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(54) Methods and apparatus for conditioning materials for packing.

(57) Materials for packing are conditioned by adjusting the moisture regain by treating the material in a conditioning atmosphere while measuring the moisture regain of the material and terminating the treatment when a predetermined moisture regain is attained. The materials are desirably supported in an enclosure through which the conditioning atmosphere is circulated until the desired regain is attained, when the material is delivered into an atmosphere with which they are in equilibrium for packing, which may be vacuum or compression packing.

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METHODS AND APPARATUS FOR CONDITIONING MATERIALS FOR PACKING

This invention relates to methods and apparatus for conditioning materials for packing by adjusting the moisture regain.

It is known that if fabrics and garments and other articles made from them, as well as yarns and other textile materials are packed when conditioned to have a low moisture regain, they exhibit good recovery from any creasing they experience during storage. In fact, garments may even be vacuum packed after suitable conditioning, and still exhibit good recovery from creasing on unpacking.

Other materials may be advantageously packed after reduction of their moisture regain without reference to subsequent recovery from creasing. Materials such, for example, as leaf tobacco, undergo a volume and weight reduction on vacuum packing after drying which reduces storage and transportation costs significantly and also preserves the tobacco from deterioration.

Various methods for conditioning garments for packing, including vacuum packing, have been proposed. Clearly, the simplest method is simply to leave the garments

in an appropriately dry or warm atmosphere long enough for them to reach equilibrium. However, this can take several days, and on that account is generally uneconomic and inconvenient. Subsequent proposals have been aimed at reducing the treatment time by combining heating and dry atmosphere treatment prior to vacuum packaging. One form of apparatus proposed for such treatment includes a conditioning tunnel with a conveyor for carrying garments through the tunnel, in which the atmosphere is maintained in different zones at different levels of relative humidity and temperature, the last-encountered zone being held at or not much above ambient temperature. The length of the tunnel and the speed of the conveyor are chosen so that passage through the tunnel takes only a few hours. The garments spend long enough, however, in the last-encountered zone so as to ensure - following the treatment in the earlier stage - that they are in equilibrium with the atmosphere in that zone no matter what the nature of the garments, their initial moisture regain or the ambient conditions.

The size of the tunnel, if an economic number of garments is to be processed, is clearly dictated by the nature of the process. It has been found that economic operation can only be contemplated, except in special circumstances, if goods are taken from different suppliers, on a 'terminal' basis. Thus, a wide variety of goods has to be dealt with, and different goods will be present in the tunnel at the same time, so that the treatment cycle has to

be tuned to the "worst case". This allows no scope for further reducing treatment time. Moreover, except, possibly, in the case of a very large manufacturer able to use the capacity of the tunnel-type plant exclusively with one category of goods, there is no possibility, using the existing treatment method, for a garment or other manufacturer to have his own plant on-site, packaging his own goods.

The present invention provides methods and apparatus for conditioning materials for packing which overcome these problems.

The invention comprises a method for conditioning materials for packing by adjusting the moisture regain, comprising the step of treating the material with a conditioning atmosphere while measuring the moisture regain of the material, and terminating said treatment when a predetermined moisture regain is attained.

It will be appreciated that while current commercial interest is in reducing moisture regain, for packing, there may nevertheless be circumstances in which regain needs to be increased. While the invention will be more particularly described in terms of reducing regain, it will be understood to be equally applicable to increasing

regain for any purpose.

The conditioning atmosphere may comprise humidity - and/or temperature - adjusted air, and is preferably passed through an enclosure for the material to be conditioned, rather than passing the material through a tunnel or the like. The conditioning atmosphere is preferably circulated, rather than passed straight to exhaust, to save energy, and may be continually processed to vary or maintain its adjustment - for example, it may be desired that treatment be carried out from beginning to end with air at 20°C and 5% RH, so that between passes through the enclosure, the recirculating air would be adjusted to these conditions; on the other hand, it may be desired to increase the temperature of the air while maintaining a low humididy level during a first part of the process, and then reduce the temperature, still under low humidity conditions, during a later part of the process. To these ends, the circulated conditioning atmosphere may be passed through a dehumidifier and/or a heater, which may be under appropriate manual or automatic control.

Once conditioned, the articles are desirably transferred to a packing room in which the atmosphere is such that it is in equilibrium with the articles. Articles so treated may be vacuum packed, or even compression packed, as will be hereinafter described.

The invention also comprises apparatus for conditioning material by adjusting the moisture regain comprising conditioning means for treating the material with a conditioning atmosphere, and moisture regain measuring means connected to control means adapted for terminating said treatment when a predetermined mositure regain is attained.

Said conditioning means may comprise an enclosure for said material through which said conditioning atmosphere is passed. The enclosure may have rail or shelving means for supporting articles of said material, and inlet and outlet means for said conditioning atmosphere. Baffle means may be provided if necessary to ensure that the by-pass ratio - the fraction of air that passes through without usefully contacting the material - is as low as possible.

Dehumidifying means comprised in said apparatus may comprise a condenser, and may comprise a rotary wheel type condenser which can also supply heat to increase or maintain the temperature of the conditioning atmosphere.

The dehumidifying means, on the other hand, may comprise absorption means, such as a vessel in which the atmosphere is passed in contact with silica gel or like moisture absorbing means. This could be of interest where the provision of power for condensers is a problem.

Said moisture regain measuring means may comprise temperature measuring means measuring the temperature of the material and the temperature of the conditioning atmosphere, and means evaluating the moisture regain of the material from the two temperature measurements. Said control means may comprise indicating means for indicating that the treatment can be terminated. The control means may, however, automatically terminate said treatment and deliver the treated material into a conditioned packing room.

Embodiments of methods and apparatus for conditioning material by adjusting the moisture regain according to the invention will now be described with reference to the accompanying drawings, in which:-

Fig. 1 is a diagrammatic illustration of a basic apparatus for carrying out the method according to the invention, and

Fig. 2 is a diagrammatic illustration of a more comprehensive apparatus.

Figures 1 and 2 illustrate a method for conditioning materials for packing by adjusting the moisture regain, and apparatus for carrying out the method, comprising an enclosure 11 for said material through which a conditioning atmosphere can be passed from an inlet 12 at one lower edge to an outlet 13 at the opposite, upper edge. The conditioning atmosphere is supplied through ducting 14 in which is a blower 15, a heater 16 and a dehumidifier 17, so that the conditioning atmosphere is circulated (with suitable provision for make-up air to compensate for leakage and for exhausting any air that is not recirculated for any reason), being continually processed by the dehumidifier 17 and the heater 16 to maintain any desired levels of relative humidity and temperature when it enters the enclosure 11.

The enclosure 11 has shelving 18 for supporting articles of the material to be processed. Only four shelves are shown, defining a labyrinthine path through the enclosure 11 from the inlet 12 to the outlet 13 so that the conditioning atmosphere is forced to encounter the entire shelf area of the enclosure. This is assisted by baffles 19 at the inlet, the objects being to ensure that no, or as little as possible, conditioning air passes through the enclosure without usefully encountering the material and

also to ensure that there are no zones where the air is static or relatively so.

The shelving 18 is preferably of mesh or perforated construction so that conditioning atmosphere can penetrate the material from below as well as above. It may, of course, for some applications, notably for the conditioning of suits or jackets or dresses for packing, be preferred to substitute rails for hangers.

The apparatus also includes moisture regain measuring means comprising a first, "dry bulb" thermometer 21 located near the inlet 11 and three "wet bulb" thermometers 22a, 22b, 22c that are on flexible leads so that they can be placed in contact with articles on the shelving 18. The thermometers can be of any convenient kind giving a temperature dependent electrical signal, for example resistance thermometers, thermocouples or thermistors. (It is of course to be understood that the expression " wet bulb" as used above does not mean that the thermometer is actually provided with a wick, rather that the material itself, being subject to evaporation of its moisture content, acts in similar fashion to the wick of a wet bulb thermometer.)

Because the conditioning atmosphere is drying the material, the material will lose heat and the thermometers 22a, 22b, 22c will record a lower temperature than the

thermometer 21. The relationship between the temperatures will in general be fairly complex, and will depend on the relative humidity and the temperature of the conditioning atmosphere entering at the inlet 12, the moisture regain of the material and the nature of the material. It will usually be arranged, however, that even though heat is used to accelerate the drying process, the temperature of the conditioning atmosphere is reduced to ambient by the end of the treatment, which effectively eliminates one variable.

Thus it is possible to terminate the conditioning process prior to establishing equilibrium between the material and the conditioning atmosphere, and it is thus also possible, and even desirable, to have the conditioning atmosphere at a relative humidity below that at which the material would be in equilibrium with it when the material is in satisfactory condition for packaging. In this way, the conditioning process can be accelerated substantially as compared to those earlier processes that require the material and the conditioning atmosphere to be brought into equilibrium.

Moreover, the fact that the conditioning atmosphere, rather than the material to be treated, is passed through the enclosure, means that relatively small enclosures can be constructed which are appropriate to the treatment of small to medium size batches of articles which articles can therefore be of a kind for any one charge, so

that they will all be processed in the same time and this time will not be prolonged by having to meet the requirements of other articles being processed at the same time which may have a higher initial moisture regain or which may be slower-drying. This is not, of course, to say that mixtures of articles cannot be processed by the present method or in the apparatus herein described. If different materials are processed together, either the one with the longer or longest processing time can be used as the determinant of the end of the treatment, the other or others being perhaps over-conditioned, though usually no harm should come of that, or each material can be monitored by a separate thermometer and the materials removed from the enclosure by interrupting the processing as and when they become ready for packaging. Multiple material-sensing thermometers are in any event, evenwhen processing only one kind of material or article at a time, provided as a check to see that conditioning is proceeding uniformly from position to position in the enclosure.

The thermometers 21 and 22a, 22b and 22c are connected to control means 23 which can give an alarm when all three material-sensing thermometers 22a, 22b and 22c indicate temperatures within a desired level with respect to the temperature read by thermometer 21, or when the average of the three material temperatures is within such a desired level.

In addition to raising an alarm on completion of the process, the control means 23 can also give an alarm if the thermometers 22a, 22b and 22c detect a significant departure from uniform or expected processing conditions.

Moreover, the control means 23 can also be arranged, if desired, actually to terminate the process on completion and even to deliver the conditioned material into a conditioned packing room. To this end, the shelving might be separable from the enclosure so that it can be loaded outside the enclosure, while a conditioning operation is in progress on material on another shelving unit, and unloaded in the same way. A convenient arrangement would be to have the enclosure actually within or adjoining a packing room.

The control means 23 (or some quite separate control means - but if, for example, a microprocessor is used, the total control function can easily be integrated in one unit) can also control the heating/dehumidifying regime. Although one regime could be specified which would be suitable for all different types of material likely to be encountered, it is nevertheless more satisfactory to tailor the regime to the actual material being processed, and this is a relatively simple thing to do with a microprocessor.

Essentially, a desirable regime for conditioning textile articles for packaging begins with an initial reduction of the moisture content of the conditioning

atmosphere. Once this has fallen below ambient, temperature can be increased to reduce the relative humidity and accelerate the rate of removal of moisture. Before the end of the process, however, temperature is again brought down to ambient or not much above ambient. In this way, the articles are brought down to a desired low moisture regain so that they will not suffer permanent creasing during storage after packing, and the temperature during the conditioning step is only raised after the moisture content of the material has been reduced somewhat so that the tendency of creases present during conditioning to persist after conditioning is not intensified by the heating. However, the desired combination of moisture regain and temperature for one fabric will be different from that for another and the optimum regime for any particular material can be determined experimentally starting from known practice in the art of conditioning for packing.

Figure 2 shows a more comprehensive conditioning plant in which a conditioning enclosure 31 and a packaging room 32 are supplied with conditioning atmosphere from a dehumidifying/heating arrangement including a blower 33 with a filter 34 and a cooling coil 35 which effects some dehumidifying by condensation. Further dehumidifying, and some heating, are effected by a rotary wheel dehumidifier 36. Further heating is supplied by a battery of electric resistance heaters 37 and/or further dehumidification by a

second cooling coil 38. A volume damper 39 controls the flow into the enclosure 31.

The packaging room 32 is also supplied with a mixture of cooled and dehumidified atmosphere, and heated and further dehumidified atmosphere by ducts 41, 42 under the control of volume dampers 41a, 42a, brought together in a mixing box 43. In this way, the atmosphere in the packaging room can be maintained so as to be in equilibrium, or substantially so, with the conditioned material supplied from the enclosure, so that regardless of the time spent in the packaging room, the conditioned material does not go out of, or too far out of, condition.

Atmosphere discharged from the enclosure 31 can be recycled through a second blower 44, a second electric heating battery 45 and the heat exchanger of the rotary wheel dehumidifier 36. This recycled atmosphere is ducted back to the blower 33 via a volume damper 46. Likewise, return atmosphere from the packaging room 32 can also be recirculated, though it will not be necessary to reprocess this further before passing it back to the blower 33. Excess atmosphere from that discharged from the enclosure 31 and the packaging room 32 is discharged from the system under the control of further volume dampers 47.

Heat can be recovered from the chiller 40 that supplies the cooling coils 35, 38 with coolant medium in condensers 48, 49 and added to the circulating atmosphere

An arrangement such as this provides a flexible and energy-efficient means for processing a wide range of textile goods for packaging, and can be readily adapted by suitable control means to optimally process any particular material or article. The control means - shown diagrammatically at 51, with thermometers 21 and 22a, 22b and 22c (though there may be more or less than three of the latter, "wet-bulb" thermometers as required) - can control the heating batteries, cooling coils, rotary wheel dehumidifier, as well as the various volume dampers according to a prearranged program as above described.

As mentioned above, the cooling coils or dehumidifiers that work by condensation, can be replaced by absorption-type dehumidifiers. By passing heated air through them, they may be stripped of moisture they have picked up from the atmosphere fed into the conditioning enclosure.

Conditioning in apparatus and by methods as above described is found to be effective not only in regular packaging and vacuum packaging of textile articles, but even in compression packaging in which much greater creasing

forces are applied than in vacuum packaging (where the maximum pressure is atmospheric pressure).

CLAIMS

1. A method for conditioning materials for packing by adjusting the moisture regain comprising the step of treating the material with a conditioning atmosphere while measuring the moisture regain of the material, and terminating said treatment when a predetermined moisture regain is attained.

2. A method according to Claim 1, in which the conditioning atmosphere comprises humidity-adjusted air.

3. A method according to Claim 1, in which the conditioning atmosphere comprises temperature-adjusted air.

4. A method according to Claim 1, in which the atmosphere is passed through a container for the material to be conditioned.

5. A method according to Claim 1, in which conditioning atmosphere is circulated.

6. A method according to Claim 5, in which circulated conditioning atmosphere is continually processed to vary or maintain its adjustment.

7. A method according to Claim 6, in which circulated conditioning atmosphere is passed through a dehumidifier.

8. A method according to Claim 6, in which circulated conditioning atmosphere is passed through a heater.

9. A method for packing materials comprising conditioning the materials according to Claim 1 and packing them in an atmosphere with which they are in equilibrium.

10. A method according to Claim 9, in which the materials are vacuum packed.

11. A method according to Claim 9, in which the articles are compression packed.

12. Apparatus for conditioning materials for packing by adjusting the moisture regian comprising conditioning means for treaing the material with a conditioning atmosphere, and moisture regain measuring means connected to control means adapted for terminating said treament when a predetermined moisture regain is attained.

13. Apparatus according to Claim 13, in which said conditioning means comprise an enclosure for said material through which said conditioning atmosphere can be passed.

14. Apparatus according to Claim 13, in which said enclosure has support means for articles of said material and inlet and outlet means for said conditioning atmosphere.

15. Apparatus according to Claim 14, in which said support means comprise shelving.

16. Apparatus according to Claim 14, in which siad support means comprise rail means.

17. Apparatus according to Claim 12, in which said conditioning means comprise dehumidifying means.

18. Apparatus according to Claim 17, in which said dehumidifying means comprise a condenser.

19. Apparatus according to Claim 17, in which siad dehumidifying means comprise absorption means.

20. Apparatus according to Claim 12, in which the conditioning means comprise heating means.

21. Apparatus according to Claim 12, in which said moisture regain measuring means comprise temperature measuring means measuring the temperature of the material and the temperature of the conditioning atmosphere, and means evaluating the moisture regain of the material from the two temperature measurements.

22. Apparatus according to Claim 12, in which said control means comprise indicating means for indicating that the treatment can be terminated.

23. Apparatus according to Claim 12, in which said control means automatically terminate said treatment and deliver the treated material into a conditioned packing room.

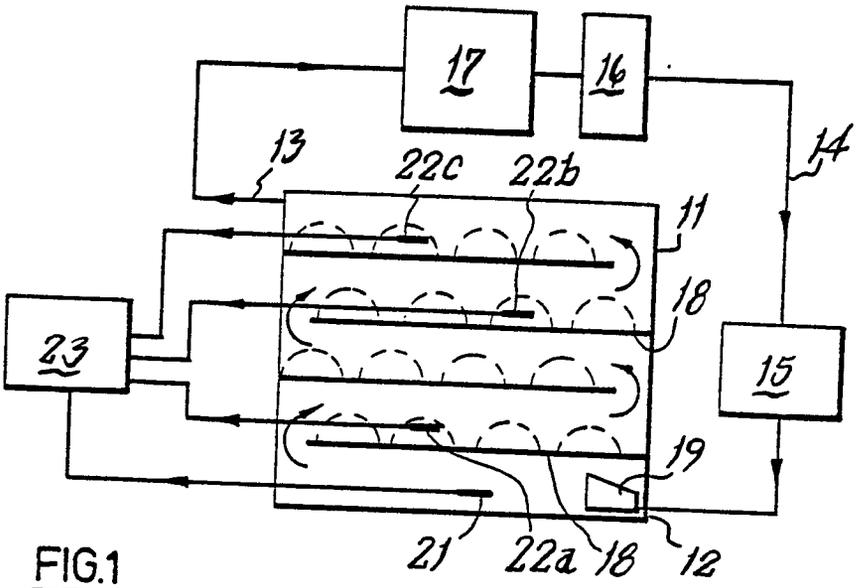
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FIG.1

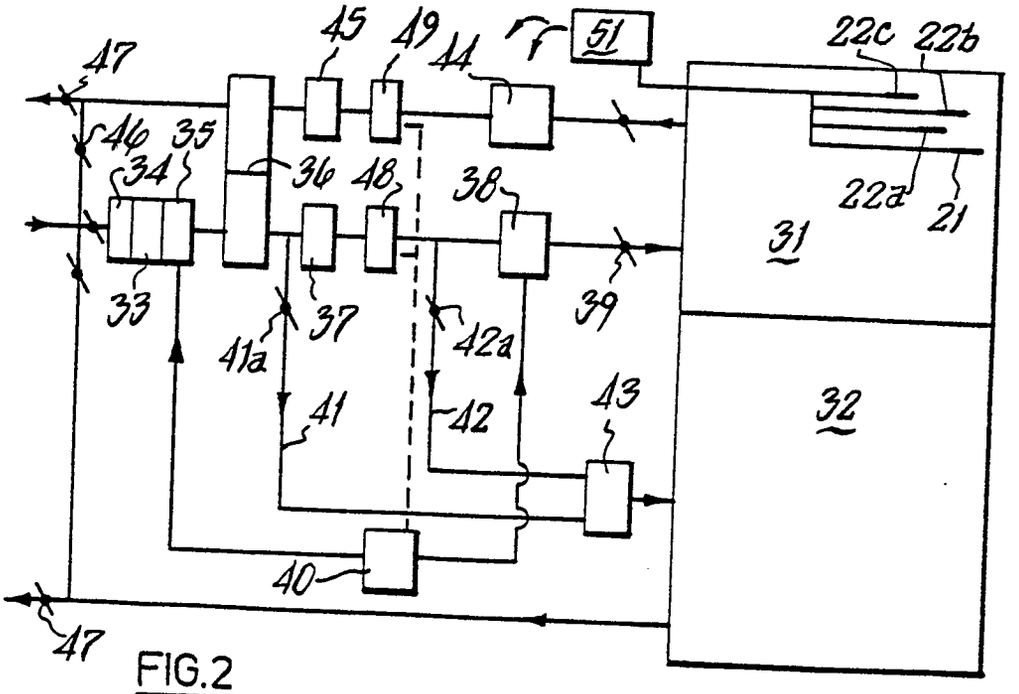
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FIG.2