

RESOURCE-SAVING TECHNOLOGY FOR SAXONY FABRIC

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Key words and phrases: improvement of efficiency; saxony fabric; scouring; ultrasonic exposure.

Abstract: The results of the study of the process of extraction of technological pollutants from woollen fabrics after various process operations (washing process) are described. The possibility of increasing the efficiency of the probed process is shown under ultrasonic influence on an extractant (washing solution).

Notations

C_{fat} – concentration of fatty substances, %;
 C_{surf} – concentration of surfactant, %;

T_p – colour stability, step;
 η – scouring efficiency, %.

One of the most crucial problems for the chemical technology of fibrous materials is to make the finishing works in the textile industry more effective. Efficiency is mainly composed of intensity, which defines speed and duration of the process and performance, economical efficiency, quality of end material; environmental and process safety. In order to meet the challenge related to the process efficiency to be improved for the finishing works in the textile industry, the limiting processes that are a mass-transfer scoring from different process contamination and drying are singled out. These processes are energy-and-water intensive and largely define the qualities of end textile materials [1].

Chemical technology processes of finishing production (washing, drying) demand big expenses of energy. When washing (extraction) a considerable quantity of chemical reagents is spent. From the total electric power consumed by finishing production about 40% is spent on scouring and up to 20 % on thermal energy. The expense of thermal energy on drying reaches 60 %. The pure water expense at washing makes, as a rule, 5 cubic meters per hour, thus 0.350 cubes of water is spent per one kg of fabric. Waste water is to 80 % of the used water. Waste water is polluted by superficially – active substances which have not been fixed by dyes, textile-auxiliary substances [2].

Therefore, reduction in power inputs and the expense of material resources-waters, chemical reagents is an urgent problem, especially in the light of government decisions in Russia on power savings in all branches.

For process extractions (washing) of technological pollution from dense saxony fabrics (coating fabrics, thick woollen cloths, military cloth) cordlike washers of batch action are used. The process is very long, up to 4 hours [3].

Figure 1 shows the curves of scouring kinetics for saxony fabric to remove various technological pollutants from dense saxony fabric and change quality factors of the object of processing treatment.

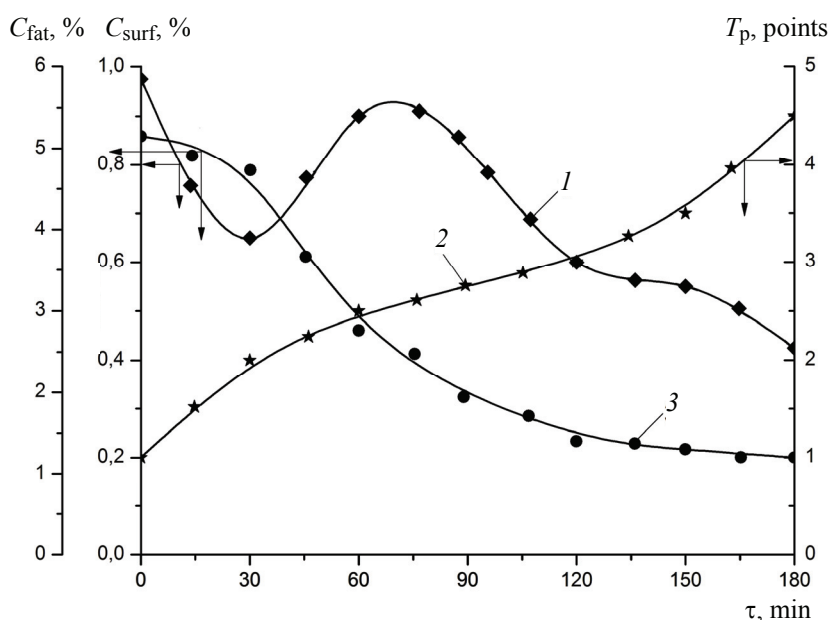


Fig. 1. Kinetics of process of washing thin felt a saxony fabric:

1 – change of density of surfactant C_{surf} ; *2* – colour stability change to a dry friction T_p ; *3* – change of density of fatty substances C_{fat}

Curve 1 defines kinetics removals of superficially-active substances, curve 2 shows removal of fatty substances that are natural fatty substances containing in a woollen fibre and deposited in the fibre in the course of reprocessing oiling agents. Curve 3 shows such an important quality factor of washing and a finished fabric as colour stability to a dry friction changes. The experimental estimation of the first two values is rather difficult and is conducted by an extraction method in Soxhlet's (extraction) apparatus.

The analysis of the content of non-fixed dyes on a fabric demands removal of thickening curves for each kind of dyes, therefore their content was defined indirectly – through colour stability to a dry friction.

It is necessary to notice that washing process is rather long, the problem essentially becomes more complicated as the process of washing of saxony fabrics, apart from surface-active substances, involves removal of two more kinds of “pollutants” – fatty substances and non-fixed dyes, which influence the quality of washing and the quality of a finished material. Thus, it is often impossible to achieve two quality factors of the washing in accordance with GOST simultaneously.

So, to achieve the quality of washing demanded in accordance with GOST on non-fixed dye, the better is the process, the longer lasts the dye. As for the content of fatty substances, the quality factor achievement on the dye can be considerably below the specification. Therefore, to improve the process condition, on the one hand, it is necessary to reduce the duration of the process, and raise the intensity of washing, but on the other hand, duration cannot be less than the required one under the chosen conditions for removal of non-fixed dyes.

The object of washing process is dense woollen fabric, which engineering characteristics are resulted in Table 1 and content is described in Table 2.

Kinetic curve washings were removed in industrial conditions and in vitro without intensifiers, and also in vitro, at observance of an industrial process condition of

Table 1
**Short engineering characteristics
of object of research**

The name of dates	Meanings of datas
Mass 1 m ² , g	760...30
Density on 100 mm: The inclement g/goods	110 153...8
Alcoholic content on breakage: Warp Fill	52...5 42...4
Elongation, % : Warp Fill	32...3 40...4
Felting, % endways	28.3
Contraction after wetting, % : Warp Fill	2.0 2.0

washing with various intensifiers. Ultrasonic fluctuations, bubbling air through a washing solution and magnetic field influence on a detergent solution were used for intensification.

However, at the first stage it was necessary to carry out a choice of a rationalised combination of duration of separate stages of washing and density of surfactant. Surfactant is entered into a washing solution in one of these stages. Surfactant is necessary not only for quality maintenance of a finished material, but it is also important for the solution of the environmental problem – activated sludge process of the textile enterprises. Traditionally, all methods of fluid processing of saxony fabrics involve cutting in a cutter solution with concentration surfactants 8...15 g/l, and standard density of surfactant in the stage of “eroded” wash-liquor makes 1,5...2,5 g/l. These process conditions do

not take into account the total density of surfactants in a wash-liquor, i.e. they do not take into account that surfactants entered at a cutting stage fall and aren't accumulated by the fabrics. It is offered to use a mix anionic surfactant and non-ionic surfactant and maintain a ratio of densities of these surfactant 4:1 as anionic surfactants remain in the fabric after cutting, thus providing the correlation between anionic surfactants and non-ionic surfactant in a mix 9:1 at total concentration of surfactants < 1,5 g/l. At this ratio and total density of surfactant is achieved a maximum synergic effect and high quality of scouring [4].

Besides, anionic and non-ionic surfactants differently influence the quality of waste water; therefore it is important that the content of anionic surfactants falls above in a used mix.

Thus, in the proposed method of liquor processing of fibrous material there is an influence of surfactants on operations of previous washing. Besides, a formula of a washing solution is offered, it includes a mix of surfactants which possess high washing ability, and are highly biodegradable.

In the further studies, under utilisation of various intensifiers, the developed process condition influenced both the duration and density of surfactants.

Table 2

Raw content of fabric

The name of components of a mix	Content percentage	Weight fraction of fatty substances, %
Woollen fibre	82	3.5...4.5
Viscose spun acetate	13	
Capron	5	

Process condition of washing

Operations	Duration of stages, min	Temperature, °C	The bath module
Washing on a cutter solution	30	30...35	10
Eroded surfactants 0,5 g/l	45	45	10
Young flood	20	30...35	15
Average water	20	30...35	15
Big water	20	20...25	20

Table 3 describes the washing process condition on a laboratory model of a cordlike washer.

The studies of scouring process of saxony fabric were carried out in vitro with utilisation of various methods of intensification.

The following intensifiers were applied: bubbling gas through a washing solution, magnetic water and ultrasonic fluctuations [5].

To study the influence of bubbling on scouring process there was created the laboratory installation presented in Fig. 2.

It consists of a washing bath 1 to which falls a rotating circular hackberry 2. The hackberry, on which the saxony 3 fastens, is rigidly connected to the shaft of the electric motor of an alternating current 4. The number of cycles of the engine is regulated smoothly. To maintain the required temperature condition the bath is placed in a thermostat 5. The temperature is checked with the contact thermometer 6. Bubbling was conducted through a cylindrical bubbler 7 with vents in diameter of 5 mm. In a bubbler the air from the ventilator (or the compressor) moves. Air expense was measured, with rheometer 8. Experiments were carried out at relative speed at the gas stage of 6 l/min.

The tests were carried out in the following succession. The weighed saxony fabric (for determination of the module of a bath) was fastened on a cylindrical hackberry, with the set speed the hackberry starts to rotate, and through a bubbler the air

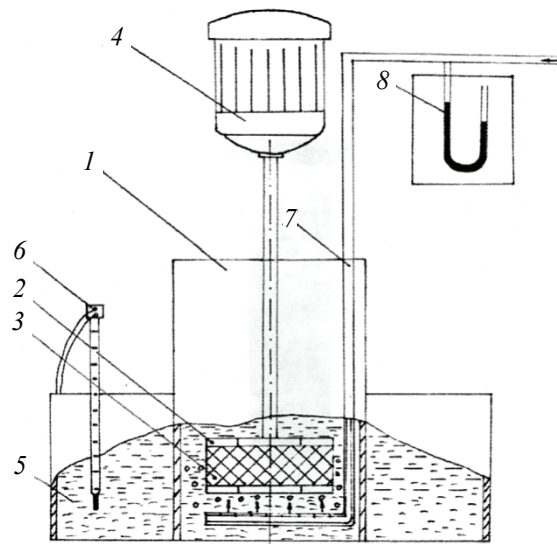


Fig. 2. Laboratory installation for research of the process of fabric washing with utilisation bubbling air:

- 1 – washing bath; 2 – cylindrical hackberry for fixing of samples;
 3 – saxony fabric; 4 – electric motor; 5 – thermostat,
 6 – contact thermometer; 7 – cylindrical bubbler; 8 – rheometer

is fed. The quality of washing was estimated in accordance with GOST. Fig. 3 shows kinetics curves of the condition of fabric washing with utilisation of bubbling gas through a washing solution.

The studies of the influence of magnetic water on kinetics of the washing process were conducted in vitro using the device for magnetic processing of water in which the values of a magnetic induction between magnets makes 100 mT. Washing water was passed repeatedly (2-3 times) through the device.

Fig. 4 shows kinetics of scouring process for saxony fabric with utilisation of magnetic water.

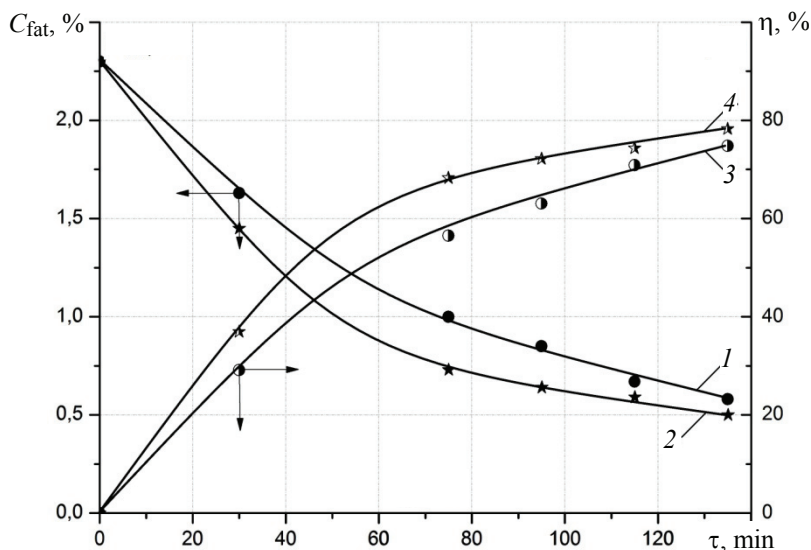


Fig. 3. Kinetics of scouring process for saxony fabric:
 1 – without intensifier; 2 – bubbling air 6 l/min; 3 – scouring efficiency without intensifier; 4 – scouring efficiency with bubbling air

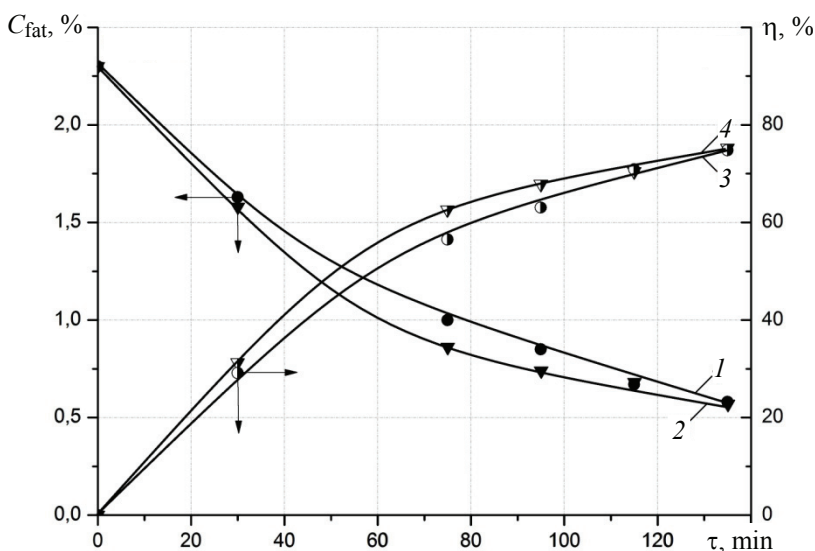


Fig. 4. Kinetics of scouring process for saxony fabric:
 1 – without intensifier; 2 – magnetic water; 3 – scouring efficiency without intensifier; 4 – scouring efficiency with magnetic water

The possibility of intensification of the washing process of saxony fabrics at the expense of ultrasound utilisation has been studied [6].

The washing process of saxony fabric in laboratory-like environment was carried out on modelling installation which allowed revealing the influence of ultrasonic vibrations on process of washing of a moving fabric (speed of 70 m/min) Fig. 5.

Acoustic fluctuations of ultrasonic frequency were created by two piezoelectric transducers fixed on the bottom of the bath with washing solution. The working frequency of fluctuations was 35 kHz. The ultrasonic generator nourishing piezoelectric transducer is executed on transistors. The bath is built in a jacket to which from below through a sealing gasket. The pan on which it is placed fastens the generator. To improve the heat-conducting path the radiator with transistors is welded on the pan bottom.

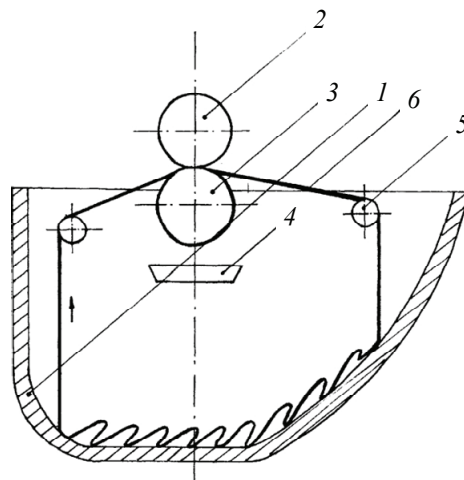


Fig. 5. The laboratory stand:

1 – washing bath; 2, 3 – squeezing the shaft;
4 – mud pan; 5 – directing shaft; 6 – saxony fabric

Fig. 6 shows kinetics of scouring process for saxony fabric with utilisation of ultrasonic fluctuations.

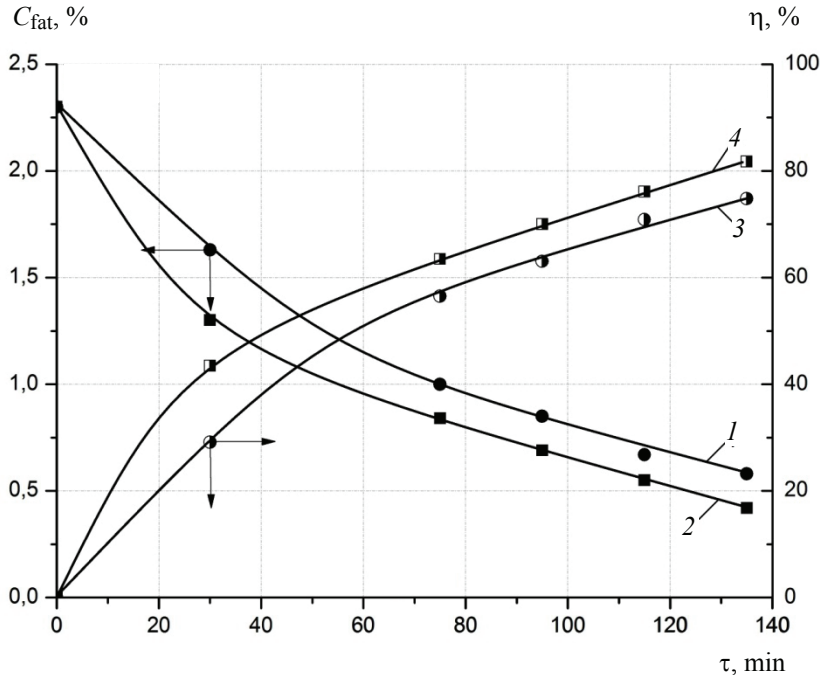


Fig. 6. Kinetics of scouring process for saxony fabric:

1 – without intensifier; 2 – ultrasound; 3 – scouring efficiency without intensifier; 4 – scouring efficiency with ultrasound

Fig. 7 shows kinetics of scouring process for saxony fabric with utilization of various methods intensification.

Fig. 8 shows scouring efficiency for saxony fabric with utilization of various methods intensification.

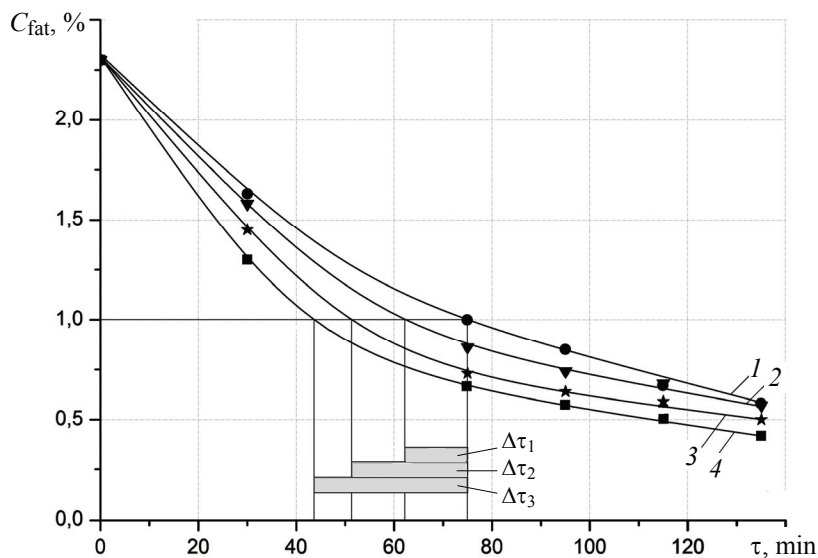


Fig. 7. Kinetics of scouring process for saxony fabric:

1 – without intensifier; 2 – magnetic water; 3 – bubbling air 6 l/min;
4 – ultrasound; reduction of duration of process ($\Delta\tau_1$ – magnetic water,
 $\Delta\tau_2$ – bubbling air of 6 l/min, $\Delta\tau_3$ – ultrasound)

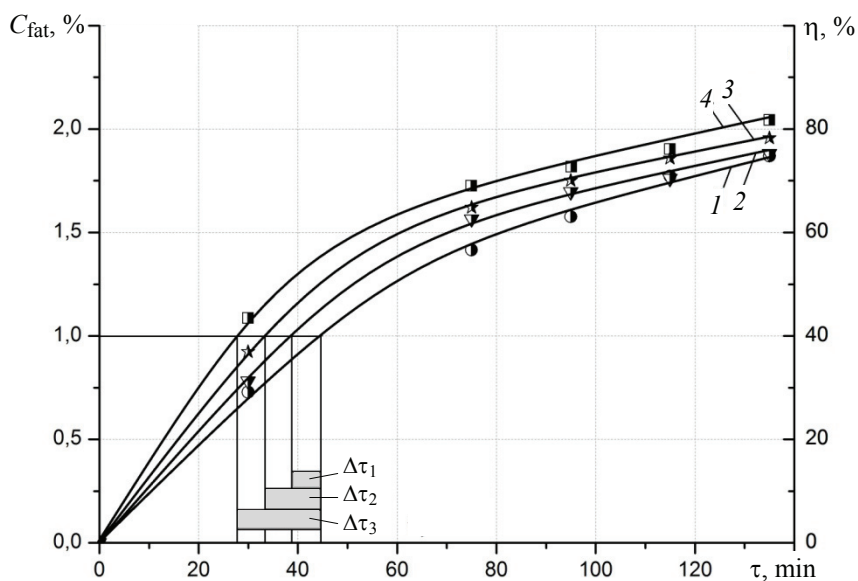


Fig. 8. A scouring efficiency for saxony fabric:

1 – without intensifier; 2 – magnetic water; 3 – bubbling air 6 l/min,
4 – ultrasound; reduction of duration of process ($\Delta\tau_1$ – magnetic water,
 $\Delta\tau_2$ – bubbling air of 6 l/min, $\Delta\tau_3$ – ultrasound)

Fig. 7 and Fig. 8 show that the value of a weight fraction of the fatty substances is equal to 1 % (that corresponds to GOST requirements), it is reached under utilisation of ultrasonic influence. The duration of the process can be reduced to 37 % that will lead to reduction in the expenses of energy, the expense of pure washing water thus will decrease, the quantity of waste water will decrease, besides under a rationalised condition the impurity of waste water surfactants will decrease; under utilisation of a mix of surfactants from the formulation of a washing solution soda ash and acetic acid necessary for its neutralization are excluded.

Summary

Thus, the studies allowed developing a rationalized condition of the washing process of dense saxonny fabrics, and defining efficiency utilisation of various methods of intensification.

Resource-saving technology applied to dense woollen materials allows an extraction of technological pollutants simultaneously with essential economy of the electric power, water and chemical reagents. It enables to raise industrial and ecological safety processes of chemical technology of finishing production of the textile industry.

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Энергоресурсосберегающий режим экстракции технологических загрязнений из шерстяных полотен

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Ключевые слова и фразы: повышение эффективности; промывка (экстрагирование); шерстяная ткань; ультразвуковое воздействие.

Аннотация: Приведены результаты исследования процесса экстрагирования технологических загрязнений из шерстяных тканей после различных технологических операций (процесса промывки). Показана возможность повышения эффективности исследованного процесса при использовании ультразвукового воздействия на экстрагент (промывной раствор).

Energiesparendes Regime der Extrahierung der technologischen Verschmutzungen aus den wollenen Leinen

Zusammenfassung: Es sind die Ergebnisse der Forschung des Prozesses der Extrahierung der technologischen Verschmutzungen aus den wollenen Stoffen nach den verschiedenen technologischen Operationen (des Prozesses der Wäsche) angeführt. Es ist die Möglichkeit der Erhöhung der Effektivität des untersuchten Prozesses bei der Anwendung von der Ultraschalleinwirkung auf das Extraktionsmittel (die Auswaschlösung) gezeigt.

Régime de la conservation de l'énergie par extraction des pollutions technologiques des tissus de laine

Résumé: Sont cités les résultats des études du processus de l'extraction des pollutions technologiques des tissus de laine après les différentes opérations technologiques (processus de lavage). Est montrée la possibilité de l'augmentation de l'efficacité du processus étudié lors de l'emploi de l'action ultrasonore sur l'extraction. (solution de lavage).

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