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DRYING CHAMBER FOR YARN-LIKE MATERIALS AND FLOK YARNS

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Abstract: The analysis of the obtained results makes it possible to identify an interesting pattern that is extremely important for the derivation of empirical formulas and, accordingly, for calculating the technological parameters of the binder application process on the threads.
Keywords: binding threads, adhesive layer, core thread, shaft.

INTRODUCTION

The need to create new materials and give materials qualitatively new properties, along with the problem of recycling polymer and other waste, aswell as rationaluse of raw materials, determine the prospects of alternative scientificand practical directions for processing fibrous raw materials [1,2].

Flockedyarns are usedfor the manufacture of pilefabrics, non-wovenand knitted fabrics for furniture, decorative and upholstery purposes (to cover the seats of vehicles, especially passenger cars), carpets, curtains, garments and other products.

Materials and products made of such a thread combine high wear resistance with an attractive appea rance, and the volume trics tructure of the flocked thread provides good water and air permeability, sound and thermal insulation, moisture absorption; combinations of the seproperties for a particular thread are achievable with appropriate selection of components: corethread, flock, glue [3].

In the technology of electro flocking in the production of flocked yarn, in particular, the method and device of the drying chamber have an exceptionally strong in fluenceon the productivity and energy consumption of the line.

The mostacceptable method forcuring the binderon a flocked yarnis, apparently, the method of drying using IR radiation. The use of infrared (IR) emitters makes it possible to cure the adhesive composition in a non-contact way, provides a sufficiently intense flow of energy, practi cally with outinertia and makes it easy to regulate the curing process.

In additionto the above, it should be added that the drying chamber, asitwas justifiedin detail in [4], mustne cessarily be builton a modular principle, this gives the following advantages [5] in each module, you can set your own optimal heating mode; it is easy to change the length of the drying chamber if necessary, for example, within creasing flocking speed.

MATERIALS AND METHODS

In this article, we will consider a possible cheme for calculating the parameters and operating mode of emitters when curing an adhesive composition on a flocked yarn by means of IR radiation. In the production of flocked yarn, a binder based on aqueous dispersions is usually used, and the proportion of solvent, i.e.water, is 50-60%.

First, it is necessary, based on the absorptions pectrum of the liquid binder, to select the emitte randits temperature. So, for example, if we consider the trans missions pectrum of water (Fig.1), which makes up the main share in acrylic binders, it is easy to notice a very strong

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absorption bandin the are a of λ3m km. This wave length corresponds to the surface temperature of the emitter T = 970^0 K [4,8].

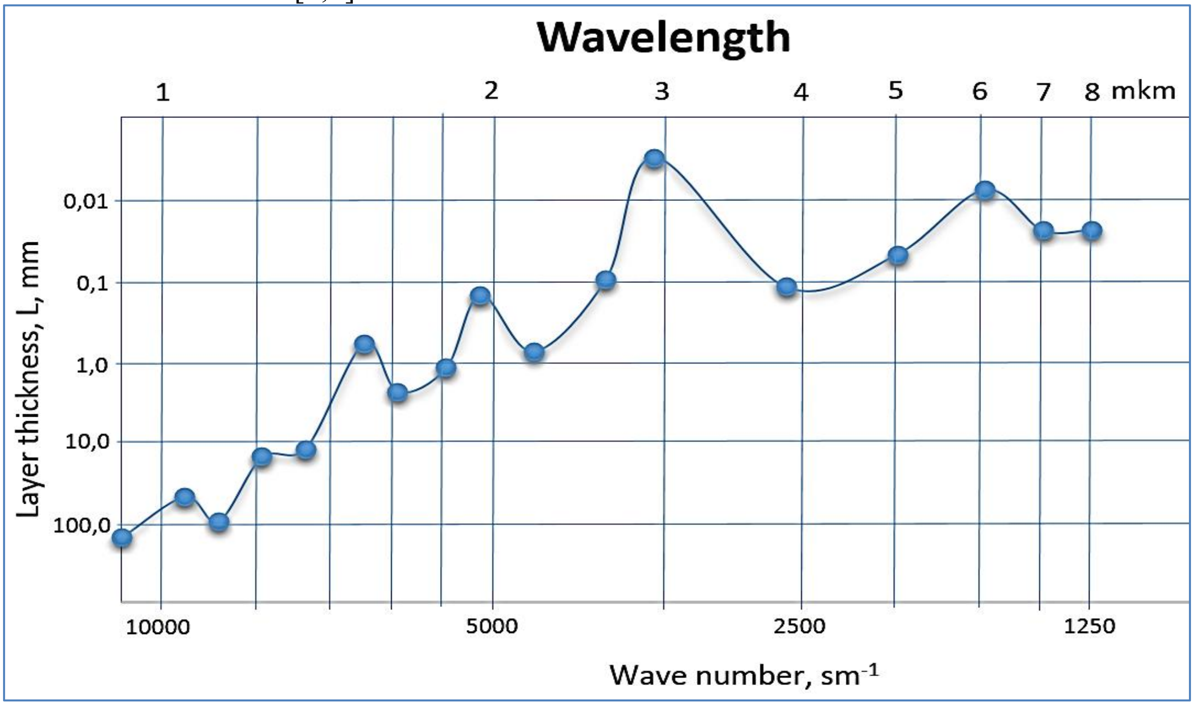

Fig. 1 Water trans missions pectrum

L- is the thickness of the layer, which weakens the intensity $I_o \cdot b \cdot e^l$times, while the coefficient$\chi_o=I/L$

Further, knowing the surface temperature of the radiator, it is easy to obtain the value of the radiation density, whichin this case will be equal to R=5.046W/sm^2.

This temperature of the radiator approximately corresponds to the operating temperature range of the nichrome wire [7]. Other absorption maxima that are important to us correspond to wave lengths of about 1.5 and 2.0 microns. These wave lengths correspond tohig herradiator temperatures, and in this case, for example, radiators with a tung stenspiralcan be used. A san example, we will give in detail the calculations cheme for a radiator with a nichrome spiral.

RESULTS

Based on the above data, it is easy to calculate what power or voltage should be applied to the IR lampso that the maximum radiation falls at a wave length of λ – 3 microns. Let's calculate a slightly more complicated case, namely, how long the nichrome wire should be so that at a voltage of 220 V it has a maximum radiation at the desired wave length, which will allow the emitter to be used at maximum power. The position in the spectrum of the maximum spectral radiation density is determined by Wien's law [6].

$\lambda T = C_0$(1)

where : σ = $5,67\text{-}10^{-8} Wm\backslash(м^2K^4)= 5,67\ 10^{-12} Vm\ (sм^2K^4)$

$R = \sigma T^4$ (2)

where: б = 5,67-10^{-8}Wт\($м^2$$K^4$)= 5,67 10^{-12}Bт (sм^{2}K^4), *R=F/S*, *S* - the surfacearea of the radiator, *F*- radiationflux(*Wm*)

Thus, $F = \sigma \cdot S\left(\frac{C_0}{\lambda_M}\right)^4$

Further, assuming that the main power is releasedin the form of radiationand, recording the power of the emitter, through the voltage U suppliedtoit, we obtain

$$\frac{U^2}{R} = G \cdot \pi \cdot d \cdot l(T)\left(\frac{C_0}{\lambda_M}\right)^4$$

Where R is the resistance of the nichromewire, d- is the diameter of the wire,

L (T) is the length of the wireat temperature T,K.

Now, expressing the resistance R^1, in terms of the resistivityρ *(T*), it is possible to determine the length of the wire that will most effective lyemitat the desired wave length λ_M

$$l(T) = \frac{U}{2}\left(\frac{\lambda_M}{C_0}\right)^2 \sqrt{\frac{d}{\sigma \cdot \rho(T)}}$$

The resistance of a radiating wire having such a length is equal to

$$R(T) = \frac{2U}{\pi d}\left(\frac{\lambda_M}{C_0}\right)^2 \sqrt{\frac{\rho(T)}{\sigma \cdot d}}$$

Based on this, it is possible to calculate the powerreleasedon the radiator

$$F = \frac{\pi d U}{2}\left(\frac{C_0}{\lambda_M}\right)^2 \sqrt{\frac{\sigma \cdot d}{\rho(T)}}$$

Now it is necessary to calculate what energy is required tore move the solvent from the binder on the filaments, after which it will be necessary to determine how many suche mitters are requiredtore move the solventin time*t*.

The amount of heatrequired to heat the massdm by T^0 is equalto

$$dQ_1 = C_1 \cdot \Delta T_1 dm$$

Where C_1- is the specificheat capacity of the binder.

The amount of heat required to evaporate the solvent, taking in to account that the mass of the solvent to be removed is less than the mass of the binder

that is, *dm -η dm (0 <1 η<1),* is equal to:

$$dQ = r \cdot \eta\, dm$$

Where*r* - is the specificheat of vaporization of the solvent.

Next, it is usually necessary to heat the binder by another T_2 to carry out the polymer ization process.

$$\boldsymbol{dQ = C_2 \Delta T_2 (1 - r) dm}$$

Then the to talamount of heat required for thermal fixationon the threads will be

$$\boldsymbol{dQ = [C_1 \Delta T_1 + r\eta + C_2 \Delta T_2 (1 - \eta)] dm}$$

Let's write for convenience $d_m = \gamma d_z$ defining as the mass of a unit of thread length,i.e.as the lineardensity of flocked yarn, but withraw glue, then

$$dQ = \left[C_1 \Delta T_1 + [C_1 \Delta T_1 + r\eta + C_2 \Delta T_2 (1 - \eta)] \gamma` d_z\right]$$

Weas sume that when passing through the drying chamber, the yarn absorbs a fraction of the radiated energy equal to X_o.. Thatis, the section of the thread d_z, passing through the drying chamberduring timet, will receive part of the energy emitted during this time by the IR emitter. Next, we willas sume that wehave *M* radiators sufficient to transmit the necessary amount of heat to *N* strands. Thatis, the proportion of radiated energy received by the section of dz fila mentsduring the passage of the drying chamber with a length of *L*ata speed of *V* will beequal to

$$\chi_0 \frac{MF}{L_0} d_z \cdot \frac{L_0}{V} = \chi_0 \frac{MF}{V} d_z$$

Equating this value to the amount of energy need ed to dry the section of the dzthread, we obtain

$$\chi_0 \frac{MF}{V} = [C_1 \Delta T_1 + r\eta + C_2 \Delta T_2 (1 - \eta)] N\beta$$

Based on the obtained formula, it is possible to determine, for example, the required number of emitters *M* with a power of *F* for drying *N* filaments, provided that the waveleng thrang eo fIR-radiation corresponds to the zone of greatest absorption.

$$M = [C_1 \Delta T_1 + r\eta + C_2 \Delta T_2 (1 - \eta)] \frac{N\beta V}{\chi_0 F}$$

DISCUSSION

It should be noted here that the power value of the emitterp is use din formula (12), there fore, this formula can beused to determine the required number of standar dinfr are dlamps produced by industry, if it is known at what power theyemitin the desired waveleng thrange.

In practice, however, thing sare much more complicated. The fact is thatin formulas (12) it is possible to approximate the value of all the parameters used, except for parameter X. This parameter depend son such heterogeneous factors as the proportion of radiation power falling within the desired wave leng thrange; the proportion of power consumed to heat the body of the drying chamber; the proportion of power consumedtoheat the air in the thermal chamber; absorption of IR radiation by water vaporgeneratedin the thermal chamberduring drying of the binder, etc.

Striving for the maximum value of the coefficient requires signify cantre search to create the most efficient thermal chamber design for flocked yarnand thread-like materials.

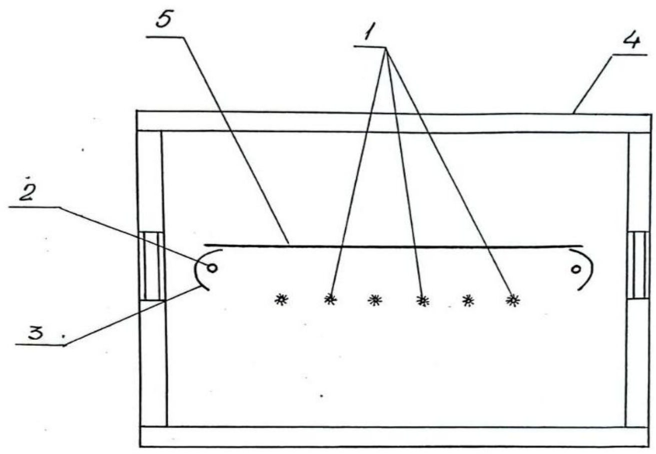

Fig. 2 Drying chamber 1– flocked yarn, 2– IR lamp, 3– paraboli creflector, 4– thermal insulation housing, 5– additional reflector

Thus, it is clear that the value of the parameter can bereliablyes timated experimentally only for this particular design of the drying chamber.

CONCLUSIONS

Inconclusion, the results of specific calculations can be given. So that a nichrome wire with a diameter of 1 mm has a maximum spectral radiation density of $\lambda = 3$ μ mat a voltage of U-220 W, it must have a length (in the heated state) of -14, Zm. In this case, the total radiation power will beap pro ximatelyequal to 2300 Watts, and the required number of suchemitters for drying 100 threads, excluding energy losses, is 6. As are sult of the research, a technology has been developed (experimentalin stallation and technological mode) that ensures the production of flocked yarn with specified properties-piledensity, linear density, torsionals tiffness. In fact, the efficiency of using radiators for drying yarn in practice will pro bably not exceed 20%, and the number of radiators then requires at least 60, i.e. the power consumption will be at least 75k W.

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