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# Methods of Calculating the Moulding Instrument Profile for Creating the Set Molecular Orientation in the Finished Product Made of Ultra High Molecular Weight Polyethylene

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**Abstract**

Methods of calculating geometric parameters of the twin-screw extruder triangle head (the "dovetail" type) for sheets made of GUR450 type of ultra high molecular weight polyethylene (UHMWPE) are suggested. Stress and stiffness calculations of the moulding instrument parts are made. Numerical methods alongside with the finite-element method (FEM) as well as analytical approaches to the determination of stress and deflection in sheets were used. The obtained stress and deflection parameters were studied analytically and with the use of the finite-element method. It was found that maximum stress and deflection parameters in the most critical sheet parts of the die have a close agreement: as for the stress – no more than 12 %, as for the displacement – no more than 4.5 %, that proves the adequate choice of the design model and analytical calculation methods. These methods can be used to calculate geometric parameters of the moulding instrument triangle heads for factory-made sheets of the size 2000×380×12 mm with the help of turn-screw extruders.

**Keywords**

Deformation channel; moulding instrument; moulding instrument operating profile; non-Newtonian liquid; twin-screw extruder; UHMWPE.



## Introduction

Nowadays the consumption level of ultra high molecular weight polyethylene (**UHMWPE**) in the domestic industry is about 7000 thousand tons a year. Practically everything is imported: raw material (UHMWPE powder of different types) and products (sheets, posts, wool fiber, textiles). The quantity of UHMWPE powder processed into products by native producers is 15–20 % of the consumption level. This testifies to the strong dependence of many Russian plants on foreign suppliers, mostly the USA and Germany. That is why the development of domestic plants processing UHMWPE is an actual task today. The development of domestic production of UHMWPE powder (Kazanorgsintez, Sibur-TomskNeftehim) also requires to create our own advanced processing base for UHMWPE.

The three main methods applied in the world to get UHMWPE products are: hot pressing, cold pressing with subsequent sintering and ram extrusion. These methods are used to process up to 90 % of UHMWPE. Melt spinning is used to get fiber.

Injection molding is used in some cases together with special machines, designed by firms-processors. So, in extruders made by companies «Braas» and «Dayco» the piston oscillatory motion at a high pressure of 200–300 Ma for the polymeric mass plastication is used. The company «DemagKunststofftechnik» uses a modified standard extruder D170 to process Hostalen GUR type of UHMWPE, where the screw construction is changed to provide the steadiness of the material motion in the cylinder, and the pressure storage device to accelerate injection is installed. Products with optimal properties are produced during the cycle which lasts from 2 to 6 minutes at the processing temperature from 200 to 230 °C and the injection pressure of about

100MPa. In multicavity compression moulds of this extruder the molding components are made, which weigh from 10 to 300 g (various slip elements, valve housing, fitments, bearings, rolls). In Japan the company «Mitsui» designed an extruder where emolliated rather than melted UHMWPE is used. The extruder works combining ram molding and transfer molding. The company manufactures driving wheels weighing 450 g for snowmobiles with the help of this extruder. The cycle time is 4 min.

The productivity of injection molding processes, taking into consideration the above mentioned characteristics of the cycle time and the weight of finished products, is 3–8 kg/hour. The productivity of hot pressing, sintering and ram extrusion processes is approximately at the same level, i.e. 3–10 kg/hour. The power consumption of the processes is about 10 kW/kg.

In this article the technical process of UHMWPE powder extrusion molding with the molecular weight of 9200 kg/mole on the base of the modernized twin-screw extruder is examined. The planned process productivity will be no less than 20 kg/hour with the power consumption of 2–3 kW/kg. Thus, the efficiency of the technical process is two times as much as the world analogs concerning productivity and 3–4 times concerning power consumption.

Despite the advantages of the screw extrusion method, the processing of UHMWPE with its help has not been applied industrially until recently due to the fact that it is necessary to use very strong mechanical loads to force shearing of high-viscosity melt of UHMWPE with a high coefficient of friction on the cut-point melt-solid body (the screw channel). Besides, in the classical variant of the screw extrusion it is impossible to avoid tearing up the melt continuity, the crystallized sample porosity growth and deterioration of mechanical properties.

In 2013 in Russia patents [1] for the technique and devices of molding long components by the screw extrusion of plasticated powder materials, including materials made of UHMWPE were registered (*patent RU 2498900 C1, 20.11.2013, patent RU 2492965 C1, 20.09.2013, patent RU 2489253 C1, 10.08.2013*). The technical result of these inventions is as follows: the increase in density, uniformity and mechanical properties of the extruded material owing to the creation of the combination of cyclic deformations of drawdown, shearing, spinning with different indices and cyclic deformations of the setting with different indices directed orthogonally to the drawdown axis in the extrusion process. The further work on the proposed technical solution in TSTU Research and Educational Centre – ISMPM «Solid phase technologies», Tambov State Technical University, allowed to decrease structure anisotropy in cross-sections of extruded stocks and eliminate material density drop in the stock. This method helped to obtain long stocks made of UHMWPE powder with a density of 0.93 g/cm³.

## Experimental

These methods relate to the production of long sheets from plasticated mass powder by extrusion. The technical result was achieved when the invention [1] was used to enable researchers to mould plasticated powder material of long sheets which have a flawless and uniform structure. The technique of molding long sheets from plasticated powder material includes molding stock and its pressing through the deformation channel of a circular cross-section at the inlet and a rectangular cross-section at the outlet (Fig. 1). In this case in the first part of the deformation channel length the deformation ratio of the material in the central zone must be no less than 80 %, and in fringe regions – no more than 20 % of the total deformation ratio along the whole length of the deformation channel.

Shifting the material along the channel axis and decreasing the width and height of fringe regions in the second part of the deformation channel length, the bulk volume in these zones is decreased regarding the bulk volume of the central zone by sqeezing it out following the model of inverse molding into the central zone.

The device to implement the technique includes a moulding element with a profile screw channel, the entrance region of which is made in the form of a calibrating die. Fig. 1 illustrates the screw channel profile surface of the molding instrument.

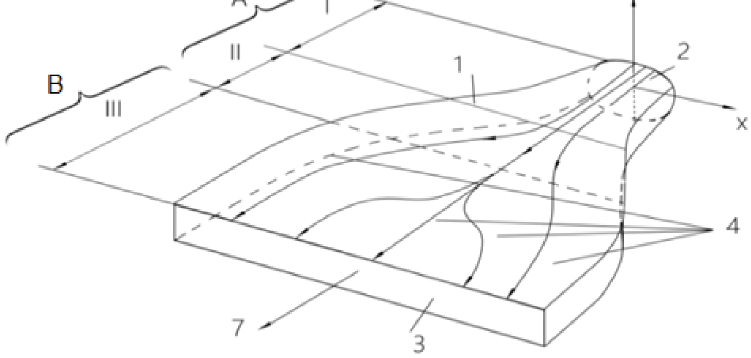



**Fig. 1. General form of the molding instrument screw channel profile**

The peculiarity of the profile surface geometry *1* (Fig. 1) of the molding instrument screw channel is to provide the molding of long sheets from plasticated powder materials. The stock pressed through deformation screw channel *1* has the shape of a rectangle with a high proportion of parameters in the horizontal and vertical planes of symmetry (*YOZ*, *XOZ*) at outlet *3*.

The width of extruded sheets can be 0.5 m and more. Due to this fact it is quite important to fully satisfy the following requirements for the molding instrument screw channel configuration in the process of designing T-dies:

1) the flow friction equality along all the threads (movement contours of all included elementary melt portions in the channel (Fig. 1, position *4*));

2) the minimal possible length of the channel and its surface to provide the minimal loading as a result of melt pressure on the molding instrument walls and consequently, the required toughness, resistance and minimal specific quantity of metal in the model. It is very important because the pressure in industrial moulding instruments can reach up to 135 MPa and the weight can be 800–1500 kg.

According to Fig. 1 the screw channel profile surface can be related to triangled instrumental moulding devices. Here extended entry zone I transfers into zone II levelling down flow friction with regard to the moulding channel width and then in the zone of moulding channel III.

That is why a triangle head concerning the channel is used as a design model for choosing parameters of the molding instrument profile (see Fig. 2). The channel is composed of transition channel A which has the length $l_o$ and the position *O* where the melt enters it, and molding channel *B* with the length *L* and the width *W*. As a rule the height transition channel *H* is 2.5–4 times greater than the height of molding channel $H_1$. As values $H_1$ and *W* are definitely associated with the molding sheet parameters, they are already known as well as value *H* at the initial stage of head projecting. It is possible to consider value L as known because it is connected with $H_1$ by the formula $L \geq (8–15)H_1$ taking into consideration the condition of flow stabilization in the molding channel and minimization of the extrudate expansion.

Thus, the task is to quantify $l_o$ or α [2] that is the same thing, as $l_o$, α and *W* are related by the formula:

$$\cos\alpha = \frac{l_0}{\sqrt{l_0^2 + \left(\frac{W}{2}\right)^2}}, \quad (1)$$

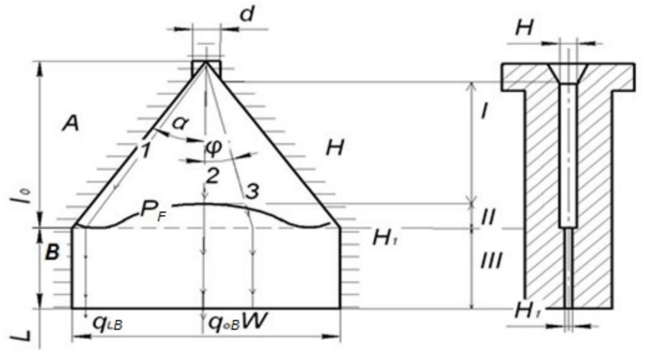



**Fig. 2. Triangled T-die design model**

and perhaps correct parameters *L*, $H_1$, *H* in boundary values which are higher than approximate values, if needed. It is also preferable to find solutions for the lowest values of $l_o$ (or maximum α) and *L*, as the thrust force of the melt pressure in the channel, parameters and the specific quantity of metal in the head are the lowest in this case.

The first limit at the maximum value of α is the lack of stagnant conditions: $\alpha_{max} < 45–60^o$.

However, this value, as a rule, is much greater than the maximum total factor α according to the condition that the flow is levelled down at the outlet of the molding channel.

Let us single out two elementary channels with the simple width along threads *1* and *2* (Fig. 2) on a provisional basis. Then, following the conditions of even flow rates $q_{\alpha B}$ and $q_{oB}$ along the molding channel length, we will get the equation

$$U = \frac{q_{\alpha B}}{q_{oB}}, \quad (2)$$

where $q_{\alpha B}$, $q_{oB}$ are specific flow rates at the outlet of reference channels.

Then writing the expressions for $q_{\alpha B}$ and $q_{oB}$, which include the required parameter $l_o$ (or α), adding them into the formula (2), equating the latter to the accepted value [*U*], we can derive the formula for quantifying the required parameter.

Reference channels represent a flat slot and the equation of the flow rate through it has the following form:

$$q = kH^{n+2}\left(\frac{\Delta p}{e}\right)^n; \quad k = \frac{1}{2^{n+1}} \cdot \frac{m}{n+2}, \quad (3)$$

where $\Delta p$ is a pressure drop along the channel length *l*; *m* and *n* are rheological constants of polymeric materials.

For the non-Newtonian liquid:

$$\Delta p = \left[2^{n+1}(n+2)\right]\frac{Q}{(WHn+2m)^{1/n}},$$

where *Q* is the rate of injection volume flow (flow-rate, productivity).

Each of the reference channels has two parts ($A$ and $B$) with different heights $H$ and $H_1$, that is why the equation (3) can be written only for one of these parts, e.g. part $B$:

$$q_{0B} = k\,H_1^{n+2}\left(\frac{p_{f0}}{L}\right)^n; \quad q_{\alpha B} = k\,H_1^{n+2}\left(\frac{p_{f\alpha}}{L}\right)^n, \quad (4)$$

where $p_{f0}$ and $p_{f\alpha}$ are pressure values of each of these channels at part $B$ inlet, besides these pressure values are not the same due to the fact that the channel lengths on part $A$ are different, and the inlet pressure $p$ is the same.

Values $p_{f0}$ and $p_{f\alpha}$ can be quantified by the equation (4) for part A:

$$q_{0A} = kH^{n+2}\left(\frac{p-p_{f0}}{l_0}\right)^n; \quad q_{\alpha A} = kH^{n+2}\left(\frac{p-p_{f\alpha}}{l_0/\cos\alpha}\right). \quad (5)$$

Solving the equations (5), concerning $p_{f0}$ and $p_{f\alpha}$, and adding formulas derived from them in such a way into the equations (2, 4), taking into consideration clear equality $q_{oA} = q_{oB}$ and $q_{\alpha A} = q_{\alpha B}$, we can write these equations in the following form:

$$q_{0B} = p^n k\left(\frac{L}{H_1^{(n+2)/n}} + \frac{l_0}{H^{(n+2)/n}}\right)^{-n}; \quad q_{\alpha B} = p^n k\left(\frac{L}{H_1^{(n+2)/n}} + \frac{l_0}{H_1^{(n+2)/n}\cdot\cos\alpha}\right)^{-n}. \quad (6)$$

Adding the equation (6) into the formula (3) and equating it to the value [U] in accordance with the approach concept, we get

$$\frac{\left[l + (l_0/l)(H_1/H)^{(n+2)/n}\right]^n}{\left[l + \left(\frac{l_0}{L\cos\alpha}\right)(H_1/H)^{(n+2)/n}\right]^{+n}} = [U]. \quad (7)$$

This equation which was solved with (2), allows quantifying the value of the required parameter $l_0$ (or $\alpha$).

It should be noted that in practice real values of [U] are 0.92–0.98, then the value $\alpha$ according to (7) turns out to be much smaller than the accepted values following the lack of stagnant conditions.

This drawback is not so important for heads with small parameters, but it is unaccepted for large heads.

In accordance with the equation (5) there will be observed an uneven melt yield in triangle heads in zone $A$ along the slot width at the junction of zones $A$ and $B$ due to different lengths of parts *1*, *2*, *3* (Fig. 2) when the slot thickness $H$ is equal to its width $W$.

This follows from the equation (6), provided the flow-rate values are equated.

$$\frac{H}{H_1} = \left(\frac{l_0 + L}{\left(\frac{l_0}{\cos\alpha} + L\right)}\right)^{n/(n+2)}. \quad (8)$$

However, if there is the prescribed slot thickness $H$ of the channel along the axis of symmetry *2* and geometric parameters of the head, it is possible to quantify such a value of the slot thickness of head edge *1* when the regular melt flow along the head width is provided. For this it is necessary to put $l_0/\cos\varphi$ instead of $l_0/\cos\alpha$ into the equation (8), and then we get the slot thickness $H_1(\varphi)$ in the direction of arbitrary beams of melt flow 3, projected at the angle $\varphi$ with regard to the axis of symmetry.

$$H_1(\varphi) = H\frac{1}{\left[\frac{l_0 + L}{(l_0/\cos\alpha) + L}\right]^{n/(n+2)}}. \quad (9)$$

### The Molding Instrument Sheet Strength and Stiffness Calculation

Fig. 3 *a* illustrates the molding instrument sheet construction which represents a pentagon consisting of an upper and lower half-molds heavily screwed on side-lay edges. The sheet intracavity has two channels through which the polymeric material molten mass is transferred under pressure. The transition channel $A$ (Fig. 3 *b*) has a triangular form, the molding channel $B$ with the length $L$ and the width $W$ has a rectangular form. Channel $B$ is the mostly loaded one. The calculation design of this sheet part is illustrated by Fig. 4 and it represents a rectangular-plan sheet, side-hinged and loaded with evenly distributed pressure $P$.

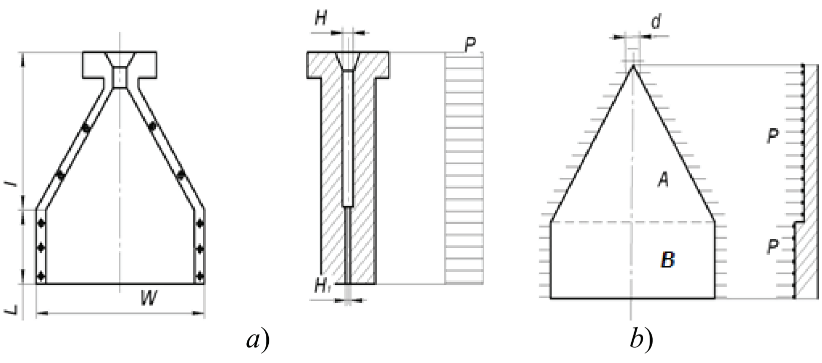



**Fig. 3. General form of the molding instrument sheet (*a*), design model of the sheet (*b*)**

A large-scale deflection in the sheet centre according to the design model:

$$f_{\max}=\frac{pa^4}{D}\Sigma_{m=1,3,5}\left(\frac{4}{\pi^5 m^5}+Am\frac{\pi my}{a}\operatorname{ch}\frac{\pi my}{a}+\right.$$

$$\left.+\beta m\cdot\operatorname{sh}\frac{\pi my}{a}\right)\sin\frac{\pi mx}{a},\quad (10)$$

where

$$Am=\frac{4}{\pi^5 m^5}\frac{V(1+V)\operatorname{sh}\alpha m-V(1-V)\alpha m\operatorname{ch}\alpha m}{(3+V)(1-V)\operatorname{ch}\alpha m\operatorname{sh}\alpha m-(1-V)^2\alpha m};$$

$$Bm=\frac{4}{\pi^5 m^5}\frac{V(1-V)\operatorname{sh}\alpha m}{(3+V)(1-V)\operatorname{ch}\alpha m\operatorname{sh}\alpha m-(1-V)^2\alpha m};$$

$$\alpha_m=\frac{m\pi b}{2a}\operatorname{ch}_{dm}=\frac{e^{dm}+e^{-dm}}{2}\operatorname{sh}dm=\frac{e^{dm}-e^{-dm}}{2}.$$

Sheet stress parameters are determined by the formulae:

$$\sigma_x=\frac{6Mx}{h_1^2},\qquad \sigma_y=\frac{6Mx}{h_1^2},\qquad \sigma_z=0,\qquad (11)$$

where

$$Mx=-D\left(\frac{\delta^2 w}{dx^2}+V\frac{d^2 w}{dy^2}\right),$$

$$M_y=-D\left(\frac{\delta^2 w}{dy^2}+V\frac{d^2 w}{dx^2}\right),\quad M_z=0,$$

$D=\dfrac{Eh^3}{12\left(1-v^2\right)}$ – the sheet flexural stiffness; $v$ – Poisson's ratio; $E$ – modulus of material elongation; $h$ – the sheet thickness.

The sheet strength and stiffness condition according to IV theory of strength

$$\sigma_E^{iv}=\sqrt{\sigma_1^2+\sigma_3^2-\sigma_1^2\sigma_3}\le[\sigma],\qquad (12)$$

$\sigma_1$, $\sigma_3$ – are the main tension and compression stress parameters: $\sigma_1>\sigma_2>\sigma_3$.

$$\sigma_1=\{\sigma_x;\sigma_y\};\ \sigma_1=\{\sigma_x;\sigma_y\};$$

$$\sigma_1=\{\sigma_x;\sigma_y\};$$

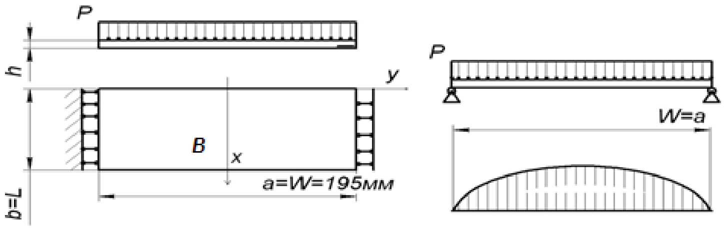
σ are working stress parameters for the molding instrument sheet material.

High-carbon instrument steel (U8) is usually used as a material.

The sheet stiffness condition:

$$f_{\max}\le[f]\qquad (13)$$

where $[f]$ = 0,25 nm is the sheet allowable deflection.




*a*) *b*)

**Fig. 4. Design model of part *B* of the rectangular sheet (*a*), simplified design model of the sheet operating as a beam (*b*)**

It is possible to consider only one member of the series ($m=1$) while calculating the sheet deflection parameters according to formula (10) due to the good convergence of the series; as for stress parameters (11) three members of the series are enough ($m$ = 1, 2, 3).

The aspect ratio of the rectangular sheet part $B$ (Fig. 4) $a/b$ = 195/50 = 3.8 is given for deflection and stress parameters when $x=a/2$, $y=0$ and it has the following form:

$$\begin{aligned} f_{\max}&=0.0131\frac{pa^4}{D};\\ \sigma_{x\max}&=0.125\frac{pa^2}{h^2/6};\\ \sigma_y&=0.0375\frac{pa^2}{h^2/6};\\ \sigma_z&=0 \end{aligned}\qquad (14)$$

It is possible to use the formulae for deflection and stress parameters derived in the same way as the formulae for ordinary beams for preliminary calculations of the molding instrument part $B$. Design models of the rectangular sheet as an ordinary beam which has unit thickness will be simplified in (Fig. 4).

$$f_{\max}=\frac{5}{384}\frac{pa^4}{D}\le[W];\qquad (15)$$

$$\sigma_{x\max}=\frac{pa^2/8}{h^2/6}\le[\sigma].\qquad (16)$$

Here is the example of the preliminary strength and stiffness calculation of the moulding instrument lower sheet.

The initial data: the material is instrument steel U8A, heat treatment is up to HRC 42-66; $\sigma_{\text{в}}$ = 1050 MPa; $\sigma_{\text{т}}$ = 900 MPa; $E = 2{,}109\cdot10^5$ MPa; $\alpha = 12{,}8\cdot10^{-6}$ 1/deg.; $v$ = 0,3; the reserve coefficient $[n]$ = 1,3.

The sizes of the head molding rectangular part $B$ are $b\times a = 50\times195$ mm; the maximum pressure is $p$ = 135 MPa (including a solid head). The allowable stress of the model material is $[\sigma]=\sigma_{\text{т}}/[n]$ = 900/1,3 ≈ ≈ 700 MPa; the allowable deflection in the area of the rectangular slot is $[f]$ = 0,25 mm. The formulae (15), (16) will be used for calculations.

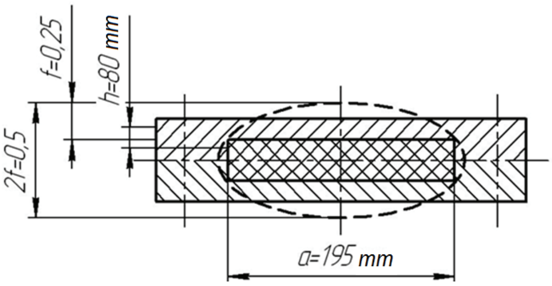



**Fig. 5. Plate deformation in the slot area**

a) determination of the half-mold thickness according to the strength condition (16):

$$h \geq \sqrt{\frac{6pa^2}{8[\sigma]}} = \sqrt{\frac{6 \cdot 135 \cdot (195)^2}{8 \cdot 700}} = 74.16 \text{ mm}; \quad (17)$$

б) determination of the half-mold thickness according to the stiffness condition (15):

$$h \geq \sqrt[3]{\frac{5}{384} \frac{p_x a^4 \cdot 12\left(1-\nu^2\right)}{E \cdot [W]}} =$$

$$= \sqrt[3]{\frac{5}{384} \frac{135 \cdot (195)^2 \cdot 12(1-0.09)}{2.109 \cdot 10^5 \cdot 0.25}} = 80.7 \text{ mm} \quad (18)$$

We consider the biggest value according to the sheet stiffness condition: $h = 80.7 \approx 80$ mm

It should be noted that calculations of the sheet thickness values made according to the formulae (14) of the plate theory give practically the same results as according to the beam theory (15), (16), but the last ones are much simpler.

Fig. 5 illustrates the plate deformation in the area of the slot with a dashed line.

Together with analytical methods concerning the determination of stress and deflection parameters in the sheet, numerical methods were used along with the finite-element method (**FEM**). The pattern of loading the half-mold with the operating head real profile is shown in Fig. 4.

Studying the results of obtained stress and displacement parameters analytically and with the use of the FEM it should be noted that the maximum stress and displacement parameters in the most critical parts of the sheet have a close agreement: as for the stress – no more than 12 %, as for the displacement – no more than 4.5 % that proves the adequate choice of the design model and analytical calculation methods.

Stress and displacement fields in the most typical cross-sections are shown in Fig. 6–11.

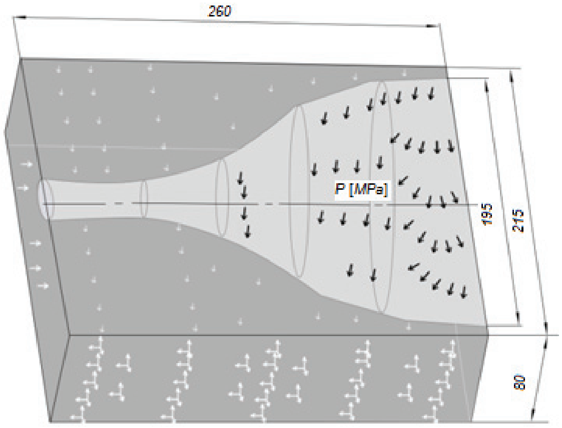



**Fig. 6. General form of the molding head lower sheet under pressure *p*, MPa**

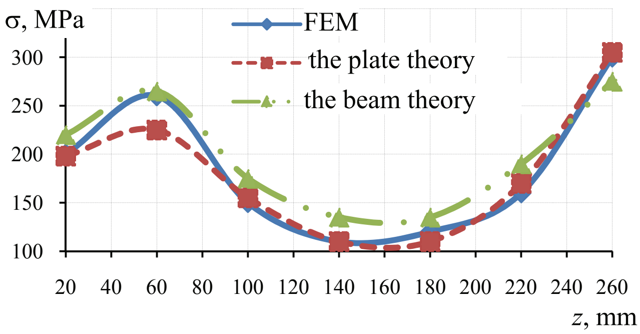



**Fig. 7. Graphic charts of stress along the molding head axis**

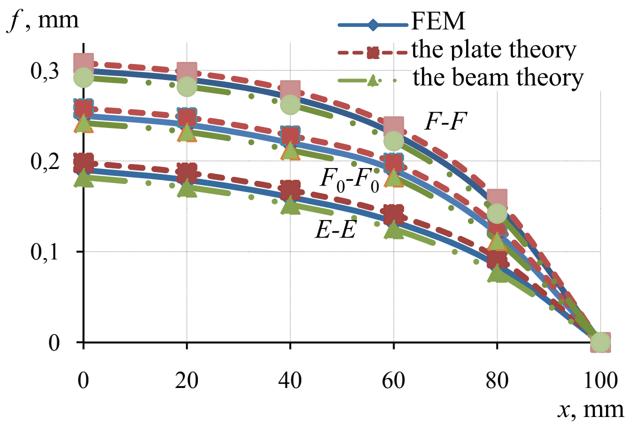



**Fig. 8. Graphic charts of deflection in cross sections *F-F*, $F_0$-$F_0$, *E-E*, perpendicular to the molding head axis**

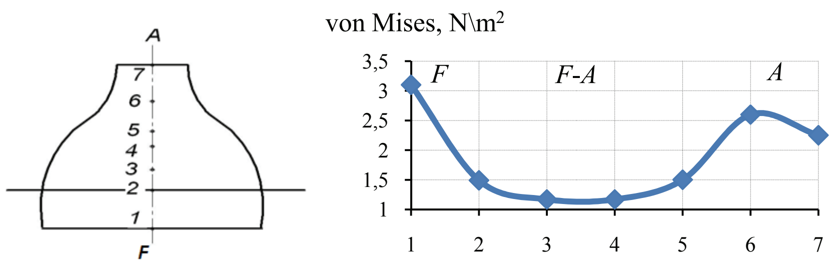



**Fig. 9. Graphic chart of stress along the channel axis according to FEM**

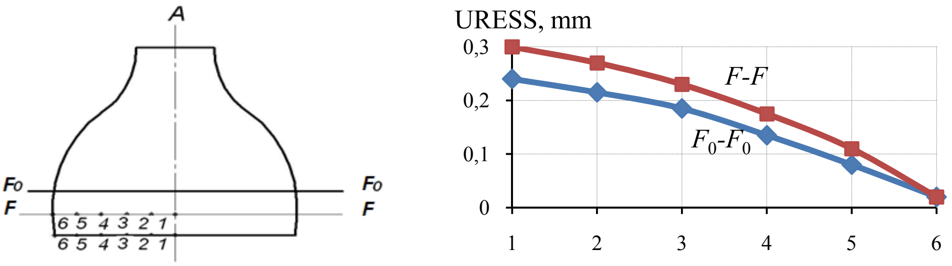



**Fig. 10. Graphic chart of displacement along the channel cross sections *F-F* and $F_0 - F_0$ according to FEM**

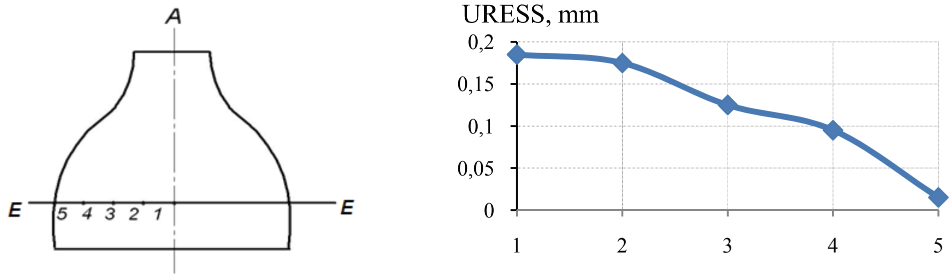



**Fig. 11. Graphic chart of displacement in the channel cross section E-E according to FEM**

### Results of the Practical Use of the Developed Techniques for Producing a Turn-Screw Extruder Head Working Profile for Processing UHMWPE

The initial data: the head pressure is ρ = 135 MPa; the inlet diameter is $d = 26$ mm; $W = 195$ mm; $H_1 = 3.4$ mm; $H = (2.5\ldots4)\cdot H_1 = 10$ mm; the material is GUR450 type of ultra high molecular weight polyethylene UHMWPE, the weight is 9200 kg/mole; $E = 500$ MPa; $\sigma_r = 21.8$ MPa, ρ = 0.93 g/sm$^3$, the melt temperature in the head is $t_0 = 240$ °C; the flow-rate value is $n = 3.4$, the material extrusion is screw, the screw feed is 30 mm/s, the material viscosity is [η] = 3500 ml/g; the screw diameter is $D = 52$ mm. The flow-rate nonuniformity coefficient must be taken as $[U] = 0.92$.

The data are taken from the report of the company LLC AVDT. The data were obtained with the use of the extruder while molding flat laboratory samples from the plate which has the following parameters: $195 \times 80 \times 3.4$ mm. To quantify the triangle head geometry the equations (1) and (7) must be used.

$$\cos\alpha = \frac{l_0}{\sqrt{l_0^2 + (W/2)^2}},$$

$$\frac{\left[l + (l_0/l)(H_1/H)^{(n+2)/n}\right]^n}{\left[l + (l_0/L\cos\alpha)(H_1/H)^{(n+2)/n}\right]^{+n}} = [U]. \quad (19)$$

The initial data are put into the equation (10), which is solved regarding variables α and $l_0$, and find α= 25° and $l_0 = 209$ mm.

Fig. 12 illustrates the molding instrument head profile geometry.

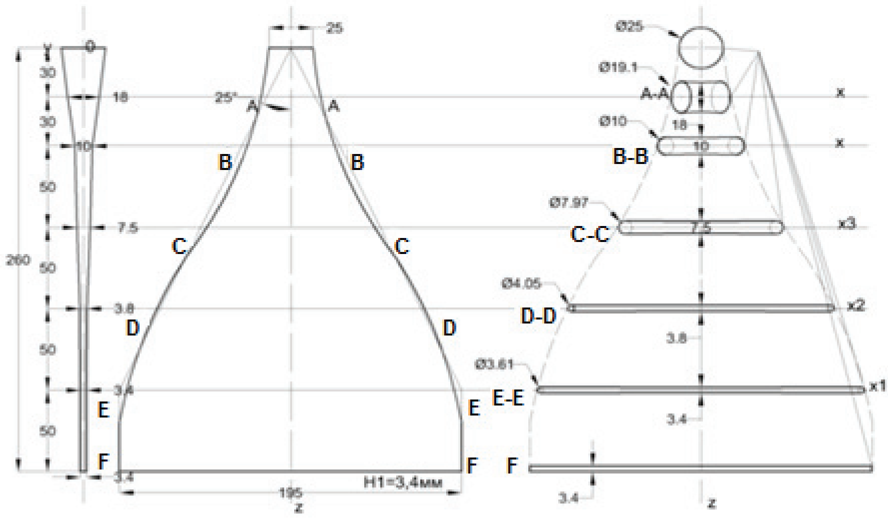



**Fig. 12. Operating channel surface embossing (the extruded material cross-section area along the head length *z* is constant)**

The head productivity maximum possible value is quantified in accordance with the formula (9) depending on the slot thickness of the head edge when the constant thickness is $H$ = const:

$$Q_{max} = V_{max} S \; [m^3/s],$$

where $V_{max}$= 30 mm/s = $3 \cdot 10^{-3}$ m/s is the maximum accepted extruder ratio; $S = W \cdot H_1$ = 195·3.4 = 663 mm$^2$ = = $663 \cdot 10^{-6}$ m$^2$ is the output slot cross section area.

Then $Q_{max} = 30 \cdot 10^{-3} \cdot 663 \cdot 10^{-6} = 1.989 \cdot 10^{-5}$ m$^3$/s = = 19,89 sm$^3$/s.

## Conclusion

1. Methods of calculating geometric parameters of the twin-screw molding instrument triangle head for molding sheets made of GUR450 type of ultra high molecular weight polyethylene UHMWPE are suggested. These techniques allowed making the operating profile of the instrument head for molding flat laboratory samples from the plate which has the following parameters: 195 × 80 × 3.4 mm, and with the good material uniformity at the output.

2. These methods can be used for calculating geometric parameters of the molding instrument triangle heads for producing industrial plates with parameters up to 2000 × 380 × 12 mm with the help of the twin-screw extruder.

3. The sheet construction is developed on the base of the obtained geometric parameters of the head operating profile. It provides the necessary strength and stiffness all over its surface.

4. Design models and calculation methods for the plate to mould sheets are suggested. Statistical and numerical results concerning stress and displacement, which allowed providing the reliable operation of the molding head in the process of molding a sheet under high working pressure, are obtained.

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