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Process for producing calcium urea-nitrate.

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FR-A- 2 057 086
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Description

The present invention relates to a process for producing calcium-urea nitrate in the form of a granular and free-flowing solid, free from the tendency to release dusts, and useful in agriculture as a nitrogenous fertilizer.

Calcium-urea nitrate is a per se known compound, and is a double salt of calcium and urea nitrate, wherein calcium nitrate constitutes approximately 40.6% by weight, and urea 59.4% by weight, and can be therefore defined by means of the formula:

\[ \text{[Ca(NO}_3\text{)}_2 \cdot 4\text{CO(NH}_2\text{)}_2] \].

Such a double salt can be obtained e.g., as a crystalline precipitate from an over-saturated aqueous solution of calcium nitrate and urea nitrate.

Calcium-urea nitrate is potentially very interesting for use as a fertilizer, in that in addition to urea nitrogen, it contains nitric nitrogen which makes it possible, among others, the ammonia losses, typical for urea alone, when it undergoes the hydrolysis process in the soil, to be prevented.

In spite of that, heretofore calcium-urea nitrate has not found a meaningful commercial success, above all due to the difficulties to be faced when this product has to be given the suitable physical characteristics for it to be used as an agricultural fertilizer.

For example, calcium-urea nitrate processing by means of crystallization, prilling and granulation by the rotary-disk method do not make it possible a granular, free-flowing product, free from the tendency to form dust, to be obtained.

In the art, also a fluid-bed processing was proposed, that involves operating difficulties, and the use of complex equipment.

However, the product which can be obtained by means of such a process, contains an excess amount of urea as compared to the amount required for forming the double salt, and such a product suffers from the undesirable characteristics deriving from the low hardness values of the granules.

GB-A-332945 teaches to solidify a sprayed aqueous system and according to this process, a granular product is obtained having a smooth surface and being particularly well suited for scattering.

The problem of preventing the decomposition of urea and the attendant formation of biuret is solved by evaporating as quickly as possible an entirely aqueous phase, in which urea is a solute, as calcium nitrate is, but not a melt. The problem of producing a granular dust-free product is not solved and furthermore the prescription of working in a definitely aqueous environment originates certain drawbacks.

GB-A-1 189 398 discloses a granulating process for the production of urea containing nitrogen and potassium fertilizers having good physical properties, such process essentially consisting in spraying a liquid mixture of the fertilizer components at 90-120°C under pressure onto a solid material in a rotary cylindrical granulating apparatus.

CH-A-490 117 teaches a similar granulating process for the production of hard granules of N-containing compounds for use in agriculture, whereby a substantially water free melt of the N-compound is sprayed onto solid particles in a rotating cylindrical apparatus in the presence of a counterstream of air.

None of the previous documents has ever attempted to solve the problem of deliquescence of calcium nitrate which is a serious obstacle to a correct granulation of the calcium-urea nitrate deriving therefrom.

Finally, to date, the formation of calcium-urea nitrate, as a granular solid, by starting from the relevant precursors in the molten state, did not find a satisfactory solution, above all when the difficulties deriving from undermelting phenomena are taken into due account.

The purpose of the present invention is overcoming the above-said drawbacks in calcium-urea nitrate preparation.

More particularly, a purpose of the present invention is a simple and advantageous method for preparing calcium-urea nitrate in the form of free-flowing granules, endowed with excellent mechanical characteristics.

Further purposes of the invention will be clear from the following disclosure.

According to the present invention, calcium-urea nitrate is prepared in the form of a granular, free-flowing and dustless solid, by process comprising the steps of:

(a) dissolving in molten urea, with stirring, calcium nitrate, in a molar ratio of urea to calcium nitrate of 4:1, at a temperature of from 100°C to 170°C and during a time of from 3min to 5min, calcium nitrate being introduced in the form of a dry powder, or a partially dehydrated powder, or a concentrated aqueous solution, to obtain a liquid composition having a maximum water content of 15% on a weight basis relative to the entire liquid composition;
(b) spraying the liquid composition thus obtained, maintained at the temperature of its formation, onto previously formed calcium-urea nitrate granules, said granules being kept at a temperature of from 40 °C to a maximum of 120 °C;
(c) cooling the sprayed granules with a gaseous coolant stream, and
(d) removing the so formed granular, free-flowing and dustless calcium-urea nitrate.

In the preferred form of practical embodiment, the maximum water content of the liquid composition exiting step (a) is 8%.

In the preparation of the liquid composition of the (a) step, calcium nitrate in the form of a dry powder, or in the form of a partially dehydrated powder, or in the form of a concentrated aqueous suspension having a water content of up to values of the order of from 15 to 18% by weight, can be used.

Furthermore, used calcium nitrate can contain ammonium nitrate as an impurity, up to levels of the order of from 5 to 6% by weight.

Ureas used in the liquid preparation of the (a) step normally shows a titer of the order of approximately 97% by weight or more, and may contain biuret as an impurity, with biuret amounts ranging up to approximately 1.2% by weight.

The process of preparation of the liquid composition is usually carried out by adding to molten urea calcium nitrate in the form of a dry powder, or in the form of partially dehydrated powder, or in the form of a concentrated aqueous suspension. Water in the composition, if present, can be adjusted within the above specified range of values, by means of the supply of water by calcium nitrate, and/or by urea and/or by means of the direct addition to the same mixture. The temperature at which the liquid composition is formed may generally vary within the range of from 100 to 170 °C. Above 170 °C, the undesired phenomenon of the release of ammonia fumes due to reactions of decomposition may occur. At temperatures lower than 100 °C, phenomena of solidification of the mass may occur.

The time necessary for calcium nitrate dissolving into molten urea varies as a function of temperature, of the physical characteristics of calcium nitrate, and of the water content of the medium inside which the process is run.

Normally, when such an equipment is used, which makes it possible molten urea and calcium nitrate to be efficaciously homogenized, the dissolving time is of the order of from 3 to 5 minutes.

The necessary time for calcium-urea nitrate to form is practically equal to the time of calcium nitrate dissolving into molten urea.

The reaction of formation of calcium-urea nitrate is exothermic, and in the absence of a cooling, causes an increase in the temperature of the mass of the order of 10 °C.

It was observed that the speed of formation of biuret, when urea is combined with calcium nitrate in calcium-urea nitrate, is considerably lower that the formation speed in urea alone.

Therefore, the time elapsing between the formation of the liquid composition of the (a) step, and the spray-processing of the same solution in the (b) step is not particularly critical.

In the (b) spraying step of the process of the present invention, the liquid composition, prepared in the (a) step, is sprayed, under the action of a hot gas, through a nozzle, on previously formed solid particles of calcium-urea nitrate, kept moving, preferably inside a revolving drum, and under the action of a gas stream, in particular of air.

The temperature of the liquid stream fed to the nozzles is practically equal to the temperature of formation of the liquid composition.

The temperature of the solid particles may generally vary within the range of from 40 °C to approximately 100 °C, and preferably of from 40 to 75 °C.

During the treatment of the (b) step of the process, water fed together with the liquid composition is removed, or substantially removed.

According to a form of practical embodiment of the present invention, the cooling of the so-formed particles of calcium-urea nitrate is completed by means of a gas stream inside a second revolving drum, connected in series to the first one.

An end step of post-drying of calcium-urea nitrate particles can be provided for, which performs the task of further enhancing the physical characteristics.

By operating according to the present invention, calcium-urea nitrate can be obtained in the form of a granular and free-flowing solid (of spheroidal shape), with a granulometry of the order of from 2 to 4 mm, free from dusts and from the tendency to release dusts.

When raw materials having the above detailed impurities are used, obtained calcium-urea nitrate has a composition which is generally comprised within the following ranges of values (as percentages by weight):
A typical calcium-urea nitrate composition which can be obtained according to the present invention is the following:

<table>
<thead>
<tr>
<th>Component</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea</td>
<td>55.3 - 58.8%</td>
</tr>
<tr>
<td>Calcium nitrate</td>
<td>37.4 - 40.6%</td>
</tr>
<tr>
<td>Ammonium nitrate</td>
<td>2.61 - 2.84%</td>
</tr>
<tr>
<td>Biuret</td>
<td>≤ 1.2%</td>
</tr>
<tr>
<td>Total nitrogen content</td>
<td>34.14-35.14%</td>
</tr>
<tr>
<td>Nitric nitrogen content</td>
<td>6.84- 7.43%</td>
</tr>
<tr>
<td>Free urea</td>
<td>0 - 4.1%</td>
</tr>
<tr>
<td>Free calcium nitrate</td>
<td>0 - 2.84%</td>
</tr>
<tr>
<td>Calcium nitrate content</td>
<td>92.1 - 98.07%</td>
</tr>
</tbody>
</table>

The process according to the present invention eliminates the need of operating with an urea excess, and makes it possible a calcium-urea nitrate to be produced, which is endowed with excellent mechanical characteristics, in particular those relating to the hardness of the granules.

Furthermore, the process of the present invention eliminates the drawbacks deriving from phenomena of undercooling of molten calcium-urea nitrate. In our opinion, this desirable result depends on the particular modalities according to which the (b) step of the process is carried out.

According to the process of the present invention, in the preparation of the liquid composition (the (a) step), calcium nitrate in the form of a dry powder, or in the form of a partially dehydrated powder, or in the form of an aqueous suspension with water content of up to values of the order of 15-18% by weight, can be used. Calcium nitrate is normally available in the form of a concentrated aqueous suspension, obtained by means of the attack of limestone with nitric acid, and subsequent concentration.

Such a suspension has a water content of the order of 15-18% by weight, and an ammonium nitrate content of the order of 5-6% by weight. Its solidification temperature is of approximately 90 °C. Its specific gravity is of approximately 1.96 g/ml, and its viscosity at 130 °C is of the order of 1.1×10^-4 m²/s (110 cSt).

According to a form of practical embodiment of the present invention, such an aqueous suspension of calcium nitrate, or similar aqueous suspensions, are directly used for preparing the liquid composition in the (a) step.

According to another form of practical embodiment of the present invention, said suspension is preliminarily submitted to a drying process in order to separate calcium nitrate as a dry powder. For such purpose, the suspension is heated to a temperature of the order of 135 °C and is then sprayed through spray nozzles located at the top of a drying tower. The droplets, falling down towards the bottom of the tower, meet a hot air stream, fed at a temperature which is typically of the order of 300-350 °C, which makes water evaporate from the interior of the droplet towards the outside thereof. That causes free-flowing, hollow granules (bulk density of the order of 0.6-0.8 kg/l) to be formed, which have a very large contact surface area, and are therefore particularly suitable for dissolving into molten urea.

Water evaporation during the drying treatment makes it possible the temperature of the granule (temperature lower than 100 °C) to be reliably controlled. In this way, no appreciable alterations occur in ammonium nitrate content, which is nearly maintained in the dried product. After this treatment, the residual water content in the solid is of the order of 1% by weight.

Suitable equipment for the above disclosed drying process step is constituted by drying towers, provided, at their top, with radially located spray nozzles, and, at their bottom, with a system for hot air feeding.

According to another form of practical embodiment of the present invention, the aqueous suspension of calcium nitrate undergoes a partial drying, in order that a partially dehydrated calcium nitrate powder may be obtained. For that purpose, the suspension, heated at a temperature of the order of 200-250 °C is sprayed into a vacuum vessel, with the flash effect being taken advantage of, which can be obtained from the vacuum combined with the temperature of the fed stream, in order to partially evaporate water, and
obtain calcium nitrate as a partially dehydrated powder (residual water content of the order of 6% by weight), to be used in the formation of the liquid composition of the (a) step of the present process.

This partial drying treatment can be accomplished inside a drying tower of the hereinabove disclosed type, additionally equipped with a suitable system for maintaining the desired vacuum level (normally of the order of 7.988 kPa (60 mmHg)) and with a system for dumping the separated steam (barometric condenser and vacuum pumps).

According to the process of the present invention, calcium nitrate in dry-powder form, or in the form of a partially dehydrated powder, or as a concentrated aqueous suspension, is mixed with molten urea, with a molar ratio of urea to calcium nitrate of, or approximately of, 4:1, by operating at a temperature comprised within the range of from 100 to 170 °C, in order to form a liquid composition containing from 0 to 15% by weight of water.

For that purpose, commercial urea, which may contain up to approximately 1.2% by weight of biuret, can be molten and homogenized with calcium nitrate, with water concentration, when water is present, being adjusted to the desired value. Obviously, in case calcium nitrate is used in the form of a concentrated aqueous suspension, urea at its maximum concentration will be used, so as to keep water content in the liquid composition within the previously detailed range of values.

A too high water content (higher than 8% by weight) in the composition would make it necessary an excessively large amount of water to be evaporated off in the (b) step of the process, that is undesired.

In case calcium nitrate is used as a dry powder, or as a partially dehydrated powder, on the contrary urea at a lower than maximum concentration may be used.

When the process is run with calcium nitrate in the form of a dry or partially dehydrated powder, this reactant is contacted and homogenized with molten urea, with water content in the composition being preferably maintained at values of the order of 1-2% by weight. Under these conditions, the process is advantageously carried out at temperatures comprised within the range of from 145 to 165 °C, and the relevant dissolution and calcium-urea nitrate formation times are of the order of a few minutes (for example, of from 3 to 5 minutes), when an efficient homogenizer is used.

When the process is carried out by starting from calcium nitrate in the form of a concentrated aqueous suspension preferably this reactant, heated at a temperature of at least 130 °C, is added to concentrated and molten urea at a temperature slightly higher than approximately 138 °C.

In this case too, a quick dissolution is obtained of calcium nitrate into molten urea and, on considering the exothermicity of the reaction, a liquid composition at a temperature of the order of 140-150 °C is obtained.

The equipment used for forming the liquid composition in the (a) step of the process of the present invention can be any equipment which makes it possible an efficacious and quick homogenization of molten urea and calcium nitrate to be obtained.

In the preferred form of practical embodiment, a reactor is used, which is equipped with a stirrer/homogenizer which enables a recycle of the material to be maintained inside the reactor. This reactor can be located immediately at the foot of the drying tower, when calcium nitrate in the form of a dry or partially dehydrated powder is used. However, a storage of calcium nitrate leaving the drying tower and its conveyance to a separate section for forming the liquid composition can be provided for.

The liquid composition obtained from the (a) step of the process of the present invention is sprayed, through spray nozzles, on solid particles of calcium-urea nitrate kept moving and under cooling conditions.

In the preferred form of practical embodiment, the liquid composition at a temperature equal to, or approximately equal to, the temperature at which it is formed, is sprayed through nozzles fed with hot air, on a set of curtains of the previously formed solid product, by operating inside a revolving drum, performing the function of agglomerator. The cooling of the solid takes place by using dried air, blown against the curtains of solid product wherein the granules are growing.

The temperature of the gas fed to the nozzle will be a function of the amount of water contained in the composition, and may vary within a range of from about 150 to about 220 °C.

The temperature of the granules will be generally maintained at values comprised within the range of from 40 to approximately 100 °C. However, in case liquid compositions richer in water are sprayed, the temperature of the granular solid shall not exceed a value of approximately 120 °C, in order to prevent phenomena of softening of the same granule. The preferred value for the temperature of the granules is of the order of from 40 to 75 °C.

The operation in the (b) step of the process of the present invention can be defined as a "film drying", which enables the granule to grow, with a free-flowing spheroidal shape being given to it.

According to a preferred form of practical embodiment, the cooling of the granular solid is completed inside a second revolving drum (or a second agglomerator), connected in series to the first one, into which
cold and dry air is injected on the rolling curtains, so as to further lower the temperature of the solid.

The so-cooled granules are sieved in order to separate the granules having the desired size (from 2 to 4 mm) from the finer granules, which are directly recycled, and from the coarse granules, which are recycled after a preliminary milling.

A step of post-drying of the so separated granules can be provided for, in order to reach optimum hardness values. Also the use of a hardener agent can be provided for.

The suitable equipment for carrying out the above disclosed operations is preferably as follows.

In the spray operation, a revolving agglomerator is used, which has a drum shape, and is positioned with its generatrix being inclined relatively to the horizontal. The drum is equipped with a system which enables it to revolve around its axis, and bears, at its end, two stationary heads. On its inner surface, devices are located, which make it possible a curtain of granules to be obtained, wherein the granules, on which the dispersion of molten calcium-urea nitrate impinges, which is sprayed through the spray nozzles, grow, without causing, under the above detailed conditions, the phenomenon of undermelting, typical of other granulation techniques, to occur.

Inside the drum, the spray nozzles, fed with air or with another inert gases, are located, which make it possible the dimensions and the shape of the droplets, and of the spray cone as a whole, to be regulated and controlled.

The inclination of the drum gives the stream of particles a helical motion, with the particles leaving from the lowermost portion of the same drum.

The cooling drum is different from the spray drum due to the only fact that it is not provided with spray nozzles. It performs the task of further cooling the solid product, before it leaves.

The sieving device may be of the type which is normally used in the art, and is used in order to select the product leaving the cooling drum, as a function of its granulometry.

As regards the system of conveyance of the solid inside the facility, the granulate is transferred from the spray drum to the cooling drum by gravity, in that the outlet of the first overhangs the inlet of the second drum.

The solid is advantageously recycled to the spray drum by means of a conveyance system of the "air-lift" type, or by means of mechanical lifting devices.

Also devices are provided for, which produce dry air at the necessary temperature for the carrying out the cooling inside the two drums. In particular, when liquid compositions with a low water content are used (in the (a) step), air streams at a relatively low temperature are required. When, on the contrary, the liquid composition contained relatively large amounts of water, higher-temperature air streams are required.

A possible post-drying treatment, destined to further remove residual water from calcium-urea nitrate, can be carried out by delivering hot, dry air through the granules, until the desired humidity removal degree is reached.

According to a form of practical embodiment of the present invention, the hardness of calcium-urea nitrate granules is controlled by adding small amounts of substances, such as, e.g., dolomite, during the preparation of the liquid composition, during the (a) step of the present process.

The process according to the present invention is now illustrated by referring to the Figure of the hereinafter attached drawing table.

More particularly, in said Figure by the reference numeral (10) the feed line is indicated, by means of which the concentrated aqueous suspension of calcium nitrate is fed to the drying tower (12) through the spray nozzle (11). By means of the line (13), to the tower (12) an air stream is fed, which is previously heated inside the furnace (14). The top of the tower (12) is connected with the cyclone (15). In the form of practical embodiment wherein vacuum is used, the tower (12) is connected, through the line (16), with the barometric condenser (17), into which water is injected by means of the line (18). By the reference numeral (19), the line is indicated, which is connected with the vacuum source.

At the bottom of the tower (12), by means of the line (20), calcium nitrate is collected in the form of a dry powder or of a partially dehydrated powder, and is sent to the homogenizer (22) after being metered in (21).

To the homogenizer (22) also molten urea is sent by means of the line (23). Inside the homogenizer (22) the liquid composition is formed, which is sent, through the line (24), to the revolving drum (25), through the nozzles (26). Into the revolving drum (25), through the line (27), also an air stream is sent, which is obtained by mixing hot air (line 30) and cold air (line 29) previously dried inside the drier (28).

Exhausted air leaves the drum (25) through the line (31) and is discharged, after a preliminary passage through the filter (32). The granular solid goes, by gravity (33), from the drum (25) to the revolving drum (34).
To the drum (34) a stream of cold and dry air is fed through the line (35), and an exhausted air stream is discharged through the line (36).

The cooled solid is discharged from the drum (34) through the line (37) and is sieved through (38). The fine products are recycled to the drum (25) by means of the line (39). The coarse products are drawn by means of the line (40), are ground in (41), and are recycled through the line (42). The solid having the desired granulometry is drawn through the line (43), and is collected after a possible post-treatment in (44) with a stream of hot air fed through the line (45).

The following experimental examples are illustrative and not limitative of the purview of the present invention.

Example 1

Inside the tower, an aqueous solution of calcium nitrate containing 18% by weight of water, 8% of ammonium nitrate and approximately 76% of Ca(NO₃)₂ is sprayed.

The hot air used as the drying air is fed to the bottom of the tower at the temperature of 330 °C.

The product is a calcium nitrate powder which has the following composition:

<table>
<thead>
<tr>
<th></th>
<th>1 - 1.5% by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>water</td>
<td></td>
</tr>
<tr>
<td>ammonium nitrate</td>
<td>1 - 2% by weight</td>
</tr>
<tr>
<td>calcium nitrate</td>
<td>98 - 98.5% by weight</td>
</tr>
</tbody>
</table>

A mixture of anhydrous calcium nitrate powder, molten urea, with added water, is prepared. Molten urea entering the mixer has the following characteristics:

<table>
<thead>
<tr>
<th></th>
<th>0.5 - 0.3% by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₂O</td>
<td></td>
</tr>
<tr>
<td>urea</td>
<td>96.9 - 97.6% by weight</td>
</tr>
<tr>
<td>biuret</td>
<td>2.6 - 2.1% by weight</td>
</tr>
</tbody>
</table>

The water added from the outside to the mixture represents 2.3% by weight of the molten mixture. A sample drawn from the molten mixture shows the following composition:

<table>
<thead>
<tr>
<th></th>
<th>1.13 - 2.21%</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₂O</td>
<td></td>
</tr>
<tr>
<td>biuret</td>
<td>1.4 - 1.68%</td>
</tr>
<tr>
<td>calcium nitrate</td>
<td>approximately 39.4%</td>
</tr>
<tr>
<td>nitric N</td>
<td>6.7 - 6.97%</td>
</tr>
<tr>
<td>total N</td>
<td>34.8%</td>
</tr>
</tbody>
</table>

The mixture is fed, through the metering pump, to the first revolving agglomerator, and is sprayed at the temperature of approximately 145 °C, with the flow rate and the temperature of compressed air fed to the nozzles, and the flow rate and the temperature of the cooling air being regulated.

The product leaving the growth granulator (at approximately 55 °C) goes to the second cooling drum, then to the sieving system, which separates the finished product (diameter larger than 2 mm) from the product which must still grow.

For a total spraying flow rate of 615 kg/h, a flow rate of 615 kg/h of end product is obtained, with an inner recycle between the two drums of about 1,230 kg/hour.

The end product is granular, with a specific gravity of approximately 1,000 g/litre, suitable for being sacked and used as such as a granular, nitrogenous fertilizer.

The characteristics of the end product are:
Example 2

A mixture of calcium nitrate and urea, with the addition of H₂O and dolomite is prepared.

The content of calcium nitrate is of 40.5% by weight.

The content of dolomite is of 47.6% by weight.

The content of dolomite and water is respectively of 4% and 8% by weight.

The nitrate is composed by: H₂O (18%), ammonium nitrate (approximately 8%) and Ca(NO₃)₂ - (approximately 76%).

Urea is composed by 99.5% of urea, and 0.5% of H₂O.

The temperature of the mixture is increased to about 100 °C; at that temperature, the mixture is molten and free-flowing.

The mixture is fed by means of a centrifugal pump, to the first revolving agglomerator, and is sprayed at the temperature of approximately 100 °C, with the temperature and the flow rate of air fed to the nozzles, and the flow rate and the temperature of hot air used as the drying air being regulated.

This latter when leaving the inner distribution manifold of the agglomerator drum, is of about 200 °C.

The temperature of the bed of granules on which the mixture is sprayed remains around 55-65 °C.

From the growth granulator, the product goes to the second cooling drum, then to the sieving system.

For a total spraying flow rate of about 50 kg/hour, a flow rate of end product of 50 kg/hour is obtained, with an inner recycle of approximately 200 kg/hour.
The analysis of the end product leaving the sieving system supplies the following results:

<table>
<thead>
<tr>
<th>ANALYSIS</th>
<th>0.3-4 mm %</th>
<th>0.4-5 mm %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total N</td>
<td>32.8</td>
<td>32.7</td>
</tr>
<tr>
<td>Ureic N</td>
<td>24.98</td>
<td>24.94</td>
</tr>
<tr>
<td>NH₄NO₃ N</td>
<td>1.03</td>
<td>1.06</td>
</tr>
<tr>
<td>Ca(NO₃)₂ N</td>
<td>6.48</td>
<td>6.51</td>
</tr>
<tr>
<td>Biuret N</td>
<td>0.32</td>
<td>0.30</td>
</tr>
<tr>
<td>Calcium</td>
<td>9.29</td>
<td>9.32</td>
</tr>
<tr>
<td>Urea</td>
<td>53.54</td>
<td>53.45</td>
</tr>
<tr>
<td>NH₄NO₃</td>
<td>2.96</td>
<td>3.02</td>
</tr>
<tr>
<td>Ca(NO₃)₂</td>
<td>38.00</td>
<td>38.16</td>
</tr>
<tr>
<td>Biuret</td>
<td>0.78</td>
<td>0.75</td>
</tr>
<tr>
<td>Water</td>
<td>1.13</td>
<td>1.18</td>
</tr>
<tr>
<td>Insolubles in H₂O</td>
<td>3.96</td>
<td>4.07</td>
</tr>
<tr>
<td>Hardness</td>
<td>300 g</td>
<td>365 g</td>
</tr>
</tbody>
</table>

**AFTER AIR DRYING FOR 16 HOURS AT 120°C**

<table>
<thead>
<tr>
<th>ANALYSIS</th>
<th>0.3-4 mm %</th>
<th>0.4-5 mm %</th>
</tr>
</thead>
<tbody>
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Claims

1. Process for preparing a granular, free-flowing and dustless calcium-urea nitrate, comprising the steps of:
   (a) dissolving in molten urea, with stirring, calcium nitrate, in a molar ratio of urea to calcium nitrate of 4:1, at a temperature of from 100 °C to 170 °C and during a time of from 3min to 5min, calcium nitrate being introduced in the form of a dry powder, or a partially dehydrated powder, or a concentrated aqueous solution, to obtain a liquid composition having a maximum water content of 15% on a weight basis relative to the entire liquid composition;
   (b) spraying the liquid composition thus obtained, maintained at the temperature of its formation, onto previously formed calcium-urea nitrate granules, said granules being kept at a temperature of from 40 °C to a maximum of 120 °C;
   (c) cooling the sprayed granules with a gaseous coolant stream, and
   (d) removing the so formed granular, free-flowing and dustless calcium-urea nitrate.

2. Process according to Claim 1, wherein the maximum water content of the liquid composition exiting step (a) is 8%.

3. Process according to Claim 1, wherein the calcium nitrate entering step (a) is a dry powder which is prepared by drying a concentrated aqueous suspension of calcium nitrate.

4. Process according to Claim 1, wherein the calcium nitrate entering step (a) is a partially dehydrated powder which is prepared by dehydrating in a vacuo a concentrated aqueous suspension of calcium nitrate.

5. Process according to Claim 1, wherein the calcium nitrate entering step (a) is a concentrated aqueous suspension of calcium nitrate having a maximum water content of 18% by weight.

6. Process according to Claim 1, wherein the starting calcium nitrate has a maximum ammonium nitrate content of 6% by weight.

7. Process according to Claim 1, wherein the starting urea has a maximum biuret content of 1,2% by weight.

8. Process according to Claim 1, further comprising the addition, in step (a), of a maximum amount of 4% by weight of dolomite relative to the overall liquid composition, is added as a hardness-controller.

Patentansprüche

1. Verfahren zur Herstellung von körnigem, freifließendem und staubfreiem Calciumnitrat-Harnstoff, welches die folgenden Stufen umfaßt:
   (a) Auflösen von Calciumnitrat unter Rühren in geschmolzenem Harnstoff bei einem Molverhältnis von Harnstoff zu Calciumnitrat von 4:1 bei einer Temperatur von 100 °C bis 170 °C und innerhalb einer Zeit von 3 Minuten bis 5 Minuten, wobei Calciumnitrat in Form eines trockenen Pulvers oder eines partiell entwässerten Pulvers oder einer konzentrierten wäfigren Lösung eingebracht wird, zur Ausbildung einer flüssigen Zusammensetzung mit einem maximalen Wassergehalt von 15 Gew.-% bezogen auf das Gewicht der gesamten flüssigen Zusammensetzung;
   (b) Aufsprühen der so erhaltenen und auf ihrer Bildungstemperatur gehaltenen flüssigen Zusammensetzung auf zuvor gebildete Calciumnitrat-Harnstoff-Granulate, welche Granulate auf einer Temperatur von 40 °C bis maximal 120 °C gehalten werden;
   (c) Abkühlen der besprühten Granulate mit einem gastförmigen Kühlmittelstrom und
   (d) Abnehmen des so gebildeten körnigen, freifließenden und staubfreien Calciumnitrat-Harnstoffes.

2. Verfahren nach Anspruch 1, worin der maximale Wassergehalt der aus Stufe (a) austretenden flüssigen Zusammensetzung 8 % beträgt.

3. Verfahren nach Anspruch 1, worin das in Stufe (a) eintretende Calciumnitrat ein trockenes Pulver ist, das durch Trocknen einer konzentrierten wäfigren Suspension von Calciumnitrat bereitet wird.
4. Verfahren nach Anspruch 1, worin das in Stufe (a) eintretende Calciumnitrat ein partiell entwässertes Pulver ist, das durch Dehydratisieren einer konzentrierten wässrigen Calciumnitratuspension im Vakuump erreitet wird.

5. Verfahren nach Anspruch 1, worin das in Stufe (a) eintretende Calciumnitrat eine konzentrierte wässrige Suspension von Calciumnitrat mit einem maximalen Wassergehalt von 18 Gew.-% ist.


7. Verfahren nach Anspruch 1, worin das Harnstoff-Ausgangsmaterial einen maximalen Biuretgehalt von 1,2 Gew.-% aufweist.

8. Verfahren nach Anspruch 1, welches weiterhin den in Stufe (a) erfolgenden Zusatz von Dolomit bis zu einer maximalen Menge von 4 Gew.-%, bezogen auf die flüssige Gesamtzusammensetzung, als Härteregler umfaßt.

Revendications

1. Procédé de préparation de nitrate de calcium-urée granulaire, s'écoulant librement et ne dégageant pas de poussières, comprenant les étapes consistant à :
   a) dissoudre du nitrate de calcium dans de l'urée fondu, en agitant le tout, le rapport molaire de l'urée au nitrate de calcium valant 4/1, à une température de 100 °C à 170 °C et en un laps de temps de 3 à 5 minutes, le nitrate de calcium étant introduit sous forme d'une poudre sèche, d'une poudre partiellement déshydratée ou d'une solution aqueuse concentrée, de façon à obtenir une composition liquide dont la teneur en eau vaut au maximum 15 % en poids, par rapport à la composition liquide totale ;
   b) pulvériser la composition liquide ainsi obtenue, maintenue à la température à laquelle elle a été formée, sur des granules de nitrate de calcium-urée préalablement formés, ces granules étant maintenus à une température valant de 40 °C à 120 °C au plus ;
   c) refroidir, à l'aide d'un courant de gaz réfrigérant, les granules arrosés par pulvérisation ; et
   d) retirer le nitrate de calcium-urée granulaire, s'écoulant librement et ne dégageant pas de poussières, ainsi formé.

2. Procédé conforme à la revendication 1, dans lequel la teneur en eau de la composition liquide issue de l'étape (a) vaut au maximum 8 %.

3. Procédé conforme à la revendication 1, dans lequel le nitrate de calcium introduit dans l'étape (a) est sous la forme d'une poudre sèche, préparée par séchage d'une suspension aqueuse concentrée de nitrate de calcium.

4. Procédé conforme à la revendication 1, dans lequel le nitrate de calcium introduit dans l'étape (a) est sous la forme d'une poudre partiellement déshydratée, préparée par déshydratation sous vide d'une suspension aqueuse concentrée de nitrate de calcium.

5. Procédé conforme à la revendication 1, dans lequel le nitrate de calcium introduit dans l'étape (a) est sous la forme d'une suspension aqueuse concentrée de nitrate de calcium, dont la teneur en eau vaut au maximum 18 % en poids.

6. Procédé conforme à la revendication 1, dans lequel le nitrate de calcium de départ contient au maximum 6 % en poids de nitrate d'ammonium.

7. Procédé conforme à la revendication 1, dans lequel l'urée de départ contient au maximum 1,2 % en poids de biuret.

8. Procédé conforme à la revendication 1, qui comporte en outre, au cours de l'étape (a), l'addition de dolomite, en tant qu'agent d'ajustement de la dureté, en une proportion d'au plus 4 % en poids par rapport à la composition liquide totale.