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# METHODS OF CHOICE OF MELT FILTRATION SYSTEM IN THE PORCESS OF SECONDARY POLYMER MATERIAL EXTRUSION

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**Summary.** Analysis of the system of melt filtration in the process of reprocessing of secondary polymer materials was done, advantages and disadvantages of existing systems were considered, methods of filtration system choice was offered.

**Key words:** filtration, polymer material, secondary reprocessing, extrusion, melt, pressure.

## INTRODUCTION

Extrinsic substances and impurities of different size and number, which negatively affect the process of extrusion, appear in the process of reprocessing of secondary polymer materials in the polymer melt. Such impurities and heterogeneities lead to the destruction of fibers, blackouts in polymer film, resistance changes in cable coat, or vulnerabilities in polymer pipes. The research showed that the presence of particles of more than 300 micrometers size may lead to cracking and rupture of polymer pipe in 15-20 years. That is why producers of gas pipes which give 50 years and more guarantee period on them must be sure that the melt does not contain particles of more than 300 micrometers size [Gneuss 2007].

There is a melt filtration stage by means of so called filtration systems for collecting solid particles form the melt in the process of extrusion (fig.1) [Dyadychev 2010].

Thus, filtration provides two directions. First, the reprocessing of secondary polymer materials and spoilage in production enables to get additional economic profits. Secondly, it provides the necessary melt filtration quality in production of the range of plastics, for example, production of polyamide granules for usage in optical systems such as mobile devices displays.

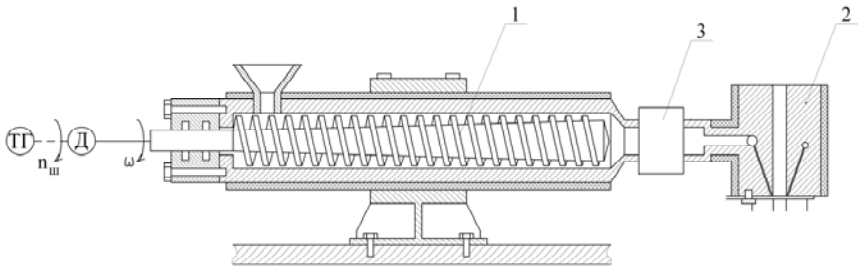


Fig.1. Extruder constructional scheme
1 – extruder, 2 – extrusion head, 3 – filtration system

## RESEARCH OBJECT

There are filtration systems of sampling and continuous action. Systems of continuous action are economically effective as the extrusion production process is not interrupted during filtration elements change. Systems of sampling action are used for lightly foul polymers or, if filtration elements may be easily changed, when extruder is brought to a stop by other reasons, such as change of polymer, colour, extrudate profile and etc [Dyadychev 2010].

Filtration systems of sampling action are the systems of candle and cassette type. In the system of candle type cylinder candle (lathing) is wrapped in expanded lath and the melt goes from extruder through array inside of the candle and goes out from it bottom-up in the head that it is forming. The candle should be taken out to change arrays. In the systems of cassette (gate) type (fig.2) flat lathing with array is set crosswise the melt current, and the arrays change is fulfilled when the cassette is moved aside. Both system types demand the stop of the production for arrays change, but as the useful filtration surface in candle filters is much bigger than this of cassette type then the change of filtration arrays occurs in this type more rarely. So, though cassette filters seem to be handier, but in practice candle filters are more advantageous, cassette filters are used mostly for polymers of low thermostability which are sensitive to dead spaces and prolonged polymer stay in the filter capacity (for instance, polyamides)

Fig.2. Cassette (gate) filter construction

The simplest systems of continuous action are two-piston and have the following construction: there are two pistons in the frame in which filtration elements are fixed. Permanent frame heating is realized by means of alternative heat bringing. The frame is isolated by thermal insulation for heat drain prevention.

Polymer melt is separated inside the frame (fig.3) in two identical currents, each of which goes to filtration hole of the pistol where filtration elements are fastened. For filtration element change the corresponding pistol is put out the frame, where the change is carried out, and then the pistol takes its operating position.

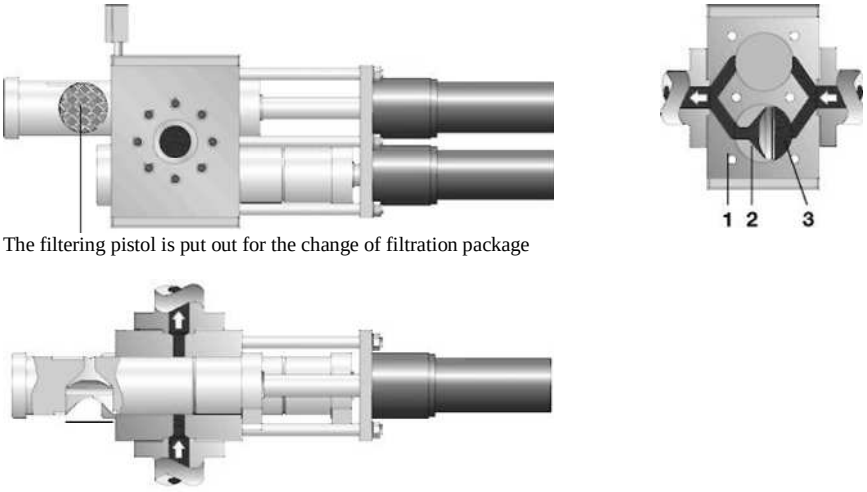


Fig.3. Two-pistol filter's construction and functioning
1 – frame, 2 – pistol, 3 - melt

The main peculiarity of rotation type filter systems construction is the disk that rotates in certain cycle between two blocks and filter elements fastened on it in circle (fig.4).

In rotary filters of the given type depuration of bolts is carried out according to the system of "back-flushing" (fig.5).

The usage of filters with reverse depuration is often recommended in reprocessing of very foul materials, the filter elements are rinsed with a small quantity of filtered polymer melt. In traditional filter adjustments it contributes to the material loss the capacity of which changes depending on the filtration technology used. When using expensive raw material components such as, for example, polyethylene terephthalate or polyamide, the factor of material flow considerably affects the efficiency of production process [Gneuss 2007].

Rotary filtration systems provide optimal melt rheological properties and short time of its going through filter. Stable production of quality products is achieved due to rotary technologies; this process is not violated during the filter elements replacement (fig.6).

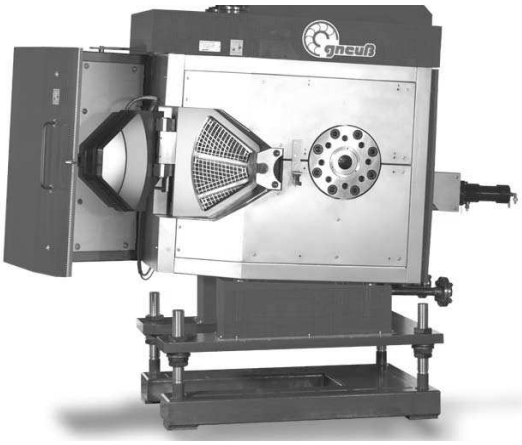

Fig.4. Rotary filter

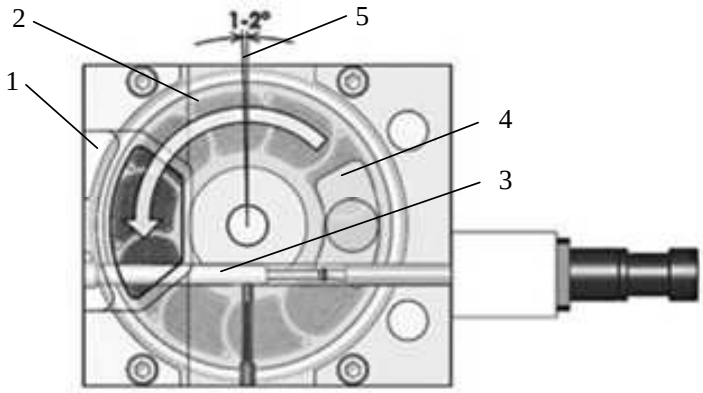


Fig.5. Scheme of the process of bolt rinse in rotation technology filtration systems
1 – door for bolt change, 2 – bolt sector, 3 – pistol of reverse injection
4 – filtration active area, 5 – progressive disk rotation in 1-2°

Rotary filtration systems contribute to high-quality goods production at the expense of higher quality filtration, on the one hand, and, on the other hand, provide wide opportunities on the use of low-grade raw materials for reprocessing, for example, production wastes and waste collected from the population, which significantly reduces production material costs [Narisava 1987].

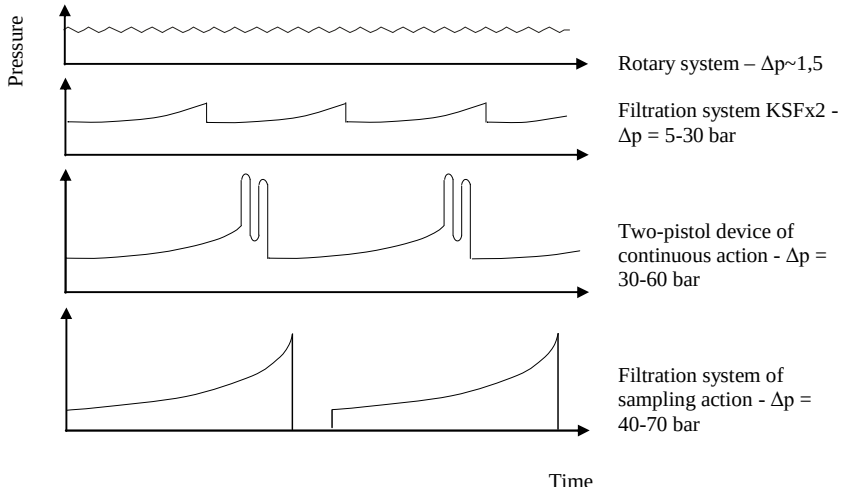


Fig.6. Comparison of the nature of the pressure changes when using different filtration systems

## RESULTS OF EXPERIMENTAL RESEARCH

When choosing polymer melt filtration technology for the concrete line of extrusion the two questions should be asked: what kind of filtration is technologically necessary for the production of goods of acceptable quality, and what filtration system it is rational to use from the economical point of view.

Extrusion lines are equipped with simple cassette filters of flat and one-pistol construction type with manual changing of filter arrays during which cassette devices are put into action using hydraulic or electromechanical devices.

These filter types belong to sampling action systems where change of foul filter elements entails a complete shutdown of extrusion line and, as the result, loss in production output.

Two-pistol bolt-changing devices, in which during normal reprocessing process flow two filtration surfaces are used simultaneously (fig.7a), belong to so called systems of continuous action, besides double filter adjustments where during filtering elements change the reserve filter is used. When the arrays in one of the filter pistols (fig.7b) is changed the production process although is not interrupted, but the filtration surface reduces accordingly.

The peculiarities of the listed above filtration technologies may cause different problems. First, as the filter arrays contaminate with mechanical impurities the resistance to melt movement grows, what causes pressing of the soft particles of the fouling and the blockage of the filtering surface with them. As the result the capacity of the system reduces, extrusion process slows. Especially sharply it is manifested during the direct change of filtering elements in two-pistol systems of continuous action as at this moment, as it was noticed before, the filtration area, partially filled with fouling, reduces.

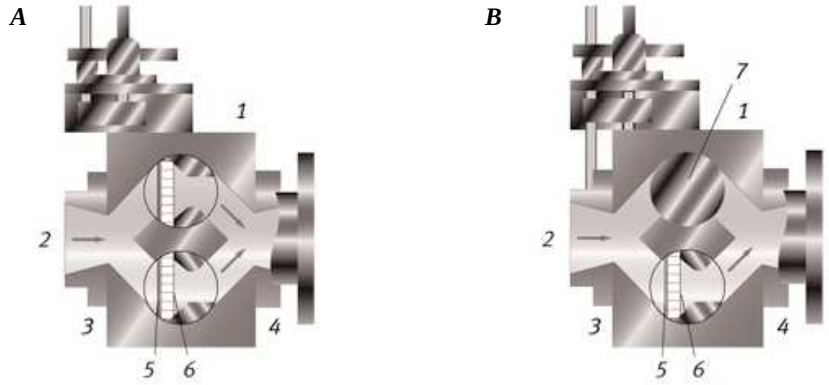


Fig.7. Scheme of the bolt changing two-pistol filtration device in full work (A) and during array change (B)
1 – filter frame; 2 – polymer melt current; 3 – input transition adapter (flange); 4 – output transition adapter (flange); 5 – perforated plate; 6 – array; 7 – closed filtration surfaces during array or bolts changing

Besides this, the products of cracking in the form of plastic particles that appear on the open surfaces of the pistols as the result of the contact with the environment and also in unavailable for clearing space between the meshes of bolts get in the main melt channel together with filtered material when the arrays are changed in this filtration systems.

These defections during filter elements change result in destabilization of technological process and production of such goods that are substandard, which will be realized at low prices, or goods that are to be reprocessed as production wastes. That is why it is necessary, if possible, to combine the arrays change with planned breaks on equipment service when using usual filtration adjustments.

The increase of the period of time between arrays change may be achieved by the following means: installation of rougher filtration or usage of clearer material. But, in the first case the goods quality will worsen, in the second case the material expenses, which occupy a considerable part in production costs, will grow.

## CONCLUSION

Filtration systems influence the efficiency and quality of the production process considerably because of the range of certain factors. In this regard, it is appropriate and reasonable to decide closely and carefully during the packaging and purchase of certain new line what filtration technology is rational and effective. The filtration type proposed by manufacturers that complete and supply equipment is often economically profitable for them, but it is not rational for the final user of the line.

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## МЕТОДИКА ВЫБОРА СИСТЕМЫ ФИЛЬТРАЦИИ РАСПЛАВА В ПРОЦЕССЕ ЭКСТРУЗИИ ВТОРИЧНОГО ПОЛИМЕРНОГО МАТЕРИАЛА

**Валерий Дядичев, Татьяна Терещенко, Ирина Дядичева**

**Аннотация.** Проведен анализ систем фильтрации расплава в процессе переработки вторичных полимерных материалов, рассмотрены достоинства и недостатки существующих систем, предложена методика выбора системы фильтрации.

**Ключевые слова:** фильтрация, полимерный материал, вторичная переработка, экструзия, расплав, давление.