Flow & bulk scales in rice milling

Taking measurements to optimise yield and efficiency

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'Measure twice, cut once' is an old adage that encourages a manufacturer to take great care in order to avoid wastage of material or time.

This approach can be applied to food manufacturing because taking measurements, such as weight, volume, flow rate etc, is crucial to monitoring the production process, ensuring quality management and preventing losses due to defectives, over processing or under processing.

In grain milling, an important parameter measured is the material flow rate (weight basis). 'Material' or 'raw material' as used in this article could refer to paddy, brown or white rice.

Improving milling conditions

Originally, weighing equipment were used mainly at the point of raw materials reception and at the finished products packaging, where they are made ready for shipping or going to the inventory.

In this system, the milling yield data can only be derived by the difference in weight between the input and the output. However, this will not represent an accurate evaluation of the milling yield as milling is a multistage process, where each step of the process can affect the final output in diverse ways.

Small or medium scale millers may only care more about their production output and may fail to measure or monitor the material in-between processing steps. Therefore, they are oblivious to the actual input capacity or flow rate, processing rate, and yield and will not be able to determine the efficiency of their milling equipment in real-time.

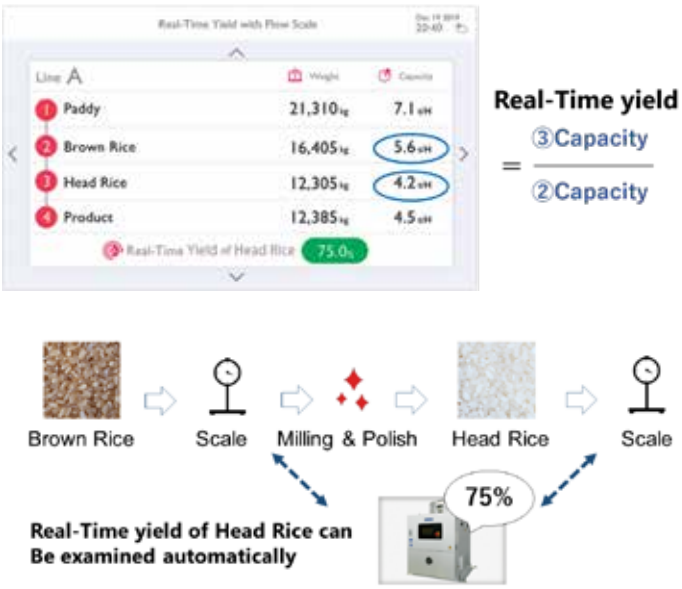
Emphases on production optimisation to reduce losses and maximise gains have necessitated the use of devices that will measure the weight of finished material and by-products and determine the real time milling yield.

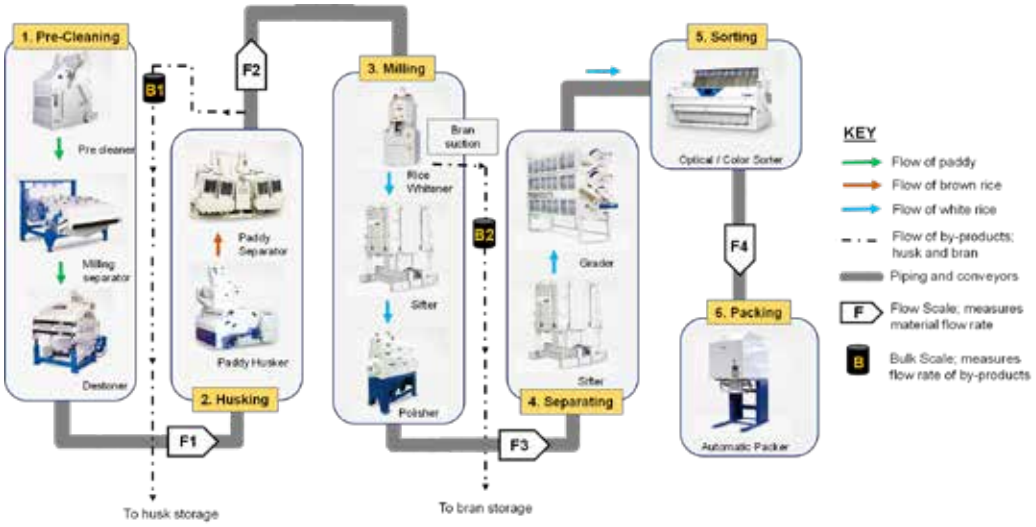
Flow scales were thus introduced at specific points on the production line to control and measure the flow rate of a material. Such numerical data can also be used to compute the yield in-between processing steps.

Overview of the milling system

The milling system in a factory is basically a line-up of machines which are interconnected by pipes, conveyors and elevators that convey material from one machine to another. In this system, every machine represents a step in the process, and the pipes show the flow of material from one processing step to another (See illustration 1.0).

The efficiency of an entire milling system and a high quality final product can be ensured when all machine steps are monitored and kept at their best performance. To achieve this,





certain performance metrics, usually measured by a flow scale, for every machine step must be monitored.

Application of flow scales in milling

A flow scale measures flow rate by constantly taking weights of the flowing material at set intervals and records it as weight per unit time (e.g. tons/H), ensuring a high speed measurement. The flow rate is then automatically converted to the weight value of processed material by multiplying it by total time of operation.

By definition, flow rate can also mean capacity. Depending on the application, there are two categories of applications of flow scales in milling, which are:

- Flow scales- helps in calculating product yield.
- Bulk scales- helps in quantifying by-products.

Flow scales and bulk scales work on the same electromechanical principle. However, the latter is designed with capabilities to measure the weight and flow rate of by-products such as husk and bran or similar materials with lower densities.

The flow rate of a material from a machine step is a key parameter which a milling operator looks out for, this is because it can:

- Evaluate the present operation of each machine step.
- Determine the right timing to make needed adjustments and to carryout maintenance.
- Maintain product quality

The comparison between the quantity of material input to a machine step and quantity of output after the machine step is an index of its operating condition and performance.

Therefore, flow scales quantify the flow rate of materials, record and transmit the data to a processor (in-built computer) that interprets the data to inform the milling operator who would make adjustments when necessary. When such adjustments are made, it enhances the efficiency of the steps that follow and cumulatively improves the yield of the final product.

Flow scales, made in a compact size, can be placed along piping and intermittently open and close to allow or restrict material flow automatically. In this particular manner, the ideal feed flow rate for a machine's optimal working condition is controlled and maintained. Thus, flow scales can both control and measure flow dynamics.

They come with a built-in weighing data communication function or software which enables automation and centralised control. Information recorded by flow scales can be used to continuously monitor processing yield during operation.

Calculating product yield

Data transmitted from flow scales to the central computing system is used in calculating product yield at specific points on the processing line at any given time. There are at least four critical points where the real-time information about yield is required to get a bird's eye view of the milling conditions, operation efficiency and output performance of each machine step.

Following this data requirement, flow scales must be installed thus:

- After the pre-cleaning step to assess the yield of clean paddy from raw paddy material.
- After husking step to assess the yield of brown rice after husking.
- After milling and polishing step to assess the yield of white rice from brown rice.
- After sorting step to assess the yield of good head rice from white rice.

As shown, each point corresponds to a transformational change which the rice kernel underwent from paddy to finished white rice. The milling efficiency and real time yield of white rice can be calculated by comparing the capacities at husking and milling steps (See Illustration 3.0).

Yield management is aimed at increasing the efficiency of the line. Using the initial consignment weight and estimated milling standard as points of reference, a milling operator or manager can quickly predict or detect machine failures and malfunctions.

In addition, any excesses above or short falls below the assumed yield value, and makes it possible to determine the properties of the raw material from each step, and make adjustments to optimise the next step or do a multi-pass.

Performance & profitability derived from flow rate data

The standards used to bench mark milling efficiency metrics are based on the typical quality of raw material from source. To establish these standards, a pilot study or test milling using

correctly taken paddy samples must be done.

These paddy samples are milled to white rice. Then head rice, husks, bran, impurities, and broken rice are separated accordingly. The percentage weight of each part is calculated and used as a standard on which to compare actual results from processing paddy consignments. Examples of some milling metrics are discussed below:

Milling degree

This is a performance metric or parameter used to determine the efficiency of a rice whitener. It is computed based on the amount of bran removed from the brown rice after passing through the rice whitener.

% Milling degree= (wt. of milled rice/wt. of brown rice) × 100

Milling recovery

A percentage of milled rice (including broken) obtained from a consignment of paddy. It is computed by dividing the weight of milled rice recovered by the weight of the paddy sample.

% Milling recovery= (wt. of milled rice/wt. of paddy input) × 100

Head rice recovery

A term used to describe the percentage of head rice (excluding broken) obtained from a consignment of paddy.

% Head rice recovery= (wt. of head rice/wt. of paddy input) × 100

Quantifying by-products?

As noted earlier, low density by-products are measured with the bulk scales such as the Satake RDBS200P-T. Apart from calculating production yield, the weight of by-products is measured because of their significant economic importance.

By-products are no longer just waste, as they can create new profits as they have found new uses. Since they hold economic value, it becomes necessary to accurately measure them.

By-products from rice milling includes husk, bran, and broken rice. Husk can be used directly as fuel (e.g. pellets, briquette) for grain dryers or processed into biofuels such as bioethanol or biodiesel. They can also be used as beddings or made into fodder to feed livestock.

Further processing of the husk has also seen applications in fibre boards or bricks used for construction. Bran is rich in oil and fibres which has uses in cosmetics, pharmaceuticals and animal feed industries. Broken rice can be used for animal feed or used to make rice-based snacks.

Yield management by weighing

In order to improve yield, maintain high processing efficiency, and trade by-products effectively, yield management by weighing becomes necessary. Satake has developed flow scales (IFW and RDBS models) that can be compatible with and work seamlessly with any rice processing line.

With the increase in size of rice mills, Satake had developed new line-up of weighing instruments to support plants with large processing capacity. As the world's food production increase, there might be need to develop even larger and smarter flow scales in the future.