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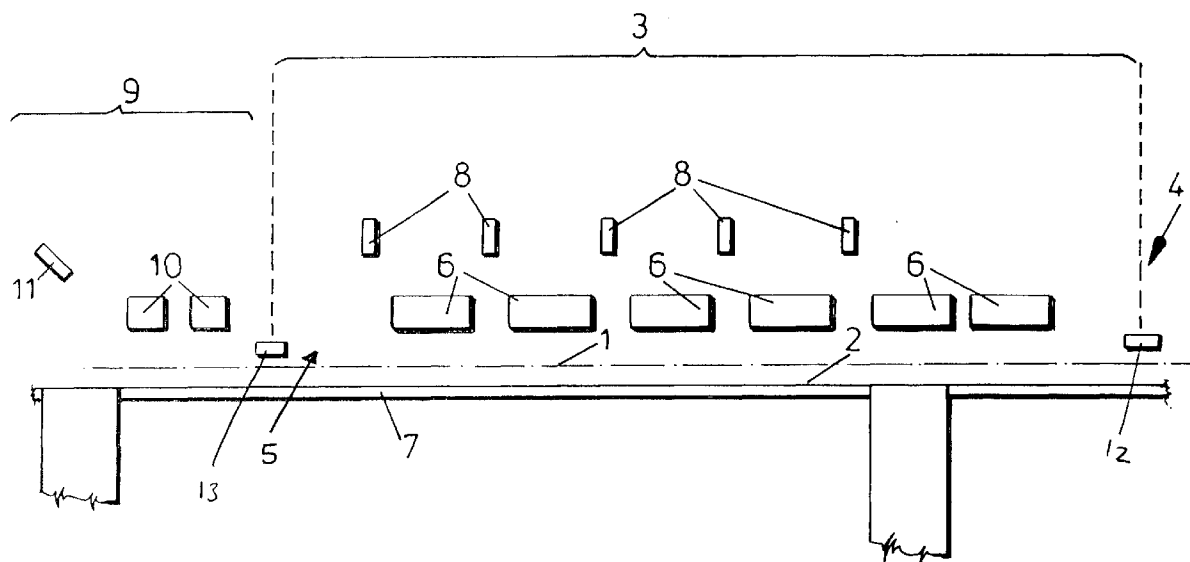
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(54) Method and apparatus for drying a textile fabric

(57) Fabric (1) is dried by means of gas fired emitters (6) that can be selectively switched on and off to control the amount the drying. A control system measures the steam evaporating from the fabric surface, the speed of conveyance of the fabric (1) and the surface temperature of the fabric and switches on or off gas fired

emitters (6) accordingly to ensure the fabric emerges from the drier at a desired residual moisture content without burning or scorching. A heat setter comprising modulated electric short wave emitters (10) and a pyrometer (11) may be used to heat set the fabric after drying.

**FIG. 1**

Description

[0001] The present invention relates to a method and apparatus for drying a textile fabric.

[0002] The use of infra red energy for textile drying is well known. For many years both gas-fired and electric infra red emitters have been used to part-dry textile fabrics. Such dryers operate at high temperatures and require careful control since there is a constant risk of scorching or burning the fabric that is being dried. In view of this risk infra red dryers have traditionally been supplemented by conventional hot air dryers which operate at much lower temperatures so that the fabric is only partially dried by the infra red dryers before the fabric is then fully dried by the hot air dryers.

[0003] In recent years it has been known to dry completely and heat set a fabric by the use of infra red dryers only. One known machine of this type uses modulated electric infra red emitters and a variable speed conveyor that conveys the fabric past the emitters. The output frequency of the emitters is modulated and the speed of the conveyor is varied to ensure that the correct energy requirement is imparted to the fabric to achieve the required residual moisture content (dryness). A disadvantage of such a machine is that using a modulated heat source is inefficient.

[0004] Hot air dryers are controlled by monitoring the surface temperature and/or the moisture content of the fabric being dried. In order to assess the amount of energy required to achieve the required residual moisture content it is necessary to measure the surface temperature of the fabric by using, for example, non contact pyrometers, and/or use moisture measurement systems. When drying using infra red energy it has been found that the surface temperature of different fabrics varied by up to 30°C for a given residual moisture content. Existing moisture measurement systems cannot accurately measure the moisture content of different fabrics without being preprogrammed with information relating to fibre content. Consequently in order to obtain meaningful information from the measurements it is necessary to know the exact fibre type and content of the fabric to be dried as it enters the drying machine. In cases of mixed fabrics the precise fibre content is often not known making accurate moisture measurement impossible. Thus with current infra red drying apparatus it is not possible to dry different fabrics entering the machine continuously one after the other to a desired residual moisture content without the risk of scorching or burning them.

[0005] It is an object of the present invention to obviate or mitigate the aforesaid disadvantages.

[0006] According to a first aspect of the present invention there is provided a method for drying a textile fabric comprising the steps of:

a) conveying the textile fabric through a drying zone comprising a succession of spaced gas fired infra-

red emitters to dry the fabric to a desired residual moisture content;

b) measuring the surface temperature of the fabric after one or more of the emitters;

c) monitoring the speed at which the fabric is conveyed;

d) measuring the amount of steam given off by the fabric in the drying zone;

e) calculating from the values measured in b), c) and d) the heat energy required to achieve the desired residual moisture content of the fabric;

f) selectively switching each emitter on or off and/or varying the speed of conveyance of the fabric in order to ensure the calculated heat energy is imparted to the fabric;

[0007] The above method allows the drying of fabrics of different types in sequence to the desired residual moisture content without risk of burning or scorching, and without knowing the fabric composition. The frequency of emission of the gas emitter is preferably between 2.7 and 3.2 microns.

[0008] According to a second aspect of the present invention there is provided apparatus for drying a textile fabric comprising a conveyor for conveying the fabric through a drying zone to dry the fabric to a desired residual moisture content, a plurality of gas fired infra red emitters spaced along the drying zone, at least one temperature transducer disposed after one or more of the emitters and for measuring the surface temperature of the fabric, means for monitoring the speed of the conveyor, a diffused laser for measuring the amount of steam given off by the fabric in the drying zone, a controller for calculating the heat energy required to achieve the desired residual moisture content and for selectively switching each emitter on or off and/or varying the speed of the conveyor in order to ensure the calculated heat energy is imparted to the fabric by the emitters.

[0009] Preferably the diffused laser comprises a transmitter at one end of the drying zone and a receiver at the other, the laser beam being configured to pass above the surface of the fabric.

[0010] The surface temperature transducer is preferably a pyrometer that is shielded from direct radiation from the emitters. Alternatively it may be a compensated pyrometer.

[0011] According to a third aspect of the present invention there is provided a method of drying and heat setting a textile fabric comprising the steps of:

a) conveying the textile fabric through a drying zone comprising a succession of spaced gas fired infra-red emitters to dry the fabric and raise it to a first predetermined temperature;

b) measuring the surface temperature of the fabric after one or more of the emitters;

c) monitoring the speed at which the fabric is conveyed;

- d) calculating the heat energy required to achieve the first predetermined temperature of the fabric;
- e) selectively switching each emitter on or off and/or varying the speed of conveyance of the fabric in order to ensure the calculated heat energy is imparted to the fabric;
- f) conveying the fabric through a heat setting zone comprising at least one modulated electric short wave infra red emitter to raise the temperature of the fabric; and
- g) measuring the surface temperature of the fabric after it passes the short wave emitter and modulating the short wave emitter to ensure the temperature of the fabric is at a second predetermined value at an exit of the heat setting zone.

[0012] According to a fourth aspect of the present invention there is provided apparatus for drying and heat setting a textile fabric comprising: a conveyor for conveying the textile fabric through a drying zone and a heat setting zone, the drying zone comprising a succession of spaced gas fired infra-red emitters to dry the fabric and raise it to a first predetermined temperature and means for measuring the surface temperature of the fabric after one or more of the gas fired infra red emitters, the heat setting zone comprising at least one modulated electric short wave infra red emitter to raise the temperature of the fabric and means for measuring the surface temperature of the fabric after it passes the short wave emitter; means for monitoring the speed at which the fabric is conveyed, a controller for calculating the heat energy required to achieve the first predetermined temperature of the fabric, for selectively switching each emitter on or off and/or varying the speed of the conveyor in order to ensure the calculated heat energy is imparted to the fabric, and for modulating the short wave emitter to ensure the temperature of the fabric is at a second predetermined value at an exit of the heat setting zone.

[0013] The means for measuring the surface temperature is preferably a shielded or compensated pyrometer.

[0014] A specific embodiment of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a schematic side view of textile drying apparatus in accordance with the present invention; and

Figure 2 is a schematic plan view of the apparatus of figure 1

[0015] Referring now to the drawings, the textile fabric 1 to be dried is conveyed between parallel endless stenter chains 2. The fabric 1 is gripped along each side edge by clips or pins (not shown) provided on the chain 2 so that it is conveyed through a drying zone 3 from entry to exit areas 4,5.

[0016] At an appropriate distance above the surface of the textile fabric 1 there are a plurality of gas fired, medium wave, infra red panel emitters 6 spaced at regular intervals along the length of the drying zone 3. Each gas emitter 6 typically has a running temperature of 850°C and heats up or cools down rapidly after being switched on or off. One example of such a commercially available emitter is supplied by Stordy Combustion Engineering Limited. Such an emitter cools from the running temperature within two seconds and heats up from switch on to approaching running temperature within four seconds and to full running temperature within 10 seconds. The emitters 6 direct the infra red rays downwards toward the conveyed fabric 1 which overlies an infra red reflective board 7 that is disposed under the area enclosed by the stenter chain 2.

[0017] The gas emitters 6 are interspersed by non-contact infra red pyrometers 8 that are positioned on alternate sides of the gas emitters 6 along the length of the drying zone 3. Each pyrometer 8 is screened from the radiation of the emitters 6 to prevent inaccurate temperature readings. Alternatively a compensated pyrometer is used which is programmed with information relating to the type and location of the emitters and other information so that stray readings are not considered.

[0018] Downstream of the drying zone 3 there is a heat setting zone 9 in which there are two short wave electric infra red emitters 10 positioned one after the other above the conveyed fabric 1, followed immediately by a compensated infra red pyrometer 11. The heat setting zone raises the temperature of the fabric 1 to a desired value after it has been dried in the drying zone 3.

[0019] In order to measure the residual moisture of the fabric passing through the drying zone a diffused laser beam is transmitted just above the surface of the fabric from a laser transmitter 12 in the entry area to a laser receiver 13 in the exit area of the drying zone.

[0020] The pyrometer temperature readings are transmitted to a central controller that incorporates a processor and which controls the operation of the emitters and the speed of the stenter chains (and therefore the speed of passage of the fabric through the drying and heat setting zones).

[0021] The frequency of the gas fired emitters is tuned to between 2.7 and 3.2 microns which is the most efficient frequency for the evaporation of water. The controller does not modulate the emitter frequency but simply switches the individual emitters on or off as desired. Once the fabric has been dried (i.e. all the moisture has been evaporated) by the gas emitters the electric emitters heat set the fabric to a temperature of typically 180°C. Electric short wave emitters are more efficient in penetrating the fabric to raise its temperature evenly to the required temperature once all the moisture has been evaporated and can be modulated efficiently.

[0022] As the fabric passes through the drying zone it is subjected to infra red radiation from the gas emitters and after each emitter the surface temperature of the

fabric is measured by the respective pyrometer and the reading is passed to the controller. The absolute temperature measured by the pyrometer is not used to control the drying operation as different fabrics will have different temperatures at each stage but the pyrometers will immediately identify a change in temperature due to a different fabric. Thus a rapid rise or fall in the reading of the first pyrometer in the drying zone will alert the controller to a change in fabric and if this is confirmed by the reading of the next pyrometer the controller switches on or off the last emitter or last few emitters depending on the magnitude of change in the pyrometer readings. This arrangement provides for an "early warning" and prevents dramatic final temperature variations. The risk of the fabric emerging from the drying zone in a scorched, burned or over-damp state is therefore reduced significantly.

[0023] As the fabric emerges from the drying zone it cools rapidly and any residual moisture immediately condenses as steam at the fabric surface. The amount of steam escaping from the fabric is measured by the diffused laser beam and is directly proportional to its moisture content which is independent of the fabric type. The passage of the laser beam is interrupted by the steam proportionately and therefore the received laser signal is a direct measurement of the amount of steam and therefore the amount of residual moisture in the fabric. This reading is passed to the controller which adjusts the speed of the stenter chain conveyor to give the required residual moisture content. At the same time the controller calculates the optimal number of switched on emitters that are required to dry the particular fabric to the desired residual moisture at the maximum speed of the conveyor and switches on the emitters accordingly.

[0024] The apparatus of the present invention thus balances the energy emitted with that required by the fabric so that the fabric is not over-dried. This is in contrast to a conventional hot air dryer where the fabric can be subjected to any amount of excess energy without damage and therefore can often be over-dried.

[0025] When the fabric is to be heat set there is no need to measure the residual moisture content of the fabric or the steam emitted and therefore the diffused laser beam is not used. The gas emitters are simply used to raise the temperature of the fabric towards the required heat setting temperature, for example to 160°C. The dried fabric leaves the drying zone and then enters the heat set zone where it passes under the short wave electric emitters which bring the temperature of the fabric up to the required heat setting temperature (e.g. 180°C). The compensated infra red pyrometer readings are fed to the controller which modulates the output of the emitters to maintain the fabric temperature at the required heat setting value.

[0026] It is to be understood that the heat-setting zone is used optionally. To dry a fabric to a predetermined residual moisture content the fabric is only heated in the drying zone.

Claims

1. A method for drying a textile fabric comprising the steps of:

- a) conveying the textile fabric through a drying zone comprising a succession of spaced gas fired infra-red emitters to dry the fabric to a desired residual moisture content;
- b) measuring the surface temperature of the fabric after one or more of the emitters;
- c) monitoring the speed at which the fabric is conveyed;
- d) measuring the amount of steam given off by the fabric in the drying zone;
- e) calculating from the values treasured in b), c) and d) the heat energy required to achieve the desired residual moisture content of the fabric;
- f) selectively switching each emitter on or off and/or varying the speed of conveyance of the fabric in order to ensure the calculated heat energy is imparted to the fabric;

2. Apparatus for drying a textile fabric comprising a conveyor for conveying the fabric through a drying zone to dry the fabric to a desired residual moisture content, a plurality of gas fired infra red emitters spaced along the drying zone, at least one temperature transducer disposed after one or more of the emitters and for measuring the surface temperature of the fabric, means for monitoring the speed of the conveyor, a diffused laser for measuring the amount of steam given off by the fabric in the drying zone, a controller for calculating the heat energy required to achieve the desired residual moisture content and for selectively switching each emitter on or off and/or varying the speed of the conveyor in order to ensure the calculated heat energy is imparted to the fabric by the emitters.

3. Apparatus according to claim 2, wherein the diffused laser comprises a transmitter at one end of the drying zone and a receiver at the other, the laser beam being configured to pass between the two above the surface of the fabric.

4. Apparatus according to claim 2 or 3, wherein the surface temperature transducer is a pyrometer that is shielded from direct emission from the emitters or is compensated.

5. A method of drying and heat setting a textile fabric comprising the steps of:

- a) conveying the textile fabric through a drying zone comprising a succession of spaced gas fired infra-red emitters to dry the fabric and

raise it to a first predetermined temperature;
 b) measuring the surface temperature of the fabric after one or more of the emitters;
 c) monitoring the speed at which the fabric is conveyed;
 d) calculating the heat energy required to achieve the first predetermined temperature of the fabric;
 e) selectively switching each emitter on or off and/or varying the speed of conveyance of the fabric in order to ensure the calculated heat energy is imparted to the fabric;
 f) conveying the fabric through a heat setting zone comprising at least one modulated electric short wave infra red emitter to raise the temperature of the fabric; and
 g) measuring the surface temperature of the fabric after it passes the short wave emitter and modulating the short wave emitter to ensure the temperature of the fabric is at a second predetermined value at an exit of the heat setting zone.

6. Apparatus for drying and heat setting a textile fabric comprising: a conveyor for conveying the textile fabric through a drying zone and a heat setting zone, the drying zone comprising a succession of spaced gas fired infra-red emitters to dry the fabric and raise it to a first predetermined temperature and means for measuring the surface temperature of the fabric after one or more of the gas fired infra red emitters, the heat setting zone comprising at least one modulated electric short wave infra red emitter to raise the temperature of the fabric and means for measuring the surface temperature of the fabric after it passes the short wave emitter; means for monitoring the speed at which the fabric is conveyed, a controller for calculating the heat energy required to achieve the first predetermined temperature of the fabric, for selectively switching each emitter on or off and/or varying the speed of the conveyor in order to ensure the calculated heat energy is imparted to the fabric, and for modulating the short wave emitter to ensure the temperature of the fabric is at a second predetermined value at an exit of the heat setting zone.
7. Apparatus according to claim 6, wherein the means for measuring the surface temperature is a shielded or compensated pyrometer.
8. A method for drying a textile fabric substantially as hereinbefore described with reference to the accompanying drawings.
9. Apparatus for drying a textile fabric substantially as hereinbefore described with reference to the accompanying drawings.

10. A method for drying and heat setting a textile fabric substantially as hereinbefore described with reference to the accompanying drawings.

11. Apparatus for drying and heat setting as textile fabric substantially as hereinbefore described with reference to the accompanying drawings.

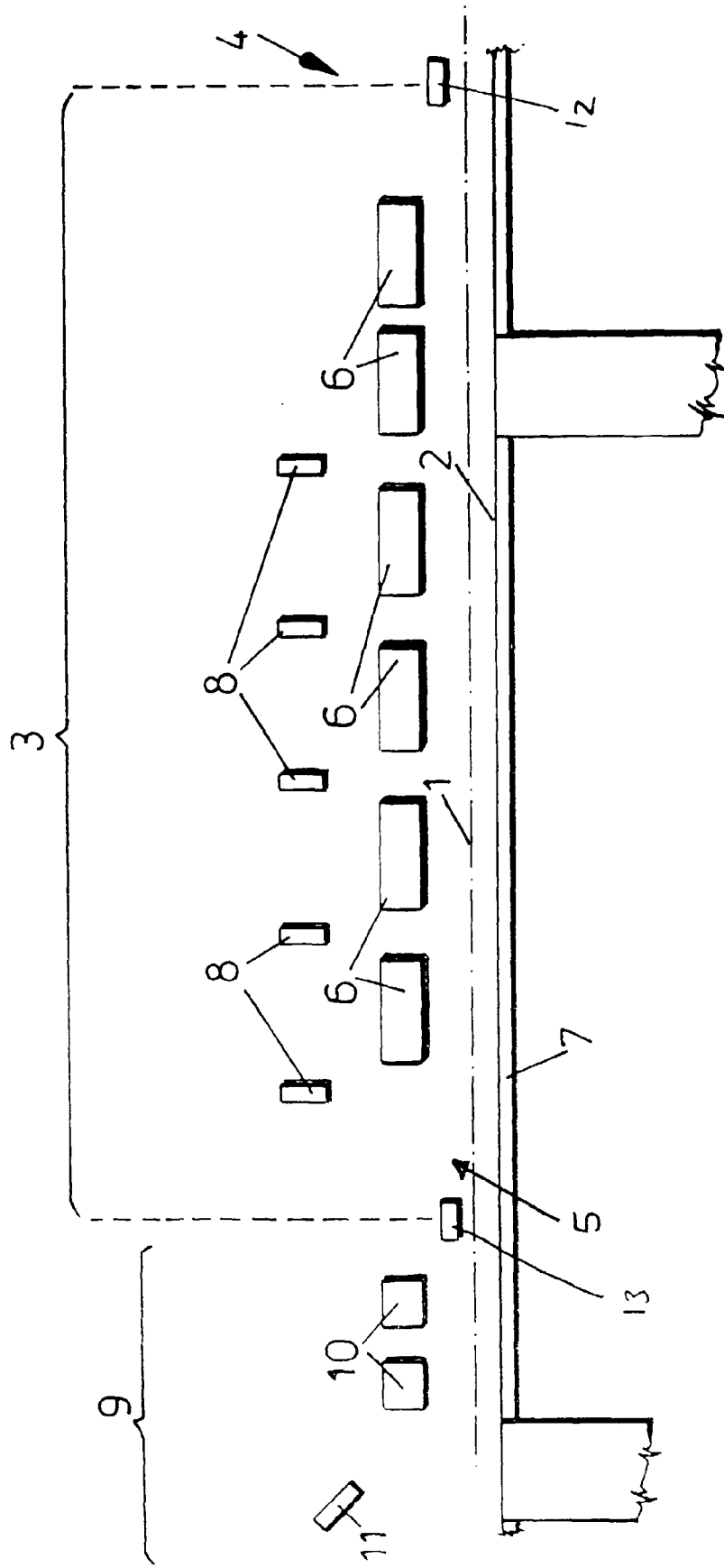


FIG. 1

