1 CONSIDER ENERGY USAGE WHEN PURCHASING AUTOMATION SYSTEM FOR BLOWN FILM LINES.

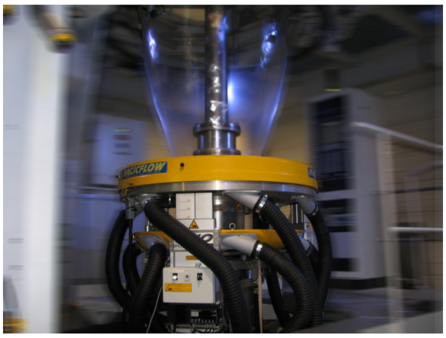
Film manufactures are increasingly seeing themselves exposed to rising production costs. Huge increases in raw material prices, higher demands on quality from the end user, shorter delivery times and the compulsion of material saving has left little elbow room.
Leading edge companies have already invested in extrusion automation with some using 3rd or 4th generation systems with high levels of automation being specified as a standard for new equipment. However there is a need for many older machines to be upgraded with modern automation systems to bring them up to date. Very efficient measures can be carried out at only a fraction of the cost of a new machine in order to increase productivity and quality.

Utilization of high performance air rings with integrated profile control not only increases the output of the line by up to 50% but also the film tolerance is improved significantly plus a measurable reduction in scrap.
In total the effectiveness of production is improved through, additional production capacity, improved film tolerances, order change times are minimized and raw material savings due to reduced gauge tolerances and shorter setup times.

The sum result of these improvements gives improved productivity and profitability and a pay back of the investment costs over a short period of time.

A wide spectrum of controlled air rings from different manufacturers at varying price levels are available to the film producer today. However detailed analysis is required prior to investment to determine not just purchase price but also guaranteed control effectiveness and also operating costs over the life of the equipment.
Although a number of principles have been introduced in order to deliver profile control two major principles for profile control via the air ring have emerged.

Option 1



Control of the cooling air volume – increased or decreased volumes of segmented cooling air regulated in relationship the thick or thin points around the bubble influencing the thickness of the film below the frost line. This procedure is almost energy neutral as each cooling air path is volumetrically isolated with each other (the number of which varies with the air ring diameter), as one area of the bubble requires less cooling air another sector requires more balancing out demand. Energy loss of input air is approx 1% or less in most applications. Since the cooling air is used to influence the film tolerances control is effective even at very high cooling capacities.

Option 2

An alternative principle is to heat the cooling air in segments around the air ring circumference. The temperature of the cooling air is regulated by heater units with accurate feed back of the air ring temperature using thermocouples inserted in each air stream. Localized temperature changes in the segments increase the rate of stretch effectively reducing the thick spots in the profile tolerances. If higher machine outputs are required the amount of heating energy required to effect the film tolerances also has to be increased correspondingly.

To compare the advantages and disadvantages of both principles we have carried our field studies with two identically constructed PLAST-CONTROL air rings with only the type of control technology (heated air / air volume) being different.

The air ring using the Option 1 principle is equipped with 48 control valves driven by high precision stepper motors. The second air ring uses the principle described in Option 2 with 64 heating elements with a power consumption 0.6 kW each.

Both air rings have identical internal and external air flow, using the same external air supply and air lip inserts. To standardize further a 3 layer Co-Extrusion line was provided by the company Kiefel Extrusions AG situated in their laboratory located in Worms Germany.

The trials were to attain knowledge in respect to cooling capacity, film tolerances and reaction behaviour as well as drawing conclusions for production operating costs.

The trails are only to analyse comparative efficiency but not absolute values and are therefore not comparable with those of other manufacturers.

1.1 Achieved Film Tolerances

Concerning the tolerance of the profile in control no great appreciable differences were seen. Depending on film production and extruder output controlled tolerances at a 2 sigma filter of between 1.5% and 3% are reached. Sufficient influence on the film tolerances was achieved by both principles.

1.2 Reaction Behaviour

Option 1 has some advantages compared to that of the temperature controlled air ring. Physically adjusting the position of the actuators is relatively quick up to a maximum of one minute but the reaction on the film is almost instantaneous. Alternatively, power adjustment of the heating elements affect on the film is slower taking between 4-8 minutes depending on cooling rate.

1.3 Cooling Capacity

There are symptomatic differences between both types of air rings. With option 1 the cooling air is fed directly to the film bubble while the heating elements in option 2 heat up the cooling air reducing the cooling efficiency of the extrusion line. This is directly reflected in the reduction of the maximum cooling capacity (higher output requires more cooling air- requiring more heat form the heating elements). Theoretically the throughput of the blown film line is reduced by approx 5% in option 2 providing that the air ring and lip geometry are identical (PLAST-CONTROL/KIEFEL Extrusions AG series of field studies).
In uncontrolled production environments performance differences are due mainly to different mechanical layouts from alternative machine builders as well as the maintained state of the machine.

1.4 Build Costs

Comparing both air rings option 2 is approx 15% less costlyr to manufacture than option 1.

1.5 Operating Costs

Option 1
Efficiency losses of approx 1% (0.25kW for a 400 mm die size) of the entire cooling air and 0.25kW of electrical power (required for electronics and valve actuation). Total running cost at 95% blower load is approx 0.5 KW this equates to **€ 440 ($572) operating costs of 8.00 hrs per year.**

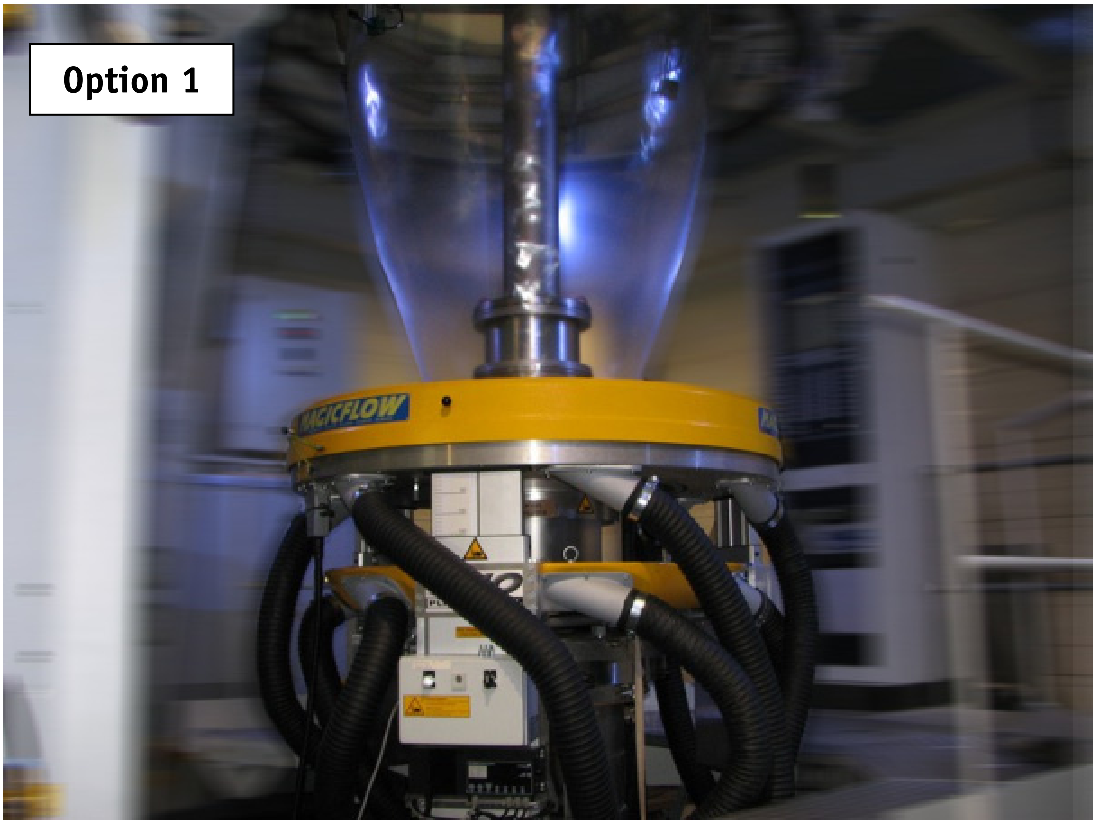
Option 2
Operating at the equivalent output and profile tolerance option 2 requires approx 5% more blower capacity **(25 kW x 0,05= 1,25kW)** as well as electrical energy to power the heating elements (64 x 0.6 KW at 40% load= 15,35 kW at a cost of 0.11€ ($0.15)/KWH). **Total running are in the range of €14,000 – €15,000 ($18,200 - $19,500) per year – 20 to 25 times higher than Option 1.**

1.6 Environmental data

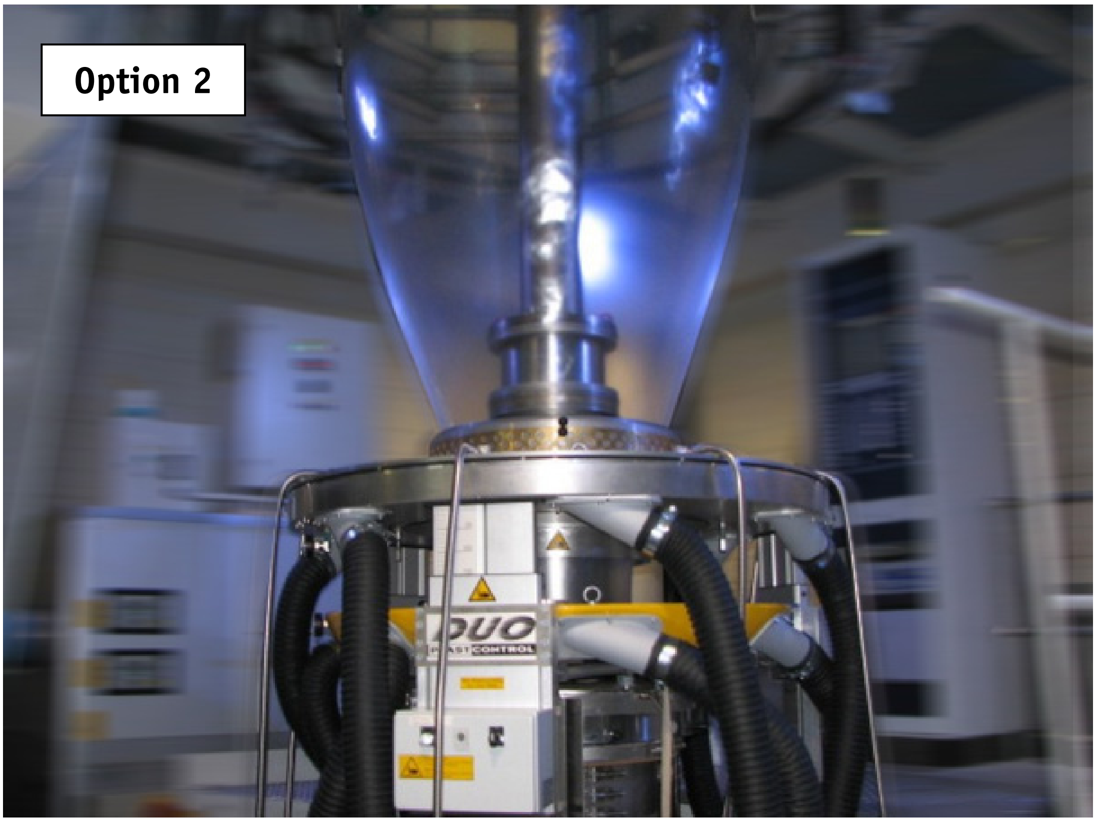
This huge difference in operational costs is not just monetary, option 2 emits approx 72,5 Tonnes of CO_2 per year. These figures may well equate to higher taxation charges levied against production costs for film producers.

To compare 72,5 Tonnes of CO_2 = the output from 60 average sized cars per year or the equivalent of 36 average households.

These hidden costs have drastic affects on profitability.



Double stack air ring DUO option 1 with 48 step motor actuators for profile control



Double stack air ring DUO option 2 with 64 Thermocouples for profile control