METHOD AND SYSTEM FOR WRAPPING LOADS WITH PRE-STRETCHED PLASTIC FILM

A method for wrapping loads with a pre-stretched extensible plastic film (F) by means of a pair of pre-stretching cylinders (2,3) after which the film is being wrapped continuously around a load (100) to make a package of the same. The method according to the invention consists of the following phases: a) apply a special pre-stretching elongation to the portion of film (F) comprised between said pair of pre-stretching cylinders (2,3); b) wrap the pre-stretched film around the load with the “normal” method; c) monitor continuously the condition of the portion of film (F) subject to pre-stretching; d) stop applying said pre-stretching as soon as it is found that the film (F) stalls to break; e) continue wrapping the film (F) around the load (100) with a temporary method preventing the film from breaking completely; f) after the portion of film (F) that started to break has completely overcome the pair of cylinders (2,3), apply the pre-stretching again to the portion of film (F) comprised between said pair of cylinders (2,3); and, g) after the portion of film that started to break is sufficiently fastened to the stack, continue wrapping the film around the load with the "normal" method.
METHOD AND SYSTEM FOR WRAPPING LOADS WITH PRE-STRETCHED PLASTIC FILM

Technical Field
This invention refers to a method and system for wrapping loads with a pre-stretched extensible plastic film.

Background art
When a load is transported it is usually placed on a pallet and wrapped with a thin plastic film that conveniently stabilises the load during any further handling of the pallet, and may also protect it.

There are currently different methods to make said stabilising covering. One widely used method entails the use of a thin plastic film, typically extensible, that is wound several times around the palletised load, tightly wrapping it. As is common knowledge, to make such a stabilising covering machines are used equipped with a winding head, carrying a reel supplying plastic film. Said winding head can move vertically, wrapping the plastic film helicoidally on the periphery of the palletised load that turns on a swivel platform, or it can move in a vertical direction with a planetary movement around the palletised load that stays still.

In either case the palletised load is wrapped with several layers of film, each comprising one winding of plastic film, until the desired stabilising covering is created. Once wrapped, the end piece of plastic film is secured to the side surface, to the covering layer immediately beneath it, to prevent the stabilising covering from unravelling during subsequent handling of the load. Hence, said end piece is cut and separated from the supply reel.

It is also common knowledge that the majority of plastic films used for wrapping loads, improve their resistance properties, especially to traction, if they are pre-stretched. For example, in the case of low density polyethylene (LLDPE), after the elastic limit has been exceeded that corresponds to an elongation of approximately 40% up to an elongation of approximately 400% (which is the point at which the film breaks), we have a progressive increase in
resistance to traction and a loss of elastic properties.  
As a result there are various advantages:  
a saving on the quantity of material used for wrapping and therefore more economical;  
5 the film's resistance to traction increases which means the load can be wrapped more strongly, giving it greater stability;  
the film becomes more rigid so that even particularly soft loads can be wrapped effectively without excessive residual elasticity deforming them to an extent that cannot be tolerated.

10 More specifically; this invention refers to a method and system for wrapping loads with an extensible film that passes through a pair of pre-stretching cylinders before being wrapped continuously around a load (relatively big) so as to wrap it, creating a stabilising covering for it.  
Systems exist that have a pair of pre-stretching cylinders between which the film passes. The downstream cylinder, with respect to the direction in which the film is being fed, is made to turn at a peripherally higher speed than the upstream cylinder which, thanks to the friction created between their surfaces and the film, elongates the film beyond the elastic limit, pre-stretching it, before it reaches the load to wrap.

20 However, the systems and methods of known technique do not allow the film to be fully exploited which is achieved close to its breaking point.  
In fact, if the film breaks completely because of excessive pre-stretching, the system has to be stopped and then started again after someone has removed the piece of film wrapped around the rollers and that did not reach the load.

25 Furthermore, in these cases it is often necessary to start all over again, wrapping the load from scratch.  
And then of course all films have imperfections which nothing can be done about: their thickness (thinness) is not always completely uniform and can differ up to 20% compared to what is declared, or there can be a discontinuity in the lamination process when the film is being produced so, if pre-stretching is high, coming too close to the theoretical maximum limit, there is the risk of breaking it completely as the actual maximum pre-stretching limit it can be subject to
varies along its entire length. Because of this, precautional measures are taken by users to avoid stopping the system: the pre-stretching degree of the film used is kept well below the theoretical maximum value.

5 Disclosure of the invention

The purpose of this invention is to achieve a method and a system for wrapping loads with a pre-stretched extensible plastic film, working safely with pre-stretching values very close to the theoretical values of the material used and which are well above the pre-stretching values actually applied in the known technique under safe conditions; this will increment the yield of the film with a simple and rational solution.

This purpose is reached by a method and system in agreement with claims 1 and 9 respectively.

Each claim outlines preferred and particularly advantageous forms of embodiment of the method and system according to the invention.

Brief Description of the Drawings

Further characteristics and advantages of the invention will appear even more evident from the following description given by way of non limiting example, with the aid of the figures shown in the accompanying drawings, wherein:

- figure 1 shows a schematic side view of a system for wrapping loads with pre-stretched extensible plastic film in agreement with this invention;
- figure 2 shows a schematic and simplified plan view of the system of figure 1;
- figure 3 shows a simplified diagram of managing pre-stretching of the system of figure 1.

Ways of carrying out the Invention

With special reference to such figures, a system for wrapping loads with pre-stretched extensible plastic film, indicated by F, has been generally designated by reference numeral 1.

As illustrated in figure 1, said system 1 comprises, summarily, a winding head 10 supporting a reel 11 supplying the film F. The reel 11 is carried by a robot 12
that, standing on the ground by means of a base 13, moves the winding head 10 in relation to a load 100 placed on a pallet 101 which does not move. Alternatively, it is possible to move the load 100 with pallet 101 in relation to the winding head 10.

5 In the example illustrated, the film F unwinds from the winding head 10 which can perform a relative rotational movement around the palletised load 100 and a relative vertical movement to wrap the load 100 helicoidally on its sides, following a pre-established wrapping direction, indicated by A.

In this way, the palletised load 100 is wrapped with several layers of film, each defined by a winding of the film F, until the desired stabilising covering is created.

When the load 100 is wrapped, the film F is cut and separated from the supply reel 11.

To improve the wrapping characteristics of the film F, it undergoes preliminary pre-stretching during which it suffers permanent deformation which diminishes its elasticity, giving us a more rigid and stable packaging compared to a film that is not pre-stretched.

In agreement with this invention and as can be see in the schematic figure 2, the head 10 comprises a pair of pre-stretching rollers or cylinders 2,3 between which the film F of extensible plastic material passes.

The film F unwinds from the reel 11, adjacent to which is the first of the two pre-stretching cylinders 2,3, that is, the upstream one. In particular, said upstream cylinder 2 is mounted between a pair of oscillating arms 21 operated by a jack 20, by means of which its position can be adjusted in relation to the reel 11.

The cylinders 2,3 are coated with a substance, rubber or other material; that exerts a high force of friction on the film F which pre-stretches the portion F running from the upstream cylinder 2 to the downstream cylinder 3 that is turning faster.

30 The two cylinders 2,3 are operated by electric motors 25,35, whose speeds are set at a constant ratio so as to ensure a constant degree of pre-stretching, controlled by encoders 27, 37 and managed by a programmable logic unit 60.
Preferably, a presser roller 4, pushed by a jack 40, works against the downstream cylinder 3 preventing the film F from slipping. Before the film F can actually be wrapped around the load 100, as described above and illustrated in figure 1, and after being pre-stretched by the two cylinders 2 and 3, it finally reaches the final idle roller 6, set with a fixed axis, around which the film winds partially and from where it reaches the surface of the load 100.

In the portion between cylinder 3 and the final roller 6 the film is pulled taut by a presser roller 5, carried by oscillating arms 51 subject to a thrusting action produced by the jack 50; the roller 5 turns idle and moves between a forward and a backward position so as to compensate for the variable quantity of film F required during wrapping, due to the particular shape of the load 100.

Of course, depending on one's requirements, in agreement with the sector's technique, a different type and layout of rollers, through which the film F passes before being wrapped around the load 100, can be chosen.

As the film F leaves the final roller 6 it is wrapped around the load 100 in a way that we shall call "normal" where, with this term, we mean, in this description, a traditional method to achieve a packed load that has the characteristics wanted, in particular, with a film subject to certain tension values (more or less constant or variable based on established criteria).

In agreement with this invention, the system 1 comprises means for continuously monitoring the tension of the film F in the portion F' which is between the two pre-stretching cylinders 2 and 3.

In the example, said tension is kept under control by monitoring the torque moment that rollers 2 and 3 are subject to. In particular, this is carried out by means of two ammeters 26, 36 that continuously measure the values of current supplied to each of the cylinder (2 and 3) motors 25, 35, transmitting them to the logic unit 60 which, also receiving the rotation speed values of the cylinders 2 and 3 via the encoders 27, 37, is able to measure the torque moment values of each pre-stretching cylinder 2,3.

It was seen that a rapid drop in film tension is a significant indication of the start of its breaking. For example, a drop in tension in the portion subject to pre-
stretching (between the two pre-stretching cylinders 2 and 3) of less than 20-30% compared to the average value measured is considered critical, and found in a very limited time interval, for instance $10^{-2}$ seconds.

Alternatively, it is possible to monitor any other value that is representative of film F tension.

When working, the film is pre-stretched in portion F' as it passes through the two pre-stretching cylinders 2 and 3, after which it is wound continuously around the load 100 with the so-called "normal" method. The level of pre-stretching is set initially at a relatively very high value.

When the logic unit 60 measures a rapid drop in tension in the pre-stretching portion F' it means the film has started to break. The logic unit 60 acts promptly on the cylinders 2 and 3 taking them to the same peripheral speed so as to stop elongation altogether.

For example, when the value of the difference of the torque exerted by the two pre-stretching cylinders 2 and 3 diminishes more than 20-30% with respect to the given average measured, in an interval of $10^{-2}$ seconds, the logic unit 60 acts immediately on the cylinders 2 and 3 as said before.

It is preferable to act on the upstream cylinder 2, bringing its peripheral speed to the same value of peripheral speed of the downstream cylinder 3. This prevents the film from breaking completely in the immediate phase.

Furthermore, a "temporary" method is activated immediately for winding the film F as it comes from the downstream cylinder 3, around the stack: this is a temporary and exceptional method that keeps the film winding around the stack to prevent the film breaking altogether; typically, this "temporary" method is carried out by reducing film winding tension compared to the "normal" method, bringing it to values close to zero.

The idle roller 5 helps do this, compensating for minor elongation immediately after pre-stretching is cancelled. In addition (or alternatively) the speed at which the film F is wrapped around the load 100 can be changed.

When the portion of film F that started to break has completely overcome the pair of pre-stretching cylinders (2,3), that is, it is no longer subject to additional elongation, the speed of the upstream cylinder 2 can be changed back to its
previous value, resetting the initial pre-stretching value.
Said "temporary" film wrapping method continues until the portion of film
about to break is wrapped completely around the surface of the stack. In such
cases, it will suffice if the partly broken portion of film is wrapped around a
layer of previously wrapped film to hold it firm, seeing as the majority of films
used have good adhesion properties or, if there is no underlying layer on the
load, it will suffice if it is wrapped directly around the load; otherwise a more or
less complete wrapping around the stack will be carried out.
After this, winding the pre-stretched film around the load can continue with the
"normal" method.
According to a preferred form of embodiment of the invention, film breakage is
monitored by controlling the value of the difference of the torque moments
exerted by the two pre-stretching cylinders 2 and 3; this value gives an idea of
the tension exerted on the film F and, therefore, if its value remains basically
constant over time it indicates the absence of breaks while, at the onset of a
break, there is a sudden drop in tension in portion F', shown by a variation of
20-30% of the value of the difference of the torque moments of the cylinders 2
and 3 in a period of time of 10^{-2} seconds.
It is of course a good idea to check tension regularly so at the very first signs
steps can be taken promptly to prevent the break extending excessively along
the film.
If the frequency with which the film F starts to break is relatively high, the pre-
stretching value set can be reduced or, vice versa, increased if the frequency is
thought to be too low.
As can be appreciated by what is described here, the method and system
according to this invention, meet the requirements and overcome the problems
described in the introductory part of the description with reference to the known
 technique. As a matter of fact, the method and system according to the
invention means you can work in complete safety, close to the maximum
theoretical pre-stretching value of the material employed, even if using films
whose characteristics are not uniform along their entire length, usually the
cheapest ones. In fact if, during wrapping, there is the start of a break, the
method according to the invention lets you act promptly and continue wrapping the load without having to stop the system working. It goes without saying that a specialized technician can make many modifications and variations to the method and system described above to meet contingent and specific requirements, especially as regards to the methods and instruments used to monitor the start of a film F break.
CLAIMS

1) Method for wrapping loads with a pre-strechlied extensible plastic film (F) by means of a pair of pre-stretching cylinders (2,3) after which the film is being wrapped continuously around a load (100) to make a package of the same, characterized by the fact that it comprises the following phases:
   a) apply a special pre-stretching elongation to the portion of film (F) comprised between said pair of pre-stretching cylinders (2,3);
   b) wrap the pre-stretched film around the load with the "normal" method;
   c) monitor continuously the condition of the portion of film (F) subject to pre-stretching;
   d) stop applying said pre-stretching elongation as soon as it is found that the film (F) starts to break;
   e) continue wrapping the film (F) around the load (100) with a temporary method preventing the film from breaking completely;
   f) after the portion of film (F) that started to break has completely overcome the pair of pre-stretching cylinders (2,3), apply said pre-stretching elongation again to the portion of film (F) comprised between said pair of pre-stretching cylinders (2,3); and,
   g) after the portion of film that started to break is sufficiently fastened to the stack, continue wrapping the pre-stretched film around the load with the "normal" method.

2) Method according to claim 1, characterized by the fact that in said phase c) the tension of the portion of film (F) subject to pre-stretching is kept under control.

3) Method according to claim 2, characterized by the fact that in said phase d) a start of film (F) breaking is detected following a rapid drop in said tension,
4) Method according to claim 1, wherein said elongation is obtained making the downstream pre-stretching cylinder (3) to turn, with respect to the direction in which the film is being fed, at a peripherally higher speed than the upstream pre-stretching cylinder (2) characterized by the fact that said phase d) is carried out taking the peripheral rotation speeds of the two pre-stretching cylinders (2,3) simultaneously to the same value.
5) Method according to claim 1, wherein said elongation is comprised between 250 and 400%.

6) Method according to claim 3, wherein said pre-stretching cylinders (2,3) are operated and controlled by independent electric motors (25,35), characterized by the fact that said phase c) of monitoring the tension is carried out through means (26,36,27,37) receiving values which are representative of the torque moments of each pre-stretching cylinder (2,3) and transmit them to a programmable logic unit (60) able to adjust the rotation speeds of each cylinder (2,3).

7) Method according to claim 6, characterized by the fact that said logic unit (60) cancels the pre-stretching exerted by the two cylinders (2,3) when the variation of the difference of the torque moments of the two pre-stretching cylinders (2,3) is at least 20-30% higher than the average value measured in an interval of $10^{-2}$ seconds.

8) Method according to claim 6, wherein said means receiving continuously values which are representative of the torque moments of each pre-stretching cylinder (2,3) consist of an ammeter (26, 36) and an encoder (27,37) for each cylinder (2,3).

9) System (1) for implementing the method according to claim 1, comprising a pair of pre-stretching cylinders (2,3) for pre-stretching a plastic extensible film (F) able to wrap a load (100), the peripheral rotation speed of at least one of the cylinders (2,3) being adjustable, characterized by the fact that it comprises monitoring means (26,36,27,37) for measuring continuously the tension of film (F) between said pair of pre-stretching cylinders (2,3), said cylinders (2,3) being taken to the same peripheral rotation speed, when said monitoring means (26,36,27,37) measure a tension value which is below a threshold value, said threshold value being an indication of the start of film (F) breaking.

10) System (1) according to claim 9, wherein said monitoring means cooperate with a logic unit (60) and consist of an ammeter (26, 36) and an encoder (27,37) for each cylinder (2,3).
**A. CLASSIFICATION OF SUBJECT MATTER**

**INV. B65B11/04 B65B57/04**

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

B65B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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**Date of the actual completion of the international search**

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**Name and mailing address of the ISA/Authorized officer**

European Patent Office, P B 5818 Patentlaan 2
NL - 2280 HV RUSWINKTel: (+31-70) 340-2040, Tx 31 651 epi nl, Fax (+31-70) 340-3016

Vigiante, Marco
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