ECONOMIC EFFECT OF HYDRO-JET FORMING WOMENS HEADWEAR DETAILS OF HOSPITALITY ESTABLISHMENST

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Abstract: *The process of forming heads hats from fabrics of new developed hydro-jet technology is described in the article. A number of experiments were conducted to optimize the hydro-jet forming and its optimal technological parameters that were determined. Formed headwears from coat fabrics and costume assortment. Completed comparison of developed technology with existing and installed economic effect from its application.*

Keywords: *hydro-jet forming, headwear details, LAWE, hospitality establishments, fabric, fibers.*

1 INTRODUCTION

Headwear, as a component of a women's suit, is an integral part of the completeness of any image. As a rule, hats are picked up under a suit using a similar material. Modern fashion trends intensively offer headdresses costume supplement of various shapes and materials. But for today headwear quality assurance requires the improvement of structures and technologies. It is also necessary to reduce the cost of materials and improving their consumer properties.

For better fitting of clothes on a person's figure, it is necessary to give it a volumetric form in certain areas. This is realized in accordance with the artist's plan and the anatomical features of the body structure. There are many technologies and ways to solve this problem for today.

Parts quality of volume form headdresses conditioned by structural performance fabrics. Also – the way of formation, an important factor of which is the power field. For a rational selection of formation modes, is expedient to forecast the process due to the analysis of applied actions to the detail of the loads headdresses. Also perspective is development of recommendations regarding the application of different loads schemes taking into account the features of the contour parts.

Increasing consumer demands for product quality makes use of new methods, techniques and research equipment for the development of production technologies.

Providing details of headdresses difficult spatial form from fabrics without constructive intervention is an extremely hard task. To do this is necessary plastify the fabric and attach it some effort. This scheme is implemented in forming volumetric details of headwear by hydrojet method due to use liquid-active working environment (LAWE) [1]. It plastify the fabric and transfers the molding effort by flooded hydrojet stream [2].

Conducting experiments on the specified equipment using LAWE will allow to optimize the formation process parts of hats of different fabrics. This will improve the quality of the products.

Thus, the actual task is to conduct research the process of hydrojet forming of women's headwear of hospitality establishments to determine the optimal technological parameters of the specified equipment. Also, it is necessary to determine the economic effect of the application proposed technology. As known, fibers have certain deformation properties, which then transmitted to threads and then – fabrics.

Considering in the complex the composition and structure of the fiber, we can make a definite conclusion. It is established that the most flexible are cotton fibers and the hardest – linen. Forming fabrics of wool fibers is happening at the expense of scales located on their surface. This significantly increases the coefficient of friction with the joining of fibers [3].

Adding chemical fibers to natural improves the shape resistance of the fabric. In particular, the use of wool with fibers, which have high plastic deformation, will increase the quality of the formed detail [4].

With decreasing fabric density, but with the same thickness of fibers and interlacing and with a decrease in the number of fibers by 10 cm the fabric becomes more mobile [5]. With a decrease in fabric bonding, the fibers are easier to move one to another and stiffness of fabric decreases [6]. The most bonded and stiff is canvas weave [7]. With an increase in the size of the main and overlap weft the connectivity and stiffness of the fabric decreases [8] which is typical for atlases, satins, and serge [9]. Such characteristic features of the fabrics with different weaving determine the complexity and difficult of their research with a wide range of desired parameters [10].

Known hydrodynamic formation method of headwear details [11] which has one common feature with hydrostatic formation. This is the use of a fluid-active working environment (LAWE) as a working environment. But with this the vector of the applied effort is always directed along the normal to each point of detail surface. This limits the ability to form difficult spatial forms.

There is a variety of equipment [12], the main element of which is the use of hydrojet technology. Typically, such equipment used in many industries.

Known study [13], which describes the process of jet penetration into a multilayer package of materials. However, it does not allow the use of hydrojet technology for non-metallic materials. Also, it is known to use a hydrojet for ground soils with the use of special technology [14]. The description of the concept of physical principles for ground soiling with the corresponding characteristics of strength is described. However, conducted studies have narrow direction. Hydrojet technology has been used in the design of underground structures [15]. At the same time to ensure the passage of relevant processes special calculations are carried out [16]. They allow to predict the impact of the jet on different materials. Formulated problems for perspective future research [17]. It should be noted, that in fact there are no studies of the process of hydrojet formation headwear details of hospitality establishments.

Therefore, there is a need investigated the process of hydrojet formation of women's headwear in designing clothing for hospitality facilities. For this need to take into account the various factors that directly affect the process and also establish the economic effect of hydrojet forming.

2 EXPERIMENTAL

The process of hydro-jet forming of hats from fabrics of a suit-coat assortment was modeled. For this reviewed the process of hydro-jet forming hat heads from appropriate fabrics taking into account the following process parameters: H_{sr} – fabric filling coefficient; C – fabric bonding coefficient; S_{nas} – area of outgoing hole nozzle; l – the distance between the tip of nozzle and detail; d – corrected sampled variance of normalized deviations ordinate of the contour formed part of headwear from the ordinates of forming element contour; R – headwear form detail relaxation ; α – angle of attack; n – headwear detail speed rotation; t – forming time; P – LAWE pressure in the system.

In conducting researches it was established that the shape resistance of the head depends on the following factors: characteristics of fabrics and yarn (fiber composition, spinning system, bonding coefficients C and filling of N_{sr} fabric); geometric parameters of nozzles and hydro-jets (shape and area of nozzle outlet hole, distance between end of nozzle and detail); mode of formation (LAWE pressure in system P, time of formation t, rotation speed of the headwear part n, angle of attack for each technological part of the headwear α).

On the basis of conducted research, a new method of hydro-jet forming was developed. It consists of the following stages:

1. The choice of a jet nozzle according to the shape and size of the outlet.
2. The semi-finished product is prepared for formation:
   - from the fabric cut out flat sample with a diameter of 170 mm;
   - sample of fabric is fixed by clamping ring on forming element, the contour of which conditionally divided for five technological parts.
3. In the working window of the developed program introduced initial data:
   - made choice of the desired contour of headgear surface parts;
   - distance from the jet nozzle end to the detail surface;
   - the magnitude of the angle of attack for each from five technological areas;
   - the number of cycles that corresponds to a certain time of formation.
4. Shaping element with fabric installed into the work camera of the equipment.
5. The camera is full by LAWE.
6. The engine is turned on which transfers the rotation on the shaft with the forming element.
7. The "Start" button is pressed in the application window, which leads to action specialized equipment. At the same time, the nozzle begins to move along a predetermined contour of the headwear surface at a certain distance from it and changing the angle of attack on the relevant technological parts.
8. Upon completion of the formation, the LAWE is pumped into the reservoir.
9. Forming element with detail is removed from the working camera and to the inverted side of the head applying a glutinous solution (carbamol CEC - 22 g/l, PVA - 75 g/l, magnesium chloride - 3 g/l) [18].

10. Detail is dried with form stabilization when applying infrared radiation and with the simultaneous removal of moisture with a vacuum pressure of 0.0008-0.0012 MPa for 15 min taking into account the recommendations [19].
11. Performing quality assessment of molded parts by graph-analytical method.

Thus, the developed method will allow to explore the process of hydro-jet forming and determine the optimal parameters of formation for fabrics of a suit-coat assortment (Figure 1).

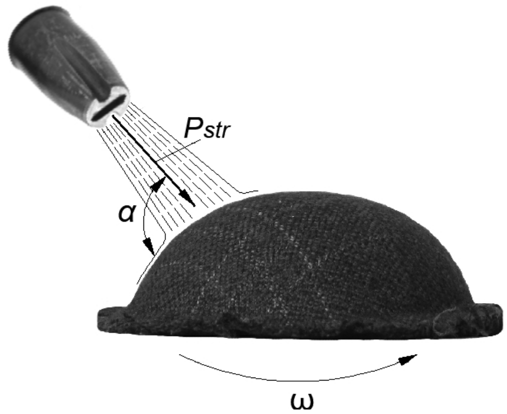

Figure 1 Theme of technological process of hydro-jet forming

A number of experiments were conducted. Input factors for which are chosen specified above factors. Fixed factors were: elliptical area of output section of conoidal jet forming nozzle S_{nas} = 7.2 mm^2; distance from the end of the nozzle to detail surface l = 5 mm; angle of attack on the five sections of the detail α_I = 90°, α_{II-IV} = 45°.

In the experiment two optimization options were used. First – corrected sample variance normalized deviations of real values ordinate points of the contour molded part from the values of ordinates contour points of forming element d. Second – relaxation value of headwear detail form after 48 hours rest R [%].

Obtained correlation indicate to interconnection of the parameters form stability d and R with different factors. These include the LAWE pressure in the system P, formation time t and detail speed rotation n. On both optimization parameters were listed factors affected in different ways. On decrease of corrected sample dispersion of normalized deviations significant impact exerts LAWE pressure in the system and its growth. The smaller – the speed of rotation, but insignificant factor, was time of formation. The greatest impact on the reduction value of detail form relaxation makes double interaction of LAWE pressure in the system and forming time. Less influence the time forming increase and also the LAWE pressure in the system. At the same time insignificant factor was detail rotational speed of headwear.

Results analysis allows to assert about the greatest impact of the LAWE pressure on the system on process of hydro-jet formation for different fabrics such as costume and coat fabrics. This explained the power aspect of the latter.

After conducted research determined optimal values of hydro-jet forming modes of experimental samples of headwear heads for the coat and costume fabrics group (Table 1).

Table 1 Technological parameters of hydro-jet forming experimental samples of headwear heads

Technological parameter	Marking	Coat fabrics group	Costume fabrics group
Hydro-jet pressure	P_{str}	0.07 MPa	0.06-0.09 MPa
Forming time	t	115-159 s	115-157 s
Rotation frequency	n	180 rpm	116-157 rpm
Inclination angles of nozzle axis relative to the head surface	α_{II}	15-25°	15-20°
	α_{III}	35-40°	35-40°
	α_{IV-V}	45°	45°

Based on the results of research were made two models of headwear with molded heads in real size by hydro-jet method (Figure 2). For headwear manufacture applied following modes of head formation (Table 2).

Figure 2 Formed headwear by hydro-jet method

Table 2 Technological parameters of hydro-jet forming headwears heads in natural size

Technological parameter	Marking	Coat fabric	Costume fabric
Hydro-jet pressure	P_{str}	0.07 MPa	0.06 MPa
Forming time	t	203 s	203 s
Rotation frequency	n	157 rpm	145 rpm
Inclination angles of nozzle axis relative to the head surface	α_{II}	25°	20°
	α_{III}	35°	40°

So, after conducted research by using proposed process of hydro-jet forming produced hats from coat and costume fabrics.

3 RESULTS AND DISCUSSION

To determine economic effect of developed technology it must be compared with the existing - hydrodynamic forming and felt headwears heads forming. In the application of the hydrodynamic method [20] created pressure at expense of external effort on the LAWE by pulsating compressed air. This method based on the environment properties evenly distributes forming effort. At the same time details forming passes when created in the camera pressure variations, resulting in vibrational oscillations of the LAWE.

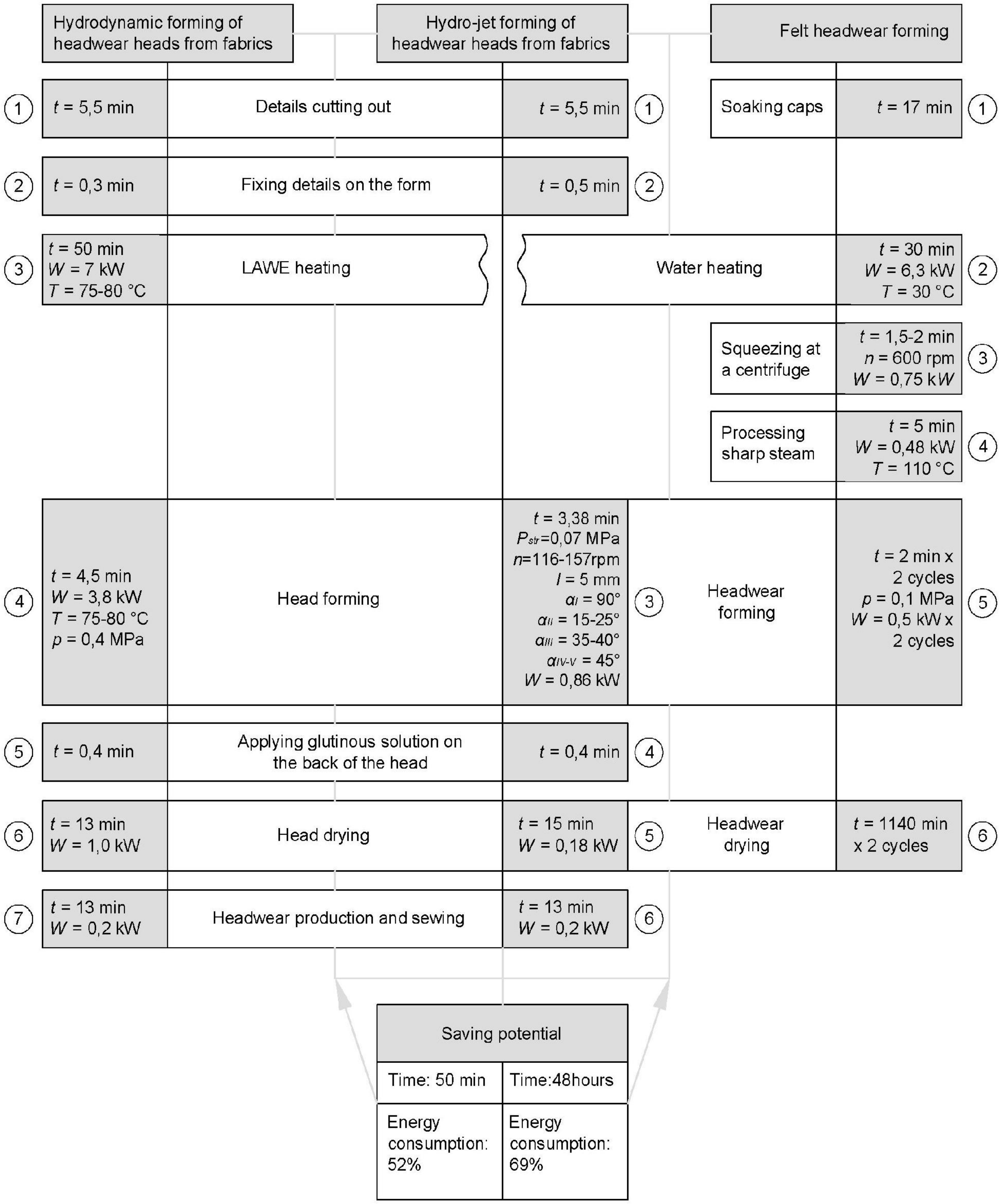

Figure 3 Saving potential developed hydro-jet technology in comparison with hydrodynamic forming and felt forming

After this LAWE derived from the camera.

In the manufacture of molded headwear are using caps of three forms: cone-shaped, caps with an enlarged head, chapels – caps with curved fields. All made from felt.

For the manufacture of felt caps used machines for wool weaving in the approximate form of headgear. They consist of a roller system, brushes and belts with a needle headset, which transfer the wool on a rotating perforated metal cone cartridge (or the same piece of netting). At the same time the fibers in the cap are chaotic, not oriented. After that the finished cap is removed from the cone. To provide the caps shape stability they are glued applying shellac – glue from natural resin released by some plants. Thus, the technology of manufacturing felt hats consists of number operations, which require additional time expenditures. As a result, the cost of finished products increases.

4 CONCLUSION

A new technology of hydro-jet forming of women's hats details is developed.

The optimization parameters for the hydro-jet head forming of headwear from the fabrics of the costume (P_{str} = 0.06 MPa, t = 203 s, n = 145 rpm, α_{II} = 20°, α_{III} = 40°) and coat assortment (P_{str} = 0.07 MPa, t = 203 s, n = 157 rpm, α_{II} = 25°, α_{III} = 35°) are determined.

It was completed comparison of developed technology with existing and installed economic effect from its application. It was determined that the economic potential of time is 50 min in comparison with hydrodynamic forming and 48 hours in comparison with the forming of felt. The economic potential of energy consumption is 52%, compared with hydrodynamic forming and 69% - forming of felt.

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