ULTRAFINE SELECTION AT YOUR FINGERTIPS

Loïc Pottier and Philippe Niel, Fives, detail the development of a new generation of classifiers designed to work with ultrafine mineral loads.

Cement producers can enhance the performance of their products by adding ultra fine filler to the ground clinker. Ultrafine particles have a d50 of < 3 µm. Other minerals industries can also benefit from using ultrafine filler. For instance, ultrafine grinding and classifying of limestone can allow producers to replace more expensive and polluting fillers.

The FCB TSV™ classifier is known for its high performance separation capabilities and minimal electricity consumption. The more than 250 operational installations and the satisfaction of its users demonstrates the performance and reliability of this system in the field, which is mainly focused on (but not limited to) the processing minerals and cements. The primary benefit of this system is the high level of production efficiency that it offers to grinding plants. It enables the reliable and accurate control

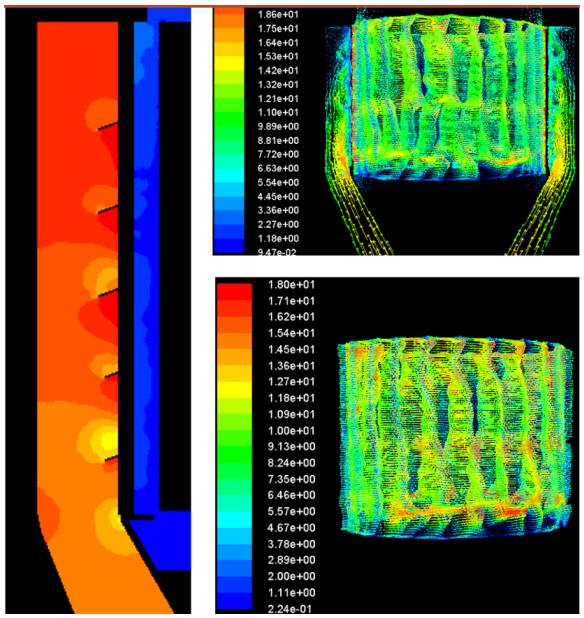

Figure 1. CFD numerical simulations.

Figure 2. Test bench configuration.

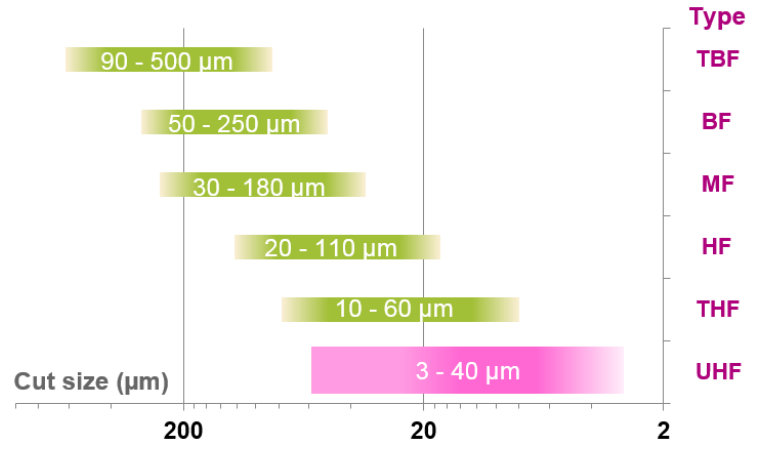

Figure 3. Cut size ranges.

of the distribution of the products' particle size, and optimises the inherent qualities of finished products themselves (sharpness of PSD curves, burnability of cement raw mix, controlled combustion of solid fuels, cement strength, etc.).

The FCB TSV technology has been extended and is now also available in the UHF (Ultra High Fineness) field with a Tromp curve cut-size lower than 3 µm. It allows UHF powder production with d50 down to 2 µm. The FCB TSV UHF is designed to address the production of such fine powders at an industrial scale, up to 15 tph throughput in a single wheel classifier.

Natural mineral materials such as limestone as well as industrial products like granulated blast furnace slag, have already been experimented on and evaluated for suitability.

Development

The usual fineness areas are commonly covered by the proven technology with cut sizes between 10 µm (very high fineness) and 500 µm (very low fineness).

The FCB TSV UHF development allows for the application of extensive in-house knowledge of separation technology within many industrial processes, associated with a new mechanical design imposed by the higher centrifugal force applied.

The basic arrangement of the previous design has been maintained. The classifier is fed with the vertical axial air inlet. The fed material first meets the guide vane, the purpose of which is to ensure proper tangential speed for an adequate and consistent speed profile all over the height of the turbine. By balancing the tangential speed of the gases with the turbine's tangential speed, the adjustable guide vane induces the best conditions for the selection efficiency of the turbine.

The material then goes through the turbine, which has blades shaped with a patented profile. This allows for the most precise selection, even for high material concentration loads at the separator inlet. This in turn leads to high capacities in a given gas flow circuit and equipment.

In addition, the anti-vortex blades in the inner part of the turbine are also a patented Fives design and contribute to minimising system power consumption.

Particular attention was paid to the distribution of gases over the entire height of the turbine. Based on CFD numerical simulations (Figure 1), different

geometric adapted models were evaluated and then validated on a pilot test bench. The configuration of the test bench is shown in Figure 2.

The main characteristics of the FCB TSV UHF pilot test bench are:

- FCB TSV UHF 400; Motor 3 kW – Variable speed
- Bag filter 50 m^2
- Feed max 1.5 tph
- Max ventilation 1500 m^3/h

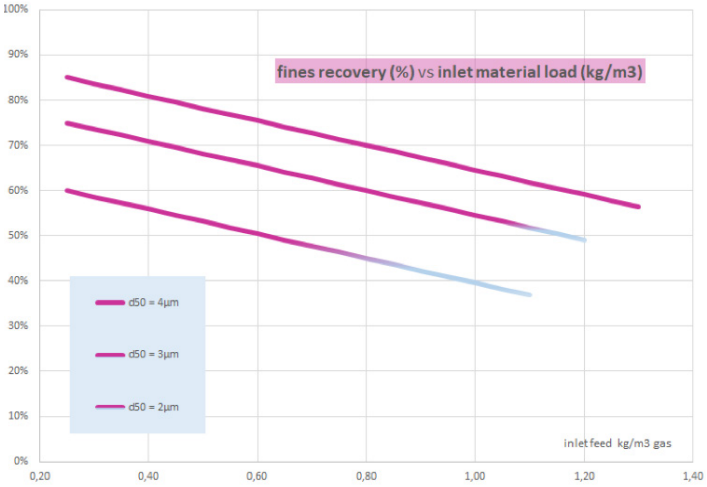

Figure 4. Incidence of the material load.

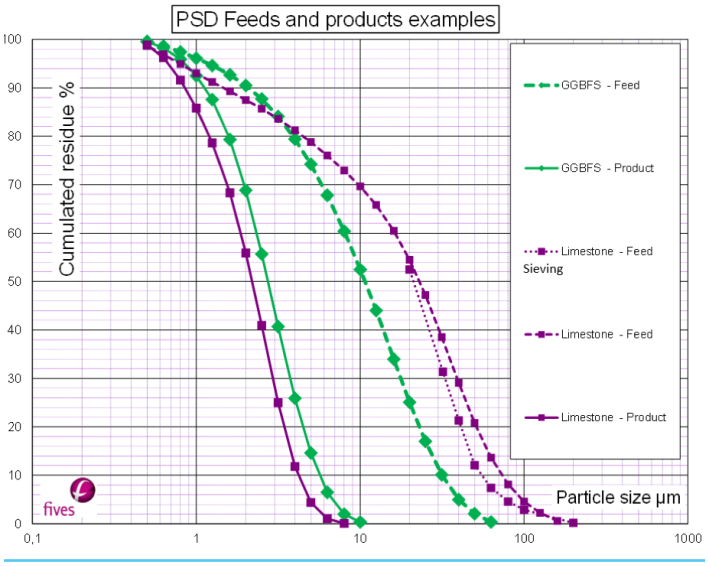

Figure 5. PSD Feeds.

The material load at the separator inlet can be selected from a range of 0.1 – 1.5 kg/m^3. The incidence of the material load is illustrated (Figure 4) with the average experiment gathering results on materials as different as blast furnace slag, gypsum, or carbonates.

Fives FCB testing facilities are able to verify the separation efficiencies achievable in a FCB TSV UHF and to establish optimal sizing that meets the given objectives of a project.

Figure 5 shows examples of particle size distribution curves of the feeds and obtained products with the pilot plant.

Applications

Ultrafine mineral loads are widely used in industry, especially for plastics, thermoplastics, and polymers. Such ultrafine mineral loads are also frequently requested in many other industries (paints, paper, etc.) or applications (ultrafine binders for water proofing of rock, oil-gas well cementing, repair of civil works, etc.).

The following are typical applications of FCB TSV UHF:

Ground Limestone

Directly taken from the pilot installation, Table 1 shows typical process data and PSD of products obtained from ground limestone. Table 2 shows the calculated operating data and product quality produced by an industrial implementation of the FCB TSV UHF.

Table 1. Process data and PSD products: ground limestone.

FEED			PRODUCT			FINES	TSV UHF			
	tph	P8 µm	d97	d50	tph		Ø mm	air m^3/h	speed rpm	ΔP daPa
Limestone	1.2	25%	7 µm	2 µm	0.13	46%	400	1500	3600	540
			10 µm	3 µm	0.19	61%			2700	384

Table 2. Operating data and product quality produced using industrial FCB TSV UHF.

FEED			PRODUCT			TSV UHF						Fan (*)
	tph	P8 µm	d97	d50	tph	Ø mm	motor KW	air m^3/h	speed rpm	ΔP daPa	kWh/t	kWh/t
Limestone	36	25%	7 µm	2 µm	4.0	2000	160	45 500	880	540	32	36
			10 µm	3 µm	5.8				704	390	14	20

*Exhaust fan after bag filter.

The corresponding Tromp curve is given in Figure 6.

Ground granulated blast furnace slag (GGBS)

GGBS with the appropriate PSD can partially replace cement in high-performance concrete. It can also improve the performance characteristics of oil well cements and squeeze cementing in order to seal leakages in oil and gas wells.

Ultrafine binders are defined by their steep particle size distribution. The d95 or d97 values are typically key parameters for the performance of the grouting of microfine binders, and the cementing of sealing powders.

GGBS (4500 – 5000 Blaine) from ball or vertical mills has been treated in the pilot test bench and results have been extrapolated to an industrial scale. Table 3 gives the main operational data from a 4 tph production unit at d50 = 2 µm.

The corresponding Tromp curve is given in Figure 7.

Conclusions

The application of Fives technology to the separation of ultrafine particles allows high selection performance with a reliable process and mechanical design at an industrial scale.

Products such as limestone, slag, and gypsum have been successfully tested in the Fives research centre located in northern France.

D50 around 2 µm are achievable with very good fines yield at industrial scale. As an example, starting from ground products with d80 around 50 µm, a production of 4 tph d50 = 2 µm can be achieved in one single turbine.

The limited pressure drop allows a low power consumption of the plant. For these types of product, the FCB TSV UHF classifier gives the following advantages:

- Very steep selection at high inlet material load.
- Minimal over size contamination.
- Lowest cost investment.
- Low operational cost with low power consumption.
- Low maintenance cost.
- Reliable technology. ■

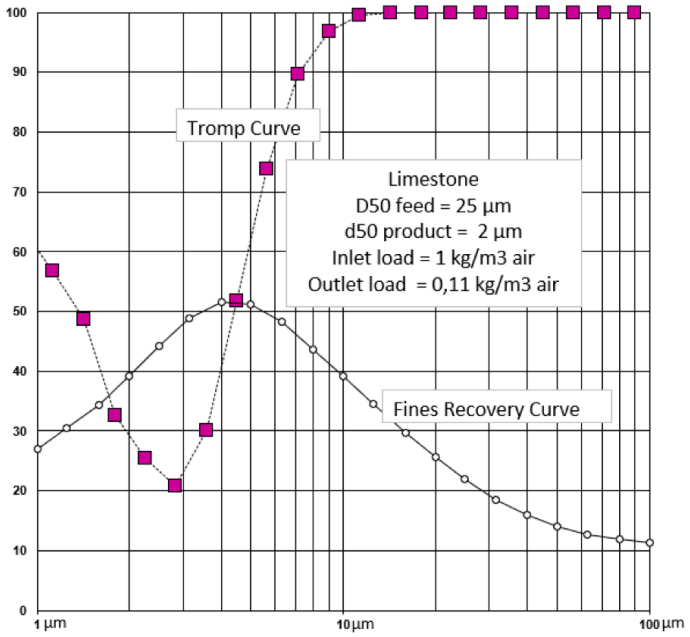

Figure 6. Tromp curve for ground limestone.

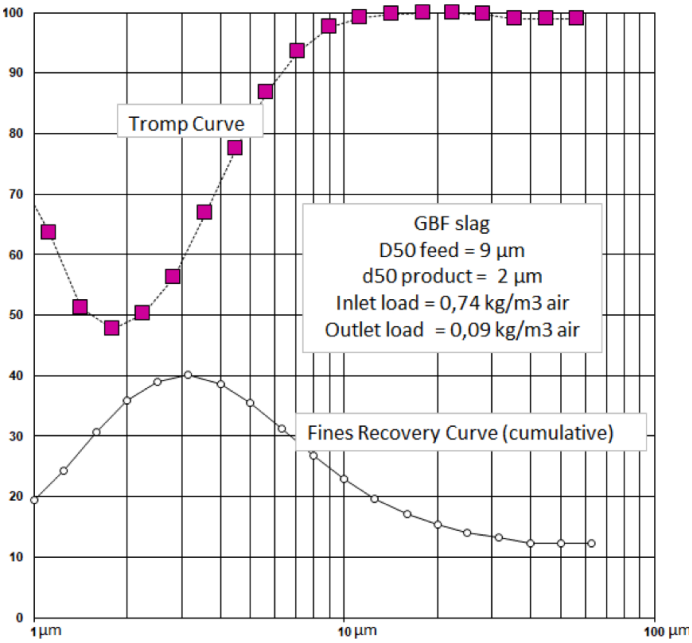

Figure 7. Tromp curve for GGBFS.

Table 3. Operational data and product.

FEED			PRODUCT			TSV UHF						Fan (*)
	tph	P8 µm	d97	d50	tph	Ø mm	motor KW	air m³/h	speed rpm	ΔP daPa	kWh/t	kWh/t
	33	44%	7 µm	2 µm	4.0	2200	200	55 100	810	520	31	42
			9 µm	3 µm	8.8				660	410	9	17

*Exhaust fan after bag filter.