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Porosity and Nonwoven Fabric Vertical Wicking Rate

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Abstract: Fabric porosity is the result of fabric constructional parameters combination and used technology of nonwoven production. The effects of fabric porosity structure, as well as the content of hydrophilic viscose and hydrophobic polyester fibres in the web mixture, on the vertical wicking rate by nonwoven fabrics have been explored in this research. Fibrous webs with a different content of viscose and polyester fibres, with the web volume mass range of 0.019-0.035 g/cm^3 were utilized during this study. The samples were produced using a dry-laid method of web forming and two methods of web bonding, e.g. needle punching and calendar bonding. Results show that higher volume porosity gives higher vertical wicking rate by all groups of tested samples regarding the content of used hydrophilic/hydrophobic fibres and that fluid flow is faster in samples with larger pores. The higher content of viscose fibres improve the vertical wicking rate, but better rising height can be achieved at samples made from 100 % of coarser polyester fibres. A prediction model of vertical wicking rate of viscose/polyester nonwovens was developed on the basis of the fundamental constructional parameters of nonwoven fabrics (fibre fineness, type of raw material, and web density) and a non-deterministic modelling method, e.g. genetic algorithms, which can serve as a useful tool for fabric engineers by developing a nonwoven fabric in order to fit desired wicking rate.

Keywords: Predictive modelling, Nonwoven fabric constructional parameters, Porosity, Wicking rate

Introduction

In the phase of a new fabric development, fabrics are engineered to fit desired end-usage properties with minimum production costs involving the costs for sample production. This is a complex task based on our past experiences and knowledge about the relationships between fabric constructional parameters combinations and predetermined end-usage properties. Many prediction models were developed which serve as a tool by developing a new fabric construction with desired end-usage properties.

Sorption properties of fabrics are essential for clothing regarding their thermophysiological comfort, home products (e.g. towels), numerous technical applications (liquid filtration, drainage, hygiene, construction, etc.), and in a number of aspects of textile production (dyeing, finishing) [1,2]. In the case of nonwovens which are used as wipes for wet cleaning, wicking is an important end-usage property in order to achieve good cleaning effect. In general, wicking takes place when a liquid travel along the surface of the fibre but is not absorbed into the fibre and replace air, trapped within the nonwoven fabric. Wicking can only occur when a liquid wets fibres assembled with capillary spaces between them [1]. While wetting and wicking are still argued to be a separate phenomenon, they can be described by a single process-liquid flow in response to capillary pressure [3,4]. More completely, in the absence of external forces, the transport of liquids in a porous media (e.g. nonwovens) is driven by capillary forces that arise from the wetting of the fabric surface. Because capillary forces are caused by wetting, wicking is a result of spontaneous wetting in a capillary system [5]. The spontaneous flow of water or wicking occurs due to a pressure differential or capillary action (capillarity). Capillarity is based on the intermolecular forces of cohesion and adhesion. If the forces of adhesion between the liquid and the pore wall (e.g. fibre surface) are greater than the forces of cohesion between the molecules of the liquid then capillary motion occurs. Transport of the liquid driven by capillary action into any porous medium is governed by the properties of the liquid (surface tension, viscosity, density), liquid-fabric surface interactions, and geometrical configuration of the pore structure in the fabric [4,5].

By developing nonwoven fabrics for cleaning wipes with good capillarity, an engineer should pay attention to the chemical nature of the used fibres, as well as on those web-constructional parameters having an effect on the porous structure. Nonwoven fabrics are highly porous materials, which allow the transmission of liquids and are, therefore, suitable materials for a cleaning wipes. The unit of nonwovens porous structure is a pore or capillary or void space, which can be situated between the fibres and within the fibres. According to several different methods to produce non-woven fabrics having consequently very different porous structure, the ideal geometric model of porous structure in the form of tube-like system, where each pore has a cylindrical shape with a permanent cross-section along its full length [6], is partially acceptable only by those nonwovens which are thin and translucence. Needle-punched nonwoven fabric is a sheet of fibres made by mechanical entanglement, penetrating barbed needles into a fibrous mat [7]. The geometrical model of three-dimensional needle-punched nonwoven fabric proposed by Mao and Rusell [8], which also represent the geometrical model of nonwoven porous structure, is constructed on a two-dimensional fibre orientation within the fabric plane, with interconnecting fibres oriented in the z-direction. Such model relies on the following basic

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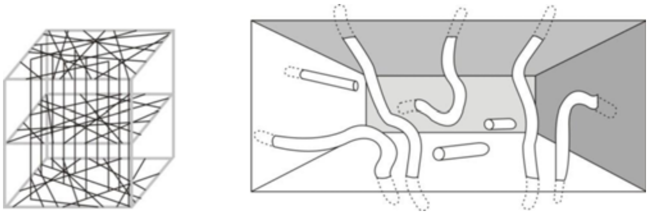

Figure 1. Geometrical models of needle-punched nonwoven fabric structure (left) and porous structure (right) [9,10].

assumptions: 1. the fibres in the fabric have the same diameter, and a fraction of the fibres is distributed horizontally in the two-dimensional plane, the rest are aligned in the direction of the fabric thickness, 2. fibre distribution in both the fabric plane and the z-direction is homogeneous and uniform, 3. in each two-dimensional plane, the number of fibres oriented in each direction is not the same, but obeys the function of the fibre orientation distribution $\Omega(\alpha)$, where α is the fibre orientation angle, 4. the distance between fibres and the length of individual fibres is much greater than the fibre diameter. In each fabric planes fibres lie in different direction and in this way produce pores with different orientations, diameters, connectivity and accessibility to fluid flow (Figure 1).

The real needle-punched nonwoven fabrics are inherently non-uniform and heterogeneous, namely porosity, thickness, fibre diameters, fibre lengths, and fibre orientation distribution frequently varies from location to location [8], thus changing the sorption properties of fabrics in a great extent. Furthermore, movement and interaction of a liquid through pores can cause both shifting of fibres and changes in pore structures [4]. Pore variation and distribution lead to preferential liquid movement toward smaller pores, resulting in partial draining of previous filled pores in nonwovens. Fibre swelling not only increases liquid retention in the fibres at the expense of the capillary liquid capacity in interfibres pores, but also complicates the pore structure [11].

It can be seen, from the literature, that there have been a lot of studies dealing with the phenomenon of wicking and its effect on thermophysiological comfort, mostly for knitted and woven fabrics [4,5,11-13]. Simile [4] reported that using the theory of capillarity and upward wicking test, one would expect water to flow faster in a medium with larger pore size; however this is not always the case. Das *et al.* [2] found out that addition of a small portion of PES fibres has increased the water wicking height to a great extent, in comparative to that of, in case of 100 % viscose woven fabric. On the other hand, Soukova *et al*. tested nonwoven fabric samples, containing 100 % viscose fibres and 11 different blends in various proportion of viscose/polyethylene terephthalate fibres in their study [12], and found that the capillary rise was higher for nonwoven fabrics containing more viscose fibres.

As there has been a dearth of published work dealing with the influence of nonwoven constructional parameters and, consequently, porosity on wicking, this study attempted for the first time to link changes in fabric construction parameters with the measured vertical wicking rate (rising height) of those needle-punched nonwoven fabrics (webs) used for cleaning wipes. In this paper, different groups of needle-punched webs having variation of the web density (e.g. the influence of geometric configuration of the pore structure in the medium), raw material (e.g. the influence of liquid-medium surface interaction), and fiber fineness (e.g. the influence of geometric configuration of the pore structure in the medium) were examined and the relationship between the fabric structural parameters and the fabric vertical wicking rate was developed on the basis of non-deterministic modelling tooll (genetic algorithms). Such a model can serve as a guideline for a fabric engineer when developing nonwoven wipes regarding the desired wicking rate.

Experimental

Sample Preparation

Fifteen dry-laid nonwoven fabrics used for cleaning wipes in a raw state were used in this research. Five fabrics sets, each having four fabric samples (except first set which has three fabric samples), were produced. Fabric sets were varied according to the fibre content in the mixture of fibrous material (87.5 % VIS/12.5 % PES; 60 % VIS/40 % PES; 30 % VIS/70 % PES and 0 % VIS/100 % PES). Mixtures of polyester, and mixtures of polyester and viscose fibres of different content, fineness, and lengths (Table 1), were used in this research. It is worth to mention that all samples were in a raw state in order to eliminate the influence of chemical treatments on wicking rate.

Within each fabric set, the samples were further varied

Table 1. The properties of used fibres

Sample no.	Fibre content VIS/PES 1/PES 2 (%)	Viscose fibres		Polyester fibres type 1		Polyester fibres type 2	
		Fibre fineness (dtex)	Fibre length (mm)	Fibre fineness (dtex)	Fibre length (mm)	Fibre fineness (dtex)	Fibre length (mm)
1-3	87.5/12.5/0	1.7	38	4.4	50	-	-
4-7	60/40/0	1.7	38	3.3	60	-	-
8-11	30/40/30	3.3	50	6.7	60	4.4	50
12-15	0/70/30	-	-	6.7	60	4.4	50

Table 2. The constructional parameters of tested samples and the results of web mass and thickness measurements, vertical wicking rate measurements, pore size measurements, and GA modelling

Sample no.	Fibre content VIS/PES (%)	Fibre density - ρ_{fib} (g/cm^3)	Fibre fineness (T, dtex)	Web mass (g/m^2)	Web thickness (mm)	Web density – ρ_{web} (g/cm^3)	Web volume fraction	Web volume porosity (%)	Average pore diameter (μm)	Experimental vertical wicking rate – VWR (mm)	Predicted vertical wicking rate – VWR (mm)	Prediction error (%)
1	87.5/12.5	1.501	2.0	143	1.202	0.119	0.086	91.4	76.7	32	32.26	0.8
2	87.5/12.5	1.501	2.0	142	0.941	0.151	0.109	89.1	75.5	30	30.54	1.8
3	87.5/12.5	1.501	2.0	142	0.576	0.247	0.178	82.2	66.5	25	25.04	0.2
4	60/40	1.460	2.3	173	1.509	0.115	0.080	92.0	76.2	27	27.65	2.4
5	60/40	1.460	2.3	201	1.558	0.129	0.090	91.0	71.8	25	26.73	6.9
6	60/40	1.460	2.3	171	0.941	0.182	0.127	87.3	80.3	24	25.99	8.3
7	60/40	1.460	2.3	200	1.071	0.187	0.131	86.9	65.0	23	23.42	1.8
8	30/70	1.415	5.0	259	1.360	0.190	0.129	87.1	86.6	23	22.90	-0.4
9	30/70	1.415	5.0	259	1.261	0.205	0.140	86.0	84.1	22	21.94	-0.3
10	30/70	1.415	5.0	279	1.182	0.236	0.160	84.0	72.2	20	19.99	-0.1
11	30/70	1.415	5.0	274	1.112	0.246	0.162	83.8	68.7	19	19.26	1.4
12	0/100	1.370	6.0	298	1.400	0.213	0.140	86.0	90.9	28	28.45	1.6
13	0/100	1.370	6.0	304	1.266	0.240	0.158	84.2	80.8	27	26.65	-1.3
14	0/100	1.370	6.0	352	1.347	0.261	0.172	82.8	75.9	25	25.04	0.2
15	0/100	1.370	6.0	343	1.235	0.278	0.183	81.7	70.1	24	24.05	0.2
										Mean error		**1.8**

according to their volume porosity. For all samples the range of their volume porosity was between 82-92 %. For this purpose, multi-layered webs, having web surface mass ranges of 100-150, 150-200, 250-300, and 300-350 g/m^2, and a web volume mass range of 0.019-0.035 g/cm^3, were produced by subjecting the fibre mixtures to carding and then cross-direction layering. The carded webs were further subjecting to pre-needling (needling density 30/cm; depth of needle penetration 15 mm; delivery speed 1.5 m/min; stroke frequency 250/min), further two-sided needling (needling density 60/cm (30/cm upper and 30/cm lower); depth of upper and lower needle penetrations 12 mm; stroke frequency 900/min; delivery speed 5.5 m/min), and thermal bonding at 180 ºC with different gaps between the rollers, in order to achieve further changes in web density and, consequently, in the volume porosity.

Table 2 shows the constructional parameters of prepared nonwoven samples. The fibre density and fibre fineness were calculated as a weighted arithmetical mean. The values of 1.52 g/cm^3 and 1.37 g/cm^3 for VIS and PES fibre densities were taken into account, respectively. Web density, volume fraction, and theoretical volume porosity were calculated on the basis of equation (1) [14].

$$P_V = \frac{V_{pores}}{V_{web}} = \frac{V_{web} - V_{fib}}{V_{web}} = 1 - \frac{V_{fib}}{V_{web}} = 1 - V_F$$

$$= 1 - \frac{\rho_{web}}{\rho_{fib}} = 1 - \frac{m_{web}}{D_{web} \cdot \rho_{fib} \cdot 1000} \qquad (1)$$

where P_V is the volume porosity, V_{pores} is the volume of the pores in cm^3, V_{web} is the volume of the web in cm^3, V_{fib} is the volume of the fibers in cm^3, V_F is the web volume fraction, ρ_{web} is the web volume mass (or web density) in g/cm^3, ρ_{fib} is the fiber volume mass (or fiber density) in g/cm^3, m_{web} is the web mass per unit area in g/m^2, and D_{web} is the web thickness in mm.

Measurement of Nonwoven Fabric Mass Per Unit Area and Thickness

The mass per unit area and thickness of tested nonwoven samples were measured according to ISO 9073-1 (Textiles – Test Methods for Nonwovens – Part 1: Determination of mass per unit area) and ISO 9073-2 (Textiles – Test Methods for Nonwovens – Part 2: Determination of thickness).

Measurement of Nonwoven Fabric Vertical Wicking Rate

The vertical wicking rates of nonwoven samples were tested according to DIN 53924 (Testing of Textiles: Velocity of Soaking Water of Textile Fabrics – method by determining the rising height) by measuring the wicking height against gravity along the longitudinal direction of the fabric. Five nonwoven strips of 200×25 mm, marked with line at 10 mm distance from the lower edge, were prior of the testing conducted 24 hours in a standard atmosphere of 20±2 °C and 65±2 % of relative humidity. Each sample was then suspended vertically with its bottom ends at a depth of 10 mm into a solution of a red dye, and at the same time the stopwatch was activated. After 10 seconds, the rising height was measured, and the average value of all measurements was calculated as a final result.

Modelling of Nonwoven Fabric Vertical Wicking Rate

In order to define the prediction model for nonwoven fabric vertical wicking rate, the genetic algorithm (GA) was used. While this method is already described in our previous research in reference [15], only a short description follows.

The independent input variables were fibre density (ρ_{fib} in g/cm^3), fibre fineness (T in dtex), and nonwoven fabric density (ρ_{web} in g/cm^3). In order to define the type of used fibres in numerical way, we used fibre density, which at the same time reflects also the influence of different content of VIS and PES fibres in the web mixture – higher fibre density in our case means more hydrophilic (VIS) fibres. It is worth to emphasize that relation between vertical wicking rate and fibre density should be strictly interpreted as relation between vertical wicking rate and type of raw material.

The dependent output variable was the vertical wicking rate (rising height) in mm. Since the GA approach is unsuitable for the evolution of prediction models (organisms) in their symbolic forms, it is necessary to define them in advance [16]. In this study, a quadratic polynomial equation with three variables was used as a pre-specified model for the prediction of vertical wicking rate:

$$\begin{aligned} VWR &= c_1 + c_2x + c_3y + c_4z + c_5x^2 + c_6y^2 + c_7z^2 \\ &\quad + c_8xy + c_9xz + c_{10}yz + c_{11}xyz \end{aligned} \tag{2}$$

where, VWR is the vertical wicking rate in mm, x is the fibre density in g/cm^3, y is the fibre fineness in dtex, z is the nonwoven fabric density in g/cm^3, and $c_{1\ldots11}$ is the constant.

Assessment of the Developed Prediction Model of Nonwoven Fabric Vertical Wicking Rate

Correlation analysis between the predicted and experimental results was used to judge the prediction performance of the developed model of nonwoven fabric vertical wicking rate. Statistical parameters were used, such as mean prediction error and correlation coefficient. Prediction error was calculated by using the following expression:

$$\text{Prediction error (\%)} = \frac{PV - EV}{EV} \cdot 100\% \tag{3}$$

where, PV is the predicted value and EV is the experimental value.

Pore Size and Pore-size Distribution Measurements

Mercury intrusion porosimetry method using the Pascal 140 computer-aided porosimeter was used for measuring the pore size of nonwoven samples. The system operates under low pressure. To remove air and residual moisture from the pore system, the nonwoven sample was first evacuated. Then, the sample cell was filled with mercury by slowly increasing the pressure up to reference level. The volume of intruded mercury was measured continuously through changes in the capacitance between the column of mercury in the dilatometer steam (capillary tube of known diameter connected to the sample cell) and a coaxial metal sheet surrounding the steam. The volume and pressure measurements' data were transferred into the computer program.

The volume of penetrated mercury is directly the measure of the sample's pore volume expressed as a specific pore volume in mm^3/g. On the basis of equation (4) [17], the distribution of pore size can be obtained from the relation between the pressure necessary for penetration (the pore dimension) and the volume of the penetrated mercury (pore volume) if the pores are assumed to be of cylindrical shape and the sample is pressure stable:

$$P = \frac{-2 \cdot \gamma \cdot \cos\theta}{r} \tag{4}$$

where P is the applied pressure in kg/cm^2, γ is the surface tension of mercury in mN/m, θ is the contact-angle in $^{\circ}$, and r is the capillary radius in μm.

Results and Discussion

Porosity vs. Vertical Wicking Rate

The results of the measured nonwoven fabric mass per unit area and thickness are presented in Table 2. The results of vertical wicking rate measurement are also evident from Table 2. Figure 2 presents the influence of volume porosity on the vertical wicking rate regarding the type of used mixture of fibres. Porosity structure is the result of nonwoven constructional parameters combination and it is expressed in the form of volume porosity. This porosity parameter indicates only which nonwoven fabrics possess more air within the structure. From the Figure 2 it can be seen that higher volume porosity means higher vertical wicking rate by all groups of tested samples regarding the content of used hydrophilic/hydrophobic fibres. More air, trapped within the structure of the fabric, allows faster movement of water through the pores.

If we analyse the porosity structure within the same group of tested samples regarding the content of VIS/PES fibres through the pore size distribution (Figure 3), it can be seen that samples with higher volume porosity, in our case, possess pores with higher average pore diameter (see also Table 2). More precisely, the frequency of larger pores (in the range 80-150 μm), for example for the samples from No.8-11, increases from 29.0 to 60.4 % as volume porosity increases from 83.8 % to 87.1 %, and at the same time the frequency of smaller pores (in the range 0-40 μm) decreases from 16.9 % to 8.1 %. Samples with larger pores have higher wicking rate (Figure 4). This is in accordance with the theory of capillarity which says that fluid flow is faster in a void with a large capillary radius than that in one with a small radius. The water moves from the larger pores to the smaller pores as height increases.

If we analysed the results according to the content of VIS and PES fibres in the web, the results are a little bit confused. Namely, by samples, made from the mixture of VIS and PES fibres, the higher content of VIS fibres improve the vertical wicking rate, which indicate that due to the higher absorption rate of VIS fibres the movement of water through the pores is also faster. Namely, samples with 30 % of VIS fibres have the lowest rising height, samples, made from the 60 % of VIS fibres the medium rising height, while the samples, made from the 87.5 % of VIS fibres have the highest rising height at the same level of pore size. The results are in the

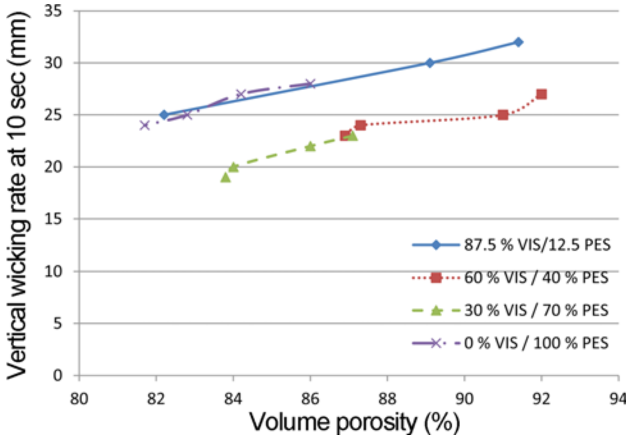

Figure 2. The influence of volume porosity on the nonwoven fabric vertical wicking rate.

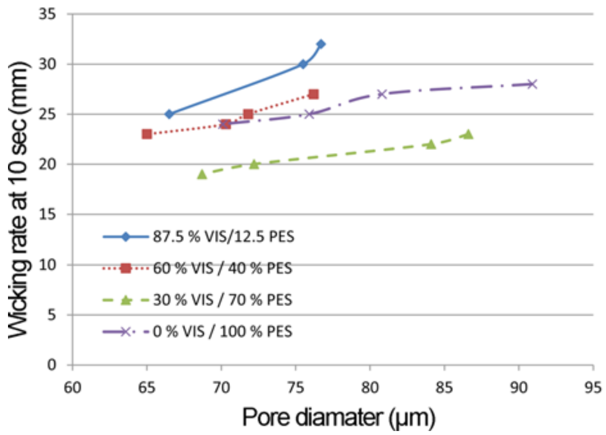

Figure 4. The influence of the pore size on the vertical wicking rate.

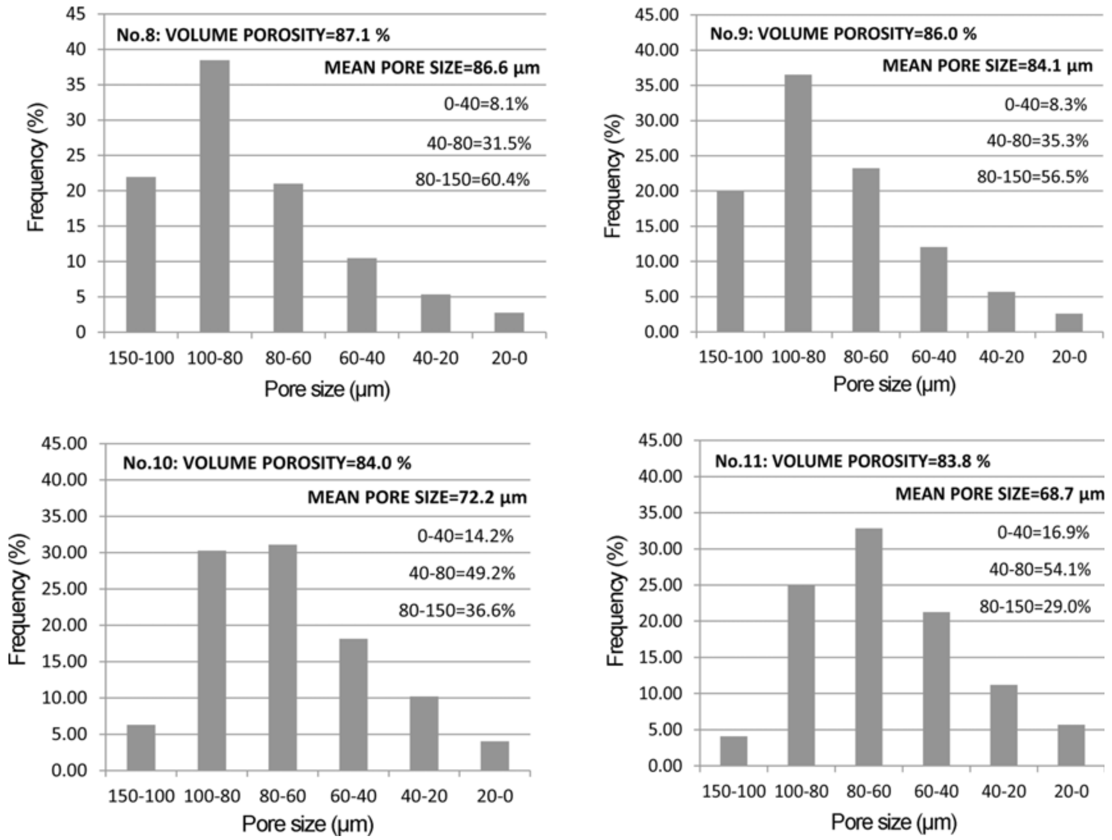

Figure 3. The pore size distribution of samples made from the 30 % VIS/70 % PES mixture (samples No. from 8 to 11).

accordance with the research which was done by Soukupova *et al.* [12]. On the other hand, samples made from the 100 % of PES fibres show that by the absence of VIS fibres, the higher wicking rate can be achieved. Namely, the samples, made from the 30 % VIS/70 % PES mixture possess lower rising height in comparison with the samples made from 100 % of PES fibres. In this case, the hydrophobic nature of PES fibres indicate that movement through the pores due to the adsorption can be faster if no bonds with water molecules are formed as it is the case by hydrophilic nature of VIS fibres at the same pore size. We should also have in mind that samples No. 1-7 were made from the finer and shorter fibres (2.2 dtex/43 mm) in comparison with the samples No. 8-15, which were made from the mixture of coarser and longer fibres (5.5 dtex, 56 mm). Those parameters also have an effect on porosity structure and fluid accessibility. There is obviously a need to have a tool, e.g. predictive model, on which basis the effect of different parameters combinations on wicking rate can be detected.

Prediction Model of Nonwoven Fabric Vertical Wicking Rate

Table 2 shows the results of the experimental values of vertical wicking rate in mm, as well as predicted ones, calculated using equation (5), where ρ_{fib} is the fibre density in g/cm^3, T is the fibre fineness in dtex, and ρ_{web} is the web (nonwoven fabric) density in g/cm^3. Table 2 also shows the prediction errors between the predicted and experimental values of vertical wicking rate.

$$\begin{aligned} VWR = {} & 45.5662 + 27.7807 \cdot \rho_{fib} + 15.2257 \cdot T + 3.87317 \cdot \rho_{web} \\ & - 5.8464 \cdot \rho_{fib}^2 + 3.92037 \cdot T^2 - 15.7118 \cdot \rho_{web}^2 \\ & - 28.9902 \cdot \rho_{fib} \cdot T - 38.7216 \cdot \rho_{fib} \cdot \rho_{web} \\ & + 4.98688 \cdot T \cdot \rho_{web} - 4.05778 \cdot \rho_{fib} \cdot T\rho_{web} \end{aligned} \tag{5}$$

$R^2 = 0.9674$

It is wort to mentioned that proposed model of nonwoven fabric vertical wicking rate is valid for the selected nonwoven samples for specific end-usage (cleaning wipes) with the selected boundary limits (fibre density 1.37-1.50 g/cm^3; fibre fineness 2-6 dtex, web density 0.115-0.278 g/cm^3) and samples in a raw state. Our purpose was to observe only the influence of fabric constructional parameters on vertical wicking rate and eliminate the influence of finishing treatments which also have significant effects.

Whilst transport of the liquid driven by capillary action into any porous medium is governed by the liquid's properties, liquid-medium surface interaction, and geometric configuration of the pore structure in the medium, it was decided to include the following basic constructional parameters as input parameters for modelling: fibre density (which is a numerical measure for the type of used fibres as well as for the content of viscose and polyester fibres in the web – the influence of liquid-medium surface interaction), fibre fineness (the influence of geometric configuration of pore structure), and web density (which is an interrelated parameter with a web's basic constructional parameters, such as thickness and mass per unit area and also represents the influence of geometric configuration of pore structure).

The most valuable information in a phase of a new fabric construction development is how to combine the basic fabric constructional parameters in order to reach the desired wicking rate. Some effects of the individual fabric parameters on the wicking rate are well-know, but the effect of their combination is sometimes difficult to recognise. Nowadays, the constructors use predictive models, which are developed on the basis of deterministic or non-deterministic modelling tools. The use of genetic algorithms as non-deterministic modelling tools is widely acceptable, while this modelling tool has the ability to capture the randomness inherent in fabric structures and does not require numerous fabric samples' data in comparison with deterministic modelling tools.

The proposed predictive model of nonwoven fabric vertical wicking rate provides fabric constructors with guidelines when developing needle-punched nonwoven fabrics with the desired wicking rate. Figures 5 and 6 show the predicted values of vertical wicking rate for samples made from the 60 % VIS/40 % PES mixture and samples, made from the 100 % PES fibres, respectively. In general, a higher vertical wicking rate of needle-punched nonwoven fabrics is achieved at lower web density (or higher porosity). It can be concluded from the predictive model, that the influence of fibre fineness on the vertical wicking rate is not linear. Namely, samples made from the coarser fibres (above 4 dtex), and samples, made from finer fibres (under 3 dtex), have better vertical wicking rate in comparison with samples, made from the fibres with fineness between 3-4 dtex, regardless the use of raw material. As said before, capillary

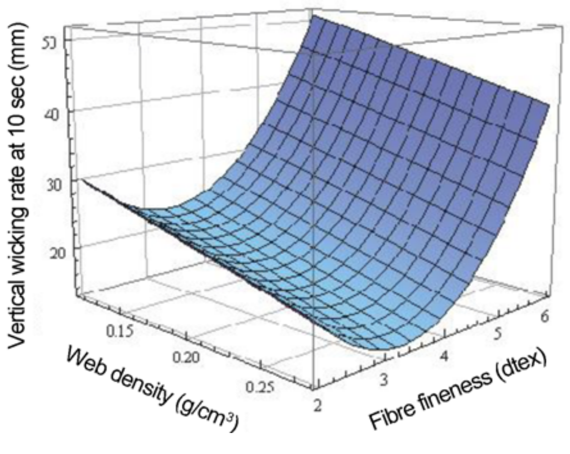

Figure 5. The influence of fibre fineness and web density on vertical wicking rate for samples made from the 60 % VIS/40 % PES mixture.

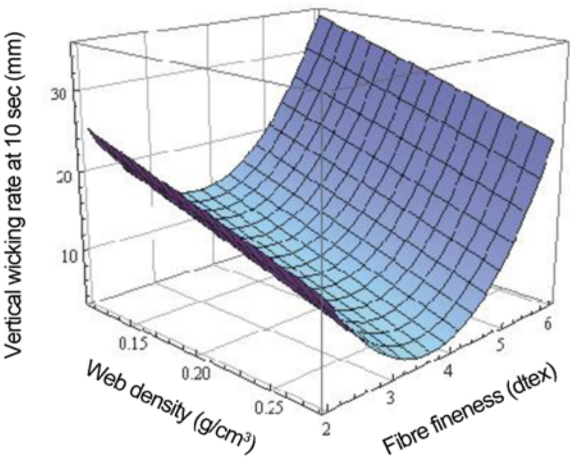

Figure 6. The influence of fibre fineness and web density on vertical wicking rate for samples made from the 100 % PES.

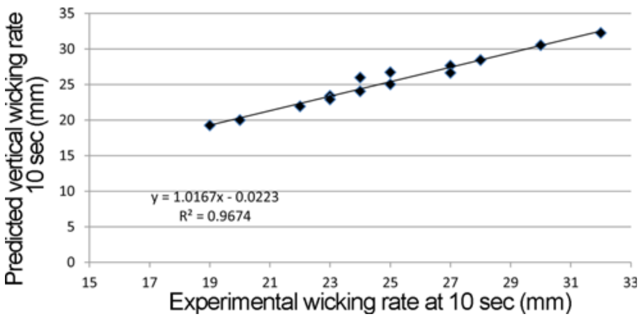

Figure 7. Scatter plot of experimental vertical wicking rate and predicted vertical wicking rate using the GA model.

effect is higher by samples with larger pores, but better rising height can be also achieved by samples with smaller pores (or finer fibres). This phenomenon clearly indicates a need for predictive model in the phase of a new fabric development.

The results show that the predicted values for the vertical wicking rate of tested nonwoven fabrics, calculated using equation (5), were in a good agreement with the experimental ones (Table 2). The mean predicted error was: 1.8 % (from 0.1 % to 8.3 %). The correlation coefficient between the predicted and experimental values for vertical wicking rate was 0.9674. The scatter plot of the experimental and predicted values for vertical wicking rate is depicted in Figure 7. Using genetic algorithms, it was possible to predict the vertical wicking rate of viscose/polyester-blended needle-punched fabrics precisely enough.

Conclusion

In the case of needle-punched nonwovens used for wet cleaning, the wipes should have good sorption properties. Besides good absorbency, they should also possess good wicking. For practical purpose the European Disposables and Nonwovens Association and the International Nonwovens and Disposables Association recommended test to measure the vertical speed at which the liquid is moving upward in a fabric as the capillarity of the test material. Regardless the fact, that this test method fails to take the effect of gravity into account, it is suitable method to find differences between different fabric constructions. While the transport of the liquid driven by capillary action into any porous medium is governed by the liquid's properties, liquid-medium surface interaction, and geometric configuration of the pore structure in the medium, we decided to focus on the influence of the porosity structure on vertical wicking rate in this study. At the same time, the prediction model of nonwoven fabric vertical wicking rate was created very precisely on the basis of fundamental fabric constructional parameters: the content of hydrophilic viscose and hydrophobic polyester fibres (e.g. fibre density), fibre fineness, and web density, by using a genetic algorithm. The developed equation relating fabric constructional parameters and wicking rate can be used as a primary guideline while selecting fabrics for wicking.

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