Extrusion Process & Technology Insights – Newsletter n.4/2018

EXTRUSION CROSSHEADS AND PROCESS

by Antonio Gumina, Technical Director – Eurotek

Crosshead is definitely the most important component in the cable production cycle. It acts on the production efficiency and on the cable quality.

In order to produce a high-performing crosshead it is strictly important to own a specific know-how on plastic materials and on extrusion process for cable production. There are two main factors in crossheads designing:

- operator needs;
- production needs and compounds characteristics.

Crossheads and extrusion lines are mainly driven by operators. Quality and productivity depend on them. For this reason, the head should be operator friendly in order to:

- guarantee the easiest assembling and processing set up procedures;
- give the lowest operator margin of error.

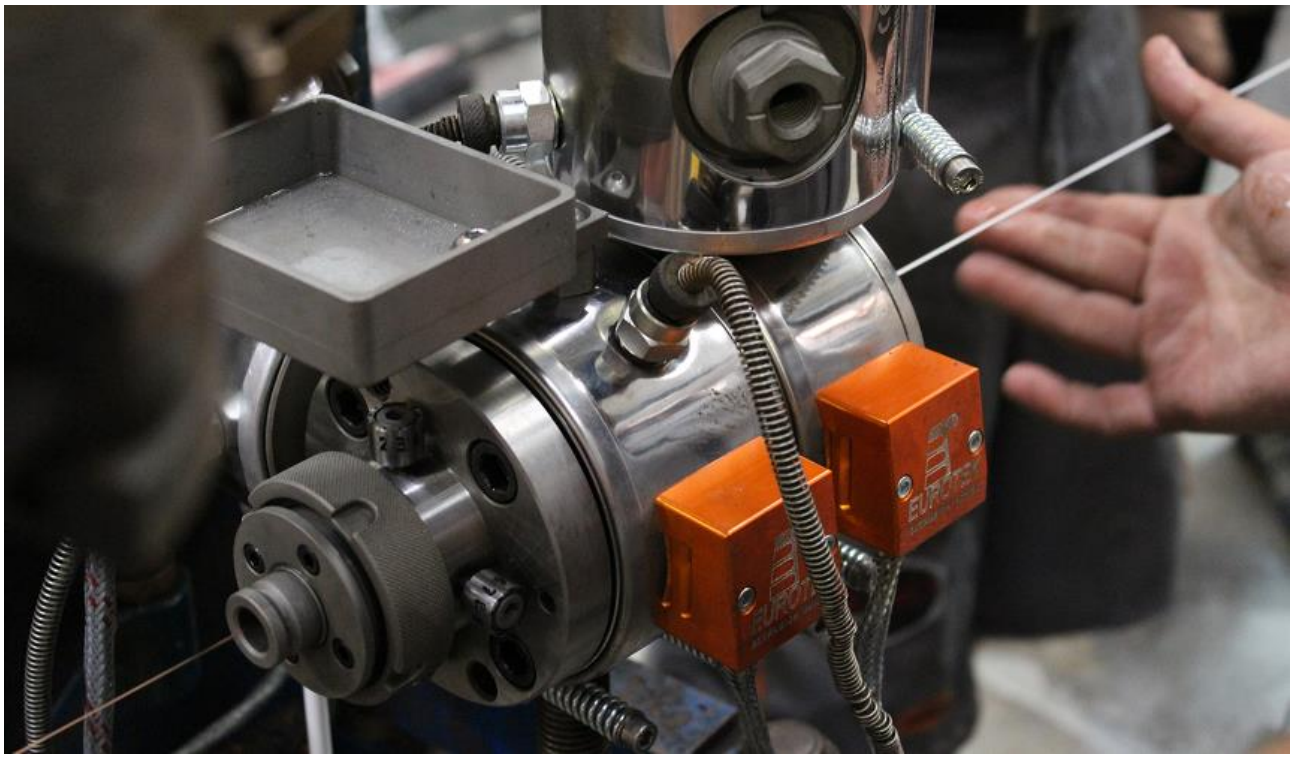

Fig. 1 - Eurotek ECF10_FT crosshead with Fine Tuning System at work with HFFR

Furthermore, crossheads productivity and high-quality depend on the compounds to be processed. Therefore, they can be designed according to compounds rheology, their viscosity (and its variation) and thermal flow.

An important role is played by:

- shape of the crosshead for the correct heat distribution around the distributor and around the entire zone where the material is passing through;
- zone to be thermoregulated for temperature control that act on the cable quality, process, surface aspect, etc.

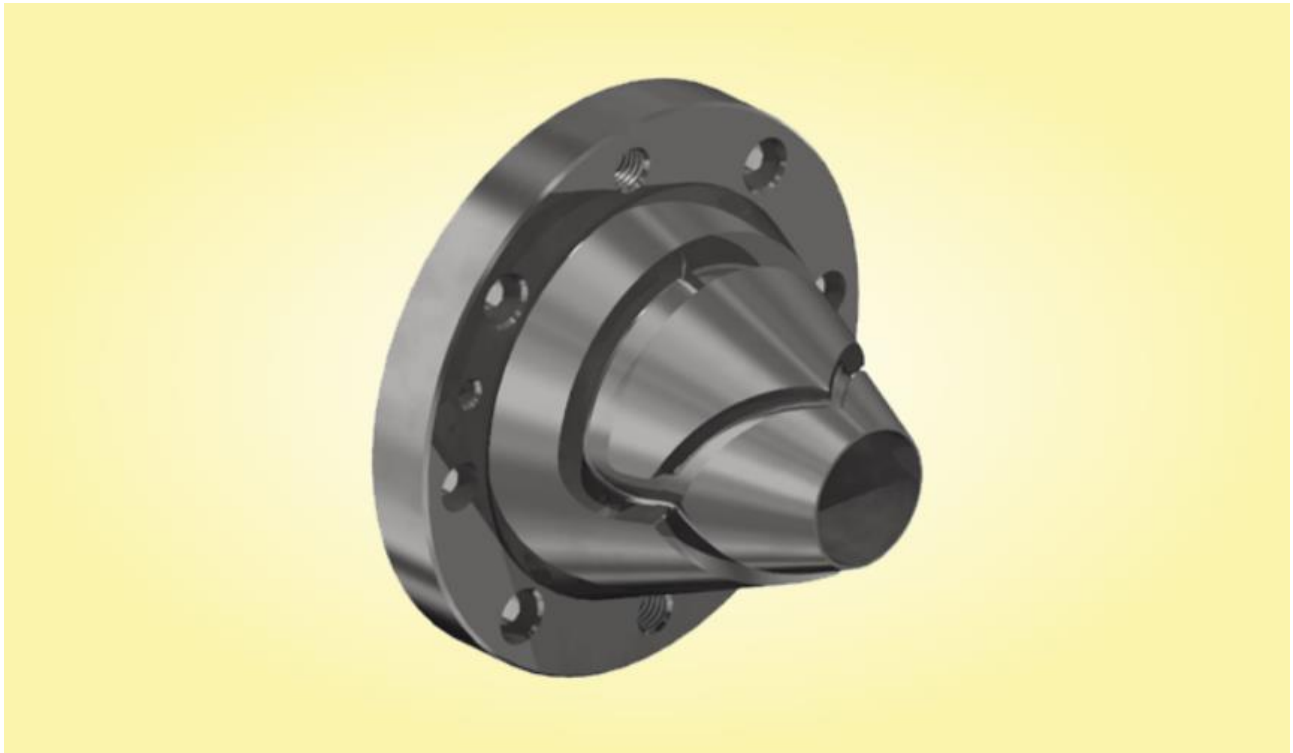

Fig. 2 - Distributor for fluoropolymers

The flow distributor design depends on the compound to be processed, even considering the process parameters during the cable production. It is really important to calculate the following parameters, according to extruder maximum and minimum output and the rheology of the compounds to be processed (considering the viscosity and its variation):

MATERIAL ENTRANCE CHANNEL SECTION (S)

Channels deep (H_0)

This value acts on:

- working pressure;
- impact pressure;
- compound speed to the entrance;
- shear rate into the distribution channels.

Channels wide (W_0)

This value acts on:

- speed of the compound to the entrance;
- relaxing effect of the compound into the distributor;
- shear rate into the distribution channels;
- acceleration of the compound into the channels.

Channels shape, section variation along the path X, heart wall shape

The section and shape of the channels will follow the calculated path. The section will change continuously in terms of H_x, W_x and shape according to the compound to be processed and the dynamic of the material flow. The performing channel shape and the heart wall shape are developed in order to help synergically the extruder to let the material flow through the head, avoiding stagnation and overheating.

Distributor diameter into the inlet zone D and angle θ

The value must be defined according to other parameters, such as angle **θ**, tools dimension to be used, distributor length **L**. Among other, these values act on the extruder back pressure, pressure distribution, speed distribution, force to extract the distributor from the head body. The distributor angle depends also on the compound to be processed, the type and the dimension of the cable to be produced. This angle influences the concentricity of the final product as well.

Length of the distributor and gap of passage ξ_g

The length is related to the compound to be extruded and influences the residence/crossing time of the compound, the shear rate, the pressure distribution, the working pressure. For this reason, L must be defined in order to avoid risk of stagnation, compound overheating, over-pressure and pre-reticulation.

The gap for material leakage (axial flow) ξ_g is defined according to the compound to be processed, head size, extruder output. This value acts on the extruder pressure, the flow distribution and the material overheating during the flowing.

Fig.3 - Distributor with Fine Tuning System for HFFR

In conclusion, the distributor length **L** must be chosen considering:

- the residence time of the compound into the head;
- angle and diameter of the distributor and tools dimension to be installed;
- channel dimensions (viscosity of the compound);
- gap for axial material passage and consequently exit gap of the distributor ξ_g.

L is strictly related to the gap ξ_g

These two values must be defined in a synergic way because they influence the residence time, the shear rate and the pressure.

Other values that must be calculated are:

- speed rate and shear rate into the distribution channels d_d;
- speed rate and shear rate into the barrier zone (leakage zone or axial channels) d_d;
- pressure distribution.

The ratio **K** between the shear rate into the inlet section and the shear rate into the axial barrier zone must have a proper value for a correct flow distribution. The **K** factor influences the distributor dimensions as well (e.g. diameter, channels).

The crosshead design, calculation and optimization are done even to deal with the compound viscosity increasing and the need of the cross-linkable compounds.

OPERATOR FRIENDLY	**PRODUCTIVITY**
Easy set up	Higher cable productivity
Fast and easy process adjustments	High cable quality
Safety	Low extruder back pressure
Product repeatability	Product repeatability
Lowest mistakes chance	Low scrap
Easy and fast maintenance	