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(54) **METHOD FOR BELT CONDITIONING IN PELLETIZING PLANTS, METHOD FOR PELLETIZING UREA AND PELLETIZING PLANT**

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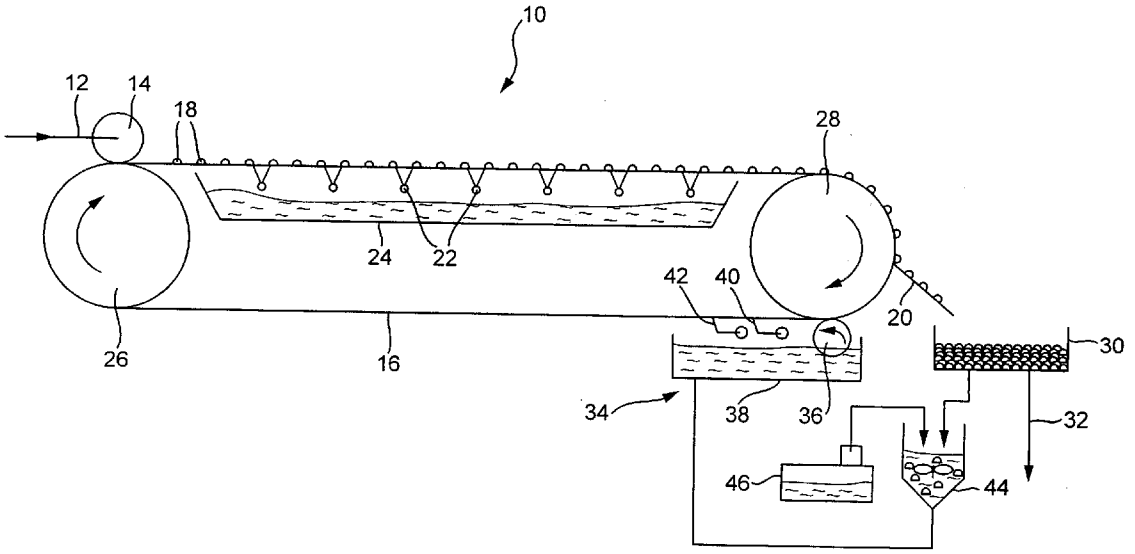
(57) **ABSTRACT**

Method for belt conditioning in pelletizing plants, method for pelletizing urea and pelletizing plant. The invention relates to a method for belt conditioning in pelletizing plants with a rotating steel belt to which is applied in drop-like manner a melt of a product to be pelletized which is then solidified on the steel belt. According to the invention there are steps of washing off product residues left on the steel belt after removing the solidified pellets using a washing liquid containing at least the dissolved product and drying the washing liquid adhering to the steel belt for forming a dry product film thereon prior to the renewed application of a melt of a product to be pelletized. Use e.g. for pelletizing urea.



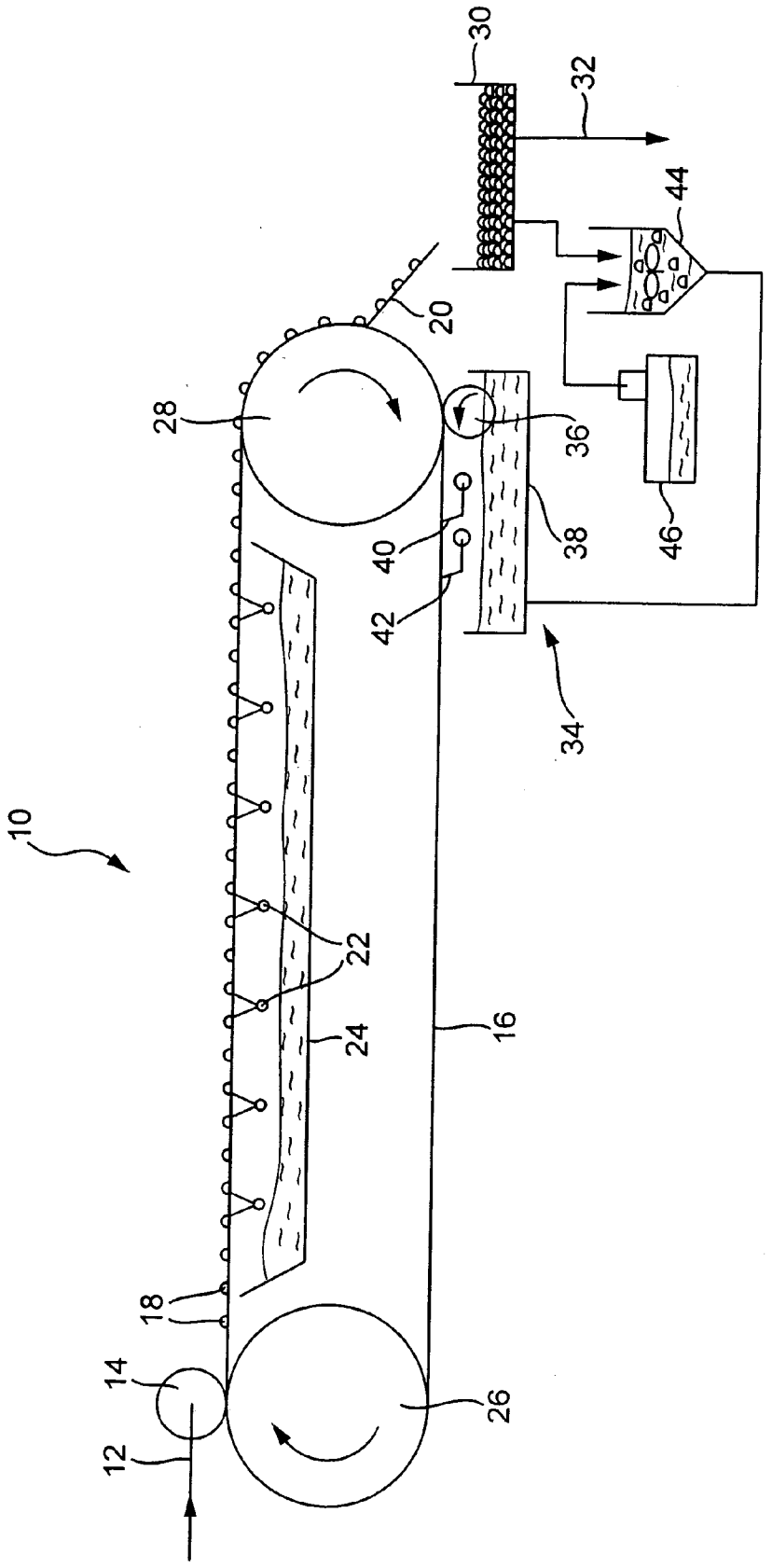


Fig. 1

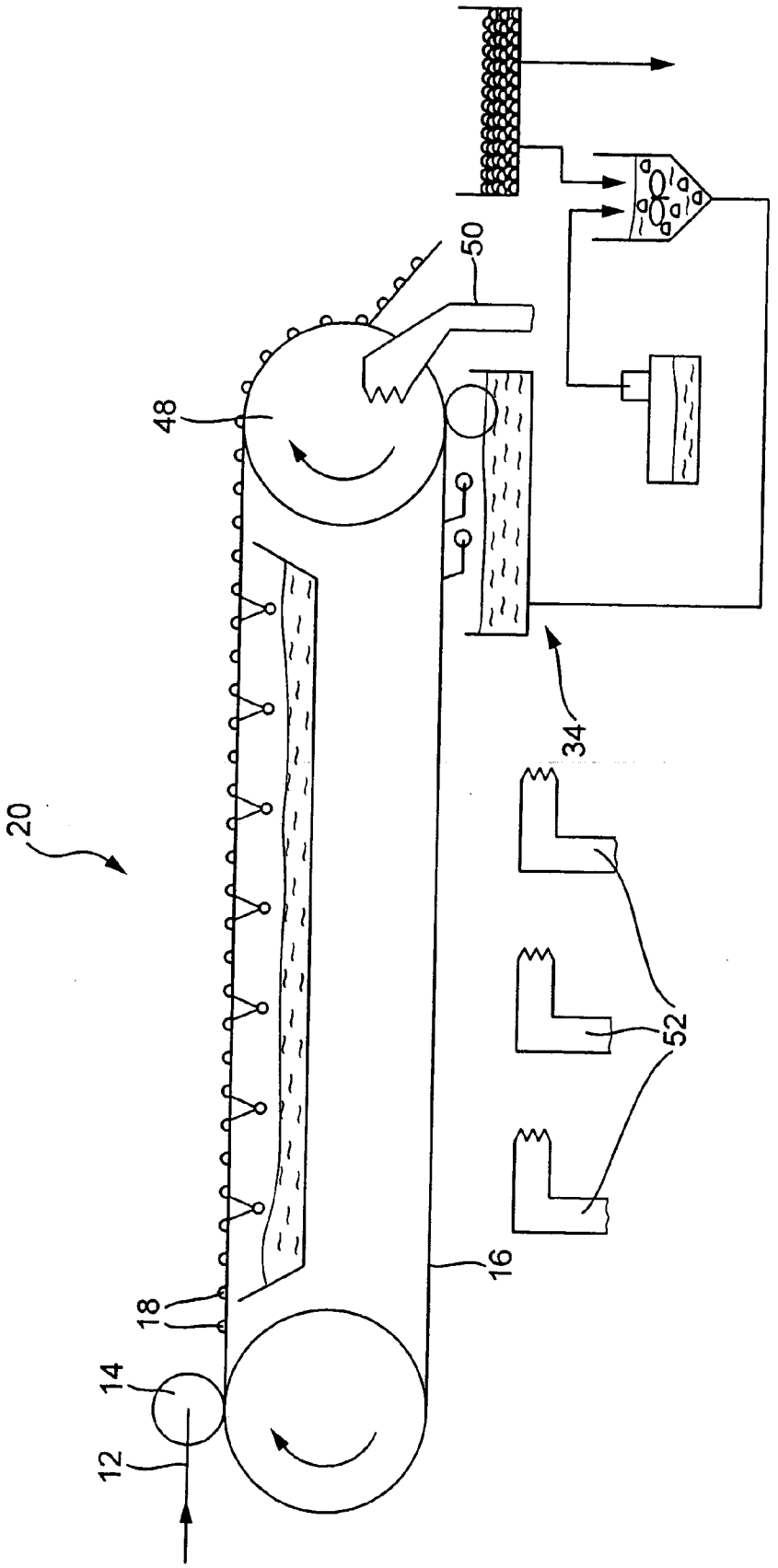


Fig. 2

METHOD FOR BELT CONDITIONING IN PELLETIZING PLANTS, METHOD FOR PELLETIZING UREA AND PELLETIZING PLANT

[0001] The invention relates to a method for belt conditioning in pelletizing plants with a rotating steel belt to which is applied in drop-like manner a melt of a product to be pelletized which is then solidified on the steel belt. The invention also relates to a method for pelletizing urea and to a pelletizing plant for performing the inventive method.

[0002] In known pelletizing methods a melt of a product to be pelletized is forced into a heated inner body and an outer tube provided with numerous holes and which rotates concentrically about the fixed inner body and deposits product drops over the entire width of a rotating steel belt. Water is sprayed onto the underside of the steel belt, so as to dissipate the heat released during the solidification of the melt and the cooling of the then formed pellets. The pellets are then removed from the steel belt in the vicinity of a reversal thereof by means of a scraper. On removal the pellets have cooled to such an extent that they can be stored and transported as bulk material.

[0003] In such pelletizing methods it is known to apply to the steel belt, shortly prior to the application of the melt, a separating agent in order to prevent caking of the pellets on the steel belt. However, a problem with separating agents is that they give rise to a detectable contamination of the pellets produced, even if they are applied in very small quantities.

[0004] When pelletizing hygroscopic, crystalline melts, particularly salt or basic melts, prior to product melt application the steel belt must be dry and as dustless as possible in order to ensure a high pellet quality. A pellet quality is defined by a high pellet shape approaching a spherical shape. If the steel belt is moist during product melt application, the product drops applied run apart, so that flat cake-like pellets are formed. In extreme cases adjacent product drops solidify together to give irregular pellet shapes. If dust-like product residues are collected on the steel belt, they can absorb moisture from the ambient air and once again reduce the pellet quality, because the melt applied absorbs moisture from the moist product residues and consequently gives rise to the formation of flat drops.

[0005] It is therefore known to wash off with water product residues adhering to the steel belt following pellet removal and to then dry said belt prior to the renewed application of a melt of a product to be pelletized. Thus, steel belt drying requires a comparatively long period of time, so that either low belt speeds must be set or additional heating means are needed in order to completely dry the steel belt up to the renewed application of a melt. Another reason for this is that rotating steel belts generally have running tracks in the form of very fine grooves or irregularities in which water is deposited and which can only be dried with difficulty. It is admittedly possible to use polished steel belts, but this is not generally economically viable. It is also disadvantageous that permanently washing liquid is obtained which contains product residues and/or separating agent and disposal thereof is ultimately necessary.

[0006] It is also known to air condition the room with the pelletizing plant and keep low the moisture content of the ambient air. It is also known to encapsulate the steel belt and expose it to dry air action. However, such measures clearly require high apparatus and energy expenditure.

[0007] The problem of the invention is to ensure a high and constant pellet quality with low apparatus and energy costs, even under unfavourable environmental conditions and/or when pelletizing hygroscopic products.

[0008] To this end the invention provides a method for belt conditioning in pelletizing plants with a rotating steel belt, to which is applied in drop-like manner a melt of a product to be pelletized which is then solidified on the steel belt involving the steps of washing off product residues present on the steel belt after removing the solidified pellets using a washing liquid, which at least contains the dissolved product, and drying the washing liquid adhering to the steel belt for forming a dry product film on said belt prior to the renewed application of a melt of a product to be pelletized.

[0009] It has surprisingly been found that through the application and drying of a thin product film, even in the case of high atmospheric humidity and hygroscopic products, a constant, high pellet quality can be ensured. Drying the washing liquid adhering to the steel belt for forming a thin, dry product film takes place more rapidly and requires less energy than the drying of a water-washed steel belt, also because with the washing liquid a product solution containing less water is present in the grooves and depressions of the steel belt, drying is faster and after drying belt unevennesses are equalled out. The washing effect of the product solution-containing washing liquid is completely adequate and caked product residues can be rapidly and reliably dissolved. The product melt to be pelletized can then be applied to a very thin, dry product film, so that the moisture absorption of product drops is greatly reduced and a constant, high pellet quality is ensured.

[0010] In a further development of the invention the steel belt is drawn off after washing for forming a washing liquid film adhering to said steel belt.

[0011] Through drawing off the steel belt a very thin, uniform thickness washing liquid film can be ensured on said belt and is then dried to a thin, uniform product film.

[0012] According to a further development of the invention the dry product film has a thickness of less than 5 μm, particularly less than 1 μm.

[0013] A product film with such a limited thickness can be rapidly formed by drying, so that it is also possible to set high belt rotation speeds. The product film cannot lead to a contamination of the pellets produced, because it is itself formed from the product to be pelletized. After removing the pellets, the product film is washed off again and supplied to the washing liquid. The washing liquid also leads to no contamination, but instead must be merely kept at the desired solution concentration by the supply of solvents, particularly water, as well as the product.

[0014] According to a further development of the invention the washing liquid exclusively comprises a solution of the product with a solvent. Advantageously water is used as the solvent.

[0015] As the washing liquid only contains the product to be pelletized and the solvent, particularly water, the washing liquid leads to no contamination and no waste quantities are in principle produced. The use of water as the solvent is

inexpensive and environmentally friendly, because no environmentally prejudicial solvent vapours are formed. Advantageously the washing liquid is an unsaturated product solution, so that product residues to be washed from the steel belt can still dissolve and consequently a reliable, thorough cleaning is ensured.

[0016] According to a further development of the invention the steel belt and/or the air surrounding the latter is heated for drying the detergent film adhering to the said belt.

[0017] Under particularly unfavourable climatic conditions, particularly in a tropical climate, the additional heating of the steel belt and/or the surrounding air can lead to a satisfactory pellet quantity. The heating of the belt leads to a lower relative atmospheric humidity in the boundary layer area of the belt and to a faster product film drying. Heating of the surrounding air increases the ambient temperature whilst simultaneously reducing the atmospheric humidity, so that this also leads to a faster product film drying. Appropriately additional heating is provided in the vicinity of the lower strand of the rotating steel belt.

[0018] According to a further development of the invention the product to be pelletized is urea. Advantageously the washing liquid contains between 40% and 80%, particularly 50% water and between 60% and 20%, particularly 50% of the product to be pelletized, particularly urea.

[0019] Problems arise when pelletizing urea due to its hygroscopic characteristics. Up to now urea pellets have been produced in so-called prilling tower, in which urea melt drops are solidified in free fall with the aid of an opposing air flow. Apart from the significant constructional costs for such prilling towers, considerable quantities of waste gas to be purified result from the opposing air flow. The invention makes it possible to ensure a high urea pellet quality, even under unfavourable environmental conditions. As the washing liquid contains only water and urea, particularly in equal parts, a very high product purity can be guaranteed in the case of a good washing action.

[0020] According to a further development of the invention the washing liquid contains an agent for preventing agglomeration of the pelletized product and/or caking of the product to be pelletized on the steel belt. The agent is advantageously a urea-formaldehyde reaction product. It is also advantageous for the washing liquid to contain 2% to 8%, particularly 5% of the so-called anti-caking agent.

[0021] To at least partly prevent caking of pellets on the steel belt and achieve a pellet shape which is at least approximately spherical, small percentages of an anti-caking agent can be added to the washing liquid. Although such an anti-caking agent is detectable in the end product, it is acceptable for certain products.

[0022] The fundamental problem of the invention is also solved by a method for pelletizing urea using the inventive belt conditioning method.

[0023] The inherently problematical pelletizing of urea as a result of the hygroscopic properties of the latter is made economically possible for the first time as a result of the inventively provided belt conditioning. Urea pellets are e.g. used as fertilizers or as a pharmaceutical intermediate. The belt conditioning according to the invention permits high speed pelletizing with a considerable output, without requiring complicated measures for air conditioning the ambient air of the pelletizing plant.

[0024] The fundamental problem of the invention is also solved by a pelletizing plant with a rotating steel belt to which is applied in drop-like manner a melt of a product to be pelletized which is then solidified on the steel belt, in which means are provided for washing off product residues present on the steel belt after removing the solidified pellets using a washing liquid containing at least the dissolved product, and for forming a dry product film on the steel belt prior to the renewed application of a melt of a product to be pelletized.

[0025] The pelletizing plant according to the invention can be operated with high belt rotation speeds even under unfavourable climatic conditions and specifically high atmospheric humidity. Thus, the pelletizing plant according to the invention permits a high pellet output, even in the case of hygroscopic products, e.g. urea.

[0026] According to a further development of the invention the means have a washing device downstream of a point for removing solidified product pellets from the steel belt, the washing device having a roller for the application of the washing liquid extending over the entire width of and engaging on the steel belt.

[0027] This makes it possible to implement a simply constructed washing device, which still supplies adequate washing liquid to the steel belt and brings about a reliable cleaning of product residues still present. The roller advantageously engages on the steel belt and is driven by the latter, so that there is no need to provide an additional drive for the washing device. The roller can have a smooth surface and engages substantially linearly on the steel belt. The roller feeds washing liquid to the steel belt and the washing liquid collects in a cross-sectionally wedge-shaped area between the roller and belt. Despite an in extreme case only linear contact between roller and steel belt, the washing liquid is consequently a really applied to the belt. The roller can have a plastic surface.

[0028] According to the invention the roller dips sectionally into a tank fillable with washing liquid.

[0029] Thus, the construction costs for the washing device are further reduced, because there is no need to provide pumps or nozzles in order to bring the washing liquid onto the steel belt. On rotating the roller washing liquid adheres to its surface and is applied to the steel belt in the vicinity of the contact point between the latter and the roller.

[0030] In a further development of the invention the means have at least one elastic draw-off lip engaging on the steel belt positioned downstream of the roller in the belt running direction.

[0031] In a simple manner these measures lead to a very thin, uniform thickness of a washing liquid film on the steel belt. The thin washing liquid film dries very rapidly to a thin product film, which advantageously has a thickness of less than 1 μm. Through the provision of a draw-off lip, it is simultaneously ensured that in the vicinity of grooves or other depressions in the steel belt a thicker washing liquid coating is left behind. After drying the washing liquid such

grooves and other depressions are then at least partly evened out by the resulting dry product layer.

[0032] According to a further development of the invention there are two substantially mutually parallel draw-off lips, which can be individually replaced.

[0033] In this way one of the two draw-off lips can be replaced during pelletizing plant operation without there having to be a production interruption.

[0034] According to a further development of the invention the means have heating coils under the return strand of the steel belt and/or at least on a heating drum engaging on the steel belt return strand.

[0035] By means of such heating devices, it is possible to bring about a rapid drying of the product film ensuring a high pellet quality even under unfavourable climatic conditions, particularly a tropical climate with high atmospheric humidity.

[0036] Further features and advantages of the invention can be gathered from the claims in conjunction with the following description of preferred embodiments of the invention. Individual features of the different embodiments can be randomly combined without leaving the scope of the invention. In the drawing show:

[0037] FIG. 1A diagrammatic representation of an inventive pelletizing plant for performing the inventive method.

[0038] FIG. 2 A diagrammatic representation of another embodiment of an inventive pelletizing plant for performing the inventive method.

[0039] FIG. 1 diagrammatically shows a pelletizing plant 10 for pelletizing urea. Urea is a meltable product, but in both the solidified and in the melt-like state it is hygroscopic. Urea pellets are e.g. used in fertilizer manufacture.

[0040] As a result of the hygroscopic characteristics of urea the danger arises in conventional pelletizing plants with a rotating steel belt that the molten urea deposited in drop form on said belt absorbs moisture and consequently the deposited drops are flattened. After solidification this can give rise to flat cake-like pellets, which in extreme cases even run together with adjacent drops. Flat cake-like drops are unfavourable for urea storage and further processing.

[0041] In per se known manner in pelletizing plant 10 a urea melt is fed through a supply line 12 to a so-called rotoformer 14, which comprises a fixed, heated inner body and an outer tube provided with a plurality of holes and which rotates concentrically about the fixed inner body and deposits the urea melt in drop-like manner over the entire width of the rotating steel belt 16. The urea drops carry the reference numeral 18 in FIG. 1. Steel belt 16 conveys away the urea drops 18 and during conveying on the upper strand of belt 16 they solidify, so that they can be removed as solid pellets from steel belt 16 using a removal device 20 in the area where said belt is reversed. To speed up solidification of urea drops 18 and to dissipate the resulting heat, the upper strand of steel belt 16 is sprayed from below with cooling water from nozzles 22 positioned above a cooling liquid tank 24.

[0042] Steel belt 16 is reversed about two spaced drums 26, 28, which rotate clockwise in each case, as indicated by the arrows in FIG. 1.

[0043] The pellets removed by means of the removal device 20 are collected in a container 30 and are supplied there, e.g. by means of a line 32 to a further processing or intermediate storage. On removal from steel belt 16 the urea pellets have solidified and cooled to such an extent that they can be conveyed on and stored in bulk material form.

[0044] The problem arises in conventional pelletizing plants that the hygroscopic urea melt and specifically the urea drops 18 absorb moisture from the ambient air and in particular from the steel belt 16. The steel belt 16 can be covered with product residues, which absorb moisture from the ambient air. In prior art plants the urea drops 18 can consequently absorb moisture from product residues on steel belt 16 and therefore assume a flat cake-like shape. This effect naturally occurs if there is a high atmospheric humidity level.

[0045] So that even in the case of high atmospheric humidity to ensure a pellet shape which is approximately spherical, a washing and draw-off device 34 is provided in which, in the vicinity of reversing drum 28, any adhering product residues are cleaned from steel belt 16 which is simultaneously provided with a thin washing liquid film, which during movement along the lower strand to reversing drum 16 dries to a thin product film. For this purpose the washing device 34 has a roller 36, which on the one hand is in contact with steel belt 16 and is driven by the latter. On the other roller 36 is sectionally immersed in a washing liquid tank 38. Thus, during the movement of steel belt 16 roller 36 is also rotated, counterclockwise in the representation of FIG. 1. Roller 36 supplies washing liquid to steel belt 16, so that any product residues which may be on said belt are dissolved and washed away by the washing liquid.

[0046] Downstream of roller 36 there are two draw-off lips 40, 42 with which washing liquid adhering to steel belt 16 is drawn off, so that only a very thin washing liquid film remains on steel belt 16 and this can rapidly dry in the path of the lower strand.

[0047] The two draw-off lips 40, 42 can be replaced separately from one another, so that replacement thereof can take place without interrupting the operation of pelletizing plants 10, 20 and therefore without stopping steel belt 16.

[0048] The washing liquid is constituted by an unsaturated urea solution containing 50% urea and 50% water. It has surprisingly been found that such a urea solution has a very good washing action and is able to reliably wash away urea residues adhering to the steel belt 16 and furthermore said urea solution dries more rapidly than water alone. Even in the case of high rotation speeds of steel belt 16, this ensures that the washing liquid film has completely dried on renewed application of the urea melt by means of rotoformer 14 and it is consequently ensured that the urea drops 18 absorb little or no moisture quantities from the steel belt 16. The product film formed on steel belt 16 after washing liquid film drying has a very limited thickness of less than 5 μm, particularly less than 1 μm. Even if said product film absorbs atmospheric humidity from the environment, the absorbed liquid quantities are so small that they deliver to product drops 18 little or no moisture and consequently cannot negatively influence the pellet quality. This is different to the situation in conventional pelletizing plants, where a product residue layer following the removal of the product pellets can have a thickness of up to 100 μm and can consequently

absorb and deliver larger moisture quantities. This also constitutes a difference compared with conventional pelletizing plants, where such product residues are washed away with water and where it has been found that with high belt speeds the steel belt **16** cannot be completely dried prior to renewed urea melt application.

[**0049**] However, it is possible in the method according to the invention to produce a thin, dry product film before the urea melt is applied again and apart from providing a dry surface said product film can also serve to even out any unevennesses and grooves in steel belt **16**. When the urea melt is applied again there is a dry urea layer in said unevennesses and grooves, whereas in conventional pelletizing plants said grooves and unevennesses contain washing water and lead to a negative influencing of the pellet quality.

[**0050**] In addition, due to the fact that the washing liquid only contains urea and water, the application of washing liquid and the resulting urea film cannot negatively influence product purity. Moreover, in principle there are no washing liquid waste quantities, because only urea residues are washed away and dissolve again in the washing liquid and do not have to be disposed of. During operation of the pelletizing plant **10** it is merely necessary to keep at the desired value the concentration of the urea solution in container **38**. The washing liquid in container **38** is produced in a mixer **44**, which is on the one hand supplied with urea pellets from pellet container **30** and on the other water from a water tank **46**. Not shown, but possibly necessary is a water supply line to washing liquid container **38**, so as to be able to set a desired urea solution concentration.

[**0051**] FIG. **2** shows a pelletizing plant **20** for pelletizing urea, which is in principle identical to pelletizing plant **10** of FIG. **1**. Therefore identically constructed and functioning elements compared with those of pelletizing plant **10** of FIG. **1** are not described again. Differences compared with pelletizing plant **10** of FIG. **1** occur in pelletizing plant **20** with respect to a heated reversing drum **48**. FIG. **2** shows in a purely diagrammatic manner heating coils **50**, which are intended to heat an outer circumference of reversing drum **48** and consequently steel belt **16**. The heating of steel belt **16** serves to more rapidly dry the washing liquid film applied by washing device **34** and consequently make it possible to operate with an even higher rotational speed of steel belt **16** and/or under extremely unfavourable climatic conditions, specifically a tropical climate, to make it reliably possible to provide a thin, dry product film when urea melt is again applied to the steel belt, thereby ensuring a high pellet quality. In addition to the heated reversing drum **48** in the vicinity of the lower strand of steel belt **16** there are heating coils **52** with which the air surrounding steel belt **16** is heated. Heating coils **52** also contribute to a rapid drying of the washing liquid film on steel belt **16** so as to give a thin product film.

1. Method for belt conditioning in pelletizing plants with a rotating steel belt to which is applied in drop-like manner a melt of a product to be pelletized and which is then solidified on the steel belt, characterized by the following steps:

washing away product residues present on the steel belt after removing the solidified pellets using a washing liquid containing at least the dissolved product and drying the washing liquid adhering to the steel belt for forming a dry product film on said steel belt prior to the renewed application of a melt of a product to be pelletized.

2. Method according to claim 1, further characterized by drawing off of the steel belt following washing off for forming a washing liquid film adhering to said steel belt.

3. Method according to claim 1, wherein the dry product film has a thickness of less than 5 μm.

4. Method according to claim 1, wherein the washing liquid exclusively comprises a solution of the product with a solvent.

5. Method according to claim 4, wherein water is used as the solvent.

6. Method according to claim 1, wherein the washing liquid contains an unsaturated product solution.

7. Method according to at claim 1, further characterized by heating the steel belt and/or the air surrounding the steel belt for drying a detergent film adhering to the belt.

8. Method according to claim 1, wherein the product to be pelletized forms a hygroscopic melt.

9. Method according to claim 8, wherein the product to be pelletized forms a salt melt or basic melt.

10. Method according to claim 1, wherein the product to be pelletized is urea.

11. Method according to claim 1, wherein the washing liquid contains between 40% and 80% solvent, and between 60% and 20%, of the product to be pelletized.

12. Method according to claim 1, wherein the washing liquid contains an agent for preventing caking of the pelletized product.

13. Method according to claim 12, wherein the agent is a urea-formaldehyde reaction product.

14. Method according to claim 11 wherein the washing liquid contains 2% to 8% of the anti-caking agent.

15. Method for pelletizing urea, characterized by a belt conditioning according to claim 1.

16. Pelletizing plant with a rotating steel belt to which is applied in drop-like manner a melt of a product to be pelletized which is then solidified on the steel belt, characterized by means for washing off product residues present on the steel belt after removing the solidified pellets using a washing liquid containing at least the dissolved product, and for forming a dry product film on the steel belt prior to the renewed application of a melt of a product to be pelletized.

17. Pelletizing plant according to claim 16, wherein the means has a washing device downstream of a point for removing solidified product pellets from the steel belt, the washing device has a roller for applying the washing liquid extending over the width of and engaging on the steel belt.

18. Pelletizing plant according to claim 17, wherein the roller engages on and is driven by the steel belt.

19. Pelletizing plant according to claim 17, wherein the roller has a smooth surface and engages substantially linearly on the steel belt.

20. Pelletizing plant according to claim 17, in wherein the roller has a plastic surface.

21. Pelletizing plant according to claim 17, wherein the roller is sectionally immersed in a tank fillable with washing liquid.

22. Pelletizing plant according to claim 16, wherein the means has at least one elastic draw-off lip engaging on the steel belt positioned downstream of washing device considered in the running direction of the belt.

23. Pelletizing plant according to claim 22, wherein there are two substantially parallel draw-off lips, which can be individually replaced.

24. Pelletizing plant according to claim 16, wherein the means have heating coils beneath the return strand of the steel belt and/or at least one heating drum engaging on a return strand of the steel belt.

25. Method according to claim 3, wherein the thickness is less than 1 μm.

26. Method according to claim 11, wherein the washing liquid contains 50% of the product to be pelletized.

27. Method according to claim 11, wherein the solvent is water.

28. Method according to claim 11, wherein the product to be pelletized is urea.

29. Method according to claim 14, wherein the washing liquid contains 5% of the anti-caking agent.

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