

Method for preparing a natural rubber

The present invention relates to a process for the preparation of a natural cup lump rubber for improving its colouration.

- 5 Natural rubber originates from the dry rubber material of the latex harvested by tapping the rubber tree and recovered in a receptacle fixed to the trunk of the rubber tree. Two conventional processes exist for recovering the rubber material from the latex. According to one of the processes, the latex, still liquid in the receptacle, is decanted, filtered, optionally stabilized or centrifuged, then coagulated, for example by means of a chemical agent.
 - 10 According to the other process, the latex is collected after its coagulation in the receptacle, also referred to as cup: a wet coagulum is then collected at the bottom of the cup, also known under the name of "cup lump". After removal of plant debris and inorganic debris from the coagulum, the natural rubber is dried, conventionally in tunnels under circulation of air at a temperature from approximately 90°C to approximately 130°C.
 - 15 As the properties of natural rubber depend in part on the coagulation process employed, it is customary to designate the rubber with a designation which originates from the choice of the coagulation process. Consequently, the terms used are natural cup lump rubber and natural latex rubber.
- Consequently, there exist technical descriptions of natural rubber, such as the "Technically Specified Rubber" specification well known under the acronym TSR: examples include the
- 20 "Standard Malaysian Rubber" and "Standard Indonesian Rubber" labels. The specification makes it possible to classify natural rubber into different grades according to its technical characteristics which result from the process employed to recover the natural rubber from the harvesting of the rubber tree latex to the drying operations on the natural rubber. The
 - 25 technical characteristics include the colouration of the natural rubber. A very low colouration of the natural rubber may be desired for certain applications, such as, for example, rubber soles. A scale, the Lovibond scale, is used to qualify the level of colouration of natural rubber. The lower the Lovibond number, the less dark in colour the natural rubber.
 - 30 The origin of the dark colouring of natural rubber is not known for certain, in particular because of the complexity of the chemical composition of rubber tree latex. Nevertheless, it would be attributed in part to an enzymatic action on phenolic compounds present in the latex, to the presence in the latex of pigments, such as carotenoids, to contamination of the latex by bacteria. It follows that natural rubber is generally dark in colour, characterized by a
 - 35 Lovibond number of at least 8, as is the case in particular for natural cup lump rubbers. It is known to reduce the Lovibond number of natural latex rubbers by adding a bleaching agent to the latex before causing its coagulation. A natural latex rubber with Lovibond numbers of at most 6, known under the TSR L grade, in particular the TSR 5L grade, is then obtained.

The Applicant Company has developed a process which makes it possible, surprisingly, to reduce the Lovibond number of natural cup lump rubbers and to produce, in particular, natural cup lump rubbers having a Lovibond number comparable to that of a TSR L grade, such as a TSR 5L or TSR 3L grade.

- 5 Thus, a first subject matter of the invention is a process for the preparation of a natural cup lump rubber which comprises the extrusion of a mixture of a natural cup lump rubber coagulum and of a bleaching agent for natural rubber in an endless screw machine equipped with a barrel, in which the screw revolves, and with a perforated die at the screw end, in which process:
- 10 a) the mixture formed of the coagulum and of the bleaching agent is compressed at a temperature of greater than or equal to 110°C and less than or equal to 210°C in the barrel,
- b) an adiabatic flash expansion at a pressure difference of greater than or equal to 30 bar is carried out at the die outlet.

The invention also relates to a natural cup lump rubber exhibiting a Lovibond number of less than 5.5, liable to be obtained by the process in accordance with the invention.

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Description

Any interval of values denoted by the expression “between a and b” represents the range of values extending from more than a to less than b (that is to say, limits a and b excluded), whereas any interval of values denoted by the expression “from a to b” means the range of values extending from a up to b (that is to say, including the strict limits a and b). Unless

20 values extending from a up to b (that is to say, including the strict limits a and b). Unless expressly indicated otherwise, all percentages (%) indicated are % by weight.

The machine used in stage a) is typically an extruder, an endless screw machine which comprises a material inlet, referred to as hopper, a body formed of a cylinder (also known as barrel) in which an endless screw (one or more) revolves, and a head which acts as support

25 for a die. This machine makes it possible to apply mechanical drying or thermomechanical drying to a product impregnated with a liquid to be removed by drying. Mechanical drying makes possible the removal of the liquid by purely mechanical forces (pressing, draining, and the like). It can be carried out by simple transfer of an amount of movement and optionally without heat transfer. Thermomechanical drying is carried out by heating, transferred to the product to be dried by degradation of mechanical energy. The water included in the product to be dried is in the liquid state under pressure and at high temperature. The stresses

30 hitherto exerted on the natural rubber in the barrel are released at the die outlet by the removal of the compression, which makes possible the adiabatic flash expansion at the die outlet. At the outlet of the die, the expansion produced also makes it possible to flash off the moisture and, if appropriate, depending on the viscosity of the product, to fragment the

35 product.

The extruder of use for the requirements of the invention can be a commercially available extruder, in particular those sold by Anderson, FOM and Welding, such as, for example, the Expander from Anderson, the Extruder Dryer from FOM or the VCU from Welding. The extruder of use for the requirements of the invention, for any one of the embodiments of
 5 the invention, is preferably a single-screw extruder.

Alternative forms of extruders are preferential in that they make it possible, at the die outlet, to achieve higher flow rates of coagulum or to promote the adiabatic expansion. Such a preferential alternative form is an extruder, the barrel of which exhibits, in the feed zone of the extruder, a (one or more) means for discharging water (free water, water in the liquid
 10 form). Mention may be made, as discharge means, of grooves in the thickness of the barrel which emerge on the internal surface of the barrel, one or more apertures in the feed zone of the extruder, which aperture makes it possible to discharge the water from the barrel. These apertures can be provided in the slit, grating or circular hole form. The feed zone is the zone which is found under the aperture of the hopper.

15 The coagulum of use for the requirements of the invention is a cup lump, in which case the natural rubber is a natural cup lump rubber. In the present patent application, natural rubber latex is understood to mean the latex resulting from the tapping of the rubber tree.

To prepare the mixture formed of the coagulum and of the bleaching agent, use is typically made of a "wet" natural rubber coagulum because it is impregnated with water which
 20 originates in particular from the aqueous washing liquors resulting from the operations of washing the coagulum, such as decontamination operations, generally carried out in a pool under water. The coagulum is preferably a coagulum which has undergone washing operations. The wet coagulum used in the process in accordance with the invention and introduced into the barrel via a hopper which equips the endless screw machine is a
 25 coagulum which preferably contains more than 5% by weight of water, in particular between 5% and 40% by weight of water, more preferentially between 8% and 30% by weight of water, more preferentially still between 10% and 30% by weight of water. The percentage of water is calculated with respect to the total weight of wet coagulum.

The wet coagulum can be in the form of granules, commonly referred to as crumbs, or of
 30 crepes. Preferably, the wet coagulum is in the form of crumbs, in particular to facilitate its introduction into the extruder via the hopper. More preferentially, the wet coagulum is formed into crumbs before its use in the process.

Preferably, the coagulum used in stage a) is typically a coagulum which has undergone a decontamination operation which is generally broken down into two stages, the primary
 35 decontamination and the secondary decontamination. The coagulum collected after the tapping of the rubber tree very often contains more or less large contaminants, such as leaves, twigs, sand and other debris which will contaminate the coagulum during the harvesting. In order to bring the primary decontamination, the aim of which is to remove the

biggest objects, to a successful conclusion, the coagulum is conventionally cut up and washed in pools of water. In the secondary decontamination, which makes it possible to remove the finest contaminants, the coagulum is conventionally shredded, then washed with water in pools and subsequently transported, for example, into creping machines and shredders. The decontamination can comprise a stage of filtration of the coagulum, in particular under pressure, for example in a specific device which comprises an extruder and a suitable filtration means installed at the outlet of the extruder. Reference may be made, for example, to the filtration process described in Patent Application WO 2016162645 A2 or to that described in Patent Application WO 2018224773 A1. Such a process makes it possible to remove contaminants with a size of greater than 1 mm, advantageously of greater than 500 μm (0.5 mm), more advantageously of greater than 100 μm (0.1 mm).

When the coagulum is decontaminated, the coagulum preferentially undergoes a filtration stage before its use in the process in accordance with the invention, in which case the coagulum is a coagulum decontaminated by a filtration stage.

Bleaching agents for natural rubber are typically salts of bisulfites or of metabisulfites. The bisulfites and metabisulfites are preferentially salts of an alkali metal or alkaline earth metal, such as sodium, potassium and magnesium. Mention may be made, for example, of sodium sulfite, potassium sulfite and magnesium sulfite, respectively of formulae NaHSO_3 , KHSO_3 and $\text{Mg}(\text{HSO}_3)_2$, sodium metabisulfite, potassium metabisulfite and magnesium metabisulfite, respectively of formulae $\text{Na}_2\text{S}_2\text{O}_5$, $\text{K}_2\text{S}_2\text{O}_5$ and MgS_2O_5 .

Thiols or mercaptans, such as 4-methylbenzenethiol, 4-tert-butylbenzenethiol, xylyl mercaptan or their salts, in particular thiolates of an alkali metal or alkaline earth metal, such as sodium 4-methylbenzenethiolate, which are known to reduce the colour of natural rubber latexes, may also be suitable as bleaching agents.

The bleaching agent can also be a mixture of at least two bleaching agents.

Preferably, the bleaching agent is a bisulfite salt, a metabisulfite salt or their mixture. More preferentially, the bleaching agent is a bisulfite of an alkali metal or of an alkaline earth metal or a metabisulfite of an alkali metal or of an alkaline earth metal or else their mixture. More preferentially still, the bleaching agent is a metabisulfite of an alkali metal or of an alkaline earth metal or their mixture, such as sodium metabisulfite, potassium metabisulfite or magnesium metabisulfite or also a mixture of at least two of them.

The amount of the bleaching agent introduced into the coagulum is adjusted by a person skilled in the art in order to obtain the desired colouration of the natural rubber. It can vary within a wide range. Preferentially, the bleaching agent is used at a content ranging from 0.5 to 20 grams of the bleaching agent per kilogram of dry natural rubber, preferentially from 2 to 10 grams of the bleaching agent per kilogram of dry natural rubber. In accordance with the specifications of natural rubber which are well known to a person skilled in the art, a natural rubber is regarded as dry when it contains less than 0.8% of moisture.

According to a first alternative of the invention, the mixture formed of the coagulum and of the bleaching agent is typically prepared during a stage prior to stage a). According to this embodiment, stage a) is preferentially preceded by a stage of soaking a wet natural rubber coagulum in an aqueous solution of the bleaching agent or by a stage of spraying a wet

5 natural rubber coagulum with an aqueous solution of the bleaching agent in order to prepare the mixture formed of the coagulum and of the bleaching agent. When stage a) is preceded by a spraying stage, the wet natural rubber coagulum is preferably sprayed with an aqueous solution of the bleaching agent in a proportion of 1 to 3 litres of solution per kilogram of dry natural rubber, it being known that the solution has a concentration ranging

10 from 5 to 200 grams, preferentially from 20 to 100 grams, of the bleaching agent per litre of solution. According to this first alternative, the endless screw machine is typically fed with the wet natural rubber coagulum impregnated with the bleaching agent via a hopper equipping the endless screw machine.

According to a second alternative of the invention, the bleaching agent is injected into the

15 coagulum in the barrel of the endless screw machine via an injection device which equips the barrel and which comprises one or more orifices emerging in the barrel. Typically, the endless screw machine is fed with a wet natural rubber coagulum and the bleaching agent is continuously introduced into the coagulum by injecting the bleaching agent into the barrel of the extruder. Preferably, the bleaching agent is injected in the form of an aqueous

20 solution. The concentration of the bleaching agent in the aqueous solution can vary over a wide range and it is adjusted by a person skilled in the art as a function of the solubility of the bleaching agent and of the targeted amount of the bleaching agent to be added to the natural rubber. For example, it can vary over a range extending from 50 g/l to 500 g/l of bleaching agent per litre of solution.

25 In order to make possible the injection of the bleaching agent into the barrel, the extruder of use for the requirements of the invention is equipped with an injection device which comprises one or more orifices emerging in the barrel. The orifices referred to as injection points are preferably located downstream of the feed zone, preferentially in a compression zone downstream of the feed zone. The injection downstream of the feed zone limits,

30 indeed even eliminates, the portion of the bleaching agent which would not be incorporated in the natural rubber, which has the effect of increasing the effectiveness of the process. The location of the injection points in the compression zone makes it possible to increase even more the effectiveness of the process by providing good incorporation of the bleaching agent in the natural rubber and a sufficient contact time between the bleaching agent and

35 the natural rubber before the adiabatic expansion.

Preferably, the injection points are located at the radially interior end of the fingers which are carried by the barrel and which extend radially towards the inside of the barrel relative to the axis of rotation of the screw. In other words, each injection point is located at the radially interior end of a finger which is carried by the barrel and which extends radially

towards the inside of the barrel relative to the axis of rotation of the screw. This location of the injection points also makes it possible to ensure effective incorporation of the bleaching agent at the heart of the natural rubber and contributes to good distribution of the bleaching agent in the natural rubber.

- 5 More preferentially, the injection points are located in fingers carried by the barrel and extending radially towards the inside of the barrel relative to the axis of rotation of the screw, such fingers being positioned in the compression zone. This location of the injection points makes it possible to increase even more the effectiveness of the process by combining the benefits contributed by the location in the fingers and the location in the
10 compression zone.

According to one embodiment of the invention, the barrel carries a single finger extending radially towards the inside of the barrel relative to the axis of rotation of the screw and at the radially interior end of which an injection point is located, it being known that the barrel can carry other fingers extending radially towards the inside of the barrel relative to the axis
15 of rotation of the screw and at the end of which there is no injection point. These other fingers promote the kneading of the natural rubber in the barrel and help to mix the natural rubber and the bleaching agent.

Typically, the pressure at the injection point, in particular at the radially interior end of the finger, is greater than 0 bar relative, which reflects the presence of material (rubber
20 coagulum) at the injection point and makes it possible to ensure that the bleaching agent is indeed injected within the natural rubber. Injection of the bleaching agent into a space of the barrel not filled with natural rubber might result in a loss in effectiveness of the process. This is because the injection into an empty space promotes the risk of entrainment of a part of the bleaching agent with the water extracted from the coagulum. To improve even more
25 the effectiveness of the process, the pressure at the injection point is preferably greater than the saturated vapour pressure of water at the temperature of that of the injection point. The temperature of the injection point is determined by the temperature inside the barrel.

In stage a), the mixture formed of the coagulum and of the bleaching agent is compressed in
30 the barrel of the extruder. This compression is of use for subsequently subjecting the natural rubber to an adiabatic expansion. The pressure to which the mixture is compressed must be sufficient to make possible an adiabatic expansion at a pressure difference of at least 30 bar. At the pressure of use for the requirements of the invention in order to carry out the compression, the mixture is brought, in stage a), to a temperature ranging from 110°C to
35 210°C. In an endless screw machine, such as an extruder, the mechanical working under high pressure is accompanied by heating of the rubber material of the coagulum, which has the effect of increasing the temperature of the coagulum. Preferably, the mixture is compressed in stage a) at a temperature ranging from 120°C to 150°C. In order to achieve the temperatures of use for the requirements of the invention, heat can also be contributed by

heating the inside of the screw machine, such as the screw or the barrel of the extruder, by means of a heating system, such as a jacket or heating resistors.

The adiabatic expansion carried out in stage b) is characterized as flash expansion in that it makes it possible for the natural rubber to change from a compressed state to a non-compressed state virtually instantaneously, typically in a time of less than a second. It is carried out at a pressure difference of greater than or equal to 30 bar or at a pressure difference of greater than 100 bar. According to a first alternative form, the pressure difference in stage b) is at most 100 bar, in particular of between 30 and 80 bar, more particularly between 30 and 70 bar. According to a second alternative form, the pressure difference is greater than 100 bar, indeed even of at least 120 bar or 150 bar. The second alternative form exhibits the advantage of also reducing the nitrogen content in the natural rubber.

As the expansion is adiabatic, the expansion occurs at the temperature at which the compression was carried out. At the end of expansion, the coagulum is generally at atmospheric pressure and its moisture content is reduced, in particular to a content of less than 5%, preferably to a content of less than 3%. At the die outlet, the natural rubber can be cut up and then packaged or alternatively cut up, dried further and then packaged.

The natural rubber can be cut up at the die outlet by a means which is capable of cutting up the natural rubber and which is positioned downstream of the die. The means capable of cutting up the natural rubber can be a knife or a pelletizer, preferably a pelletizer.

Preferably, the natural rubber recovered at the die outlet is dried by additional drying in order to further reduce its residual moisture content, in particular to a content of less than 0.8%. Before the additional drying, the natural rubber is advantageously cut up at the die outlet by a means which is capable of cutting up the natural rubber and which is positioned downstream of the die. The means capable of cutting up the natural rubber can be a knife or a pelletizer, preferably a pelletizer. The divided state in which the natural rubber is found after having been cut up makes it possible to render the additional drying more effective.

The drying time is adjusted by a person skilled in the art as a function of the drying temperature and as a function of the residual water content in the natural rubber on conclusion of stage b). It is preferable to apply as short a drying time as possible in order to preserve the structure of the polyisoprene chains of the natural rubber and its properties. This is why a drying time of less than 10 minutes is recommended and preferred. In order to obtain, with such short drying times, a natural rubber containing less than 0.8% of water and regarded as being dry, the drying is preferentially convection drying. Any known means for convection drying may be suitable. In particular, a fluidized bed, such as a hot air vibrating sieve, is preferred, which is a known device conventionally used in processes for the manufacture of synthetic rubbers. Advantageously, the natural rubber recovered at the die outlet is dried by additional drying, preferably by convection drying, preferentially by means

of a fluidized bed, more preferentially by means of a hot air vibrating sieve. The convection drying is preferably carried out under air. The convection drying under air can be carried out at a temperature ranging from 90°C to 180°C, preferably at a temperature ranging from 90°C to 130°C, in particular from 110°C to 130°C.

5 According to a specific and preferential embodiment of the invention, the process additionally comprises a stage during which a viscosity stabilizer is added to the coagulum, in particular before stage a) or before stage b), in which case the natural rubber obtained according to the process is a “stabilized” natural rubber. Typically, the viscosity stabilizer is added inside the barrel, according to a first alternative form, or outside the barrel before
10 stage a), according to a second alternative form.

The viscosity stabilizers for stabilizing the viscosity of natural rubber are well known to a person skilled in the art of natural rubber. They make it possible to reduce or eliminate the tendency of natural rubber to harden on storage. Any compound known to stabilize the viscosity of natural rubber may be suitable as viscosity stabilizer of use for the requirements
15 of the invention. Mention may be made, for example, of hydroxylamine, its salts, hydroxyalkylamines, their salts, semicarbazide, dimedone, compounds having a triazole function and compounds having a hydrazide function. Preferably, the viscosity stabilizer is dimedone or a compound derived from ammonia chosen from compounds of formula XNH_2 and their salts, where X is a group chosen from hydroxyl and hydroxy(C_1-C_4)alkyl groups, or a
20 mixture of these compounds. The salt can be a weak acid salt of compounds of formula XNH_2 or a strong acid salt of compounds of formula XNH_2 optionally neutralized with a strong base. For the neutralization with a strong base, reference may be made, for example, to the description of Patent Application WO 2017085109. More preferentially, the viscosity stabilizer is hydroxylamine sulfate or hydroxylamine sulfate neutralized with sodium
25 hydroxide, very advantageously hydroxylamine sulfate.

According to the first alternative form, the viscosity stabilizer is introduced into the barrel of the extruder via an injection device which comprises one or more orifices emerging in the barrel. The injection device intended to inject the viscosity stabilizer typically has the characteristics of the injection device described for the injection of the bleaching agent. The
30 injection pressure and temperature conditions are also identical to those described for the injection of the bleaching agent. Preferably, the viscosity stabilizer is injected in the form of an aqueous solution. The viscosity stabilizer is distributed within the natural rubber under the effect of the mechanical forces exerted in the barrel during the operation of the extruder. It is assumed that the viscosity stabilizer reacts with the natural rubber in the
35 barrel under the effect of the heat contributed by the kneading and possibly by a system for heating the inside of the screw machine, such as a jacket or heating resistors.

According to the second alternative form, the addition of the viscosity stabilizer carried out outside the barrel before stage a) is typically performed by soaking the wet coagulum in the viscosity stabilizer or by spraying the wet coagulum with the viscosity stabilizer. The viscosity

stabilizer is generally used in solution, typically aqueous solution, for the soaking or spraying operations. To make it easier to bring the wet coagulum into contact with the viscosity stabilizer, in particular by soaking or by spraying, the wet coagulum is preferably provided in the form of crumbs and is advantageously decontaminated, in particular by a filtration stage, as described above. When the addition is carried out by a spraying stage, the wet coagulum is preferably sprayed with an aqueous solution of viscosity stabilizer in a proportion of 1 litre to 3 litres of solution per kilogram of natural rubber (dry rubber material), it being known that the solution has a concentration ranging from 2 grams to 30 grams of stabilizer per litre of solution.

- 10 When a viscosity stabilizer is added before stage a) of the process in accordance with the invention, the coagulum intended to feed the endless screw machine in stage a) of the process in accordance with the invention is a coagulum which then contains a viscosity stabilizer.

The amount of viscosity stabilizer added to the natural rubber according to the first alternative form or the second alternative form is adjusted by a person skilled in the art in order to obtain the desired stabilization of the viscosity of the natural rubber. It can vary within a wide range depending on the chemical nature of the viscosity stabilizer. It can vary within a range extending from 2.4 mmol to 24 mmol, more preferentially from 6 mmol to 24 mmol and more preferentially still from 8 mmol to 18 mmol equivalent of dimedone or equivalent of XNH_2 per kilogram of natural rubber.

The natural rubber, another subject matter of the invention, is a natural cup lump rubber exhibiting a Lovibond number of less than 5.5, preferentially of less than or equal to 5, more preferentially of less than or equal to 4. Preferably, the natural cup lump rubber has a Lovibond number of greater than 3. In particular, the natural cup lump rubber has a Lovibond number of greater than 3 and less than or equal to 5, preferentially of less than or equal to 4. The natural cup lump rubber in accordance with the invention can be prepared according to the process in accordance with the invention in which the wet natural rubber coagulum originates from a cup lump coagulum. Preferably, the natural rubber according to the invention exhibits a plasticity retention index of greater than 70, advantageously of greater than 80, and a Mooney viscosity $\text{ML}(1+4)$ at 100°C of less than 75, preferentially of between 50 and 75, more preferentially of between 50 and 70.

According to a particularly preferential embodiment of the invention, the natural cup lump rubber is devoid of impurities greater than 0.5 mm in size. Such a natural rubber can be prepared by a particularly preferential embodiment of the process in accordance with the invention which employs a stage of decontamination of the wet coagulum using an extruder and a suitable filtration means installed at the outlet of the extruder as described above. Alternatively, the decontamination of the wet coagulum can also be carried out in a well-known manner by washing actions on the coagulum formed into crumbs, these washing operations carried out in pools of water being repeated several times.

According to another particularly preferred embodiment of the invention, the natural cup lump rubber is a stabilized natural rubber which can be prepared by another particularly preferential embodiment of the process in accordance with the invention which employs an addition of a viscosity stabilizer to the coagulum as described above.

- 5 Advantageously, the natural cup lump rubber is devoid of impurities with a size of greater than 0.5 mm and is a stabilized natural rubber.

To sum up, the invention is advantageously implemented according to any one of the following embodiments 1 to 45:

- 10 Embodiment 1: Process for the preparation of a natural cup lump rubber which comprises the extrusion of a mixture of a natural cup lump rubber coagulum and of a bleaching agent for natural rubber in an endless screw machine equipped with a barrel, in which the screw revolves, and with a perforated die at the screw end, in which process:

- a) the mixture formed of the coagulum and of the bleaching agent is compressed at a temperature of greater than or equal to 110°C and less than or equal to 210°C in the barrel,
 15 b) an adiabatic flash expansion at a pressure difference of greater than or equal to 30 bar is carried out at the die outlet.

Embodiment 2: Process according to Embodiment 1, in which the bleaching agent is a bisulfite salt, a metabisulfite salt or their mixture.

- 20 Embodiment 3: Process according to Embodiment 2, in which the bisulfite salt is a bisulfite of an alkali metal or of an alkaline earth metal.

Embodiment 4: Process according to Embodiment 2, in which the metabisulfite salt is a metabisulfite of an alkali metal or of an alkaline earth metal.

- 25 Embodiment 5: Process according to either one of Embodiments 1 and 2, in which the bleaching agent is sodium metabisulfite, potassium metabisulfite or magnesium metabisulfite or also a mixture of at least two of them.

Embodiment 6: Process according to any one of Embodiments 1 to 5, in which the bleaching agent is used at a content ranging from 0.5 to 20 grams of the bleaching agent per kilogram of dry natural rubber.

- 30 Embodiment 7: Process according to any one of Embodiments 1 to 6, in which the bleaching agent is used at a content ranging from 2 to 10 grams of the bleaching agent per kilogram of dry natural rubber.

Embodiment 8: Process according to any one of Embodiments 1 to 7, in which stage a) is preceded by a stage of soaking a wet natural rubber coagulum in an aqueous solution of the bleaching agent or by a stage of spraying a wet natural rubber coagulum with an aqueous

solution of the bleaching agent in order to prepare the mixture formed of the coagulum and of the bleaching agent.

Embodiment 9: Process according to Embodiment 8, in which the wet natural rubber coagulum is sprayed with an aqueous solution of the bleaching agent in a proportion of 1 to 3 litres of solution per kilogram of dry natural rubber, the solution having a concentration ranging from 5 to 200 grams.

Embodiment 10: Process according to Embodiment 8 or 9, in which the wet natural rubber coagulum is sprayed with an aqueous solution of the bleaching agent in a proportion of 1 to 3 litres of solution per kilogram of dry natural rubber, the solution having a concentration ranging from 20 to 100 grams of the bleaching agent per litre of solution.

Embodiment 11: Process according to any one of Embodiments 1 to 7, in which the endless screw machine is fed with a wet natural rubber coagulum and the bleaching agent is injected into the coagulum in the barrel via an injection device which equips the barrel and which comprises one or more orifices emerging in the barrel.

Embodiment 12: Process according to Embodiment 11, in which the bleaching agent is injected in the form of an aqueous solution.

Embodiment 13: Process according to any one of Embodiments 8 to 12, in which the wet natural rubber coagulum contains more than 5% by weight of water.

Embodiment 14: Process according to any one of Embodiments 8 to 13, in which the wet natural rubber coagulum contains between 5% and 40% by weight of water.

Embodiment 15: Process according to any one of Embodiments 8 to 14, in which the wet natural rubber coagulum contains between 10% and 30% by weight of water.

Embodiment 16: Process according to any one of Embodiments 1 to 15, in which, the endless screw machine comprising a feed zone, the injection point(s) are located in a compression zone downstream of the feed zone of the extruder.

Embodiment 17: Process according to Embodiment 16, in which the injection point(s) are located at the radially interior end of fingers which are carried by the barrel and which extend radially towards the inside of the barrel relative to the axis of rotation of the screw.

Embodiment 18: Process according to either one of Embodiments 16 and 17, in which the pressure at the injection point is greater than 0 bar relative.

Embodiment 19: Process according to any one of Embodiments 16 to 18, in which the pressure at the injection point is greater than the saturated vapour pressure of water at the temperature of that of the injection point.

Embodiment 20: Process according to any one of Embodiments 1 to 19, in which the mixture formed of the coagulum and of the bleaching agent is compressed in stage a) at a temperature ranging from 120°C to 150°C.

5 Embodiment 21: Process according to any one of Embodiments 1 to 20, in which the pressure difference in stage b) is at most 100 bar.

Embodiment 22: Process according to any one of Embodiments 1 to 21, in which the pressure difference in stage b) is of between 30 and 80 bar.

Embodiment 23: Process according to any one of Embodiments 1 to 22, in which the pressure difference in stage b) is of between 30 and 70 bar.

10 Embodiment 24: Process according to any one of Embodiments 1 to 23, in which the natural rubber recovered at the die outlet is dried by additional drying.

Embodiment 25: Process according to Embodiment 24, in which the additional drying is convection drying.

15 Embodiment 26: Process according to Embodiment 24 or 25, in which the additional drying is convection drying under air at a temperature ranging from 90°C to 180°C.

Embodiment 27: Process according to any one of Embodiments 24 to 26, in which the additional drying is convection drying under air at a temperature ranging from 110°C to 130°C.

20 Embodiment 28: Process according to any one of Embodiments 24 to 27, in which the additional drying is convection drying by means of a fluidized bed.

Embodiment 29: Process according to any one of Embodiments 24 to 28, in which the additional drying is convection drying by means of a hot air vibrating sieve.

25 Embodiment 30: Process according to any one of Embodiments 24 to 29, in which, before the additional drying, the natural rubber recovered at the die outlet is cut up by a means which is capable of cutting up the natural rubber and which is positioned downstream of the die, preferably a pelletizer.

Embodiment 31: Process according to any one of Embodiments 1 to 30, which process comprises a stage during which a viscosity stabilizer is added before stage a) or before stage b).

30 Embodiment 32: Process according to Embodiment 31, in which the viscosity stabilizer is hydroxylamine, its salts, hydroxyalkylamines, their salts, semicarbazide, dimedone, compounds having a triazole function and compounds having a hydrazide function.

Embodiment 33: Process according to either one of Embodiments 31 and 32, in which the viscosity stabilizer is a compound derived from ammonia chosen from compounds of formula XNH_2 and their salts, where X is a group chosen from hydroxyl and hydroxy(C_1-C_4)alkyl groups, or a mixture of these compounds.

- 5 Embodiment 34: Process according to any one of Embodiments 31 to 33, in which the viscosity stabilizer is added at a content ranging from 2.4 mmol to 24 mmol, preferentially from 6 mmol to 24 mmol, more preferentially from 8 mmol to 18 mmol equivalent of dimedone or equivalent of XNH_2 per kilogram of natural rubber.

- 10 Embodiment 35: Process according to any one of Embodiments 31 to 34, in which the coagulum is a coagulum decontaminated by a filtration stage.

Embodiment 36: Natural cup lump rubber exhibiting a Lovibond number of less than 5.5.

Embodiment 37: Natural cup lump rubber according to Embodiment 36, exhibiting a Lovibond number of less than or equal to 5.

- 15 Embodiment 38: Natural cup lump rubber according to Embodiment 36, exhibiting a Lovibond number of less than or equal to 4.

Embodiment 39: Natural cup lump rubber according to any one of Embodiments 36 to 38, exhibiting a plasticity retention index of greater than 70 and a Mooney viscosity ML(1+4) at 100°C of less than 75.

- 20 Embodiment 40: Natural cup lump rubber according to Embodiment 39, exhibiting a Mooney viscosity ML(1+4) at 100°C of between 50 and 75.

Embodiment 41: Natural cup lump rubber according to Embodiment 39, exhibiting a Mooney viscosity ML(1+4) at 100°C of between 50 and 70.

Embodiment 42: Natural cup lump rubber according to any one of Embodiments 39 to 41, exhibiting a plasticity retention index of greater than 80.

- 25 Embodiment 43: Natural cup lump rubber according to any one of Embodiments 36 to 42, which natural rubber is stabilized.

Embodiment 44: Natural cup lump rubber according to any one of Embodiments 36 to 43, which natural rubber is devoid of impurities with a size of greater than 0.5 mm.

- 30 Embodiment 45: Natural cup lump rubber according to any one of Embodiments 36 to 44, which natural rubber has a Lovibond number of greater than 3.

A better understanding of the abovementioned characteristics of the present invention, and also others, will be obtained on reading the following description of several

implementational examples of the invention, which are given by way of illustration and without limitation.

Examples

Moisture content of natural rubbers:

- 5 The water content in a natural rubber (or moisture content of a natural rubber) is determined with a Mettler Toledo HB43-S halogen moisture analyser. The moisture analyser is an automated device which incorporates a crucible, a balance and a cover intended to close the crucible. The crucible is positioned on the balance. The cover comprises a means for heating by a halogen lamp, this heating means being triggered when the cover is lowered
10 onto the crucible. In the crucible, a sample of 10 grams of natural rubber is weighed exactly: the device records the corresponding weight "a". The cover is lowered to close the crucible, which triggers the temperature rise to reach a setpoint of 160°C. When the device detects a reduction in weight of less than 0.001 g per minute, the device takes a reading of a weight
15 equation:

$$\text{Water content (\%)} = 100 * ((a-b)/a)$$

Lovibond number:

- The number in the Lovibond scale is measured according to the method described in the document entitled "RRIM Test Methods for Standard Malaysian Rubbers", *SMR Bull. No. 7*,
20 *Rubb. Res. Inst. Malaysia*, Revised Edition 1992 by Yu Tong, published and printed by the Rubber Research Institute of Malaysia, Part B.10.

Mooney viscosity:

- Use is made, in order to measure the Mooney viscosity (ML), of an oscillating consistometer as described in Standard ASTM D1646-2007 (Reapproved 2012). The measurement of the
25 Mooney viscosity is carried out according to the following principle: the natural rubber is moulded in a cylindrical chamber heated to 100°C. After preheating for one minute, the rotor rotates within the test specimen at 2 revolutions/minute and the working torque for maintaining this movement is measured after 4 minutes of 8 rotations. The Mooney viscosity (ML(1+4)) is expressed in "Mooney units" (MU, with 1 MU = 0.83 newton.metre).

- 30 Plasticity retention index:

The plasticity retention index (PRI) is measured according to Standard ASTM D 3194-04.

Preparation of a natural rubber NR1 according to a process not in accordance with the invention:

An extruder is fed with a cup lump coagulum in the form of crumbs having a water content of 25.8%. The extruder is a single-screw extruder; it is equipped with a perforated die at the screw end and with a pelletizer positioned at the die outlet. The extruder comprises a jacket, and its barrel exhibits, in the feed zone, means for discharging water (grooves, slits, holes).

5 The speed of the screw is 150 revolutions/min, the pressure is 43 bar, the temperature of the coagulum is 132°C, the temperature and the pressure being measured by sensors positioned as close as possible to the die, between the die and the end of the screw closest to the die. Once it has left the extruder, the coagulum in the form of crumbs is dried on a hot air vibrating sieve at a temperature of 110°C for approximately 5 minutes. The natural
10 rubber NR1 is recovered.

Preparation of a natural rubber NR2 according to a process not in accordance with the invention:

The same starting coagulum as that used to feed the extruder in the process for the manufacture of NR1, also in the form of crumbs, was dried according to a traditional process
15 conventionally used for the manufacture of the TSR20 grade, that is to say drying in a tunnel under hot air at a temperature ranging from 108°C to 125°C for 4 hours 30 minutes. The natural rubber NR2 is recovered.

Preparation of a natural rubber NR3 according to a process not in accordance with the invention:

20 An extruder is fed with a cup lump coagulum in the form of crumbs having a water content of 15.3%. The coagulum is a coagulum matured for 45 days, that is to say a cup lump coagulum which has undergone maturation for 45 days, maturation being a phenomenon well known to a person skilled in the art of natural rubber. Typically, the latex, after oozing out from the rubber tree into the cup, coagulates and is left to itself for the maturing time.

25 The extruder is a single-screw extruder; it is equipped with a perforated die at the screw end and with a pelletizer positioned at the die outlet. The extruder comprises a jacket, and its barrel exhibits, in the feed zone, means for discharging water. The speed of the screw is 150 revolutions/min, the pressure is 51 bar, the temperature of the coagulum is 132°C, the temperature and the pressure being measured by sensors positioned as close as possible to
30 the die, between the die and the end of the screw closest to the die. At the outlet of the extruder, the natural rubber is recovered in the form of crumbs which are subsequently dried on a hot air vibrating sieve at a temperature of 110°C for approximately 5 minutes.

Preparation of a natural rubber NR4 according to a process not in accordance with the invention:

35 The same starting coagulum as that used to feed the extruder in the process for the manufacture of NR3, also in the form of crumbs, was dried according to a traditional process conventionally used for the manufacture of the TSR20 grade, that is to say drying in a tunnel

under hot air at a temperature ranging from 108°C to 125°C for 4 hours 30 minutes. The natural rubber NR4 is recovered.

Preparation of a natural rubber NR5 according to an embodiment of the process in accordance with the invention:

- 5 The natural rubber NR5 is prepared according to a process which differs from the process for the manufacture of NR1 in that sodium metabisulfite is added to the wet coagulum before its introduction into the extruder according to the following conditions. 20 kg of natural rubber coagulum having a water content of 25.8% and being in the form of crumbs are sprayed three times in succession with 10 litres of an aqueous solution of sodium
- 10 metabisulfite at a concentration of 100 g/l. The content of impurities in the natural rubber NR5 is 0.04%. The content of impurities in a natural rubber is well known in the field of natural rubber under the term "dirt content", which refers to a method of the Rubber Research Institute of Malaysia intended for Malaysian standard rubbers. According to this standard, the "dirt content" value expresses the percentage of impurities in natural rubber
- 15 which have a size of greater than 44 µm.

Preparation of a natural rubber NR6 according to an embodiment of the process in accordance with the invention:

- The natural rubber NR6 is prepared according to a process which differs from the process for the manufacture of NR3 in that sodium metabisulfite is added to the wet coagulum before
- 20 its introduction into the extruder according to the following conditions. 20 kg of natural rubber coagulum matured for 45 days having a water content of 15.3% and being in the form of crumbs are sprayed three times in succession with 10 litres of an aqueous solution of sodium metabisulfite at a concentration of 100 g/l.

- 25 Preparation of a natural rubber NR7 according to an embodiment of the process in accordance with the invention:

- The natural rubber NR7 is prepared according to a process which differs from the process for the manufacture of NR1 in that sodium metabisulfite and hydroxylamine sulfate are added to the wet coagulum before its introduction into the extruder according to the following conditions. 20 kg of natural rubber coagulum having a water content of 25.8% and being in
- 30 the form of crumbs are sprayed three times in succession with 10 litres of an aqueous solution of sodium metabisulfite and of hydroxylamine sulfate with respective concentrations of 100 g/l and 15 g/l.

Preparation of a natural rubber NR8 according to an embodiment of the process in accordance with the invention:

- 35 The natural rubber NR8 is prepared according to a process which differs from the process for the manufacture of NR3 in that sodium metabisulfite is added to the wet coagulum before

its introduction into the extruder according to the following conditions. 20 kg of natural rubber coagulum matured for 45 days having a water content of 15.3% and being in the form of crumbs are sprayed three times in succession with 10 litres of an aqueous solution of sodium metabisulfite and of hydroxylamine sulfate with respective concentrations of 100 g/l and 15 g/l.

Preparation of a natural rubber NR9 according to an embodiment of the process in accordance with the invention:

The natural rubber NR9 is prepared according to a process which differs from the process for the manufacture of NR1 in that sodium metabisulfite is continuously injected into the extruder according to the following procedure and in that the convection drying of the natural rubber is carried out at 120°C. The extruder is also equipped with holes for injecting the sodium metabisulfite. A finger according to the invention is used for the injection of the sodium metabisulfite and other fingers are installed between the injection point and the die in order to promote the compounding between the sodium metabisulfite and the natural rubber. The speed of the screw is 150 revolutions/min, the pressure at the injection point for the sodium metabisulfite solution is 14.5 bar, the temperature of the coagulum at the injection point is 82°C. An aqueous sodium metabisulfite solution prepared at 500 grams of sodium metabisulfite per litre of solution is continuously injected into the extruder at the injection point. An amount by weight of sodium metabisulfite, with respect to the dry natural rubber, in a proportion of 1 part by weight of sodium metabisulfite per 100 parts by weight of dry natural rubber, is continuously injected into the extruder. At the outlet of the extruder, the natural rubber is recovered in the form of crumbs which are subsequently dried on a hot air vibrating sieve at a temperature of 120°C for approximately 5 minutes. The same starting coagulum as that used to feed the extruder in the process for the manufacture of NR1 was used in the form of crumbs.

Preparation of a natural rubber NR10 according to an embodiment of the process in accordance with the invention:

The natural rubber NR10 is prepared according to a process which differs from the process for the manufacture of NR3 in that sodium metabisulfite is continuously injected into the extruder according to the following procedure and in that the convection drying of the natural rubber is carried out at 120°C. The extruder is also equipped with holes for injecting the sodium metabisulfite. A finger according to the invention is used for the injection of the sodium metabisulfite and other fingers are installed between the injection point and the die in order to promote the compounding between the sodium metabisulfite and the natural rubber. The speed of the screw is 150 revolutions/min, the pressure at the injection point for the sodium metabisulfite solution is 1.2 bar, the temperature of the coagulum at the injection point is 91°C. An aqueous sodium metabisulfite solution prepared at 500 grams of sodium metabisulfite per litre of solution is continuously injected into the extruder at the injection point. An amount by weight of sodium metabisulfite, with respect to the dry

natural rubber, in a proportion of 1 part by weight of sodium metabisulfite per 100 parts by weight of dry natural rubber, is continuously injected into the extruder. At the outlet of the extruder, the natural rubber is recovered in the form of crumbs which are subsequently dried on a hot air vibrating sieve at a temperature of 120°C for approximately 5 minutes. As
 5 for the manufacture of NR3, the coagulum is a coagulum matured for 45 days having a water content of 15.3% and being in the form of crumbs.

Preparation of a natural rubber NR11 according to an embodiment of the process in accordance with the invention:

10 The natural rubber NR11 is prepared according to a process which differs from the process for the manufacture of NR1 in that sodium metabisulfite is continuously injected into the extruder according to the following procedure and in that the convection drying of the natural rubber is carried out at 120°C. The extruder is also equipped with holes for injecting the sodium metabisulfite. A finger according to the invention is used for the injection of the sodium metabisulfite and other fingers are installed between the injection point and the die
 15 in order to promote the compounding between the sodium metabisulfite and the natural rubber. The speed of the screw is 150 revolutions/min, the pressure at the injection point for the sodium metabisulfite solution is 18.6 bar, the temperature of the coagulum at the injection point is 82°C. An aqueous sodium metabisulfite solution prepared at 500 grams of sodium metabisulfite per litre of solution is continuously injected into the extruder at the
 20 injection point. An amount by weight of sodium metabisulfite, with respect to the dry natural rubber, in a proportion of 1 part by weight of sodium metabisulfite per 100 parts by weight of dry natural rubber, is continuously injected into the extruder. At the outlet of the extruder, the natural rubber is recovered in the form of crumbs which are subsequently dried on a hot air vibrating sieve at a temperature of 120°C for approximately 5 minutes. The
 25 same starting coagulum as that used to feed the extruder in the process for the manufacture of NR1 was used in the form of crumbs.

Preparation of a natural rubber NR12 according to an embodiment of the process in accordance with the invention:

30 The natural rubber NR12 is prepared according to a process which differs from the process for the manufacture of NR3 in that sodium metabisulfite is continuously injected into the extruder according to the following procedure and in that the convection drying of the natural rubber is carried out at 120°C. The extruder is also equipped with holes for injecting the sodium metabisulfite. A finger according to the invention is used for the injection of the sodium metabisulfite and other fingers are installed between the injection point and the die
 35 in order to promote the compounding between the sodium metabisulfite and the natural rubber. The speed of the screw is 150 revolutions/min, the pressure at the injection point for the sodium metabisulfite solution is 4.5 bar, the temperature of the coagulum at the injection point is 92°C. An aqueous sodium metabisulfite solution prepared at 500 grams of sodium metabisulfite per litre of solution is continuously injected into the extruder at the

injection point. An amount by weight of sodium metabisulfite, with respect to the dry natural rubber, in a proportion of 1 part by weight of sodium metabisulfite per 100 parts by weight of dry natural rubber, is continuously injected into the extruder. At the outlet of the extruder, the natural rubber is recovered in the form of crumbs which are subsequently
 5 dried on a hot air vibrating sieve at a temperature of 120°C for approximately 5 minutes. As for the manufacture of NR3, the coagulum is a coagulum matured for 45 days having a water content of 15.3% and being in the form of crumbs.

Preparation of a natural rubber NR13 according to a process not in accordance with the invention:

10 The natural rubber NR13 is prepared according to a process which differs from the process for the manufacture of NR2 in that sodium metabisulfite is added to the wet coagulum before its introduction into the dryer according to the following conditions. 20 kg of natural rubber coagulum having a water content of 25.8% and being in the form of crumbs are sprayed three times in succession with 10 litres of an aqueous solution of sodium
 15 metabisulfite at a concentration of 50 g/l.

Preparation of a natural rubber NR14 according to a process not in accordance with the invention:

The natural rubber NR14 is prepared according to a process which differs from the process for the manufacture of NR2 in that sodium metabisulfite and hydroxylamine sulfate are
 20 added to the wet coagulum before its introduction into the dryer according to the following conditions. 20 kg of natural rubber coagulum having a water content of 25.8% and being in the form of crumbs are sprayed three times in succession with 10 litres of an aqueous solution of sodium metabisulfite and of hydroxylamine sulfate with respective concentrations of 50 g/l and 15 g/l.

25 Preparation of a natural rubber NR15 according to a process not in accordance with the invention:

The natural rubber NR15 is prepared according to a process which differs from the process for the manufacture of NR4 in that sodium metabisulfite is added to the wet coagulum before its introduction into the dryer according to the following conditions. 20 kg of natural
 30 rubber coagulum matured for 45 days and formed into crumbs and having a water content of 15.3% are sprayed three times in succession with 10 litres of an aqueous solution of sodium metabisulfite at a concentration of 50 g/l: the mixture of wet coagulum and of bleaching agent which feeds the extruder then has a water content of 25.8%.

35 Preparation of a natural rubber NR16 according to a process not in accordance with the invention:

- The natural rubber NR16 is prepared according to a process which differs from the process for the manufacture of NR4 in that sodium metabisulfite and hydroxylamine sulfate are added to the wet coagulum before its introduction into the dryer according to the following conditions. 20 kg of natural rubber coagulum matured for 45 days formed into crumbs are
- 5 sprayed three times in succession with 10 litres of an aqueous solution of sodium metabisulfite and of hydroxylamine sulfate respectively at 50 g/l and at 15 g/l: the mixture of wet coagulum and of bleaching agent which feeds the extruder then has a water content of 25.8%.

Natural rubber	Process	Water content in the wet coagulum (%)	Lovibond number	ML	PRI
NR1	Not in accordance	25.8	6	48	83
NR2	Not in accordance (TSR20)	25.8	9	67	77
NR3	Not in accordance	15.3	7	59	95
NR4	Not in accordance	15.3	8	84	71
NR5	In accordance	25.8	3.5	51	100
NR6	In accordance	15.3	4.5	66	106
NR7	In accordance	25.8	3.5	51	94
NR8	In accordance	15.3	6	61	95
NR9	In accordance	25.8	3.5	52	101
NR10	In accordance	15.3	4	72	96
NR11	In accordance	25.8	3.5	55	97
NR12	In accordance	15.3	5	65	92

NR13	Not in accordance	25.8	8	67	81
NR14	Not in accordance	25.8	9	66	81
NR15	Not in accordance	15.3	9	78	63 5
NR16	Not in accordance	15.3	8	81	76
NR17	In accordance	25.8	3.5	50	90

Table 1

Preparation of a natural rubber NR17 according to an embodiment of the process in accordance with the invention:

The natural rubber NR17 is prepared according to a process which differs from the process for the manufacture of NR1 in that sodium metabisulfite is added to the wet coagulum before its introduction into the extruder according to the following conditions. 20 kg of natural rubber coagulum having a water content of 25.8% and being in the form of crumbs are sprayed three times in succession with 10 litres of an aqueous solution of sodium metabisulfite at a concentration of 50 g/l.

All the natural rubbers recovered after drying are dry: their moisture content is less than 0.8%.

The Lovibond number was measured for each of the natural rubbers NR1 to NR17. The results appear in Table 1.

The results show that the natural rubbers obtained by the process in accordance with the invention have a Lovibond number which is much lower than that of the natural rubber of TSR20 grade. These results are even obtained in the presence of a maturing of the natural rubber or in the presence of a stabilization of the natural rubber. The process in accordance with the invention also makes it possible to obtain natural cup lump rubbers having a Lovibond number which is as low as, indeed even lower than, that of the latex natural rubber TSR 5L for which a Lovibond number of 6 is specified. The natural rubber in accordance with the invention can thus be used in rubber compositions, in particular for tyres, and can advantageously replace natural rubbers of TSR 5L and TSR 3L grades, for example in applications where a low colouring of the natural rubber is desired.

Claims

1. Process for the preparation of a natural cup lump rubber which comprises the extrusion of a mixture of a natural cup lump rubber coagulum and of a bleaching agent for natural rubber in an endless screw machine equipped with a barrel, in which the screw revolves,
5 and with a perforated die at the screw end, in which process:
 - a) the mixture formed of the coagulum and of the bleaching agent is compressed at a temperature of greater than or equal to 110°C and less than or equal to 210°C in the barrel,
 - b) an adiabatic flash expansion at a pressure difference of greater than or equal to 30 bar is
10 carried out at the die outlet.
2. Process according to Claim 1, in which the bleaching agent is a bisulfite salt, a metabisulfite salt or their mixture, the bisulfite salt preferentially being a bisulfite of an alkali metal or of an alkaline earth metal, the metabisulfite salt preferentially being a metabisulfite of an alkali metal or of an alkaline earth metal.
- 15 3. Process according to either one of Claims 1 and 2, in which the bleaching agent is used at a content ranging from 0.5 to 20 grams of the bleaching agent per kilogram of dry natural rubber, preferentially from 2 to 10 grams of the bleaching agent per kilogram of dry natural rubber.
- 20 4. Process according to any one of Claims 1 to 3, in which stage a) is preceded by a stage of soaking a wet natural cup lump rubber coagulum in an aqueous solution of the bleaching agent or by a stage of spraying a wet natural cup lump rubber coagulum with an aqueous solution of the bleaching agent in order to prepare the mixture formed of the coagulum and of the bleaching agent.
- 25 5. Process according to Claim 4, in which the wet natural cup lump rubber coagulum is sprayed with an aqueous solution of the bleaching agent in a proportion of 1 to 3 litres of solution per kilogram of dry natural rubber, the solution having a concentration ranging from 5 to 200 grams, preferentially from 20 to 100 grams, of the bleaching agent per litre of solution.
- 30 6. Process according to any one of Claims 1 to 3, in which the endless screw machine is fed with a wet natural cup lump rubber coagulum and the bleaching agent is injected into the coagulum in the barrel via an injection device which equips the barrel and which comprises one or more orifices emerging in the barrel.
7. Process according to Claim 6, in which the bleaching agent is injected in the form of an aqueous solution.

8. Process according to any one of Claims 4 to 7, in which the wet natural cup lump rubber coagulum contains more than 5% by weight of water, in particular between 5% and 40% by weight of water, preferentially between 8% and 30% by weight of water, more preferentially between 10% and 30% by weight of water.
- 5 9. Process according to any one of Claims 1 to 8, in which the natural rubber recovered at the die outlet is dried by additional drying, preferably by convection drying, preferentially by means of a fluidized bed, more preferentially by means of a hot air vibrating sieve.
- 10 10. Process according to Claim 9, in which the additional drying is convection drying under air at a temperature ranging from 90°C to 180°C, preferably from 110°C to 130°C.
11. Process according to Claim 9 or 10, in which, before the additional drying, the natural rubber recovered at the die outlet is cut up by a means which is capable of cutting up the natural rubber and which is positioned downstream of the die, preferably a pelletizer.
12. Process according to any one of Claims 1 to 11, which process comprises a stage during
15 which a viscosity stabilizer is added before stage a) or before stage b).
13. Natural cup lump rubber exhibiting a Lovibond number of less than 5.5, preferentially of less than or equal to 5, more preferentially of less than or equal to 4.
14. Natural cup lump rubber according to Claim 13, exhibiting a plasticity retention index of
20 greater than 70 and a Mooney viscosity ML(1+4) at 100°C of less than 75, preferentially of between 50 and 75.