METHOD TO CONVERTING A SHRINK TUNNEL OF A PRODUCTION MODE AND METHOD FOR CONVERTING A SHRINK TUNNEL FROM A PRODUCTION MODE TO A STANDSTILL MODE

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ABSTRACT

A method for converting a shrink tunnel to a production mode, the method comprising at least opening one shrink tunnel entrance section and/or opening one shrink tunnel exit section. Furthermore, the method comprises at least one of the following steps: a) raising the temperature inside the shrink tunnel to a predefined target value (Ti-PM); b) switching on the conveyance means or raising the speed of the conveyance means to a specified target value (V(F)-PM); c) switching on or increasing the chain cooling capacity to a specified target value (P(G)-PM); d) switching on or increasing the bundle cooling capacity to a specified target value (P(G)-PM). According to the invention, the opening of the shrink tunnel entrance section and/or the opening of the shrink tunnel exit section are performed at the earliest together with carrying out one of the steps a), b), c), and/or d).
Fig. 2

1) Closing of entrance and exit section

2) Simultaneously (a), (b), (c), (d), and (e)

BM

PM

T - SB < Ti - PM
V(F) - SB < V(F) - PM
P(F) - SB < P(F) - PM
P(G) - SB < P(G) - PM

S

T - S ≥ RT
V(F) - S = 0
P(G) - S = 0
P(F) - S = 0
Switching on or decreasing the capacity of a load AND SIMULTANEOUSLY closing of entrance and exit section

Fig. 3

BM

SB/S
T-SB, T-S ≥ RT
VF-SB, VF-S
P-F-SB, P-F-S
P-G-SB, P-F-S

Switching on or increasing the capacity of a load

a) a(0 bb)
a(0 cc)
a(0 dd)
a(0 ee)
a(0 ff)

PM

T-F-PM
V(F)-PM
P(F)-PM
P(G)-PM
METHOD TO CONVERTING A SHRINK TUNNEL OF A PRODUCTION MODE AND METHOD FOR CONVERTING A SHRINK TUNNEL FROM A PRODUCTION MODE TO A STANDSTILL MODE


[0002] The present invention relates to a method for operating a shrink tunnel. In particular, the invention relates to a method for converting a shrink tunnel to a production mode and to a method for converting a shrink tunnel from a production mode to a standstill mode.

BACKGROUND

[0003] It is a known process in filling lines and packaging lines to wrap a foil around objects, in particular bottles, cans, beverage cartons or the like, and to subsequently transport them through a shrink tunnel. These foil-wrapped objects are preferably termed as so-called bundles in the beverage industry. In such an instance, the foil is a heat shrinking foil, which is also known to the expert as LDPE, LLDPE shrink film. After being wrapped in a packaging machine, the objects, which then have such a foil wrapped around them, are conveyed through a shrink tunnel, where they are impinged with hot air so that the foil shrinks and comes to fit closely around the objects. Immediately following the shrink tunnel is a cooling section having ventilators for the purpose of quickly cooling the bundles so that these maintain their stability and thus their transportability.

[0004] Such a shrink tunnel essentially comprises a circulating endless conveyance means, which is covered by an enclosure (tunnel) along a partial section, said enclosure forming the tunnel. Furthermore, a shrink tunnel comprises, usually, a plurality of heating elements and also ventilators or air blowers for generating the required hot air and subsequently distributing the hot air throughout the interior of the tunnel. In order to attain a particularly even distribution of the hot air after generating it, one part of the hot air is channeled by means of suitable hot air ducts into so-called shaft walls and another part of the hot air is channeled into a chamber, which is located immediately below the conveyance means of the shrink tunnel. Preferably, the bundles are thus actively impinged with hot air from at least three sides. At this point, the basic structure of a shrink tunnel will be only roughly sketched. An expert from the packaging industry will be sufficiently acquainted with the structure of such shrink tunnels so that no further detailed explanations are required here.

[0005] As previously mentioned, such a shrink tunnel requires a hot gaseous medium, typically hot air, for the purpose of shrinking the foil. This hot air is generated by means of the heating means, which form a part of the shrink tunnel. The generated hot air, or the hot air generated by the heating means, as the case may be, is preferably generated by using electrical energy. Meanwhile, there is a tendency to generate the required hot air by means of a so-called gas burner, for instance. Unfortunately, the required gas is not readily available in many places, which again results in the use of electrically heated shrink tunnels.

[0006] Such electrically heated shrink tunnels have a high demand for electrical energy, entailing substantial costs for the operator. Notably, generating the hot air consumes the largest amount of energy in a shrink tunnel. It has now been ascertained that it is possible to lower the consumption of electrical energy in a shrink tunnel by switching the shrink tunnel into a so-called standby mode for the duration of certain operating states or operating modes when the shrink tunnel is not needed for production. In this context, the output of one or more loads of the shrink tunnel is reduced, thus lowering the energy consumption in comparison to the energy consumption during production operation.

[0007] Such a shrink tunnel and, respectively, such a procedure for operating a shrink tunnel is presented in DE102010011640 A1, for instance. It describes a shrink tunnel, which, apart from the customary production mode, also comprises a further, so-called standby mode, with the shrink tunnel being operated in said standby mode at a reduced output as compared to the output in production mode. In this context, the switchover between the customary production mode and the additional standby mode is effected in a time-controlled and/or signal-controlled manner. By switching to the standby mode, several measures are effected which lead to reducing the energy demand of the shrink tunnel. One such measure would be, for instance, to enable adjusting the existing target temperature to a standby temperature that is reduced in comparison to the target temperature, thus resulting in lowering the required heat capacity. A further measure would be, for instance, to reduce the transport speed of the transport means on the side of the shrink tunnel in order to minimize the energy discharge and respectively the heat discharge from the tunnel. It is again obvious that by measures such as shutting down the cooling for the transport means on the side of the shrink tunnel and by also shutting down the cooling for the bundles coming out of the tunnel, it would be possible to reduce the energy demand. Provided that each tunnel section is assigned at least two electrically operated air blowers, shutting down one of the air blowers of the heating means in each tunnel section would be another measure to reduce the energy demand.

[0008] It is furthermore known that the so-called standby mode involves a further measure wherein the two openings in the entrance and exit sections of the shrink tunnel are at least partly closed. It is conceivable that during a customary production mode the shrink tunnel entrance section and the shrink tunnel exit section have to be sufficiently wide open for the bundles to enter and exit the shrink tunnel without hindrance. In the instance of a switchover between the respective operating modes, i.e. between the production mode and the standby mode, the shrink tunnel entrance section and the shrink tunnel exit section are either opened or closed. The switchover between the two operating modes is then also triggered in a time- and/or signal-controlled manner. Such a control for operating a shrink tunnel and such a shrink tunnel itself are described in DE 102010020957 A1, for instance.

[0009] The above outlined prior art thus already discloses a shrink tunnel and, respectively, a method for controlling a shrink tunnel alternating between two operating modes in a time- and/or signal-controlled manner and involving a different energy demand for each of the two operating modes. The document further discloses a shrink tunnel and, respectively, a method for controlling a shrink tunnel wherein, on switching between two operating modes, the shrink tunnel openings in the exit and entrance sections of the shrink tunnel are additionally opened or closed.
BRIEF SUMMARY OF THE INVENTION

[0010] An object of the present invention is to optimize the outlined prior art in such a manner that the energy demand of the shrink tunnel is further optimized and, in particular, minimized in a standstill mode, for instance in the standby mode and, respectively, on switching between the production mode and a standstill mode, for instance the standby mode.

[0011] The present invention provides a method for converting a shrink tunnel to a production mode and by a method for converting a shrink tunnel from a production mode to a standstill mode.

[0012] By applying a defined sequence of individual, previously mentioned measures for operating or controlling a shrink tunnel after the time- and/or signal-controlled switchover between the individual operating modes as known from prior art has been effected, it is possible to reduce the energy demand from immediately after the switchover up to reaching the specifications of the respective operating mode even further.

[0013] The present invention thus provides a first method for converting a shrink tunnel having a conveyance means to a production mode, which method involves opening at least one shrink tunnel entrance section and/or opening one shrink tunnel exit section. This method may in particular relate to the initial operation of a shrink tunnel or to the conversion of a shrink tunnel from a standby mode to a production mode. It is furthermore possible to convert a shrink tunnel to the production mode if the shrink tunnel has been in a so-called stop mode for the duration of a lengthy standstill with all energy loads having been shut down. A fundamental difference between the standby mode and the stop mode is that the shrink tunnel is maintained at a lower, second target temperature in the standby mode as known from prior art. According to the duration of the standstill, shutting down all energy loads during the stop mode may cause the inside of the shrink tunnel to cool down to the ambient temperature. The actual tunnel temperature on powering the shrink tunnel back up to production mode again is not previously known.

[0014] The method comprises at least one of the following steps: a) raising the temperature inside the shrink tunnel to a predefined target value; b) switching on the conveyance means or raising the speed of the conveyance means to a specified target value; c) increasing the chain cooling capacity for cooling the conveyance means to a specified target value; d) increasing the bundle cooling capacity to a specified target value. According to the invention, the opening of the shrink tunnel entrance section and/or the opening of the shrink tunnel exit section are performed at the earliest together with carrying out one of the steps a), b), c), and/or d). The target values are preferably already the production values.

[0015] It is intended at this point to go into the details of the components of a shrink tunnel as required for the methods according to the invention.

[0016] A shrink tunnel according to the invention for the methods according to the invention thus comprises at least the component parts as described in the following. Such a shrink tunnel comprises a conveyance means driven by an electric motor and one or more device units, which may also work in combination with each other (for instance hot air blowers in the form of ventilators, heater batteries, sensors), and which are necessary for generating the required hot air and thus necessary for setting the temperature inside the shrink tunnel and, respectively, for reaching a predefined target value, for instance a temperature in degrees Celsius. In particular, sensors may be provided inside the shrink tunnel for measuring the actual temperature and transmitting the value to a control unit. The actual temperature is compared to the target temperature and then the hot air blowers and/or heater batteries are adjusted to accordingly set the target temperature inside the shrink tunnel. A shrink tunnel according to the invention as employed for the method according to the invention furthermore comprises a so-called electric chain cooling including, for instance, one or more device units, which may also work in combination with each other, such as ventilators and sensors, as the case may be, and which device units are arranged outside of the tunnel interior, preferably below the circulating conveyance means. The cooling units serve for cooling the conveyance means, which may be a net grid conveyor link chain or a so-called roller bar chain, for instance. The conveyance means heats up while passing through the shrink tunnel. Before passing through the shrink tunnel again, the conveyance means has to be cooled down during the return movement, as otherwise there is a risk of the packaging means and/or of the subsequently conveyed articles at least partly melting and sticking to the conveyance means. Furthermore, a shrink tunnel according to the invention as employed for the method according to the invention comprises at least one or more device units, which may also work in combination with each other, such as axial ventilators or cross-flow fans, which are commonly arranged immediately downstream from the shrink tunnel interior and thus outside and above and/or on the side of the conveyance means, and which are required for cooling the bundles and thus supplying the required cooling capacity. It is further provided for the method according to the invention that doors or other suitable closing elements are arranged in the sections of the two tunnel openings of the shrink tunnel according to the invention, which doors or closing elements automatically close or open, as required, wherein the doors or closing elements in a closed state reduce heat discharge from the shrink tunnel. In order to operate all the mentioned loads in a defined manner, and in particular in a defined sequence, the shrink tunnel further comprises a separate control means, which allows carrying out the methods according to the invention.

The data required for the methods according to the invention are stored in this control means. Preferably, the shrink tunnel required for the method according to the invention is further equipped with at least one sensor system (for instance a light barrier) at the infeed side of the tunnel and with at least one further sensor system (for instance a light barrier) at the outfeed side of the tunnel. For the method according to the invention it is furthermore important that the separate control unit belonging to the shrink tunnel has an interface with a packaging machine arranged immediately upstream from the shrink tunnel or with the control unit of such a packaging machine and that the shrink tunnel control unit and the packaging machine or the packaging machine control unit may communicate with each other. In this context, the communication interface for the communication between the shrink tunnel and the upstream packaging machine may be established via a so-called Ethernet connection.

[0017] Because the individual measures or steps that are necessary for operating a shrink tunnel according to the invention have different energy demands on the one hand side and require different periods of time depending on specific parameters on the other hand, it is advantageous to define a sequence for carrying out the individual measures or steps.
By defining a sequence for carrying out the individual steps, it is possible to once again reduce the energy demand while carrying out certain measures. Assuming there is a first production mode and a standby mode, each of these two operating modes thus has to run through a number of steps, which in turn are based on defined target values as parameters. In order to reach these target values, each switchover from one operating mode to the other operating mode effects certain measures or steps to be initiated. It has been shown that by performing the individual steps or measures in a defined sequence, it is possible to reduce the energy demand during the performance of individual or several steps once again due to this defined sequence.

In the methods according to the invention, it is therefore a primary factor at which point in the sequence one individual step is performed or several steps are performed and furthermore how much time is needed to fully implement this step or these several steps.

The method according to the invention and further embodiment forms or developments of the method according to the invention will be described in detail in the following sections.

The method according to the invention for operating a shrink tunnel wherein the shrink tunnel is to be converted to the production mode in this context involves opening at least one shrink tunnel entrance section and/or opening one shrink tunnel exit section. This procedure is applied in the instance of the shrink tunnel initially being in a standby mode or in the instance of the shrink tunnel having been previously shut down completely and in a stop mode, as is the case in an initial operation, for example. The method according to the invention furthermore comprises at least step a) raising the temperature inside the shrink tunnel to a predefined target value, and/or step b) switching on the conveyance means or raising the speed of the conveyance means to a specified target value, and/or step c) increasing the chain cooling capacity to a specified target value, and/or step d) increasing the bundling cooling capacity to a specified target value. The energy demand of the method according to the invention is reduced by opening the shrink tunnel entrance section and/or opening the shrink tunnel exit section at the earliest together with performing one of the previously mentioned steps a) to d).

A further method variant according to the invention proposes that the shrink tunnel entrance section and/or the shrink tunnel exit section are opened simultaneously with one of the steps a) to d) being performed or at the latest after one of the steps a) to d) has been performed.

It is thus particularly advantageous to employ a method for operating a shrink tunnel wherein the opening of the shrink tunnel entrance section and/or the opening of the shrink tunnel exit section are performed at the earliest when the temperature inside the shrink tunnel has reached the specified target value. It can thus be avoided that the shrink tunnel entrance section and/or the shrink tunnel exit section are prematurely opened during the process of heating up the interior of the shrink tunnel, which heating is effected by means of several electrical energy consuming device units working individually or also in cooperation with each other. The device units, such as heater batteries, heater blowers, or air blowers, for instance, which are required for the heating process, can thus be operated as efficiently as possible, because the shrink tunnel entrance section and/or the shrink tunnel exit section are in a closed state. If both the shrink tunnel entrance section and the shrink tunnel exit section are closed during the heating process, the duration of the heating process may thus be reduced, in particular the duration will be reduced for step a) raising the temperature inside the shrink tunnel to the predefined target value. By opening the shrink tunnel entrance section and/or the shrink tunnel exit section at the earliest when the predefined target value of step a), raising the temperature inside the shrink tunnel, has been reached, the duration of the heating process is reduced and furthermore, heat loss is minimized, thus lowering the energy demand resulting from the heating process for step a). Furthermore, due to the shortened duration of the heating process by opening the shrink tunnel entrance section and/or the shrink tunnel exit section at the earliest when the target value of step a) has been reached, the provisioning time for maintaining the shrink tunnel in a target state necessary for production is also shortened.

In a further special embodiment form, the steps of “opening the shrink tunnel entrance section and/or opening the shrink tunnel exit section” are performed in dependence on the progress of step a) raising the temperature inside the shrink tunnel to a predefined target value. In this way, the opening of the shrink tunnel entrance section and/or the opening of the shrink tunnel exit section may already be performed on reaching a predefined temperature, which is below the target value for the production mode, so that it is possible to prevent heat accumulation from building up in the shrink tunnel interior shortly before reaching the predefined target value for the temperature inside the shrink tunnel. Potential heat accumulation inside the shrink tunnel is thus avoided, which could otherwise lead to the first bundles that are conveyed through the shrink tunnel to be overheated. In other words, due to opening the shrink tunnel entrance section and/or opening the shrink tunnel exit section on reaching a defined target temperature, which, for instance, corresponds to 90% to 95% of the predefined target value for the temperature inside the shrink tunnel, it is possible to prevent heat accumulation from building up within the shrink tunnel, thus avoiding overheating or damaging of the first bundles that are conveyed through the shrink tunnel after having completed step a) raising the temperature inside the shrink tunnel to a predefined target value. This results in improving the quality of the first bundles that are processed in the shrink tunnel, which might otherwise have to be rejected, as the case may be.

A further special embodiment form of the method according to the invention provides that step b), i.e. switching on the conveyance means or raising the speed of the conveyance means, is performed in dependence on the progress of heating the shrink tunnel to a predefined target temperature. It may, for instance, be provided that the conveyance means is not switched on before the temperature inside the shrink tunnel has reached approximately 90% of the target value. For production mode, the conveyance means also requires a certain target temperature. The quality of the shrinking results in the bottom section of the bundles is impaired if the conveyance means is too cold. If the conveyance means is switched off to standby mode, heating up the shrink tunnel interior will essentially result in only heating up the transport section within the shrink tunnel. According to the respective arrangement, the return section of the conveyance means, however, will remain cold. In this context, the point of time for switching on the conveyance means or for raising the speed of the conveyance means is selected in such a way that, on passing through the shrink tunnel, all sections of the conveyance means are sufficiently heated up during the time that is nec-
ecessary for heating up the shrink tunnel to the final target value of the required temperature inside the shrink tunnel so that the conveyance means is overall heated up to the necessary production temperature.

[0026] At the same time it may be necessary to switch off the chain cooling means or to increase the chain cooling capacity in order to attain the desired temperature for the conveyance means, in particular with regard to the temperature in the shrink tunnel entrance section.

[0027] Another special embodiment variant of the method according to the invention therefore provides for the chain cooling capacity to be increased to a predefined target value in dependence on a measured chain temperature. In a shrink tunnel, the conveyance means, for instance a net grid conveyor link chain or a roller bar chain, is constantly cooled during regular production mode to prevent overheating. Overheating of the conveyance means would lead to melting the packaging means and also to partly melting the articles, as the case may be. This would result in the conveyance means becoming soiled with plastic residues and also in hindering the further transport. Also, this might lead to impairing the quality of the finished, shrink-wrapped bundles. Now, the method according to the invention also provides that, in addition to opening the shrink tunnel entrance section and/or opening the shrink tunnel exit section, both being performed at the earliest together with one of the steps a), b), c), or d), while step c) is being performed, i.e. while the cooling capacity for cooling the conveyance means is being increased, the increase of the chain cooling capacity is performed in dependence on a measured conveyance means temperature. By increasing the cooling capacity in dependence on the measured temperature of the conveyance means, this cooling capacity increase is performed only when actually required. This allows a further targeted and efficient reduction of the energy demand. The temperature of the conveyance means is measured by a sensor reading, in particular in the shrink tunnel entrance section or following it, and the temperature is then compared to a predefined target value. This target value corresponds to a temperature value that the conveyance means is supposed to have in the shrink tunnel entrance section. While the conveyance means is being returned, it undergoes an adapted cooling process between the shrink tunnel exit section and the shrink tunnel entrance section. The result of this cooling process can be verified by a second temperature sensor arranged in the return section and, if necessary, the chain cooling capacity can then be adapted once again.

[0028] It has further been shown that it may be useful for the shrink tunnel doors or closing elements to be opened not only in dependence on the temperature inside the shrink tunnel, but also in dependence on the bundles, which are produced by the upstream packaging machine and transported along the conveyance means through the shrink tunnel. In this manner it is also possible to prevent energy loss caused by prematurely opening the doors or the closing elements. On starting the packaging machine, for instance, it is possible to use the time that is needed by the packaging machine for wrapping a first bundle, which is subsequently transferred to the shrink tunnel. This is by no means an insignificant time span. When the packaging machine is restarted, a certain time passes before the shrink tunnel is required for its customary production task, namely for shrinking bundles, as there is a number of individual steps that have to be performed first, such as dividing up the individual articles into a bundle assembly, conveying the bundle assembly to a foil wrapping module, wrapping shrink film around the bundle assembly, conveying the wrapped shrink film bundle away, and transferring it to the conveyance means. It is therefore conceivable to open the shrink tunnel entrance section only after the packaging machine has already started producing and wrapping shrink film bundles. It is particularly preferable if the shrink tunnel entrance section is not opened any earlier than on completing the first bundle wrapped in shrink film. The shrink tunnel exit area can either be opened under the same conditions or else, in dependence on the speed of the conveyance means, only after a certain time has passed. The point of completing the wrapped shrink film bundles and transferring them onto the conveyance means and the previously known conveying speed of the conveyance means together can be used to very precisely assess the transport duration for the first bundle to reach the shrink tunnel exit section. The shrink tunnel exit section can then be opened in time before the bundle reaches it.

[0029] The shrink tunnel entrance section and the shrink tunnel exit section can also each have their own sensor system, which is a further special way of designing the control of the shrink tunnel doors to be even more efficient and to require fewer complicated programming tasks. Such a sensor system design would provide at least one first light barrier upstream of the shrink tunnel entrance section. In dependence on sensor occupancy, i.e. the sensor system detecting an object or objects, and in dependence on a specified time interval, this light barrier arrangement controls the time point for opening the two shrink tunnel doors wherein the shrink tunnel entrance section is opened first and the shrink tunnel exit section is opened only after a subsequent specified time interval has passed. It is alternatively possible to open the shrink tunnel exit section at the same time as the shrink tunnel entrance section is opened. This manner of controlling the opening process of the two shrink tunnel doors or closing elements appears to be particularly preferable and, at the same time, it represents the simplest and most immediate option for opening the shrink tunnel doors or the closing elements precisely when it is necessary, i.e. in particular when the bundles are fed into the shrink tunnel or, respectively, when they are located closely upstream of the shrink tunnel entrance section or, respectively, when the bundles are located inside the shrink tunnel closely upstream of the shrink tunnel exit section.

[0030] It should be mentioned here that this manner of controlling the shrink tunnel doors by means of a light barrier arrangement may also be employed for closing the shrink tunnel entrance section and the shrink tunnel exit section as immediately and as quickly as possible. In this context it is possible to provide one light barrier arranged upstream of the shrink tunnel entrance section and one light barrier respectively arranged immediately downstream of the shrink tunnel exit section.

[0031] It is furthermore possible to operate the conveyance means at a higher transport speed for a short period of time before or during transfer of the first bundles to the conveyance means in the reactivation measure for the full restart of the shrink tunnel or for the restart from standby mode to production mode. This additional process step only indirectly contributes to optimizing energy demand or, respectively, energy consumption. Due to the doors being previously closed, a so-called heat accumulation builds up in the shrink tunnel when the tunnel is reactivated and the tunnel doors are opened only together with or shortly before reaching the necessary
target operating temperature in the shrink tunnel interior. The first bundles to be fed into or pass through the tunnel immediately after the doors have been opened are exposed to the above-mentioned heat accumulation. This may cause the first bundles, which are fed into the shrink tunnel, to potentially be impinged with too much heat energy. For this reason, it may be necessary to temporarily raise the transport speed of the conveyance means above the regular transport speed required for normal production operation after this late opening of the shrink tunnel doors. By temporarily raising the transport speed for a short time, proportionally, the amount of heat energy acting on the bundles that pass first is the same as on the other following bundles, which are conveyed through the shrink tunnel under normal production conditions at normal transport speed. In order to clearly distinguish between the first bundles being passed through the shrink tunnel at an accelerated transport speed, and the following bundles being conveyed through the shrink tunnel under normal production conditions, it should be noted here that the first bundles comprise a number of at least five bundles, and a maximum, however, of 25 bundles. If more bundles than that were conveyed through the shrink tunnel at an accelerated transport speed, optimal shrinking results could no longer be ensured, as the heat accumulation would then be lacking. In terms of duration, the short-term increase of the transport speed can be defined as approximately one to three minutes.

[0032] As already described, the shrink tunnel may be in a stop mode with all energy loads being completely switched off. Or else, the shrink tunnel is in a standby mode with the capacity of the energy loads at least partly reduced. In this context, a certain number of the energy loads may also be completely switched off, for instance a certain number of the heating means. Essentially, the shrink tunnel can be switched from standby mode back to production mode relatively quickly. In stop mode, however, all energy loads are switched off so that the shrink tunnel can even cool down to the ambient room temperature depending on the duration of the standstill. In particular, the stop mode of the shrink tunnel is initiated by first carrying out all process steps a) to e), and then switching the control unit to stop mode, thus effecting the shutdown of all energy loads. In order to switch the shrink tunnel back to production mode, a further process step f) may therefore be provided for waking the control unit and thus the shrink tunnel from the stop mode first, and then converting it to a so-called run mode wherein, for instance, all heating means of the shrink tunnel are operated at maximum capacity. When subsequently a temperature inside the shrink tunnel is reached that approximately corresponds to the target inside temperature during standby mode or to approximately 85% to 90% of the target inside temperature during standby mode, the capacity of the heating means is reduced again and the process steps for converting the shrink tunnel from standby mode to production mode are initiated.

[0033] The invention furthermore relates to a method for converting a shrink tunnel to a production mode wherein the method comprises at least opening one shrink tunnel entrance section and/or opening one shrink tunnel exit section. Here, the shrink tunnel entrance section and/or the shrink tunnel exit section of the shrink tunnel are initially closed. First, the shrink tunnel is converted to an operating mode. This is effected by switching on or increasing the capacity of at least one load within the shrink tunnel. The opening of the shrink tunnel entrance section and/or the opening of the shrink tunnel exit section are performed at the earliest together with switching on the at least one load within the shrink tunnel or together with increasing the capacity of the at least one load within the shrink tunnel. In particular, the opening of the shrink tunnel entrance section and/or the opening of the shrink tunnel exit section is not intended to be performed before a minimum temperature in the interior of the shrink tunnel has been reached. This is monitored and controlled by means of a temperature sensor coupled to a control unit, for instance. The capacity of further loads is subsequently increased to production capacity, thus switching the shrink tunnel to production mode.

[0034] Furthermore, the invention relates to a method for converting a shrink tunnel from a production mode to a standstill mode. Standstill mode can be understood to refer to a standby mode for operating the shrink tunnel at a decreased capacity. Standstill mode, however, can also be understood as a stop mode, where all energy loads of the shrink tunnel are completely shut down. The method comprises at least the closing of one shrink tunnel entrance section and/or the closing of one shrink tunnel exit section. The method furthermore comprises at least one of the following steps: a) lowering the temperature inside the shrink tunnel to a predefined target value; b) reducing the speed of the conveyance means to a specified target value; c) decreasing the chain cooling capacity to a specified target value; d) decreasing the bundle cooling capacity to a specified target value. According to the invention, the closing of the shrink tunnel entrance section and/or the closing of the shrink tunnel exit section are intended to be performed at the latest together with performing one of the steps a), b), c), or d).

[0035] Furthermore, it may provided that the closing of the shrink tunnel entrance section and/or the closing of the shrink tunnel exit section are performed at the earliest before performing one of the steps a), b), c), or d). It is particularly preferable for the closing of the shrink tunnel entrance section and/or the closing of the shrink tunnel exit section to be performed as the first step before performing one of the steps a), b), c), or d). In particular, the steps a), b), c), or d) may be performed in an optional sequence or they may be performed simultaneously.

[0036] According to one embodiment of the invention, the speed of the conveyance means is reduced at the latest together with the lowering of the temperature inside the shrink tunnel. The constant movement of the conveyance means always ensures that the conveyance means is not subjected to a continuous heat supply during the heating process of the shrink tunnel. In particular, there is no heat supply to the return section, thus allowing the conveyance means to cool down respectively in each section. If the transport speed of the conveyance means would already be reduced before lowering the temperature inside the shrink tunnel or if the conveyance means would be completely stopped, intense overheating might occur locally to the conveyance means in the interior of the shrink tunnel, which might also lead to damaging the conveyance means or other components within the shrink tunnel. As described above, the conveyance means therefore usually also has to be cooled during normal production operation to prevent overheating of the conveyance means and damages to the bundles to be processed caused by such overheating.

[0037] According to one embodiment of the invention, reducing the chain cooling capacity is performed at the latest together with lowering the speed of the conveyance means. In combination with the above-mentioned, the result
is that it is preferable to lower the temperature inside the shrink tunnel, to reduce the transport speed of the conveyance means, and to reduce the chain cooling capacity all at the same time.

[0038] The method can furthermore comprise an additional step (e) for assessing the position of the bundles being conveyed on the conveyance means and for performing the closing of the shrink tunnel entrance section and/or the closing of the shrink tunnel exit section in dependence on the assessed position.

[0039] When the method for converting a shrink tunnel from a production mode to a standstill mode is intended to be carried out, bundles will no longer be supplied to the shrink tunnel for processing. Also, no bundles should remain inside the shrink tunnel during standstill mode. Thus, the shrink tunnel entrance section could already be closed after conveying the last bundle into the shrink tunnel, while the shrink tunnel exit section cannot be closed before the last bundle has left the shrink tunnel. In such a case, however, heat accumulation may build up so that it is preferable to close both sections at the same time after all the bundles have left the shrink tunnel.

[0040] According to another embodiment form, it may also be provided for the target values of the process steps (a), (b), (c), and/or (d) to equate zero during foreseeable longer time periods of standstill. In particular, it may be provided that all energy loads of the shrink tunnel are shut down in a so-called stop mode. In such an instance, the temperature inside the shrink tunnel is also not monitored so that, in the extreme, the shrink tunnel can cool down to a temperature that approximately corresponds to the prevailing ambient temperature.

[0041] In particular, a further step (f) for switching the control unit of the shrink tunnel to a stop mode may be provided at the latest after all steps (a) to (e) have been performed. The performance of all steps (a) to (e) is, in particular, an indication of a longer duration of standstill and therefore serves as a signal to the control unit to completely shut down all energy loads.

[0042] The invention furthermore relates to a method for converting a shrink tunnel from a production mode to a standstill mode wherein the method comprises at least closing one shrink tunnel entrance section and/or closing one shrink tunnel exit section. In production mode, the shrink tunnel entrance section and the shrink tunnel exit section are at least partly opened in order to ensure that the articles or article compilations may enter the shrink tunnel through the shrink tunnel entrance section and may leave the shrink tunnel through the shrink tunnel exit section. The shrink tunnel is first switched to an operating mode by switching off at least one load within the shrink tunnel or by decreasing the capacity of at least one load within the shrink tunnel. According to the invention, the closing of the shrink tunnel entrance section and/or the closing of the shrink tunnel exit section are performed at the earliest together with switching off the at least one load within the shrink tunnel or together with decreasing the capacity of the at least one load within the shrink tunnel. In particular, it is provided for the shrink tunnel entrance section and the shrink tunnel exit section to be closed simultaneously with switching of the at least one load or with decreasing the capacity of the at least one load. The heat inside the shrink tunnel is thus largely retained in the interior, causing the shrink tunnel to cool off less quickly. By switching off further loads or by decreasing their capacity, the shrink tunnel can subsequently be switched to a standstill mode, in particular to the standby mode, or even to the stop mode. If it is required to switch the shrink tunnel back to production mode for a new production process, this may be performed via the intermediate step of the operating mode, for instance. In dependence on the given actual temperature inside the shrink tunnel during standstill mode, less energy may be required, as the case may be, for reaching operating mode and subsequently reaching production mode.

BRIEF DESCRIPTION OF THE DRAWINGS

[0043] In the following passages, the attached figures further illustrate exemplary embodiments of the invention and their advantages.

[0044] FIG. 1 shows a schematic overview of a method for converting a shrink tunnel to different operating modes.

[0045] FIG. 2 shows a preferred embodiment form of a method for converting a shrink tunnel from a production mode to a standby mode and subsequently to a stop mode.

[0046] FIG. 3 shows a schematic overview of a method for converting a shrink tunnel between a production mode and a standstill mode via an intermediate operating mode.

DETAILED DESCRIPTION

[0047] The same or equivalent elements of the invention are designated by identical reference characters. Furthermore and for the sake of clarity, only the reference characters relevant for describing the respective figure are provided. It should be understood that the detailed description and specific examples of the method according to the invention, while indicating preferred embodiments, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

[0048] FIG. 1 shows a schematic overview of a method for converting a shrink tunnel to different operating modes. In production mode PM, the shrink tunnel largely has an interior temperature Ti-PM, which is defined as necessary for the regular shrinking operation. This temperature is below the melting temperature of the packaging materials and of the articles. The interior temperature Ti-PM may be, for instance, approximately 200 degrees Celsius in production mode PM. The conveyance means for conveying the articles or article compilations, which are wrapped into the packaging means, moves at a predefined production speed V(F)-PM. The conveyance means may, in particular, be a continuously moving endless conveyance means. On passing through the shrink tunnel, this conveyance means heats up and on returning, it is at least partly cooled down again by first air blowers or other first cooling means providers between the shrink tunnel exit section and the shrink tunnel entrance section. In production mode, the first cooling means providers work at a cooling capacity of P(F)-PM. Furthermore, the bundles are cooled down by means of second air blowers or other second cooling means providers after leaving the shrink tunnel and before being supplied to further processing devices. In production mode, the first cooling means providers work at a cooling capacity of P(F)-PM.

[0049] In order to reduce the energy demand of the shrink tunnel during standstill times caused by the production or by repairs, it is possible to switch the shrink tunnel to a first standby mode SB. The following measures are, in particular, performed either individually or in an optional combination.

[0050] (a) The temperature inside the shrink tunnel is lowered to a predefined target value Ti-SB, which is, for instance,
between 50 degrees Celsius to 80 degrees Celsius below the temperature Ti-PM inside the shrink tunnel during production mode.

Furthermore, the speed of the conveyance means is reduced to a specified target value V(F)-SB, which is below the speed V(F)-PM of the conveyance means in production operation or production mode PM.

The chain cooling capacity is decreased to a specified target value P(F)-SB, which is below the chain cooling capacity P(F)-PM in production operation or production mode PM.

The bundle cooling capacity is decreased to a specified target value P(G)-SB, which is below the bundle cooling capacity P(G)-PM in production operation or production mode PM.

Furthermore, the shrink tunnel entrance section and the shrink tunnel exit section are closed by doors or other suitable closing elements at the latest together with performing one of the steps a), b), c), or d).

Preferably, the position of the bundles being conveyed on the conveyance means is assessed in a process step ee). The closing of the shrink tunnel entrance section and/or the closing of the shrink tunnel exit section are performed in dependence on the assessed position of the bundles. In particular, the shrink tunnel entrance section is not closed before there are no longer any bundles left in the infeed section to the shrink tunnel. Furthermore, the shrink tunnel exit section is not closed before there are no longer any bundles left in the interior of the shrink tunnel.

After the shrink tunnel has reached standby mode SB, it is possible to switch the control unit to a stop mode in a process step ff), in particular for longer durations of standstill. This step initiates the complete shut down of all energy loads of the shrink tunnel and switches the shrink tunnel to a stop mode S. In stop mode S, all target values of the process steps aa) to dd) each equate to a value of zero. In particular, the heating means are switched off so that the interior of the shrink tunnel cools out without the temperature being monitored and, according to the duration of the standstill, it largely adapts to the ambient temperature RT. Furthermore, the conveyance means itself as well as the chain cooling means and the bundle cooling means are completely shut down.

In order to convert the shrink tunnel from standby mode SB back to production mode PM, the following measures are performed either individually or in an optional combination:

a) The temperature inside the shrink tunnel is heated to a predefined target value of the temperature Ti-PM inside the shrink tunnel for production mode PM.

b) The speed of the conveyance means is raised to a speed V(F)-PM of the conveyance means in production mode.

c) The chain cooling capacity is increased to the chain cooling capacity P(F)-PM in production mode.

d) The bundle cooling capacity is increased to the bundle cooling capacity P(G)-PM in production mode.

Furthermore, the doors or closing elements of the shrink tunnel entrance section and the shrink tunnel exit section are opened at the latest together with performing one of the steps a), b), c), or d).

There are essentially two possibilities for converting the shrink tunnel from stop mode S back to production mode PM. In the first possibility, the control unit is switched from stop mode to an activating mode. In the process, the energy loads of the shrink tunnel are at least partly switched off so that the shrink tunnel is switched to standby mode with a defined temperature Ti-SB inside the shrink tunnel, a reduced speed V(F)-SB of the conveyance means, a decreased chain cooling capacity P(F)-SB, and/or a decreased bundle cooling capacity P(G)-SB. The final adaptation of the tunnel capacity to production mode PM and the opening of the entrance section and/or exit section of the shrink tunnel are subsequently performed.

Alternatively, it is possible to switch the control unit from stop mode to a run mode. The run mode is used for establishing production mode PM within as short a time as possible by temporarily operating at least a part of the energy loads at an increased capacity. In particular, it may be provided that the heating means are temporarily operated at maximum capacity. The temperature in the interior of the shrink tunnel is sensor-monitored in this context. The capacity of the heating means is switched to normal production capacity on the temperature inside the shrink tunnel exceeding a defined value in the process, said value being specified at between 85% to 95% of the temperature Ti-PM inside the shrink tunnel during production mode PM. The run mode according to process step f) on the one hand effects the interior of the shrink tunnel to be heated up quickly, while, on the other hand, it serves for avoiding overheating of the shrink tunnel interior by adjusting the capacity in due time.

Preferably, the entrance section and exit section of the shrink tunnel are not opened before the necessary temperature inside the shrink tunnel has been adjusted. It may furthermore be provided that the entrance section is not opened before bundles for processing are located in the infeed section to the shrink tunnel. Furthermore, the exit section can also be opened only after the first bundles are already in the shrink tunnel. In addition, the conveyance means can be temporarily operated at an accelerated transport speed for a short time before or during the transfer of the first bundles onto the conveyance means. This prevents the quality of the shrink wrapping to be impaired due to heat accumulation in the shrink tunnel. By temporarily raising the transport speed for a short duration of between one to three minutes, the amount of heat energy acting on the first bundles passing through the shrink tunnel is the same as the amount of heat energy acting on the other following bundles, which are conveyed through the shrink tunnel under normal production conditions at normal transport speed. This is particularly necessary if the heating process of the shrink tunnel is not monitored by sensors.

According to a particularly preferred embodiment form as presented in FIG. 2 the method for converting a shrink tunnel from a production mode PM to a standby mode SB and subsequently to a stop mode S provides that the shrink tunnel entrance section and the shrink tunnel exit section are first closed. In a subsequent further step, the capacity of the energy loads mentioned under aa) to dd) is decreased. This preferably happens largely simultaneously. Closing the shrink tunnel, in particular, effects the heat to be largely stored within the shrink tunnel so that less energy is required for maintaining the stand by temperature target value Ti-SB inside the shrink tunnel. As described in the context of FIG. 1, the control unit can be used for effecting a complete shut down of the shrink tunnel and switching the shrink tunnel to stop mode S.

FIG. 3 shows a schematic overview of an embodiment form of a method for converting a shrink tunnel between
a production mode PM and a standstill mode, in particular a standby mode SB or a stop mode S, via an intermediate operating mode BM.

0064] In production mode PM, the shrink tunnel entrance section and the shrink tunnel exit section are at least partly opened in order to ensure that the articles or article compilations may pass through. On shutting down, the shrink tunnel is first switched to an operating mode BM by switching off a load within the shrink tunnel or by decreasing the capacity of a load within the shrink tunnel. In the context of the presented embodiment form, the closing of the shrink tunnel entrance section and/or the closing of the shrink tunnel exit section are performed simultaneously with switching off the load within the shrink tunnel or with decreasing the capacity of the load within the shrink tunnel, thus causing the heat in the shrink tunnel to be largely retained in the interior of the tunnel. It is subsequently possible to switch the shrink tunnel to a standstill mode, in particular to standby mode SB or even to stop mode S, by switching off further loads or by decreasing their capacity according to one of the process steps as described in the context of the FIGS. 1 and 2, the process steps being (a) and/or (b) and/or (c) and/or (d) and/or (e) and/or (f).

0065] If it is required to switch the shrink tunnel from standstill mode SB or SO to production mode PM for a new production process, this may likewise be performed via the intermediate step of the operating mode BM. In dependence on the given actual temperature inside the shrink tunnel during standstill mode SB or S, less energy may be required, as the case may be, for reaching operating mode BM and subsequently reaching production mode PM. The shrink tunnel entrance section and the shrink tunnel exit section are closed in standstill mode SB or S. First, the capacity is raised by switching on a load within the shrink tunnel or by increasing the capacity of that load. The opening of the shrink tunnel entrance section and/or the opening of the shrink tunnel exit section are performed at the earliest in conjunction with switching on the load within the shrink tunnel or together with increasing the capacity of the load within the shrink tunnel. According to the presented embodiment form, the opening of the shrink tunnel entrance section and the opening of the shrink tunnel exit section are not performed before operating mode BM has been reached. Operating mode is reached when, for instance, a predefined temperature is present in the interior of the shrink tunnel. In the exemplary embodiment shown here, the opening of the shrink tunnel entrance section and the opening of the shrink tunnel exit section are, in particular, only performed in the context of one of the process steps as described by the FIGS. 1 and 2, these steps being (a) and/or (b) and/or (c) and/or (d) and/or (e) and/or (f).

0066] The invention has been described with reference to a preferred embodiment. Those skilled in the art will appreciate that numerous changes and modifications can be made to the preferred embodiments of the invention and that such changes and modifications can be made without departing from the spirit of the invention. It is, therefore, intended that the appended claims cover all such equivalent variations as fall within the true spirit and scope of the invention.

What is claimed is:

1. A method for converting a shrink tunnel to a production mode, the method comprising at least opening one shrink tunnel entrance section or opening one shrink tunnel exit section;

and at least one of the following steps
a) raising the temperature inside the shrink tunnel to a predefined target value (Ti-PM);
b) switching on a conveyor or raising the speed of the conveyor means to a specified target value (V(F)-PM);
c) switching on or increasing a chain cooling capacity to a specified target value (P(F)-PM);
d) switching on or increasing a bundle cooling capacity to a specified target value (P(G)-PM);
wherein the opening of the shrink tunnel entrance section or the opening of the shrink tunnel exit section are performed at the earliest together with performing one of the steps a), b), c), and/or d).

2. The method as recited in claim 1 wherein the opening of the shrink tunnel entrance section or the opening of the shrink tunnel exit section are performed at the latest after one of the steps a), b), c), and d) has been performed.

3. The method as recited in claim 1 wherein the opening of the shrink tunnel entrance section or the opening of the shrink tunnel exit section are performed at the earliest when the predefined target value of at least one of the steps a), b), c), and d), has been reached.

4. The method as recited in claim 1 wherein step b) is performed in dependence on the progress of heating the shrink tunnel to a predefined target temperature (Ti-PM).

5. The method as recited in claim 1 wherein increasing the chain cooling capacity to a specified target value (P(F)-PM) according to step c) is performed in dependence on the progress of heating the shrink tunnel to a predefined target temperature (Ti-PM).

6. The method as recited in claim 1 wherein increasing the chain cooling capacity to a specified target value (P(F)-PM) is performed in dependence on a measured temperature of the conveyor.

7. The method as recited in claim 1 wherein the method additionally comprises a step e) for assessing the position of the bundles being conveyed on the conveyor and for performing the opening of the shrink tunnel entrance section or the opening of the shrink tunnel exit section in dependence on the assessed position.

8. The method as recited in claim 1 wherein the opening of the shrink tunnel entrance section and the opening of the shrink tunnel exit section are performed at the same time.

9. The method as recited in claim 1 wherein the speed of the conveyance means is raised above the specified target value for a short time and at the earliest together with opening the shrink tunnel entrance section or opening the shrink tunnel exit section.

10. The method as recited in claim 1 an additional step f), which switches a control unit of the shrink tunnel to a run mode, is performed before all other steps.

11. A method for converting a shrink tunnel to a production mode, the method comprising:
at least opening one shrink tunnel entrance section and/or opening one shrink tunnel exit section;
switching the shrink tunnel first to an operating mode by switching on at least one load within the shrink tunnel or by raising the capacity of at least one load within the shrink tunnel,
the opening of a shrink tunnel entrance section or the opening of a shrink tunnel exit section are performed at the earliest together with switching on the at least one
load within the shrink tunnel or together with increasing the capacity of the at least one load within the shrink tunnel.

12. A method for converting a shrink tunnel from a production mode to a standstill mode, the method comprising: at least closing one shrink tunnel entrance section and/or closing one shrink tunnel exit section; and at least one of the following steps
   a) lowering the temperature inside the shrink tunnel to a predefined target value (Ti-SB, Ti-S);
   b) reducing the speed of s conveyor to a specified target value (V(F)-SB, V(F)-S);
   c) decreasing a chain cooling capacity to a specified target value (P(F)-SB, P(F)-S);
   d) decreasing a bundle cooling capacity to a specified target value (P(G)-SB, P(G)-S);
   wherein the closing of the shrink tunnel entrance section or the closing of the shrink tunnel exit section are performed at the latest together with performing one of the steps a), b), c), or d).

13. The method as recited in claim 12 wherein the closing of the shrink tunnel entrance section and/or the closing of the shrink tunnel exit section are performed at the earliest before performing one of the steps a), b), c), or d).

14. The method as recited in claim 12 wherein the closing of the shrink tunnel entrance section or the closing of the shrink tunnel exit section are performed at the latest before the predefined target value of at least one of the steps a), b), c), or d) has been reached.

15. The method as recited in claim 12 wherein reducing the speed of the conveyor is performed at the latest together with lowering the temperature inside the shrink tunnel.

16. The method as recited in claim 15 wherein decreasing the chain cooling capacity is performed at the latest together with reducing the speed of the conveyor.

17. The method as recited in claim 12 wherein the method additionally comprises a step e) for assessing the position of the bundles being conveyed on the conveyance means and for performing the closing of the shrink tunnel entrance section and/or the closing of the shrink tunnel exit section in dependence on the assessed position.

18. The method as recited in claim 12 wherein the closing of the shrink tunnel entrance section and the closing of the shrink tunnel exit section are performed at the same time.

19. The method as recited in claim 12 wherein all target values of the process steps a) to d) each equate to a value of zero.

20. The method as recited in claim 12 wherein an additional step ff), which switches a control unit of the shrink tunnel to a stop mode, is performed at the latest after all other steps have been performed.

21. A method for converting a shrink tunnel from a production mode to a standstill, the method comprising: at least closing one shrink tunnel entrance section or closing one shrink tunnel exit section; switching the shrink tunnel first to an operating mode by switching off at least one load within the shrink tunnel or by decreasing the capacity of at least one load within the shrink tunnel, wherein the closing of a shrink tunnel entrance section or the closing of a shrink tunnel exit section are performed at the earliest together with switching off the at least one load within the shrink tunnel or together with decreasing the capacity of the at least one load within the shrink tunnel.

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