Consultant **Robin Kent** offers advice to film and sheet extruders on how to cut energy bills

Cutting extrusion energy bills

Film and sheet extrusion are similar in many ways to other extrusion processes, and many of the actions to improve energy efficiency are common (see the recent article in ***Pipe and Profile Extrusion*** on some of the more general actions that can be taken). However, there are some very specific – and simple – actions that can help to cut energy use in film and sheet extrusion.

The blown film process uses extrusion to produce a homogeneous melt that is fed into a circular die head to produce the familiar bubble that is cooled, slit, wound and possibly post-treated depending on the product.

Within this process, drive gearing and torque levels should be examined to check the loading on the extruder motor. If loading is low, then adjusting the gear ratios and motor size can lead to considerable reductions in energy use. As with profile extrusion, there is a growing trend to fit AC motors with variable speed drives (VSDs) – which can reduce operation and maintenance costs.

Die heads can be heated via conventional band heaters or using hot oil heaters – similar to mould heaters in injection moulding. For hot oil heaters, all the oil transfer piping should be insulated in order to reduce heat losses – and to remove any Health and Safety issues with hot oil lines.

Cooling down

The cooling rate of the blown film is a limiting factor in process speed, and can be accelerated by blowing cold air onto the surface of the bubble. As extrusion speed increases, the chill or frost line (where solidification of the extrudate takes place) will be higher on the bubble – and the bubble can become unstable. Increasing the air flow rate can increase cooling but if it is too high then the bubble can become distorted and unstable.

The correct chilling of the bubble is therefore critical to good production and the temperature and volume of the air are varied to get the chill line at the correct location on the bubble. In many cases fixed speed fans are used – and simply damped to control the air flow. This is highly inefficient: instead, fans should be controlled with VSDs using feedback from the chill line location.

The position of the chill line is controlled by blowing chilled air onto the bubble, but this air is often blown through uninsulated hoses. These hoses sit in hot areas, and considerable parasitic heat gain will result.

In some processes, tempering ovens are used to post-treat films to get the correct properties. In common with many ovens, these are often inadequately insulated or sealed – which is a waste of energy. At the same time, the cycle times for these ovens are not well

Energy is a precious commodity. Intelligent energy management can deliver huge savings to the extrusion process

Tips: film extrusion

- Insulate all hot oil lines to reduce energy use, to reduce Health and Safety issues and to reduce the temperature in the area. Heaters must be adequately controlled to prevent overheating
- Use VSDs to control fans to locate the chill line. A 20% reduction in fan speed using a VSD will reduce the energy use by 49%. VSD controllers should be considered for all fans and blowers
- Where chilled air is used, ensure that all chilled air lines are adequately insulated to prevent parasitic heat gain

Tips: edge trim

- Examine all regranulators and their loading pattern: could they be replaced with smaller models if working patterns were changed?
- If regranulators are still lightly loaded, very lightly loaded motors can be fitted with motor optimisers to cut energy use
- Sites should carefully calculate all the costs of recycling edge trim (including energy costs and handling costs) to see if it is actually saving money. While recycling is laudable, if it is not profitable then you should either refine the process to make it profitable or stop recycling

Tips: sheet extrusion

- Transfer lines should be fitted with insulation to cut energy use, reduce Health and Safety issues and to reduce the temperature in the area. Heaters must be properly controlled to prevent overheating. The same is true for dies in each case
- Co-extruders are often left running, even when no run is planned. They should be purged and shut down if they are not going to be used for over three hours

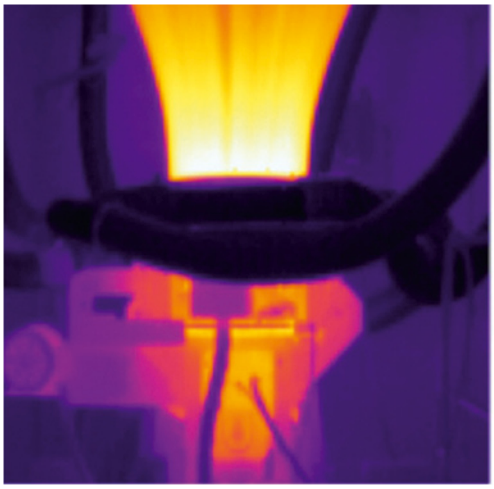
Tips: cooling

- Ventilation fans should be linked to the main drive: when the main extruder drive is stopped, the fan will automatically stop after a pre-set time.
- Fans can be VSD-controlled to reduce energy usage by using the temperature in the exhaust area as a signal

Tips: post-treatment

- Post-treatment ovens should be sealed and insulated at all openings and surfaces
- Cycle times for post-treatment ovens are often not well controlled or optimised. Simple controls can reduce energy usage in post-treatment ovens

Temperature profile of blown film line: the white area is at 178°C, while the dark blue area is 22.4°C. Considerable parasitic heat gain can be experienced in the cooler area if insulation is not used



Only the best factories tend to insulate transfer lines. Here, the temperature in the white area is 126°C

controlled – but simple controls could help to reduce energy use.

Sheet extrusion

Sheet extrusion differs from film extrusion in that the resulting material is thicker and is generally an intermediate material rather than the final product. It is extruded through a slit die directly onto sizing rollers which control overall sheet thickness. It can produce solid sheet – which is extruded as a flat sheet straight onto the cooling rollers – or foam sheet, which is generally extruded as a tube that is slit and flattened before rolling into reels.

As with other extrusion processes, the main drive and motor gearing is a good place to identify energy savings (as discussed earlier for film extrusion). Heating and cooling along the barrel is important, and this was covered in the recent article in ***Pipe and Profile Extrusion***.

A slightly special case in sheet is co-extrusion, in which material of an A-B-A format is produced – where A and B are different materials. If co-extruders are only used occasionally they should be subject to good purging and shutdown procedures. Transfer lines between co-extruders or the main feed and the die are rarely insulated except in the best factories. There is little shear heating in these areas and heater bands are needed to keep the plastic molten.

The case is similar for uninsulated dies, which have significant heat losses. Again, there is little shear heating in this section – so heaters are needed to keep the plastic molten.

Many extruders have exhaust fans above the die area to remove hot air and fumes created during processing. These will be fixed speed fans and controls are rarely conveniently located. Ideally, they should be linked to the main drive, so that when the extruder drive stops, the fan will follow after a pre-set time. Also, the temperature in the exhaust area can be used as a signal to control fans using VSDs.

Another important area is cooling rollers. They are cooled by chilled water – but the chilled water settings are rarely investigated. One possibility is to increase water temperatures to the minimum required by the process.

Trim regranulation

On most sheet lines, the sheet is trimmed to width and the edge trim is recycled (sometimes in a closed loop) back into the process. While this saves on material cost, there is an associated energy cost – which, again, can be reduced.

It sounds incredible, but the energy used for regranulation can exceed the energy used by the extruders: the regranulators in one factory were all very large, allowing complete rolls to be reground if needed (such as for quality issues, or at start-up). However, most of the time they were only used for edge trim and were often running unloaded. Minor changes in operational procedures – replacing the large regranulators with smaller edge trim regranulators, and dedicating some large regranulators for roll regrinding – saved considerable energy, and paid for a complete refit of the regranulation area.

In cases where edge trim volumes are very small, recycling may not even be financially viable – despite the cost of the material loss.

No way to control a fan! In this case, a simple VSD would have cut the cost of running the fan by around 85% and provided much better control

Good insulation on the rear of a sheet die – such as here – will save energy and ensure that plastic remains molten

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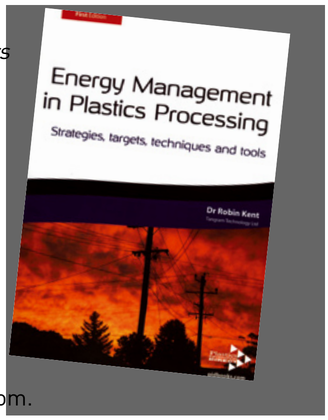
Robin Kent's book, Energy Management in Plastics Processing*, was recently published by Plastics Information direct. For more information,* ***click here***.



He recently ran a full-day masterclass on Energy Management in Plastics Processing *in Coventry, UK, with plans to run more in future.* To request details, e-mail Matt Wherlock: mjw@amiplastics.com.

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