

Profile and sheet extrusion

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Introduction

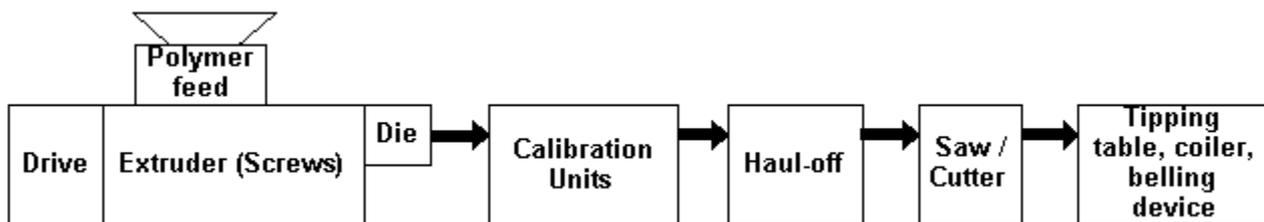
The extrusion process may be very easily visualised perhaps the best examples are the meat grinder and the toothpaste tube. However, the very simplicity of these examples belies the complexity of the process and extrusion technology is highly developed both as a science and as an art.

Hopefully this short article will give the designer some idea of the possibilities for extrusion and stimulate design with extrusion.

Using extrusions

The extrusion line

The extrusion line begins with the hopper which holds the plastic material (in either powder or granule form). The hopper continuously feeds the material to a heated barrel which contains a rotating screw. This screw transports the polymer to the die head and simultaneously the material is heated, mixed, pressurised and metered. Needless to say the detailed design of an extruder screw is extremely complex in order to perform all the above tasks. At the die the polymer takes up the approximate shape of the article and is then cooled either by water or air to give the final shape. As the polymer cools it is drawn along by haul-off devices and either coiled (for soft products) or cut to length (for hard products).



The layout of an extrusion line



The processes during extrusion

Extrusion processes

The typical extrusion line described above can be used, with modifications, to produce a wide variety of products. Some typical examples are:

- Wire coating: for all types of wires and cables.
- Monofilament: for rope, bristles and synthetic textile fibres.
- Blown film: for plastic bags, plastic film and heat shrinkable film for food packaging.
- Sheet extrusion: for sign production, refrigerator interiors and even small boat hulls. When a clear sheet is produced it can be used in glazing or lighting applications.
- Pipe and tube: plastic tubing is used for garden hose, industrial hose, food and drink, transport and hydraulic or pneumatic control. Plastics pipe is used for water, gas, agricultural drainage, sewers and drains. New developments allow plastics pipe to replace copper pipe for heating and hot and cold-water services.

Profile extrusion

This is probably the most interesting area for engineering designers and the possibilities are virtually limitless. The initial constraint of a constant cross section is overcome in many applications by fabrication techniques such as cutting, drilling, welding and stamping and by innovative processing techniques such as co-extrusion of soft and hard polymers, multiple colour extrusion and in-line application of decorative foils or adhesive tapes.

Materials.

Most common thermoplastic polymers can be used for extrusion and the material choice is dependent on both the performance requirements and on the economic constraints. It is here that the designer should seek specialist advice from the extrusion company or material suppliers.

The most commonly used material for general purpose extrusions is PVC. The wide application of this material is due to cost, chemical resistance and its availability in various hardnesses and colours. The hardness of PVC can vary from the rigid type used for windows (Shore 'A' hardness of 100 or British Standard softness of 0) to the plasticised or soft version used for garden hoses (generally Shore 'A' 80 deg or BSS 38) and even down to very soft materials of Shore 'A' 60 deg (BSS 75) which have limited uses. The colour can be either matched to a colour sample or chosen from several hundred standard colours. PVC is a very versatile material but, as with all materials, there are limitations and again specialist advice should be sought for critical applications.

Tolerances.

While plastics extrusions can be produced to consistent tolerances the designer must be aware that these are not the same as for machined parts or for metals extrusion and are generally greater. The tolerance bands applicable vary with the relevant dimension, the material used and with the manufacturer but in general BS 3734:1978 for extruded rubber products (Table 2 Class E 2) can be used as a guide. Specific tolerances for critical areas and non-critical tolerances must be discussed and agreed between customer and producer. Inevitably, the unit price increases with the number of toleranced dimensions and the tightness of the tolerances specified.

Examples of applications

Typical applications/design possibilities.

The following application examples have been chosen to illustrate possibilities and the same ideas and techniques can, obviously, be used in many fields such as:

Window profiles

The basic frame of the window is an extruded, unplasticised PVC section. This section contains air gaps or chambers which are carefully designed to give the necessary thermal and sound insulation. The normal colour is white and the polymer is UV stabilised to prevent fading. New developments with co-extrusion and printing techniques allow the profile to be produced with wood-effect or coloured finishes. This basic profile is mitre cut and welded into a frame to fit the windows of the house exactly. Extrusions are also used to provide the essential sealing lips on the profile. By skilled design a system of extrusions is built up to provide outward opening windows, tilt and turn windows, patio doors, roller shutters and other elements of the glazing system of the house.

Sealing sections

Extrusions are applied in many sealing applications where the designer has considerable choice in fixing method. A co-extrusion of hard and soft materials will allow the hard material to be screwed, nailed, stapled or glued to one sealing face and the soft material will still provide the required seal. A single hardness soft extrusion can be punched or stapled but may need a reinforcing rod. Alternatively, it may be clipped into one sealing face using a groove in the face as a location/fixing area. The designer can choose between these varied options and the extrusion manufacturer can provide advice on the technology available. Typical application areas are refrigerator door seals (which incorporate a magnetic extrusion for an airtight seal), car door and boot seals, acoustic cabinet seals and the window seals described above.

Modular drawer profiles

Drawer systems utilising extrusions are available both as DIY and professional kits. These illustrate important options for the designer: the ability to use an extrusion to provide variable length and width and the use of injection moulded corner pieces to provide the necessary jointing. The requirements for light weight and easy assembly rule out the use of welding and the assembly is built up using the clip-in corner pieces which give rigidity and professional finish.

Decorative trim

The decorative trim strips seen on bedroom and other furniture are examples of two important techniques available. One is the ability to apply a foil to the extruded PVC to give a bright and attractive finish (an option which is often used in the automobile industry for trim and bumper strips although, in this case, special exterior foils and techniques are necessary). The other is the use of double sided tape for rapid and strong mounting of the profile. For fixing to smooth, flat surfaces i.e. furniture, a film tape is used but when the surface is not regular then a foam tape may be used to give the necessary surface conformance and adhesion.

More examples are possible but the engineering designer is seeking to innovate and, hopefully, those examples outlined above can help this innovation through increased awareness of the process and its capabilities.

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