

Refiner and process for grinding and homogenizing materials containing particles

The invention relates to a refiner for grinding and homogenizing materials containing particles, including chocolate, compound, cacao, paints and inks, comprising a set of rollers mounted in a frame, a motor for driving at least one roller, preferably with an adjustable speed. The invention further relates to a process comprising the steps of feeding a material containing particles to a set of rollers, grinding and homogenizing the material at least by means of the set of rollers, and discharging the material from the set of rollers.

As explained in EP 1 043 070, for milling a pasty or dough-like mass, such as a suspension of premixed ingredients, it is known to use roll mills having cambered rolls that have a smooth surface. Through the milling, the size of particles in the pasty or dough-like mass is reduced. The milling in such a roll mill is done by letting the material pass through gaps between pairs of rotating rolls, such that there is a correlation between the gap width and the particle size. Such roll mills may be used in connection with the processing of any type of pasty or dough-like mass. In a general way, roll mills with smooth surface rolls are suitable for any type of material that has the capability of clinging to the rolls in such a way that it may be transported by the rolls and passed from one roll to the next during transport.

EP 1 043 070 relates to a milling device, comprising a roll mill having a plurality of rolls for milling a mass, surface imaging means for imaging a surface on at least one of said rolls and for generating a corresponding surface image, and image processing means for processing said surface image. In EP 1 043 070, it is

stressed that ensuring an even coverage of rolls during processing greatly enhances the quality of the product.

"Although it was known that the gap width and the average particle size in the product are correlated, the inventors  
5 recognized that an uneven coverage of material on the rolls (especially the last roll) leads to an increased average particle size and to wider distributions, i.e. distributions having a larger mean deviation. The object of milling  
10 however is to obtain a predetermined average particle size with little deviation from the mean value, to thereby obtain a defined quality. Consequently, a preferred embodiment of the present invention employs the imaging means and control feed-back in such a way that the coverage on the rolls is even."

15 US 4,603,815 relates to a refiner for mixtures and suspensions having a non-Newtonian rheological characteristic, such as chocolate, which comprises a plurality of power driven refining rollers, and a means of changing the pressure thereof on the respective supports,.

20 US 5,379,950 relates to a method for controlling the grinding of a dispersion of solid particles in a doughy-pasty mass, such as a chocolate mass, on a roller mill line.

It is an object of the present invention to provide a refiner for improved grinding and homogenizing materials  
25 containing particles.

To this end, the refiner according to the present invention is characterised by a sensor for measuring at least one parameter indicative of particle size  
distribution.

30 In an aspect, the difference between the measured ("ist") particle size distribution and a desired ("soll") particle size distribution is used for controlling, by means of a processor, at least one of the gap(s) between the rollers, and thus the pressure(s) exerted by the rollers on  
35 the material, the rotating speed of the rollers, and the

friction between the material and the surface of the rollers, to set the particle size of the particles leaving the refiner. Thus, a more accurate particle size distribution can be provided.

5           In a further aspect, the sensor is positioned near the last roller of the set. In yet a further aspect, the sensor is adapted for measuring a spot on (the material on) a surface of a roller, in particular of the last roller. It is preferred that the spot has a diameter in a range from 10  
10 to 40 mm, preferably in a range from 15 to 35 mm, preferably in a range from 20 to 30 mm, preferably the spot has a diameter of about 25 mm. Within these ranges, a good representation of the particle size distribution can be obtained.

15           The sensor and/or the processor can be adapted for measuring a spectrum of frequencies and preferably for splitting the spectrum of frequencies into different subspectra, preferably a near infrared subspectrum.

20           In an aspect, at least one of the sensor and the processor is adapted for converting each of the measured subspectra into a signal, wherein the shape and amplitude of the signal are indicative of the particle size distribution.

25           In this context, other suitable parameters indicative of particle size distribution include the number of particles, e.g. in combination with a statistical models or lab measurements, and actual particles size.

          In a further aspect, at least one of the sensor and the processor is adapted for inline measuring of the particle size distribution.

30           In another aspect, at least one of the sensor and the processor is adapted for inline analyzing content of a material containing particles, such as water, sugar, fat and protein content, and inline controlling, based on the inline analyzed content, the refiner.

In yet another aspect, that the processor is adapted for comparing the inline analyzed content with a recipe database of the process, determining the recipe of the material containing particles from the recipe database on basis of the inline analyzed content, and automatically setting a machine, such as the refiner, or process. Thus, e.g. after starting a machine, such as a refiner, or changing the recipe, the (new) recipe can be recognized automatically and settings of the machine/refiner adjusted automatically preferably without intervention by e.g. an operator.

In yet a further aspect, a first sensor is positioned at the centre of a roller and a second sensor is positioned near an edge of the roller. With two sensors it is possible to establish whether particle size distribution is the same over at least part of the length of a roller. Both sensors measure a parameter indicative of particle size distribution and the measured parameters are compared with each other.

The present invention further relates to a process for grinding and homogenizing materials containing particles, including chocolate, compound, cacao, paints and inks, the process comprising the steps of feeding a material containing particles to a set of rollers, grinding and homogenizing the material at least by means of the set of rollers, and discharging the material from the set of rollers, and characterised by the step of: measuring at least one parameter indicative of particle size distribution.

In an aspect, the process comprises the step of controlling, based on the measurements, at least one of the gap(s) between the rollers, and thus the pressure(s) exerted by the rollers on the material, the rotating speed of the rollers, and the friction between the material and the surface of the rollers.

In another aspect, the process comprises the steps of inline analyzing content of a material containing particles, such as water, sugar, fat and protein content, and inline controlling of the process on basis of the inline  
5 analyzed content.

In yet a further aspect, the process comprises the steps of comparing the inline analyzed content with a recipe database of the process, determining the recipe of the material containing particles from the recipe database on  
10 basis of the inline analyzed content, and adjusting the process to the determined recipe.

The invention will now be explained in more detail with reference to the drawings, which schematically show a preferred embodiment according to the present invention.

15 Figure 1 is a side view of a refiner according to the invention.

Figure 2 is a rear view of the refiner shown in Figure 1.

20 Figure 3 is a front view of the refiner shown in Figure 1.

Figure 4 is a cross-sectional view of the refiner shown in Figure 1.

Figure 5 is a detail, marked V in Figure 4, on a larger scale.

25 A step during the process of producing for example chocolate is refining a viscous mass, e.g. containing ingredients necessary for producing chocolate. In practice, refining of the viscous mass is often done with a five roller refiner. The viscous mass is introduced into the five  
30 roller refiner 1 at an entry roller 2 of five at least substantially parallel, adjacent rollers 2-6, and subsequently the viscous mass is moved through the refiner 1 by means of the five rollers in the form of a film. The movement of the viscous mass through the refiner 1 is in the  
35 form of a serpentine moving through the gap between each

pair of the successive rollers 2-6. When the viscous mass is introduced at the entry roller 2, the viscous mass forms a film on at least a part of a surface of the entry roller 2. The film of viscous mass is transferred to the successive roller after moving through a gap between the roller from which the film of viscous mass is transferred and the successive roller. The viscous mass also forms a film on the successive roller(s). When the viscous mass reaches the exit roller 6, the film of viscous mass is scraped off the exit roller 6 for example by means of a knife 7. Other ways of scraping the viscous mass from the exit roller 6 are known. After leaving the refiner 1, the viscous mass is moved for example to a conche by means of a transporting device 8.

The refiner 1 serves to refine the viscous mass e.g. to control the size of the particles in the viscous mass. When the viscous mass is intended for producing chocolate, the size of the particles in the viscous mass is important, for example for the flavor of the chocolate. It is therefore advantageous to be able to control the particle size, preferably online.

In the shown embodiment, the refiner 1 is provided with one motor 11 for driving the rollers 2-6 with an adjustable speed. It is, however, possible that two or more of rollers, e.g. each of the rollers, are provided with a motor.

As shown in Figures 3 to 5, the refiner 1 is provided with a sensor 9 for measuring at least one parameter indicative of particle size distribution, and a processor adapted for controlling, based on the measurements, at least one of the gap(s) between the rollers, the rotating speed of the rollers and the friction between the material and the surface of the rollers.

The pressures exerted by the rollers 2-6 on the material are set by adjusting the gap between each pair of the successive rollers 2-6, which gap between each pair of

the rollers 2-6 may be adjusted by means of mechanical means, such as hydraulic or pneumatic cylinders, electrical means, such as a stepper motor, or a combination thereof. It is preferred that the processor is adapted for adjusting the gap between two adjacent rollers in order to reduce or to increase the pressure exerted on the material in the refiner 1.

The particle size of the particles in the material may also be controlled by the rotating speed of the rollers 2-6 or the friction between the mass and the surface of the rollers 2-6. It is noted that the refiner 1 may comprise e.g. two, three or five rollers. The sensor 9 is placed near the exit roller 6 of the refiner 1. In this embodiment, the sensor 9 is positioned above the exit roller 6 of the refiner. By providing the sensor near the exit roller 6 and measuring the particle size distribution on a surface of the exit roller 6 where the film of viscous mass is still present, it is possible to measure the particle size distribution in the product inline.

The sensor is adapted for measuring a spot (Figure 5) on a surface of a roller, which spot has a diameter in a range from 10 to 40 mm, preferably in a range from 15 to 35 mm, more particularly in a range from 20 to 30 mm. In this example, the spot has a diameter of 25 mm.

The sensor and/or the processor, e.g. contained in unit 9, are adapted for measuring a spectrum of frequencies and preferably for splitting the spectrum of frequencies into different frequency areas of the near infrared spectrum. Each frequency area may be converted into a signal, wherein the shape and the amplitude of the signal are indicative of a particle size distribution.

The processor can be adapted to provide a correlation between the measurements and the desired particle size distribution. E.g., the processor can be adapted for calculating, from the measurements, particle

size distribution on basis of statistical functions and/or lab analysis, e.g. correlations established via lab measurements. The sensor/processor can be calibrated accordingly. carried out to establish a correlation between the measured parameter value and the desired parameter value.

In an embodiment, a signal is generated at least every 25 milliseconds for controlling at least one of gaps between the rollers 2-6, the speed of each of the rollers 2-6 and friction on basis of the correlation between the measured parameter and the desired parameter.

In a further embodiment, the processor is adapted for inline analysing of the water, sugar, fat and/or protein content of the product and thus inline control of the refiner or other machines or processes with this application. Further, in an embodiment, the refiner is arranged to start automatically by means of the processor being adapted for comparing the inline analyzed content with a recipe database of the process, determining the recipe of the material containing particles from the recipe database on basis of the content analyzed inline, and automatically setting a machine, such as the refiner, or the process. The machine or process may be set automatically without interaction of an operator.

As can be seen in Figure 3, it is also possible that a first sensor 9 is positioned at the centre of a roller 6 and a second sensor 10 is positioned near an edge of the roller 6. With two sensors 9, 10 it is possible to ensure that the particle size distribution is at least substantially the same over the length or part of the length of the roller 6. Both sensors measure a parameter indicative of particle size distribution, the measured parameters are compared with each other. If the signals of the comparisons are substantially within the same range, two adjacent rollers are substantially parallel, ensuring that the

particle size over the whole length of the roller 6 is substantially the same.

It is noted that both sensors 9, 10 may share one processor or that both sensors 9, 10 each have their own  
5 processor, which processors are connected with each other.

It is noted that the average particle size may lie in a range from 1  $\mu\text{m}$  to 100  $\mu\text{m}$ , preferably in a range from 1  $\mu\text{m}$  to 100  $\mu\text{m}$ , with an accuracy of  $\pm 1 \mu\text{m}$ .

The invention is not restricted to the above-  
10 described embodiments, which can be varied in a number of ways within the scope of the claims. For example, in addition to chocolate, the present invention can be applied also to produce compound, cacao, fat, fillings or non-food products such as paint, lacquer, ink et cetera that contain  
15 particles, e.g. pigments.

**CLAIMS**

1. Refiner (1) for grinding and homogenizing materials containing particles, including chocolate, compound, cacao, paints and inks, comprising a set of rollers (2-6) mounted in a frame, a motor (11) for driving at least one of the rollers (2-6), **characterised by** a sensor (9) for measuring at least one parameter indicative of the particle size distribution in the material.

2. Refiner (1) according to claim 1, comprising a processor adapted for controlling, based on the measurements, at least one of the gap(s) between the rollers (2-6), the rotating speed of the rollers (2-6) and the friction between the material and the surface of the rollers (2-6).

3. Refiner (1) according to claim 1 or 2, wherein the sensor (9) is positioned near the last roller (6) of the set.

4. Refiner (1) according any one of the preceding claims, wherein the sensor (9) is adapted for measuring a spot (12) on a surface of at least one the rollers (2-6).

5. Refiner (1) according to claim 4, wherein the spot (12) has a diameter in a range from 10 to 40 mm, preferably in a range from 15 to 35 mm, preferably in a range from 20 to 30 mm.

6. Refiner (1) according to any one of the preceding claims, wherein at least one of the sensor (9) and processor is adapted for measuring a spectrum of frequencies and preferably for splitting the spectrum of frequencies into different subspectra, preferably a near infrared subspectrum.

7. Refiner (1) according to claim 6, wherein at least one of the sensor (9) and processor is further adapted for converting each measured subspectrum into a signal,

wherein the shape and amplitude of the signal are indicative of a particle size distribution.

8. Refiner (1) according to any of the preceding claims, wherein at least one of the sensor (9) and the processor is adapted for inline measuring of at least one parameter indicative of particle size distribution.

9. Refiner (1) according to any one of the preceding claims, wherein at least one of the sensor (9) and processor is adapted for inline analysing content of a material containing particles, such as water, sugar, fat and protein content, and/or processor is adapted for inline controlling, based on an inline analysed content, the refiner (1).

10. Refiner (1) according to claim 9, wherein the processor is further adapted for comparing the inline analysed content with a recipe database for determining the recipe of the material containing particles and preferably for automatically adjusting the refiner to the determined recipe.

11. Refiner (1) according to any one of the preceding claims, wherein a first sensor (9) is positioned at the centre of a roller (6) and a second sensor (10) is positioned near an edge of the roller (6).

12. Process for grinding and homogenizing materials containing particles, including chocolate, compound, cacao, paints and inks, the process comprising the steps of:

feeding a material containing particles to a set of rollers (2-6),

grinding and homogenizing the material at least by means of the set of rollers (2-6), and

discharging the material from the set of rollers (2-6),

**characterised by**

measuring at least one parameter indicative of particle size distribution in the material.

13. Process according to claim 12, further comprising the step of controlling, based on the measurements, at least one of the gap(s) between the rollers (2-6), the rotating speed of the rollers (2-6) and the friction between the material and the surface of the rollers (2-6).

14. Process according to claim 12 or 13, further comprising the step of inline analysing the content of a material containing particles, such as water, sugar, fat and protein content, and/or inline controlling, based on an inline analysed content, of the process.

15. Process according to claim 14, further comprising the steps of comparing the inline analysed content with a recipe database, determining the recipe of the material on basis of the inline analysed content, and adjusting the process to the determined recipe.