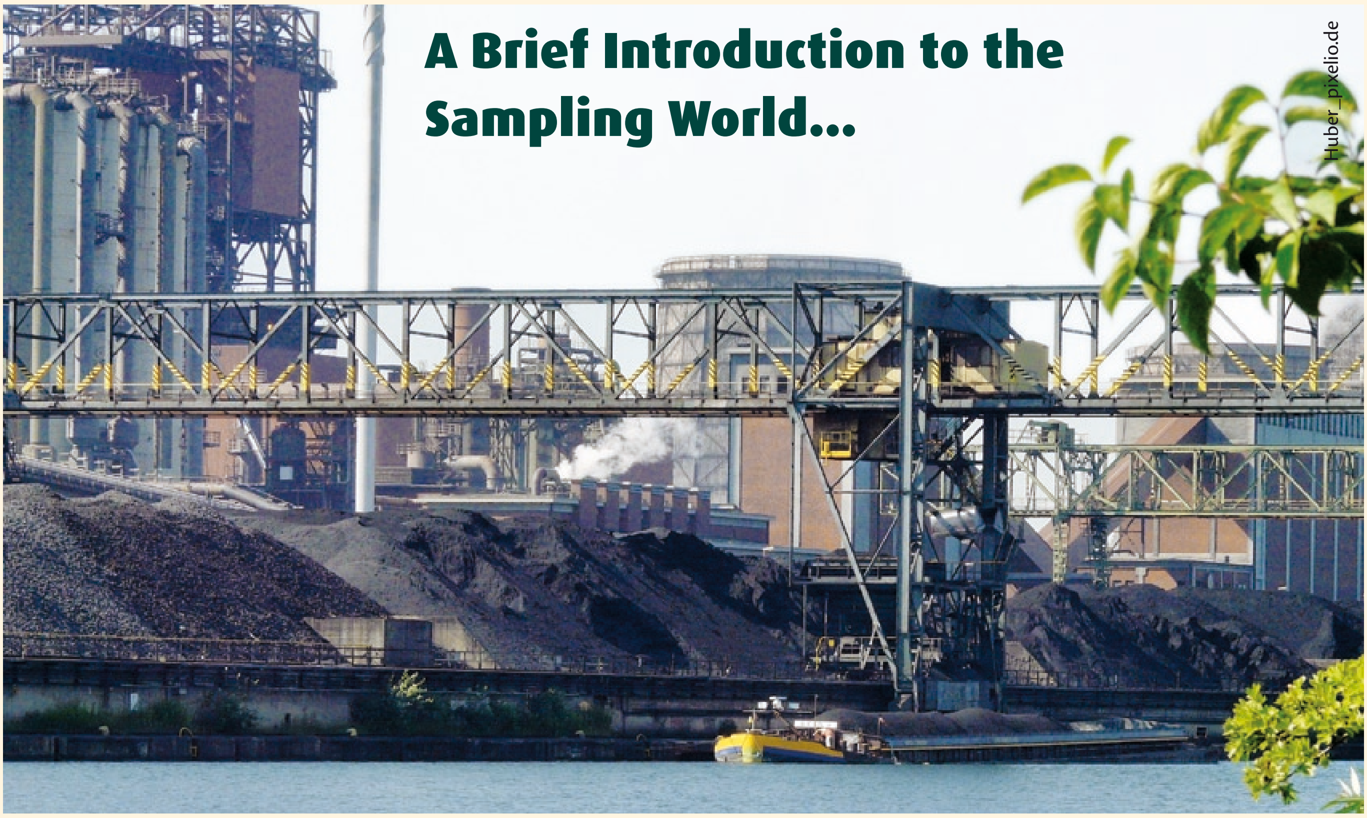
bsh5_07 spTN_DAVIN_How to Collect

How to Collect a Representative Sample?



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"I have to analyze 200 grams of product, but I have a ship with 50.000 tons of product ... How shall I proceed?"

The above question is a good starting point to explain and study what the sampling operation is or has to be. This question is essential for two main reasons: it shows how difficult it is to obtain representative samples in their process or from a large quantity of product (boat, train, etc.) and it also shows how essential the sampling operation is for the product qualification (optimization of the production, of the mine or for the quality classification of a product).

1. Why Sampling?

Why do we have to collect samples? Is it possible to take few grams of product for analysis with a simple bucket, diverter or bypass in the flow? The sample has to be representative from the whole lot. But what does "lot" mean?

A "lot" is the complete mass of product from which we want to obtain a representative sample. A lot has to be considered for one analysis.

For example, if we want one analysis for a whole 50.000 tons boat, the lot is 50.000 tons. If we would have been required two analyses for the same boat, the lot would have been 25.000 tons. In a continuous process, if the flow is 2.000 t/h and we want one analysis per hour, the lot is 2.000 tons. If we would have been required one analysis each 8 hours, the lot would have been 16.000 tons.

What could be the representativeness of 200 grams of product, collected by a simple bucket, compared to 16.000 tons? We have to remember how significant the results of the analyses based on the so small 200 grams sample can be. In case of a boat discharging, the analyses based on the sample give information in order to check the conformity of the product according to the order. Sales consequences can be serious! In a continuous process, they can give information for the optimization of a mine, for the quality of product or for the process control.

The main problem is the huge disproportion between the mass of the sample (200 grams in our example) and the mass of the whole lot (50.000 tons in our example). A few hundred grams of product have to represent several hundred or thousand tons.

That is why we have to understand what "homogeneity" and "heterogeneity" are.

2. What Do "Homogeneity" and "Heterogeneity" Mean?

This is a very crucial definition: "A flow or a product is homogeneous when all the particles are strictly identical". The question arises whether this is realistic or not. Unfortunately, homogeneity cannot exist in mining and quarrying industries, mineral industry, food industry, in fact, in the majority of solid bulk industry. That is why we have to consider the flow or the product as heterogeneous.

There are two types of heterogeneity:

- The heterogeneity of constitution
- The heterogeneity of distribution

The heterogeneity of constitution depends on the composition of each particle. Each particle can be composed of several minerals. The most different the particles are, the higher the constitution heterogeneity will be.

The heterogeneity of distribution depends on the distribution of the particles in the lot. The higher the difference of composition or density between each particle or group of particle is, the higher the distribution heterogeneity will be.

Because of those heterogeneities, a flow or a product cannot be homogeneous.

Those heterogeneities can be accentuated by the particle size segregation from handling systems. The most important segregation can appear at the discharge of belt conveyors. When a product is handled by a belt conveyor, movement and vibrations create a particle size segregation thus fine particles keep located close to the belt. The heterogeneity of distribution is very high. A primary particle size classification is automatically created and the heterogeneity is increased by the belt conveyor.

If we consider the discharge of this belt conveyor, its speed transfers a kinetic energy to each particle. The bigger the particle is, the higher the kinetic energy will be. That is why big particles go far away from the chute compared to fines. A new segregation is then created.

On a belt conveyor and at its discharge, the heterogeneity of distribution is very high. The aim of the sampling operation is to collect a small mass of product which has to represent the whole lot. In other words, the aim of sampling is to get a representative quantity of product from a lot.

The sampling operation cannot be limited to a simple handling operation. Specific standards, sampling rules and theories have to be taken into consideration. That is why we can classify all those devices in two categories: the *sample-takers* and the *samplers*.

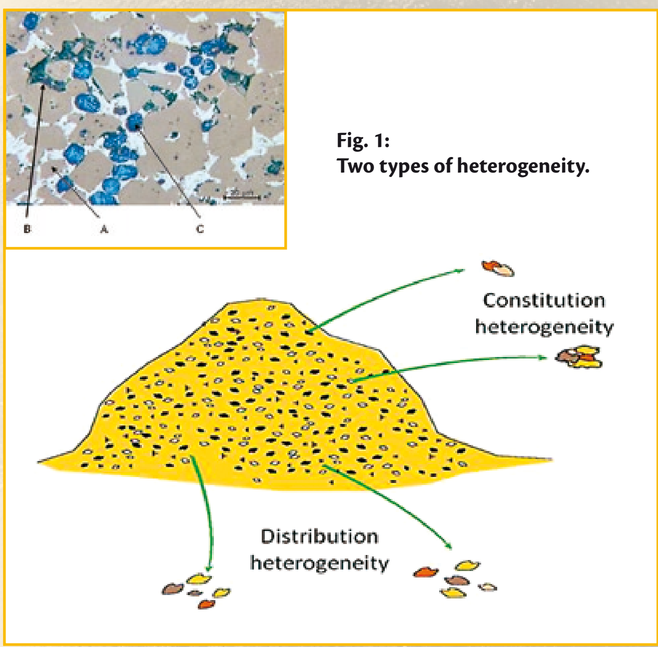

Fig. 1:
Two types of heterogeneity.

Fig. 2: Particle size distribution on a belt conveyor.

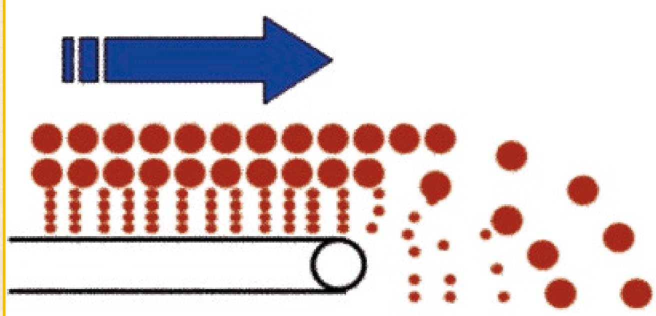

Fig. 3: Heterogeneity at a belt's discharge point.

3. Difference Between a Sample-taker and a Sampler?

A sample taker is a technical device designed to take product. It cannot guaranty any representativeness and it collects specimens.

A sampler is a technical solution designed to obtain representative samples.

4. Direct Consequences of the Heterogeneity of the Product

The aim of the sampling operation is to collect a sample for several analyses like particle size distribution, chemical analyses, humidity, etc. Because of the heterogeneity of the product it is very difficult to obtain a sample with exactly the same characteristics of the whole lot.

That is why the following two important rules have to be respected:

- The sample has to be composed of a minimum mass of product. In fact, the bigger the maximum particle size of the product is, the larger the sample must be. In the opposite, if the maximum particle size of the product is very fine, the sample could be composed of a very small mass.

- The sample must be equiprobable. That means all the particles must have the same probability to be taken by the sampling device.

A consequence to these rules is: no sampling without complete handling of the whole lot.

What about a stock pile?

A stock pile is another example of heterogeneousness: big particles or spherical particles roll outside the pile and fines remain concentrated to the center. Because of this heterogeneity of distribution, representative samples can be collected during the constitution of the stock pile (at the discharge of the belt conveyor for example) or when the stock pile is completely handled.

5. Three Steps To Obtain A Representative Sample

- If we want to collect a representative sample, the first step is to obtain a complete cross cut of the flow of material

- The second step is to take into consideration the specific sampling standards if they exist

- The third step is to respect theoretical knowledge based on known sampling rules

The sampler has to obtain a complete cross cut of the flow.

This rule is a direct consequence of the equiprobability. This is the only way for each particle to have the same probability to be collected by the sampler. Therefore most of the samplers are located in chutes of product (vertical ducts, discharge of belt conveyors, etc.) because it is the only location where we can obtain a whole cross cut.

According to this rule, we have to be very careful about the cross-belt solution. This device cannot collect fine particles located close to the belt (otherwise it could be damaged) and owing to the heterogeneities and segregation, a bias could be obtained. This solution cannot guaranty the representativeness.

If they exist, sampling standards have to be taken into consideration.

For many products, a sampling standard exists and explains how the sampling operation has to be made: location of the sampler, type of sampling device, minimum mass of the elementary sample, minimum sampling frequency. They also give information about the design of the sampling device (width of sampling slot, sampling speed, etc..). Those standards also teach how to reduce the mass of samples and then, help to design a complete sampling tower according to the different analyses.

Theorical knowledge

Standards are not the only way to design a sampling solution. Sampling theories are another way to design and calculate a suitable sampling solution. One of the most world renowned sampling specialists, Pierre GY, has written several books to explain his theory which is very famous in mining industry.

6. Conclusion

Sampling bias can be far greater than analysis ones. Pierre Gy, a world renowned sampling specialist, states: "On the primary sampling, bias can be up to 1 000 % and up to 50 % on the secondary sampling whereas they never exceed 0,1 to 1 % in analysis." The result of an analysis depends on the quality of the sample. The more representative the sample is, the more accurate and correct the analysis will be. But, we have to keep in mind that a non representative sample can imply false analyses and consequences can be dramatically serious!

Sampling can be far more important than analysis.

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