Method of separation of quarry fines

Context

The seeker operates one of the largest limestone quarries in the world: approximately 6 million tons of limestone aggregates are produced each year. The use of a wet processing technology for aggregate production generates as a by-product about 300 000 t/year of quarry fines[1] (0/100 µm, D50 = 12 µm). During the production process, these fines are concentrated, flocculated and pumped in slurry form (varying from 380 ÷ to 530 g/L) to settling ponds that occupy a large part of the quarry site. The amount of already deposited material is estimated to be 10 million tons:

- Approx. 7 million tons of « plastic » settled material with a moisture content of 25 to 30%
- Approx. 3 million tons of « liquid » material with concentration of 500 g/L.

The mineralogical composition of these fines is mainly concentrated of 3 components: limestone, clay and silica in the form of quartz.

• Limestone, which constitutes the largest share (more than 60% of the composition of these fines), allows the production of diverse types of product:

o Component (filler / addition) for plaster, concrete, mortar

o Paint filler

o Filler for glue, adhesive, putty

o Filler for plastic

o Filler for asphalt, bituminous membrane

o Animal Feed Component

[1] Fines obtained from the washing of a crushed stone aggregate as it is processed into a product are called pond fines, pond screenings, pond slimes, washing fines or pond tailings

• Clay that represents 19% (Illite + Kaolinite), may allow the production of diverse types of product:

o Sealing material for landfill and pond (based on the waterproof characteristic of the clay)

o Ceramic

o Cement

o Paint filler

o Filler for rubber

o Filler for plastic

o Cosmetics (thalassotherapy)

o Vinification product (high level of cleanliness required)

• Quartz that represents 11% of these fines, allows the production of diverse types of product:

o Component (filler / addition) for epoxy concrete and other building materials

o Abrasive component

o Glass (subject to iron content reduction)

These fines also contain goethite which can have a negative / penalizing impact on some uses (colouring impact).

Today, these fines are not being used and if no solution is found by 2025, the storage of these by-products will require significant investments through the opening of a third settling pond.

Before being able to reuse these fines, the Seeker is looking for a method of separating the different components of the fines (with minimal loss) at the end of the aggregate washing process. In the past, he has experimented a number of techniques in order to separate the main components, but none of them have satisfied the demands.

The objective of the challenge is to find an economically viable method to separate mainly the 3 components (Limestone, Clay and Quartz-Silica) at the end of the washing processes to allow their commercialization.

Existing

Among the solutions tested by the Seeker (hydrocyclone separation technology, dry separation technology (micro-classifiers Sealmax Poittemill and Alpine – Hosokawa 100 MZR)), none of them was retained for economic and technical reasons. Hydrocyclone based technology tested in 2006 allowed for better separation of the clay fraction than dry methods, but it still had several disadvantages:

o difficult to set up at that time

o too expensive to exploit

o Failure to respect the desired particle size (10 µm)

o Product enriched with clay but with a limestone content always considerable

As a result, the tests were not conclusive and the experiment was interrupted.

Constraints

The solution research must respect several constraints:

• Technical / mechanical constraints:

o Large volume (100.000 to 300.000t / year of product to be treated)

o Concentration varying between 380 and 530 g/L

o Purity of the limestone obtained from the separation ($CaCO_3$ + $MgCO_3$ >95%, blue value MBf < 3g/kg)

o Purity of the clay obtained from the separation (kaolinite + illite > 80%, permeability coefficient $K \leq 10^{-9}$ m/s)

o Purity of Quartz (SiO_2 > 98,5%, Fe_2O_3 < 450 ppm)

o Limestone resulted from the separation must be dry at the end of the process

• Economic constraints:

o Total cost of production (= cost of separation of 3 components + disposal cost of by-products) < approximately 15 € / t.

• Ecological and environmental constraints:

o The industrial process must respect the HSE (Health Safety Environment) constraints.

In view of these requirements, the Seeker is looking for a technical solution to treat the minimum of 100,000t / year of washing fines and to separate the 3 components while guaranteeing the purity level for each of the 3 components.

Price

A bonus of 10 000 € will be paid for the purchase of the solution respecting all the stated constraints.

A premium of € 25,000 will be paid if the purchased solution has already been tested on an analogous site with the elements respecting the same constraints or the results of a Proof of Concept to verify it.