

Novel design of a continuous centrifuge for low grade massecuites

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abstract

The paper describes the development of a completely new centrifugal concept with superior properties. Based on proven, successful state of the art machine concepts new ideas have been introduced which deviated significantly from conventional design features. After a novel concept was found design work started to build a trial machine which was tested under industrial conditions in Central America and in Europe. As a result this new machine proved to be able to provide higher capacity at improved sugar quality and reduced power consumption. In addition it needs less space (smaller foot print) than its predecessors of comparable capacity. The machine offers high reliability and availability, is easy to operate and needs less maintenance. Highest safety standards are ensured by FEM (finite element method) calculations, tests during fabrication and safety devices at the machine.

Keywords: **continuous centrifugals, low grade massecuite**

Novedoso diseño de una centrifuga para masas cocidas de bajo grado

Este trabajo describe el desarrollo de un concepto totalmente nuevo de centrifugación con propiedades superiores. Basándose sobre los conceptos de las máquinas, probado, exitosos y ultramodernos, se han introducido nuevas ideas que se distancian significativamente de las características de diseño convencionales. Una vez hallado un nuevo concepto se comenzó el trabajo de diseño para construir una máquina de prueba que se probó bajo condiciones industriales en América Central y en Europa. Como resultado esta nueva máquina probó ser capaz de proveer una mayor capacidad con una calidad de azúcar mejorada y un consumo de energía más reducido. Además requiere menos espacio (una huella menor) que sus predecesoras de capacidad comparable. La máquina ofrece alta confiabilidad y disponibilidad, es fácil de operar y requiere menor mantenimiento. Se han asegurado altos niveles estándar de seguridad mediante cálculos por el método de elementos finitos (FEM), las pruebas durante su fabricación y los mecanismos de seguridad en la máquina.

Neue Kontinuierliche Zentrifuge für Nachproduktfüllmasse

Das Ziel bestand darin, ein vollständig neues Zentrifugenkonzept mit hervorragenden Eigenschaften zu entwickeln. Hierbei sind in einen bewährten und erfolgreichen maschinentechnischen Stand neue Ideen eingeflossen, in dem ganz neue konstruktive Wege beschritten wurden. Nachdem ein neuer Ansatz gefunden war, wurde mit der Entwicklung und dem Bau einer Pilotmaschine begonnen, die unter Betriebsbedingungen in Mittelamerika und Europa getestet wurde. Als Ergebnis hat sich gezeigt, dass mit der neuen Maschine höhere Durchsatzleistungen bei gleichzeitig besserer Zuckerqualität und reduziertem Energieeinsatz zu erreichen sind. Darüber hinaus zeichnet sich die Maschine gegenüber Vorläufermodellen vergleichbarer Leistung durch einen geringeren Platzbedarf aus. Weitere Eigenschaften sind eine hohe Betriebssicherheit und Verfügbarkeit sowie leichte Bedienbarkeit und ein geringerer Wartungsbedarf. FEM-Berechnungen, Prüfungen während der Fertigung sowie Sicherheitseinrichtungen an der Maschine gewährleisten höchstmögliche Sicherheit.

Novo projeto de uma centrífuga contínua para massa cozida de baixo grau

O artigo descreve o desenvolvimento de um conceito completamente novo de centrífuga com propriedades superiores. Baseadas em conceitos eficazes e comprovados de tecnologia de ponta, novas idéias que se desviaram significativamente de recursos de projetos convencionais foram introduzidas. Depois que um novo conceito foi encontrado o trabalho de projeto começou a construir uma máquina de teste, que foi avaliada sob condições industriais na América Central e na Europa. Como resultado esta nova máquina provou ser capaz de fornecer maior capacidade na melhoria da qualidade do açúcar e um consumo de energia reduzido. Além disso, precisa de menos espaço (menor espaço exigido) do que suas antecessoras de capacidade semelhante. A máquina oferece alta confiabilidade e disponibilidade, é fácil de operar e necessita de menos manutenção. Elevados padrões de segurança são assegurados pelos cálculos de FEM (método de elementos finitos), ensaios durante a fabricação e dispositivos de segurança na máquina.

Introduction

The continuous centrifugals of this completely newly designed model (Fig. 1) are highly sophisticated machines. The reduced installation height and the small space requirements make them easy to install. They are clearly arranged and easy to assemble. Thanks to the more efficient massecuite processing using a new standard product distributor or the "Turbo3" option, the downstream separation of syrup and sugar crystals can be performed with maximum efficiency, allowing excellent technological results.

By reducing the number of wear parts and using components with a longer service life, the availability of the centrifugals could be enhanced. Moreover, far less maintenance is required, which minimises costs. All important components have undergone FEM analysis, to ensure high safety. Additional safety and monitoring functions have been integrated into the improved centrifugal control unit. The Turbo3 product distributor and parts of the housing design are patent pending; outlet openings in the basket are patented.

Applications for continuous K3000 centrifugals

These continuous centrifugals are used in the cane and beet sugar factories as well as in sugar refineries, where separated sugar is processed in the dry, melted or magmatised state. Melting or magmatising can take place inside the machine.

The K3300 model has been developed specially for high throughputs of C or B massecuites (equivalent to low - raw or high - raw product) in beet or cane sugar factories. Further sizes with special versions adapted to specific requirements are scheduled to follow.

Operation

The feeding system – consisting of an electro-pneumatic butterfly control valve that is steplessly variable with the motor current, a feed duct, compensator, sight glass, and feed pipe – delivers the massecuite, water and steam continuously to the product distributor. In the distributor head, the media are thoroughly mixed, evenly distributed and accelerated. This processed massecuite is fed from the distribution cone of the product distributor into the pre-separation stage of the basket, where a large part of the syrup is already separated from the crystals. The crystals then float smoothly onto the working screen of the second basket stage. The greater the diameter, the greater the centrifugal force. The residual mother liquor is separated from the sugar crystals that are retained on the screen. The crystals are washed by addition of water via the washing system. Owing to the separate wash water addition in the pre-separation stage and in the upper stage, the crystal loss can be reduced and the sugar quality decisively improved. With the effect of the centrifugal force, the washed sugar crystals move over the basket edge into the sugar compartment. From there the sugar continuously falls into the conveying element to be installed underneath the centrifugal, or it is melted or magmatised inside the centrifugal and passes through a pipe for further processing.

Design and features

Its new look already makes the K3000 series centrifugal stand out from other continuous centrifugals. Its compact design requires only little space and is clearly arranged. As a self-discharging, conical centrifugal, it is designed vertically and operated continuously.

Figure 1. Schematic picture of a K 3300 centrifugal

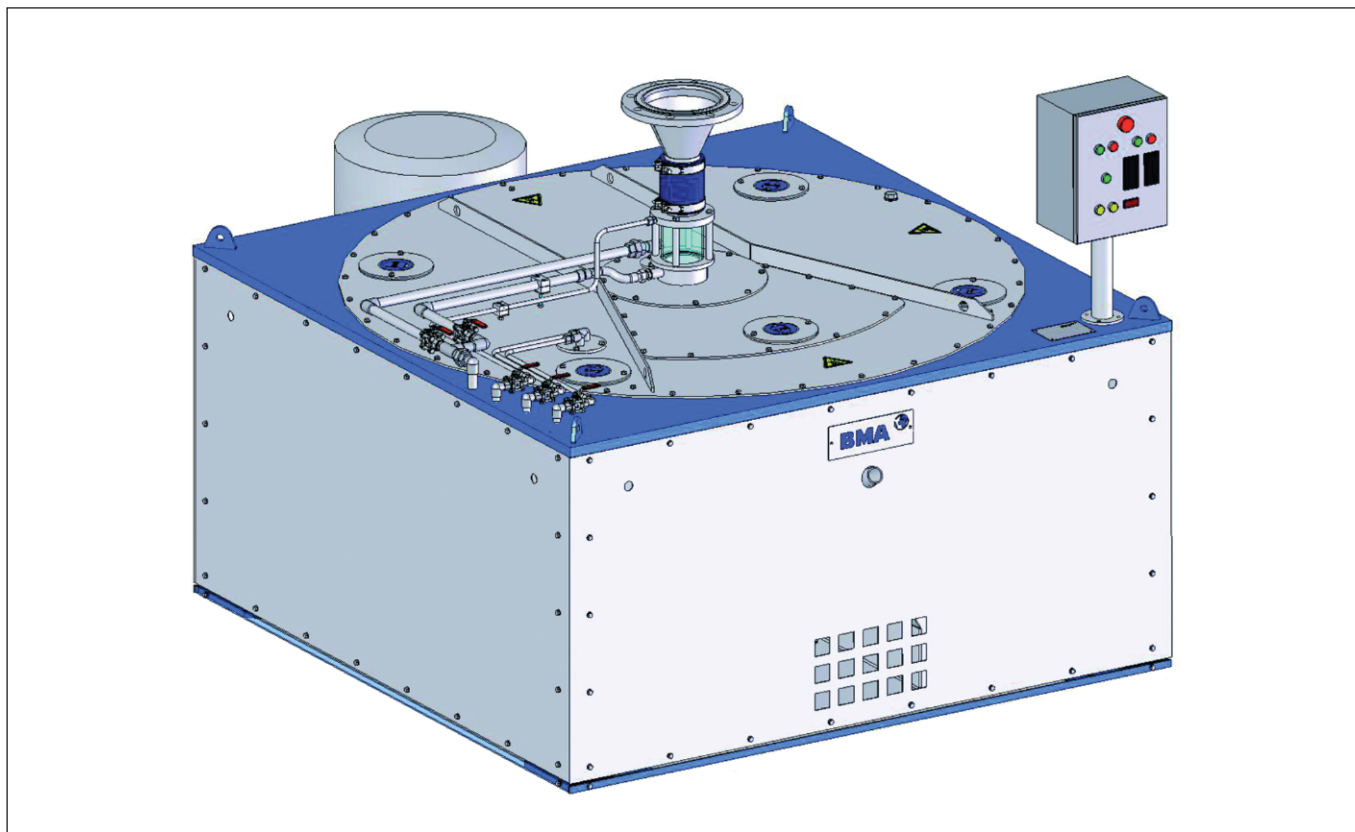
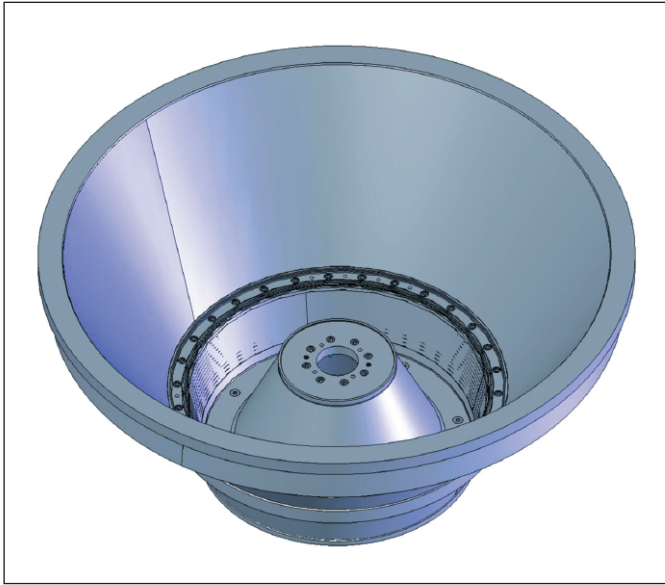


Figure 2. New basket design

The basket is driven from below via a V-belt drive by the external three-phase AC motor. All rotating parts are enclosed in the housing. The closed design of the housing and the feeding system prevents the ingress of cold air, which favours separation, particularly with highly viscous massecuites. All housing parts that come into contact with the sugar crystals are made of stainless steel. As basket material, stainless steel with a particularly high strength and resistance to stress-corrosion cracking is used, which is also highly resistant against chlorine ions. The patented outlet openings in the basket shell ensure quick syrup discharge. The baskets have been optimised for centrifuging massecuites of low or high purity. Following many years of testing with basket angles from 24° to 35°, the best option for each product has been defined, with some involving equipping the baskets with pre-separation stages. The proven design of the backing screen ensures unhampered removal of the syrup on the basket shell and provides optimum support for the working screen. The screens installed in the basket are fixed by means of a clamping ring. Its specific geometry optimises the distribution of the crystal suspension on the working screen even further. The new way of fixing the screen with clamping rings makes further auxiliary means for screen assembly redundant. The pre-separation stages are equipped with a wear-resistant wedge-bar screen, in order to reduce maintenance costs and downtimes (Fig. 2).

The housings are equipped with large removable screw-on covers, which provide free access to the entire inside of the centrifugal. In addition, a smaller inspection door has been provided, which allows easy replacement of the screens and even of the product distributor when required. The new construction of the centrifugal with a vibration-isolating support of the basket, the bearing assembly, the inner casing with V-belt duct and the motor provides for a smooth and stable running of the centrifugal. This structure also allows positioning the rubber buffers outside the heat-affected zone, which makes them easier to

replace. Moreover, a non-contacting gap sealing between the upper basket edge and the inner casing can be provided, which avoids wearing seals.

The grease-lubricated bearing assembly of the K3000 series centrifugals has been made very sturdy and the application of lubricants could be reduced drastically. The bearing points to be lubricated are easily accessible for the operator. As the new centrifugal is easy to inspect and access, soiling in the centrally located product distributor and the basket can be easily and quickly removed through a hand hole inspection cover. The feeding system projecting into the product distributor is equipped with connections for water and steam addition. The divided nozzle assembly allows for a well-aimed wash water application in the lower and upper stages of the basket. Glass elements have been completely eliminated. The flow rate of the wash water is measured by a magneto-inductive flow meter and indicated on the display of the operator panel.

In order to improve operational reliability, all important components have undergone FEM calculation. The standard equipment including electronic vibration control not only enhances safety, it also meets the requirements for an unattended centrifugal station. The new K3000 series is also characterised by improved operator friendliness. For example, insufficient V-belt tension is indicated

Figure 3. K3300 next to its predecessor K2300

Table 1. Technical data of the K3300 model

Upper basket diameter:	1,300 mm
Basket angles:	14° / 30°
Screen surface:	19,500 cm ²
Required space:	1,990 mm x 1,990 mm
Length incl. motor:	2,700 mm
Housing height:	1,030 mm
Height incl. butterfly control valve:	1,670 mm
Maximum gravity factor:	2,906
Maximum speed:	2,000 rpm
Low-raw massecuite, beet*:	17 (up to 19) t/h
C massecuite, cane*:	19 (up to 22) t/h
High-raw massecuite, beet*:	33 (up to 42) t/h
B massecuite, cane*:	35 (up to 45) t/h
*maximum throughput depending on the massecuite quality () for particularly easily separable massecuites and, if applicable, for special technical configurations of the centrifugal	

to the operator. Visible mild steel parts are painted, and the outer housing is clad with stainless steel panel sheets. The continuous centrifugals can be equipped with numerous additional modules.

To achieve high processing rates, the centrifugals can be equipped with the new Turbo3 product distributor to process highly viscous massecuites. This can increase performance by 15-25%. Moreover, the new Turbo3 distributor allows a significant increase in the purity of the low-grade sugar and thus a reduction in the undesired non-sugar recirculation.

The machine can be supplied as melting and also as magmatizing centrifugal. The sugar is melted / magmatized with a suitable medium in the sugar compartment of the centrifugal housing. The resulting liquor or the affination magma leaves the centrifugal via two pipe connections. For this purpose, the centrifugal is equipped with a ring pipe that has boreholes for feeding the melting medium, and a stainless steel conduit for collecting the liquor / magma. Medium dosing is controlled as a function of the processing rate. This allows achieving a largely constant dry substance content of the liquor / magma, about 72° Brix for liquor and up to 93° Brix for magma. When using continuous centrifugals as melting or magmatizing machines, there is no need for sugar screw conveyors or melting tanks with stirrers, so the system is less complex.

The housing can be made in stainless steel for all surfaces that come into contact with massecuite, sugar, syrup, and water.

An efficient syrup separator considerably relieves the downstream crystallisation stage.

Range of equipment configurations and additional modules

The range of modules allows tailoring the centrifugal to specific operating conditions and desired equipment features. Available are for instance different baskets optimised for the product to be processed, various screening and operating speeds, the

“Turbo3” product distributor, internal syrup separation and a magmatizing/melting system.

Material and design

The housing is entirely made of stainless steel. Visible mild steel parts can be painted according to customer’s request. Monitoring of bearing temperature and antifriction bearings is possible. Additional flushing and steam-out line inside the housing can be provided. Automated lubricant dosing is available.

Additional items

The machine can come with a discharge hopper for dry sugar, a pneumatic-operated butterfly control valve (as safety device that closes in the event of a malfunction or an emergency and thus interrupts the massecuite flow into the centrifugal) and a lump strainer for installation in the feed pipe.

Drive and control concept

Drive

The performance of the standard motors used depends on the application. The compact control cabinet includes a soft starter for a smooth start up of the centrifugal. This feature allows reducing motor cabling by 50%. The control cabinet accommodates a lockable mains switch.

Operator panel

The operator panel (IP55) attached to the centrifugal is made of stainless steel and clearly structured (Fig. 3). It provides for the necessary protection of the electronics and for easy cleaning. All sensors and actors directly mounted onto the centrifugal are cabled to the operator panel, allowing to perform a comprehensive functional test prior to delivery of the centrifugal and to minimise commissioning time. The controllers can be supplemented by a Profibus DP connection to a higher-level process control system. All variables required for monitoring of the centrifugal and to modify parameters are already stored as defaults in data modules. Warning lights on the operator panel would indicate when re-tensioning of the sensor-monitored V-belts is required. The vibrations of the centrifugal are monitored by an electronic vibration sensor. If a limit value is exceeded, a warning light is activated. The flow rate of the wash water is indicated via a display.

The maximum throughput rates listed in table 1 assume the use of a Turbo3 product distributor for low-raw (C) massecuite processing.