THE ENSURING OF NONWOVENS CHARGING WITH ADHESIVES AND CHEMICAL AUXILIARS BY CONTROLLING THE LIQUOR LEVEL IN THE VAT AND THE PRESURRE OF FOULARD CYLINDER

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REZUMAT. Tehnologiile de obținere a textilelor nețesute utilizează o mare diversitate de procedee de consolidare cu flote de adezivi, care pot conține uneori și agenți chimici de ignifugare, de antistatizare etc. Utilajele pe care se realizează aceste tratamente oferă o anumită flexibilitate a tehnicilor de depunere a flotelor de consolidare prin imersare (impregnare) totală a materialului în flota fulardului sau prin preluarea flotei prin transfer de pe suprafața cilindrului. În acest articol este prezentată posibilitatea de automatizare a instalației pentru menținerea constantă a nivelului flotei și este simulată situația apariției unui perturbări în încărcarea cu flotă.

Cuvinte cheie: nețesute, adezivi, nivelul flotei, simulare.

ABSTRACT. The technologies for producing nonwoven textiles uses a great diversity of methods for consolidation with the solutions of adhesives, which can sometimes contain chemical fire retardant, antistatic etc. The machinery which makes these treatments provide some flexibility of techniques for consolidation deposit the liquor by totally immersing of the material (impregnated) in the liquor in foulard or by taking the transfers liquor on the cylinder. This article presents the possibility of system automation for maintaining the liquor level constant and the situation is simulated appearance of a disturbance in the loading liquor.

Keywords: nonwoven, adhesives, liquor level, simulation.

1. INTRODUCTION

The technologies for producing nonwoven textiles are using a variety of methods of consolidation with the adhesives liquor, which can sometimes contain chemical for fire retardant, antistatic etc. The machinery which makes these treatments provides some flexibility within the liquor deposition techniques consolidation.

For example, the Santa Lucia technological line can be achieved the consolidation by total material, immersion (impregnated) in an adhesive liquor of foulard (figure 1), or by taking the transfer adhesive liquor from the drum surface (figure 2) etc. In both cases the technology variants are important to ensure a certain technologically recommended load, depending on destination.

2. THE ENSURING THE LOADING OF NONWOVENS WITH ADHESIVE LIQUOR TREATMENT BY SQUEEZING FORCE SELF-REGULATION

Regardless of the liquor deposition treatment variant to the nonwoven textile, by changing the pressing force of the cylinder foulard on its material can be adjusted the loading with the liquor out of the vat. The flow of feeding pump must be equal to the flow rate of consumption of adhesive liquor in the vat by the textile material. At the same time, it must ensure a constant level of the adhesive liquor in a vat. The feeding pump flow is known and constant and any deviation from the prescribed value of adhesive liquor level must be corrected by modifying the squeezing force. It would be necessary to provide such of technological liquor treatment loading self-regulation and, finally, the substance loading in the dry state exit from the machine.

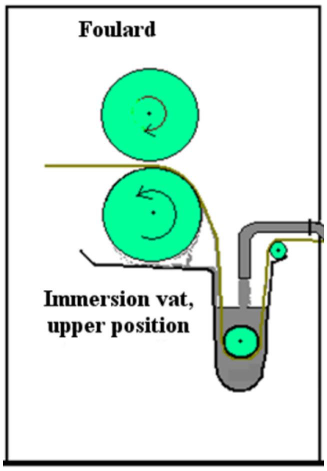


Fig. 1. Consolidation by total immersion.

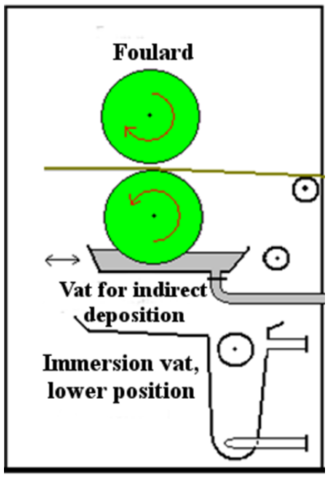


Fig. 2. Consolidation by liquor transfer.

To achieve this objective it is necessary a relationship for calculating the flow of foulard pump feeding depending on the supply flows with textile material and its charge with liquor (the liquor consumption rate). At the same time would be required a dosage pump with continuous feed, a self-regulation system of foulard squeezing force depending on the level of the vat adhesive liquor, an appropriate computer software etc. The following are some technological relationships required for such modern system of self-regulation. [1]

The feed flow of the nonwoven textile material means the mass fed per unit time. It is calculated with relationship [1]:

$$Q_{amt} = \frac{m_{mt} H v_{mt}}{10^3} \tag{1}$$

where: Q_{amt} represents the feed flow of textile material subjected to consolidation [kg/min]; m_{mt} – textile material mass, per surface unit, fed at foulard [g/m^2]; H – the width of material [m]; v_{mt} – speed of textile material [m/min].

The feed flow of consolidation liquor represents the fed liquor mass to foulard, per unit time, by dosing pump. It can calculate pumps specific relationships, such as:

$$Q_{af} = v_{af} \cdot S_{af} \cdot \rho_f \tag{2}$$

where: Q_{af} represents the fed flow with consolidation and treatment [kg/min]; v_{af} – the flow speed of the consolidation adhesive liquor from the feed pipe [m/min]; S_{af} – the flow area [m^2]; ρ_f – volumetrically density of adhesive liquor treatment [kg/m^3].

The load flow of the textile with treatment-consolidation liquors is the impregnated liquoring mass into the textile material in its output in the foulard. The use of a dosing pump for feeding the foulard, the flow of load material (the liquor consumption flow) must be equal to the feed flow rate to ensure a constant level of immersion liquor in a vat of the textile material. In these conditions the loading rate of textile material, Q_{imt}, will be [1]:

$$Q_{imt} = Q_{af} \tag{3}$$

The **technological loading of the textile** with consolidation - treatment liquor represents the increase percentage in weight of the textile at the outlet from foulard, technologically recommended. It is calculated according to the loading of substances, technologically recommended of textile material, after drying out, and the treatment impregnated liquor concentration [1]. It used the relation:

$$I_{tf} = \frac{I_{ts}}{K_f} \cdot 100 \tag{4}$$

where: I_{tf} represents the technologically recommended load with consolidation liquor [%]; I_{ts} – technologically recommended load with consolidation substances in dry state [%]; K_f – liquor concentration in consolidation - treatment substances [%];

For example, deposition of latex on the synthetic fur is technologically recommended I_{ts} = 10 – 12 %, and K_f = 8 – 10 %. If adopted I_{ts} = 11% and K_f = 9%, results I_{tf} = 122,2%.

The **textile effective loading** with consolidation-treatment liquor represents mechanically loading performed on foulard, dependent on several factors, including the pressing force of the foulard cylinders on the impregnated material. To ensure the technological value (I_{ts}), the effective loading with liquor treatment will be determined by one of the equations:

$$I_{ef} = \frac{Q_{imt}}{Q_{amt}} \cdot 100 \quad \text{or} \quad I_{ef} = \frac{Q_{af}}{Q_{amt}} \cdot 100$$

$$\text{or} \quad I_{ef} = \frac{10^5 \cdot Q_{af}}{m_{mt} \cdot H \cdot v_{mt}} \qquad (5)$$

Equaling the effective load that must be carried out mechanically with the liquor treatment loading recommended technologically, with follows:

$$\frac{Q_{af}\ 10^3}{m_{mt}\ H\ v_{mt}} = \frac{I_{ts}}{K_f} \qquad (6)$$

The technological requirement to maintain a constant level of liquor in foulard (the degree of the vat filling) can be achieved only if the feed flow with the liquor treatment of vat complies the relationship:

$$Q_{af} = \frac{m_{mt}\ H\ v_{mt}\ I_{ts}}{10^3\ K_f} \qquad (7)$$

According to this relationship, the feed pump flow is proportional to the mass of the surface unit of the product, its width, working speed and technological load with substances of dry product. It is in inverse proportion to the concentration of the treatment liquor.

When using a recirculation circuit between foulard vat and general reservoir the total flow of supply treatment liquor will be:

$$Q_{at} = Q_{af} + Q_{rf} \qquad (8)$$

where: Q_{at} represents the total feed flow through feed pump; Q_{rt} – the return flow of the pump between central reservoir and foulard watt. It may be constant regardless of product characteristics.

Mass finished material, per unit area, is calculated from the relationship:

$$m_{mf} = m_{mt} \frac{100 + I_{ts}}{100} \qquad (9)$$

where: m_{mf} – mass finished material, after loading and drying [g/m^2] .

3. RESULTS AND POSSIBLE USES

Using the characteristics of nonwoven textile obtained on the Santa Lucia machine, in Table 1 may take some of the calculated values for feeding pump flow, to impregnate through the total immersion. These flows should be equal to liquor consumption (liquor load of the textile) which finally provides the loading with dry a substance technologically required for the article in question, respectively the final mass of the product (m_{mf}).

Table 2 shows the flow calculated values of the dosing pump and mass of the finished material can follow if the impregnation is performed by the transfer of the liquor from a latex coating cylinder, according to the principle of Figure 2.

Table 1. **The calculated flow rate of the feed pump (dosing) for impregnation by immersion**

Article	Formula (basic elements)	m_{mt}, [g/m^2]	H, [m]	v_{mt}, [m/min]	I_s, [%]	K_f, [%]	Q_{af}, [kg/min]	m_{mf}, [g/m^2]
Rear insole	Latex 9090 47,06 % Calcite 44,12 % Water 8,82 %	300	1,56	3,2	400	67,65	8,85	1500
Insole with PP insertion	Latex 5587 52,9% Calcite 39,2% Water 7,9%	220	1,56	4,2	354,5	65,68	7,78	1000
Insole with PP insertion	Latex 5587 53,21% Calcite 38,32% Water 8,47%	210	1,56	5,1	138	64,92	3,55	500
Soft insole	Latex 5587 19,22% Water 80,78%	350	1,56	6,8	28,6	9,61	11,05	450

Table 2. **The calculated flow rate of the feed pump (dosing) for impregnation transfer**

Article	Formula (basic elements)	m_{mt}, [g/m^2]	H, [m]	v_{mt}, [m/min]	I_s, [%]	K_f, [%]	Q_{af}, [kg/min]	m_{mf}, [g/m^2]
Fur 250	Latex 9090 100%	220	1,56	6,2	13,6	50,0	0,58	250
Fur 350	Latex 5587 100%	300	1,56	5,5	16,7	50,0	0,85	350
Car moquette	Latex 5587 73,21% Calcite 29,79%	350	1,56	5,1	22,8	63,39	1,0	430
Car moquette	Latex 5587 73,21% Calcite 29,79%	400	1,56	5,1	37,5	63,39	1,88	550

The use of equations (7) and (8) would allow self-adjustment of the material loading with treatment substances, by introducing software in the process computer of the machine, which ensures feeding of foulard machine vat according to the scheme shown in Figure 3. The computer (4) of the machine can be fixed the feeding pump flow (5), depending on the parameters highlights by (7) and (8), so as to ensure equality between the supply flows of liquor and loading rate flow with liquor of material.

The effective loading with liquor, mechanical achieved, depends on the squeezing force of the material from the foulard cylinders. After loading of the vat foulard to the level required technologically, level that must be kept constant, the ensuring of the equality between the effective loading with liquor and liquor loading technological is made possible only by controlling the squeezing force, by the same computer, based on information received from the measuring device the of the liquor level. So if the vat liquor is reduced with Δh_x, value under the prescribed value (i.e. degree of filling the vat is 90%), and level gauge sends to computer the command to increase squeezing force P_x. It decreases the effective loading with the liquor of material, bringing it to a technological prescribed value. If the level of the vat liquor goes above prescribed by a certain amount Δh_x, is transmitted to computer the order for lowering of the force P_x. It thus increases the effective loading with liquor (liquor consumption) until the value technological prescribed.

Through these commands shall ensure the equality between the effective loads with liquor achieved mechanical and technological loading with liquor adopted according to product processed.

An example of a process system control is shown in figure 4, realized with Xcos library of Scilab software. The maintaining a constant level is performed automatically by means of a PID controller using a feedback system. The transfer function of the process is obtained by applying the inverse Laplace function, equation 10 [2] [4].

$$h = 0{,}4 \cdot e^{-at} \tag{10}$$

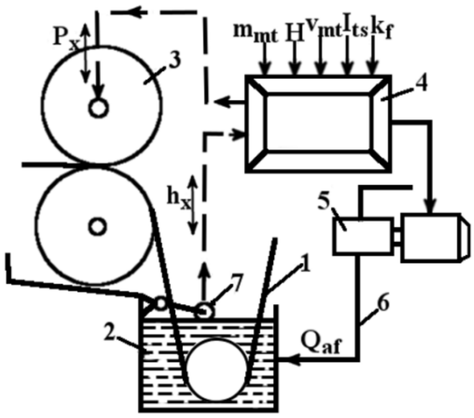


Fig. 3. Computer control scheme:
1 – textile material; *2* – immersion vat; *3* – calendar cylinders; *4* – computer; *5* – feeding pump; *6* – feeding pipe; *7*– level gauge; P_x – presing force on the cylinder foulard; h_x – the level of the treatment liquor; Q_{af} – the feed flow rate with liquor.

The system's response to receiving the order filling is shown in figure 5.a, in this case doesn't exist the disturbing factors. In case of disturbances (block ON/OFF open), the system response will be in the figure 5.b.

In summary, the combination between fixing the constant value of a feeding pump flow depending on the manufacturing article, according to the relations (7) and (8), and the variation of squeezing force, computer controlled depending on the liquor level in foulard allows the insurance of mechanical conditions for obtaining the prescribed technological loading with liquor, respectively with dry-consolidation and treatment of the material. This objective can be achieved by the machine manufacturer by adopting a system of self-regulation according to the principle shown in figure 3.

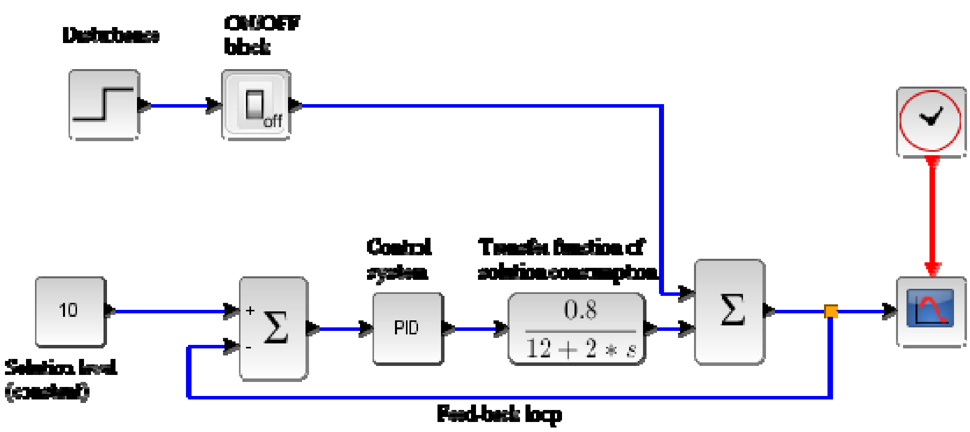
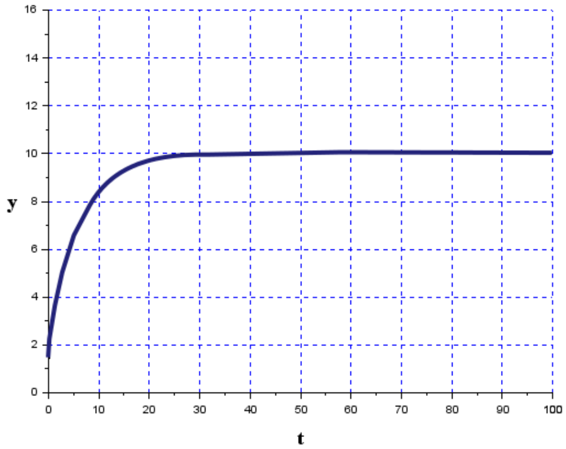
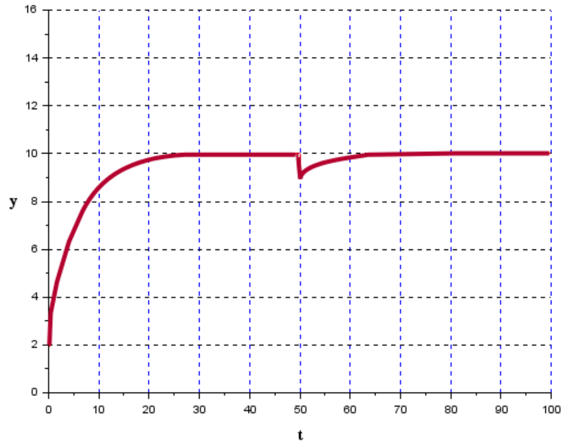


Fig. 4. Control system of solution level in foulard [3].



a.



b.

Fig. 5. System responses:
a – without disturbances; *b* – with disturbances [3].

4. CONCLUSIONS

1. The ensuring nonwovens loading by substances consolidation, to the values technologically necessary requires a precise control of material loading as liquor of foulard, even during the process.

2. Adopting a supply system of vat foulard with dosing pump with adjustable flow would allow setting a feed rate equal to the rate of consumption of the liquor in the vat by textile material.

3. On the basis of equality of flow consumption of the liquor from the vat with the feeding pump flow with liquor of vat, can be assured the material loading with adhesives and other substances to the required technological level, by varying the pressing-squeezing force according to the liquor level in vat deposit.

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