A new range of batch centrifugals – ZUKA, from Fives Cail

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Abstract

A new range of batch centrifugals, named ZUKA, were launched on the sugar market by Fives Cail Group at the end of 2005. This new range, completely rehauled, represents a significant technological advance and responses to a demand of the market which has evolved: higher capacities, reliability, accessibility for maintenance, cleanliness, attractive design. This article emphasizes the main directions that have guided the project and which represent the pillars of this development: performance and associated innovations; the design; and the new services.

Zuka, una nueva serie de centrífugas en tanda presentada por Fives Cail

Una nueva serie de centrífugas en tanda, llamada ZUKA, fue presentada al mercado del azúcar a fines del 2005 por Fives Cail Group. Esta nueva serie, completamente revisada, representa un avance tecnológico significativo que responde a la demanda del mercado, y que ha ido evolucionando en cuanto a su capacidad más alta, más confiabilidad, mejor accesibilidad para el mantenimiento, limpieza y un diseño más atractivo. Este artículo da énfasis a las tres direcciones que han guiado este proyecto y que representan los tres pilares de este desarrollo: el desempeño y las innovaciones asociadas; el diseño y los nuevos servicios.

Introduction

After a detailed marketing review made in 2003 to our customers, the first steps of an important development commenced in 2004. Five project teams concentrated on the following aspects: conception, fabrication, driving unit and automation, services and costs. A prototype was manufactured at the end of 2004 and installed for tests at the beginning of 2005 in a factory at the Tereos Group in France. The tests continued throughout 2005.

In this article, we will develop the 3 research directions that have guided the project:

• Performance and associated innovations
• The design, and
• The new services

Performance and associated innovations

The productivity of a centrifugal is measured by the capacity of the basket and the number of cycles per hour that the machine is able to produce.

Capacity

The new range of ZUKA centrifugals comprises five models: ZUKA 1250, ZUKA 1500, ZUKA 1750, ZUKA 2000, ZUKA 2250 with respective capacities per cycle of 1250 kg, 1500 kg, 1750 kg, 2000 kg and 2250 kg.

With a wider range in comparison with the old range which included 3 models and with a higher capacity of the largest model (the largest old model, 2612, did not exceed 2000 kg), Fives Cail proposes machines corresponding more precisely to the different needs of our customers.

Performance

The performance, measured by the number of cycles per hour, depends on more complex various factors such as, at constant charge of the basket:

• installation criteria: position of the massecuite distributor
• process criteria: massecuite properties and conditions
• mechanical criteria:
+ inertia of the moving parts,
+ type of equipment involved in the process of sugar discharge
• electrical criteria: power of the driving unit.
A cycle diagram which shows the different phases of a cycle is a fundamental tool to identify the factors working as the levers (see Figure 1).

Among these 5 main phases, some of them are closely linked to conditions on site, others to the configuration itself of the machine:

**a. The phases depending on conditions on site:**

The charging phase

The duration of this phase will be influenced by the position of the massecuite distributor, the operating level in the distributor and the size of the feeding valve.

Rapid and smooth charging could be favourable to the stability of the machine. However, a violent charging could make the machine unstable whereas a slow charging increases the cycle time, but also could produce a massecuite layer with an inclined profile, instead of a vertical face.

The spinning phase

The duration of this phase is affected by the properties of the massecuite. This phase determines the quality and the moisture content of the spun sugar and will be closely dependent on the crystal size and CV of the massecuite.

The design of the machine has a limited influence on these 2 phases for which the site conditions are dominant.

**b. The phases depending on the configuration of the machine:**

The acceleration and deceleration phases

Two factors have been analyzed: the inertia of the basket and the driving unit.

The inertia

The inertia of the basket comes from the mass of the basket components, but also and especially its geometry, height to diameter (H/D).

Fives Cail has selected a ratio of 0.75 forming a good compromise between the stability of the machine and the optimized inertia. Some components of the machine, like the suspension, supporting and fixing the shaft of the basket, have been redesigned to improve the stability.

This ratio of 0.75 has been then applied to all the models of the ZUKA range.

The driving unit

In collaboration with Leroy Somer, Fives Cail has tested a specific technology for the particular application of sugar centrifugation: the hybrid permanent magnet motor.
is achieved by 3 Hall Effects probes implemented in the stator. These probes are precise, reliable and durable.

Moreover, the high yield of the motor has contributed to a significant reduction in energy consumption: the measurements taken on the ZUKA 1750 prototype has given values under 0.7 kW/ton of massecuite for performances of more than 30 cycles per hour so a saving of 20% in comparison with the old model, 2512, for which energy consumption was about 0.9 kW/ton of massecuite for performances of 22.5 cycles per hour equivalent to the other centrifugals models of the market (see Figure 2).

The discharging phase

The duration of this phase is composed of a time for sugar discharging and a time for the movement of the discharger components. The rotational movements are short whereas the vertical movements are longer.

Fives Cail has developed an innovative principle, based on the simultaneous working of 2 dischargers, positioned diametrically opposite in the basket at two different levels. This principle is patented (see Figure 3).

The discharger for the upper part of the basket simply effects a rotation of the plough.

The discharger of the lower part combines a small vertical movement with a rotation of the plough. The 2 diametrically opposed dischargers create 2 independent streams of sugar resulting in smooth choke free discharge of sugar from the basket.

So, the discharging time has been reduced by 40% which in itself increases the performance by 2 to 2.5 cycles per hour.

Each model of the ZUKA range is available with a single or double discharger.

A machine with a single discharger could be upgraded later with a double one. With the initial driving unit, the machine will be able to increase its performance from to 2 to 2.5 supplementary cycle/hour.

The results

The combination of all these innovations and improvements has led to increases in productivity by up to 25% in comparison with the old models (see Tables 1 and 2). In particular, the ZUKA 1750 prototype has reached performances of 31 cycles/hour in industrial operation, with beet massecuite (Purity 93-95) (see Tables 1 and 2).

Additional technological innovations

a. The discharge cone

Originally inside, it has been relocated under the basket to

Table 1. Performance comparison based on equivalent driving units

<table>
<thead>
<tr>
<th>Machine</th>
<th>Load kg</th>
<th>Discharger</th>
<th>Number of Cycles / h</th>
<th>Productivity TMC/h</th>
<th>Performances Progress %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2512</td>
<td>1750</td>
<td>mono</td>
<td>22.5</td>
<td>39.4</td>
<td>100%</td>
</tr>
<tr>
<td>ZUKA 1750s</td>
<td>1750</td>
<td>mono</td>
<td>26</td>
<td>45.5</td>
<td>115%</td>
</tr>
<tr>
<td>ZUKA 1750d</td>
<td>1750</td>
<td>double</td>
<td>28</td>
<td>49</td>
<td>125%</td>
</tr>
</tbody>
</table>

For cane massecuite Pty > 83

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Table 2. Performance comparison based on equivalent driving units

<table>
<thead>
<tr>
<th>Machine</th>
<th>Load kg</th>
<th>Discharger</th>
<th>Number of cycles/h</th>
<th>Productivity TMC/h</th>
<th>Performances Progress %</th>
</tr>
</thead>
<tbody>
<tr>
<td>D 612</td>
<td>2000</td>
<td>mono</td>
<td>26</td>
<td>52</td>
<td>100%</td>
</tr>
<tr>
<td>ZUKA 2250s</td>
<td>2250</td>
<td>mono</td>
<td>24</td>
<td>54</td>
<td>105%</td>
</tr>
<tr>
<td>ZUKA 2250d</td>
<td>2250</td>
<td>double</td>
<td>26</td>
<td>58.5</td>
<td>113%</td>
</tr>
</tbody>
</table>

For cane massecuite Pty > 83

free up space for the 2 dischargers. The cone is actuated by a pneumatic cylinder. With this configuration, the windage effect on the sugar belt conveyor has been minimized and the discharge improved (see Figure 4).

b. The feeding pipe

A pneumatically operated flap valve is used to direct the massecuite onto the deflector. The system is fully secure in the closed position being able to hold the massecuite in the crystallizer even when it is full (see Figure 5).

c. The basket

The hub and the bottom are in one cast part allowing a design which facilitates improved sugar discharge. Specifically, the arms of the hub are inclined, and follow the flow of sugar, preventing any sugar remaining behind after the discharge phase.

Figure 4. Discharge cone

Figure 5. Feeding pipe
A small deflector cone is fixed on the shaft to direct the flow of massecuite onto the basket working screen (see Figure 6).

d. Cleanliness and hygiene aspects

The lubricated mechanisms of the dischargers have been fully sealed in water tight boxes and are away from the feeding zones. The suspension has greasing points for each bearing limiting the quantities of grease introduced. The wash water spray pipe is retractable. Additionally, the automatic program regulates the quantity of water used to wash the sugar according to the load in the basket, optimising the water consumption and especially reducing the sugar melting.

The design

Often the main criteria for choosing industrial equipment are performance and reliability, now the design has also become a significant factor in the decision.

The clean and refined lines with integrated functionality and embellishments incorporating technical advantages all add value to the machine. The first impression of a machine is based on appearance and overall design. It contributes to the perceived quality. The centrifugal station is often the most visited and noticed part of a sugar factory.

During the development of the new range of ZUKA centrifugals, a professional designer assisted Fives Cail to change the shape of the machine and at the same time improving its functionality. Cleanliness aspects in particular have been studied to limit areas where sugar and water may collect and to make routine cleaning much easier. The electrical and pneumatic connections are now hidden and installed under the monitor casing covers. The motor cover also prevents water contamination and reduces motor noise. All are examples of a design being functional whilst remaining aesthetically pleasing (see Figures 7 and 8).

The services

The services constitute an important dimension of this development project because it highlights the Fives Cail wish to provide maximum support and assistance at all times, whether for operation, maintenance or repair. All the latest modern technologies have been employed to facilitate the sourcing of assistance and information by the end user.

Assistance on-line

For a battery of centrifugals, in accordance with the sketch (see Figure 9), Fives Cail proposes a solution based on the following
configuration:
- Each machine control cabinet integrates an individual switch, connected to the PLC and the display panel of the machine.
- These individual switches are linked to a collector in line with a HUB.
- The HUB collects, transforms and adapts the information for the transfer by the phone line. It is connected to a regular phone line.

With this system, and with customer controlled access, we can query each PLC of the centrifugals from the Fives Cail office or from the office of the customer.

We can gather data about production and performance of the battery, or data about production and performance of just one centrifugal, or data regarding the condition of any machine. This system becomes a real asset in the starting phase of the machines, during training or breakdown.

Technical documentations on CD-ROM supports

Provided on CD-ROM, the technical documentation includes menus allowing a quick access routing to the required information or drawings. Some views in 3D with representations of external equipment involved in the process and with internal views help to understand the machine operations. For the maintenance, several drawings of exploded parts have been included to assist the customers in identification (see Figure 10).

Conclusion

All the constituent parts of this new range of batch centrifugals, ZUKA, have been reconsidered and redesigned. Some of them are
the subject of major innovations like the double discharger. By combining all these technical innovations, with an aesthetic approach and a new notion of services, Fives Cail puts a new attractive and reliable industrial tool at the customers' disposal delivering the highest productivity of the market. With 5 models proposed with one or two dischargers, the ZUKA centrifugals cover all the specific needs of each customer. With more than 20 references in the world within its inaugural year, this outstanding initial success shows the high interest from customers for this new equipment.