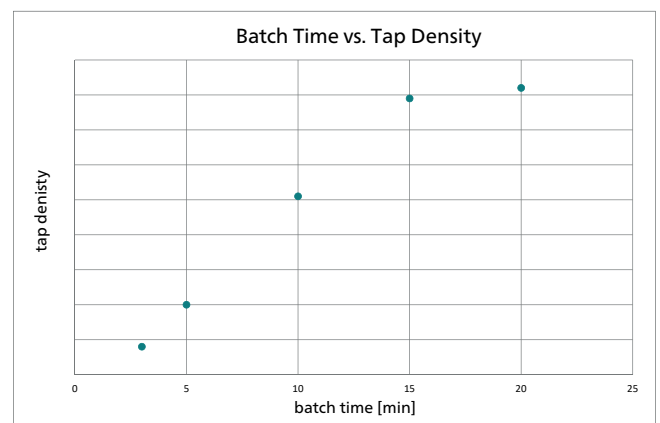
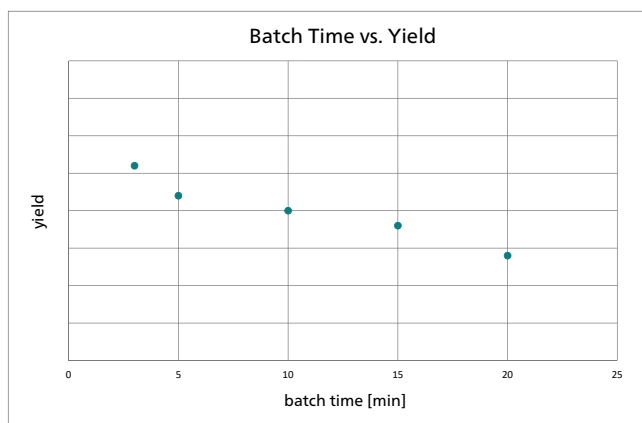


EFFICIENT ROUNDING

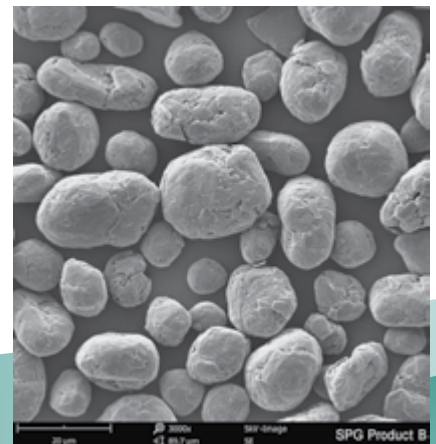
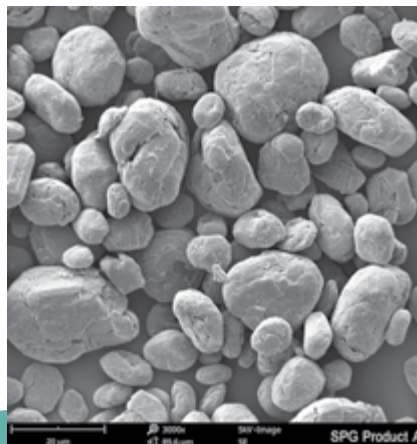
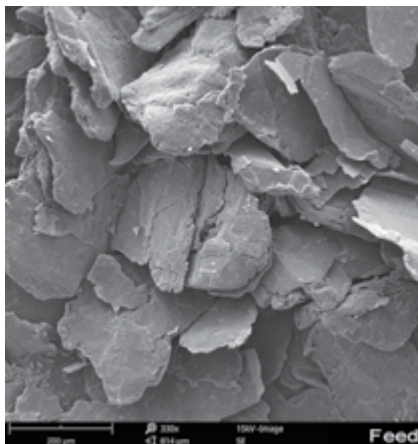
For the manufacture of lithium-ion-batteries spherical graphite is ideally required. Natural graphite and graphite manufactured by synthesis are both plate-shaped and have the typical layered structure. Therefore, the further processing- and size-reduction task consists of the manufacture of a rounded final product with a narrow particle size distribution, a high yield and tap density.

With specific settings, it is possible to achieve the maximum yield of final product with the desired quality. Quality criteria such as distribution width, tap density and particle size can be influenced by varying the process parameters.

In this way, using the newly developed NETZSCH and Dorfner ANZAPLAN *GyRHO* system, all qualities required by the market, such as spherical graphite with a tap density of 963 g/l and a d50 value of 16.8 μm (yield based on a raw material volume of 60.7 %) are achievable.



REM pictures



Product A: Yield = 60.7 wt.-%,
d50 = 16.8 μm , tap density = 963 g/l

Product B: Yield = 49.3 wt.-%,
d50 = 18.4 μm , tap density = 1019 g/l

Plant data for the NETZSCH *GyRHO* System compared to competing systems:

30 % higher plant availability in comparison to previously used processes

90 % lower maintenance costs thanks to a significantly lower number of machines

60 % smaller surfaces at identical production capacity thanks to compact setup

65 % total yield* thanks to the innovative plant concept, optimized grinding chamber- and classifier design


* up to 65 % total yield based on amount of raw material and depending on its origin and type

35 % lower operating costs* compared to standard plant trains

60 % less energy for identical production capacity (half of installed power and optimized operation mode)

* Opportunity-, working-, spare part-, electricity costs, depreciation and costs for graphite concentrate

YOUR ADVANTAGES AT A GLANCE



The NETZSCH Group is an owner-managed, international technology company with headquarters in Germany. The Business Units Analyzing & Testing, Grinding & Dispersing and Pumps & Systems represent customized solutions at the highest level. More than 4,000 employees in 36 countries and a worldwide sales and service network ensure customer proximity and competent service.

Our performance standards are high. We promise our customers Proven Excellence – exceptional performance in everything we do, proven time and again since 1873.

Proven Excellence. ■

Business Unit Grinding & Dispersing – The World’s Leading Grinding Technology

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