In a method for controlling the evacuation process in a chamber to be evacuated in a vacuum packaging machine, the switching time starting with initiation of the evacuation process until reaching a specified threshold value or switching pressure \( p_s \) is determined, then the evacuation time required for reaching a desired ultimate pressure is extrapolated from this switching time and the evacuation process is terminated upon reaching this evacuation time.
METHOD FOR CONTROLLING A VACUUM PACKAGING MACHINE AND VACUUM PACKAGING MACHINE

BACKGROUND OF THE INVENTION

[0001] The invention relates to a method for controlling a vacuum packaging machine and to a vacuum packaging machine.

[0002] The following methods have been in use thus far for controlling the evacuation process in vacuum packaging machines:

[0003] The simplest method used is time control, i.e., the evacuation process is positively ended after a specified time, which can be pre-selected at the machine, for example. The end result obtained by this method is very imprecise. The inaccuracy of this purely time-controlled process results from a number of parameters that affect the progression of the evacuation process, in particular also from the fact that the chamber volume changes depending on the quantity of goods inserted for packaging, and due to insertion or removal of compensating plates, etc. In order to attain a specific vacuum with this method, it is necessary to set the evacuation time somewhat higher, however with the disadvantage of a significant reduction in the efficiency of a vacuum packaging machine (number of packaged units per time unit).

[0004] A further known method consists in terminating the evacuation process upon reaching a pressure indicated on a measuring instrument (vacuum gauge). The essential disadvantage of this method consists in the fact that the very low pressure at the end of the evacuation process (ultimate pressure) can be measured only very inaccurately with such instruments.

[0005] A further known method is the use of sensor controls, in which the prevailing pressure in one of the chambers of the packaging machine is constantly monitored by a sensor in order to control the evacuation process. Suitable sensors and the corresponding analysis electronics are expensive and especially also susceptible to breakdowns.

[0006] It is an object of the invention to provide a method which enables the optimized control of the evacuation process and gas injection process in a vacuum packaging machine.

SUMMARY OF THE INVENTION

[0007] In the invention, the evacuation process and/or the gas injection are controlled based on the signal of one single sensor, which depending on the type of sensor, switches from one state to a second state, as soon as the pressure in the evacuated or gas-injected chamber has reached a specified threshold value or switching pressure. The switching pressure during the evacuation is considerably higher than the desired ultimate pressure. For example, the switching pressure is on the order of 200 mbar, while the desired ultimate pressure is 20 mbar or 2 mbar.

[0008] Based on the elapsed time or time period between the initiation of the evacuation process or of the gas injection and the point at which the switching pressure is reached (switching or response time), the evacuation time required until the desired ultimate pressure is reached or the entire evacuation time or gas injection time is determined by an electronic control and analysis unit. This time is then used, for example, to set a timer in the electronic control and analysis unit so that the evacuation or gas injection process is terminated after the evacuation time or gas injection time has elapsed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The invention is described in more detail below based on an exemplary embodiment with reference to the drawings, wherein:

[0010] FIG. 1 shows a very simplified schematic representation of a vacuum packaging machine; and

[0011] FIG. 2, illustrates the control of the evacuation process, shows the time-pressure curve during evacuation of the chamber of the packaging machine, with different parameters, such as chamber volume and/or air humidity and/or air temperature and/or state of the packaging machine, etc.

DETAILED DESCRIPTION OF THE INVENTION

[0012] The vacuum packaging machine 1 depicted very schematically in FIG. 1 and used for packaging foods in vacuum-tight packages or containers 2, has a vacuum chamber 3 located in a packaging line, in which the containers 2 to be packaged are inserted and then sealed after evacuation. The vacuum chamber 3 is connected by means of a vacuum line 4 with a source for the vacuum, e.g. with a vacuum pump 5.

[0013] The evacuation time is controlled by means of an electronic analysis and control unit 6 and the signal of a pressure sensor 7, which in the depicted embodiment is provided at the vacuum chamber 3 and responds to the prevailing negative pressure in the vacuum chamber 3. Of course, the sensor 7 can also be located elsewhere, for example in the vacuum line 4 or in a separate measuring line connected with the interior of the chamber 3.

[0014] The sensor 7 is designed as a simple switch that responds to a negative pressure or a threshold pressure or a switching pressure p, and that upon reaching the pressure p, switches from one electrical state to a second electrical state, e.g. switches on or off. The sensor 7 consists, for example, of a mechanical pressure measuring element that works together with a switch, said measuring element being, for example, a pressure cell or a cylinder pressurized by spring force or a curved tube (tube spring), which changes its radius of curvature depending on the inner pressure. Other designs are also conceivable.

[0015] FIG. 2 shows three different curves, which are designated there as “Evakuiervorgang x, Evakuiervorgang y, Evakuiervorgang z” means “evacuation process x, evacuation process y and evacuation process z” and which depict the curve of the pressure in chamber 3 in dependence on the time during the evacuation process. The progression of these curves varies depending on various parameters, e.g. volume of the chamber 3, air humidity, air temperature, state of the packaging machine and in particular of the pump 5.

[0016] Independent of this, all the curves have in common that the reduction of the pressure P in chamber 3 always takes place exponentially in dependence on the evacuation time. This enables a very simple control of the evacuation process, namely in that after initiation of the evacuation process, at the time t, the switching time t is measured at
which the pressure \( p_a \) is reached and the sensor 7 responds or sends a sensor signal to the electronic analysis and control unit 6.

[0017] The switching times are designated for the various progression of the evacuation in FIG. 2 with the additional index \( x, y, \) and \( z \), i.e. \( t_{sx}, t_{sy}, \) and \( t_{sz} \). Taking into account the switching time within which the sensor 7 responds after initiation of the evacuation process, i.e. the difference between the time \( t_s \) and the time \( t_{sy}, \) and taking into account the basic progression of the pressure-time curve of the evacuation process, the time can then be determined at which a desired ultimate pressure, for example a pressure of 20 mbar or 2 mbar, is reached and at which the evacuation process can be terminated. The switching pressure \( p_s \) at which the sensor 7 responds, is for example 200 mbar and therefore considerably above the desired ultimate pressure, which is for example only 10% or less than the switching pressure.

[0018] This means that the control of the evacuation process is purely a time control, however not a positive control but rather a control in which the termination of the evacuation process is determined taking into account the switching time until the pressure \( p_s \) is reached and taking into account the basic exponential pressure-time curve. This type of control takes into account not only the parameters defined by the design of the packaging machine \( i \), e.g. the volume of the chamber 3 and flow volume of the vacuum pump 5, but also changing parameters, such as air humidity, air temperature, changes in the state of the machine, e.g. of the vacuum pump 5.

[0019] Based on these parameters, the following time values can be derived for reaching the switching pressure \( p_s \):

[0020] Evacuation process \( x \): duration of the evacuation of atmospheric pressure to \( p_s \), e.g. 6 seconds

[0021] Evacuation process \( y \): duration of the evacuation of atmospheric pressure to \( p_s \), e.g. 8 seconds

[0022] Evacuation process \( z \): duration of the evacuation of atmospheric pressure to \( p_s \), e.g. 10 seconds

[0023] If a vacuum or negative pressure of 20 mbar is desired, for example, then the total evacuation time is as follows:

[0024] Evacuation process \( x \): total evacuation time e.g. 15 seconds

[0025] Evacuation process \( y \): total evacuation time e.g. 20 seconds

[0026] Evacuation process \( z \): total evacuation time e.g. 25 seconds

[0027] If a vacuum or negative pressure of 2 mbar is desired, for example, then the total evacuation time is as follows:

[0028] Evacuation process \( x \): total evacuation time e.g. 30 seconds

[0029] Evacuation process \( y \): total evacuation time e.g. 40 seconds

[0030] Evacuation process \( z \): total evacuation time e.g. 50 seconds

[0031] The time for which the evacuation process is maintained after reaching the switching pressure \( p_s \) until the termination of the evacuation process is then determined for example in the control unit 6 taking into account the switching time \( t_s \) that elapses until the switching pressure \( p_s \) is reached and taking into account the desired pressure (e.g. 20 mbar or 2 mbar) at the end of the evacuation process, namely taking into account an algorithm stored in the control unit or using data stored in tabular form in memory 6.1 of the control unit 6, e.g. data or data sets in tabular form that contain the total evacuation time as a function of the switching time.

[0032] In detail, the control takes place so that the total time \( T_{sax} \) of the evacuation process, i.e. the total time from switching on of the vacuum pump until switching off of the pump is based on a definite function, namely:

\[
t_{sax} = K \cdot F \cdot t_{ax},
\]

where \( K \) is a constant, for example with the value of 0.5 or 1.0 and \( F \) is a factor, which in turn is a function of the time \( t_{ax} \) so that a specified ultimate pressure is reached at switching off of the vacuum pump at a specified value for the factor \( F \) independent of the fill volume of the vacuum chamber and therefore independent of the volume of air to be evacuated from the chamber. For this purpose, the values determined, e.g. by measuring, for the factor \( F \) for different times \( t_{ax} \) and for the particular model of the packaging machine are stored in tabular form in the memory 6.1 of the electronic measuring and control unit 6.

[0033] In a preferred embodiment the vacuum that is reached at the time when the vacuum pump is switched off can be set for different applications of the packaging machine, for example by means of an adjusting device, e.g. a rotary knob etc., by changing the factor \( F \) progressively or incrementally so that the vacuum corresponding to the respective setting is reached independent of the fill level of the vacuum chamber 3, i.e. independent of the volume of air to be evacuated. In this embodiment also the values for different factors \( F \) allocated to a particular vacuum are stored in tabular form for different times \( t_{ax} \) in the electronic measuring and control unit 6 or in memory 6.1 there.

[0034] The logic of the electronic measuring and control unit 6 is designed so that in case a measured time \( t_{ax} \) does not exactly correspond to a time value stored in the table, the next higher time value \( t_{ax} \) and its corresponding factor \( F \) stored in the table are used for calculating the total time \( T_{sax} \).

[0035] Furthermore, the logic of the electronic measuring and control unit can also be designed for calculation of intermediate values from values stored in the table.

[0036] The invention was described above based on an exemplary embodiment. It goes without saying that numerous modifications are possible without abandoning the underlying inventive idea upon which the invention is based.

[0037] Instead of only one sensor 7, for example, it is possible to provide two or more such sensors, which then switch or respond at different switch pressures \( p_s \), so that by determining two or more switching times \( t \) the expected curve of the evacuation process can be calculated or extrapolated even more precisely, resulting in further optimization of the control of the evacuation process.

[0039] The measurement of the time \( t \) starts for example at atmospheric pressure, e.g. by means of a contact or sensor upon closing of the chamber 3, or after closing of the chamber and switching on of the vacuum pump, upon reaching a specified initial pressure threshold value.

[0040] Furthermore, a measurement of the changing sound level dependent on the pressure is possible.
For facilities or machines with gas injection, the method according to the invention can also be executed in reverse manner. The invention was described above in connection with a vacuum packaging machine, in which the evacuation process takes place in a chamber. Other designs are also conceivable.

Furthermore, it was assumed above that the control of the evacuation process, i.e. the beginning and the end of the evacuation process, takes place by controlling the vacuum pump. Generally it is also possible to control the evacuation process by providing a valve arrangement, which is used to connect the interior of the chamber with the vacuum source, i.e. with the pump, for initiating the evacuation process and then to disconnect the interior of the chamber from the vacuum source and connect it with the atmosphere upon termination of the evacuation process.

What is claimed is:

1. A method for controlling the evacuation process in a processing chamber of a vacuum packaging machine, wherein the switching time starting with initiation of the evacuation process until reaching a specified threshold value or switching pressure \( p_s \) in the processing chamber is determined, and then the evacuation time required for reaching a desired ultimate pressure is extrapolated from this switching time and that the evacuation process is terminated when reaching this evacuation time.

2. A method for controlling gas injection in a processing chamber of a vacuum packaging machine, wherein switching time starting with initiation of the evacuation process until reaching a specified threshold value or switching pressure \( p_s \) in the processing chamber is determined, then the evacuation time required for reaching a desired ultimate pressure is extrapolated from this switching time and the evacuation process is terminated upon reaching this evacuation time.

3. The method according to claim 1, wherein after initiation of the evacuation process, the switching times are determined until one first and at least one second switching pressure \( p_s \) are reached, and the evacuation time or gas injection time is then extrapolated from these switching times.

4. The method according to claim 1, wherein the evacuation time is determined using a formula that takes into account a typical, exponential curve of the evacuation process.

5. The method according to claim 1, wherein the evacuation time is determined using data or data sets stored in a memory of an electronic measuring and/or control unit.

6. The method according to claim 1, wherein a total time \( T_{\text{term}} \) after which the evacuation process is terminated, is determined by the following function:

\[
T_{\text{term}} = K \times t_k \times \frac{1}{F}
\]

where \( K \) is a constant, \( t_k \) is the time until the pressure threshold value is reached and \( F \) is a factor which is stored as a function of \( t_k \) in tabular form in the memory of an electronic measuring and control unit that controls a vacuum source or a vacuum pump.

7. The method according to claim 1, wherein the pressure in one processing chamber of the packaging machine is measured with the at least one sensor.

8. The method according to claim 1, wherein during the evacuation, a switching pressure \( p_s \) is a multiple, at least approximately 10 times greater than an ultimate pressure.

9. The method according to claim 2, wherein during the gas injection, a switching pressure \( p_s \) is a multiple, at least approximately 10 times less than an ultimate pressure.

10. A vacuum packaging machine with at least one processing chamber to which a vacuum or negative pressure can be applied during an evacuation process, with at least one sensor designed as a pressure switch that responds to the pressure in the processing chamber, and with one control unit that controls the evacuation process based on the signal from the sensor, wherein the sensor has a first and a second electric state and switches from the first state to the second state upon reaching a threshold or switching pressure \( p_s \) in the processing chamber, the electronic control and analysis unit comprises means for measuring the switching time between the initiation of the evacuation process and the response of the at least one sensor upon reaching the switching pressure \( p_s \) in addition to further means to create a time signal for terminating the evacuation process based on the at least one switching time and taking into account a specified or configured ultimate pressure.

11. The vacuum packaging machine according to claim 10, wherein for controlled gas injection, the electronic control unit comprises means for measuring the switching time between the initiation of the gas injection and the response of the at least one sensor upon reaching the switching pressure \( p_s \) in addition to further means to create a time signal for terminating the gas injection based on the at least one switching time and taking into account a specified or configured ultimate pressure.

12. The vacuum packaging machine according to claim 10, wherein at least two sensors, which respond at different switching pressures \( p_s \) and therefore at different switching times \( t_k \), and that the electronic control and analysis unit creates the time signal for terminating the evacuation process taking into account the at least two switching times \( t_k \).

13. The vacuum packaging machine according to claim 10, wherein the electronic control and analysis unit comprises at least one memory, in which typical data is stored for the time of the evacuation process or of the gas injection depending on the at least one switching time \( t_k \).

14. The vacuum packaging machine according to claim 10, wherein the electronic control and analysis unit determines the total time \( T_{\text{term}} \) after which the evacuation process is terminated, by the following function:

\[
T_{\text{term}} = K \times t_k \times \frac{1}{F}
\]

where \( K \) is a constant, \( t_k \) is the time until the pressure threshold value is reached and \( F \) is a factor which is stored as a function of \( t_k \) in tabular form in the memory of an electronic measuring and control unit that controls a vacuum source, or a vacuum pump.

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