

GREEN FOAM, GREATER PROFIT

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Thin-sheet PE process from Alemo cuts carbon emissions, energy use and materials cost

Rising raw material prices, increasing energy costs, pressure for recyclable packaging and insulation materials, and regulations to reuse plastics and promote circularity are important trends pushing foam producers to change or upgrade technology to keep up with an ever more challenging business environment. Market benefits that arise from the development of enhanced technology are more important than ever.

Alemo, a manufacturer of foam production, extrusion and converting machinery and equipment in Slovenia, has

developed a process using its extruders, winders and special equipment like variable mandrels and hydraulic die regulators to extrude foam sheet of low-density polyethylene that is lightweight, non-abrasive, chemically inert and water resistant. The non-crosslinked material is intended to be made with post-industrial and post-consumer recyclate (PCR) and is itself 100 percent recyclable.

Extruded PE (EPE) foam sheet made with the process can be produced in 95- to 120-inch widths at a thickness of 0.02 inches (0.5 mm) with less than 5 percent deviation—one half the thickness of conventional EPE foam sheets. The density of the EPE foam is 0.26 pounds/square foot (11 grams/square meter). The 50 percent reduction in thickness is achieved without tradeoffs in the properties or performance

possible with conventional 0.04-inch-thick PE foam sheet.

The characteristics of EPE foam are familiar to the packaging, insulation and construction industries. The new non-crosslinked EPE foam, which a European customer using the process supplies under the “Zeropointfive” brand, can be substituted for crosslinked PE foam which, because it is not easily recyclable, generates a greater carbon footprint than non-crosslinked EPE and thus does not meet circular economy requirements.

The use of recycled materials for EPE foam processing is a big challenge, as EPE is demanding enough to foam with virgin material. The issue is not just recycling up to 100 percent of the scrap EPE foam collected in-house or by foam converting companies, but to introduce the use of PCR material, which has higher levels of contaminants that need to be filtered out



Image shows an Alemo EPE foam line configured to make 0.02-inch-thick sheet in roll widths of 95 to 120 inches—50 percent thinner than conventional EPE foam sheet. Courtesy of Alemo

for good foaming results. In Europe, only around one-third of collected plastics is recycled into new products¹. To cope with this challenge, an improved mixing and continuous melt filtration technology has to be applied to guarantee stable and reliable foam extrusion. Achieving higher rates of contamination removal and maintaining melt flow index rates at acceptable levels require an enhanced mixing screw design and better filtration process without losing cost-effectiveness, productivity, quality and product safety.

Let's look at three examples of how Alemo's technology can significantly improve production efficiency and lower carbon emissions in the production of non-crosslinked EPE foam. The data have been made available for comparison purposes from the European EPE foam producer noted above that prefers to remain anonymous.²

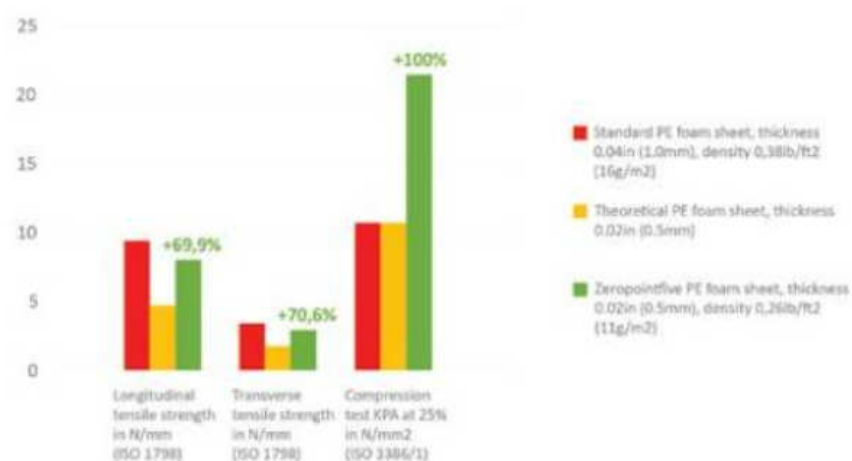
Cutting Carbon by Half

Carbon footprint measures the total greenhouse gas emissions that are directly or indirectly associated with a product, organization or service. The standard specifies principles, requirements and guidelines for quantifying and communicating the carbon footprint of products in compliance with international standards for the evaluation of a product's life cycle.

Now let's have a look at the Zeropointfive product. This is an innovative EPE foam sheet produced with Alemo's advanced extrusion technology. The EPE sheet was developed to redefine market standards by creating a benchmark in performance and carbon footprint. The process can produce sheet with half the thickness of conventional EPE foam while maintaining properties and performance. As a result, it can reduce the environmental impact of an EPE foam product by 50 percent, generate fewer greenhouse gas emissions in road transport as a result of lower product weight, significantly reduce the use of raw material and eventually incorporate up to 100 percent post-industrial recyclate. Alemo extruders can now successfully extrude foam sheet with 15 percent PCR. The company is working on increasing that amount.

The standard EPE foam sheet thickness in Europe (for protective packaging) is 0.04 inch (1 mm). When you divide that in half, you expect just half the performance. But this might not be always the case. See below the laboratory test results supplied by the undisclosed European

EPE foam producer:



Tests show that the Zeropointfive sheet achieves 100 percent better compression compared with the same thickness in conventional EPE foam sheet. At the same time Zeropointfive is 69.9 percent better in longitudinal tensile strength and 70.6 percent better in transverse tensile strength compared with PE foam sheet of the same thickness that is extruded by conventional technology (and described in the graph as "theoretical").

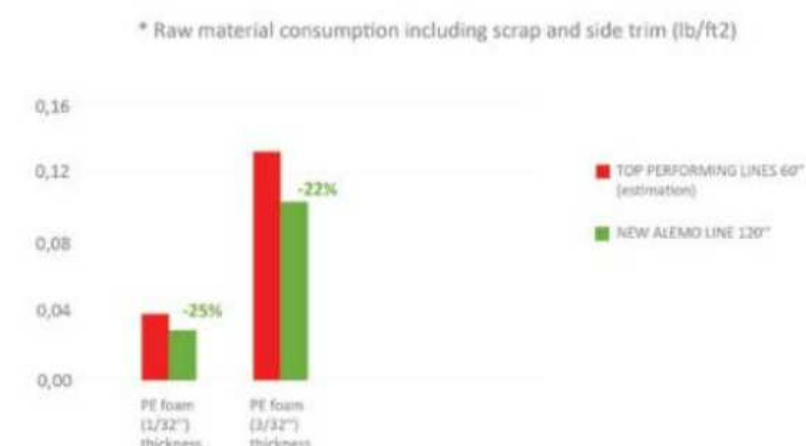
The undisclosed customer's Zeropointfive EPE sheet is the latest product development in foam packaging produced on Alemo extruders. This

achievement will significantly reduce environmental impact and double the profitability of foam producers—a win-win solution for everybody.

Less Energy and Material

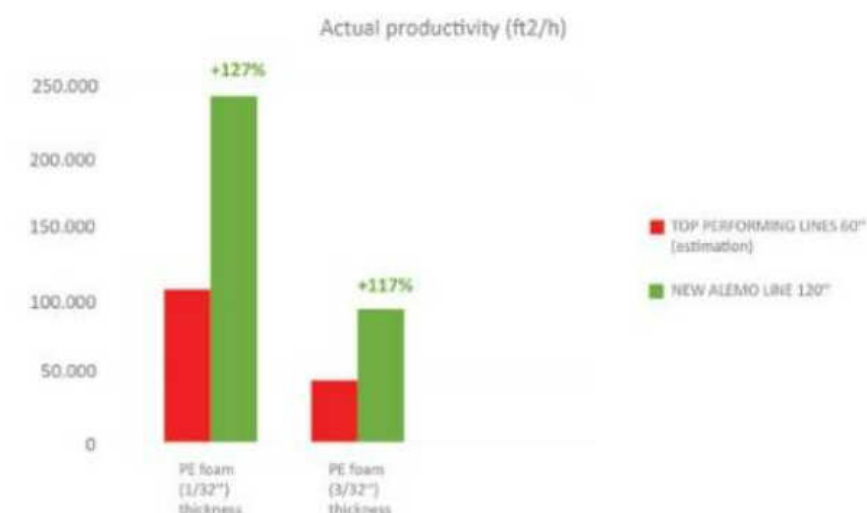
EPE foam production has many areas that need improvement, notably in such areas as lower density, cell size, strength, performance and productivity. Extrusion of thin PE foam on 60- or 72-inch-wide rolls requires one level of technology, but extrusion of foam sheet on 120-inch rolls at 0.02- to 0.04-inch thicknesses means maintaining less than 5 percent deviation in thickness and density, and thus requires a completely different level of technology. Productivity can be more than doubled due to improvements in die design, expanding mandrels and winding technology. Such technology is proven and available with Alemo foam machinery. Slitting changes to achieve different roll widths, for example, can be made on-line without stopping production with Alemo technology.

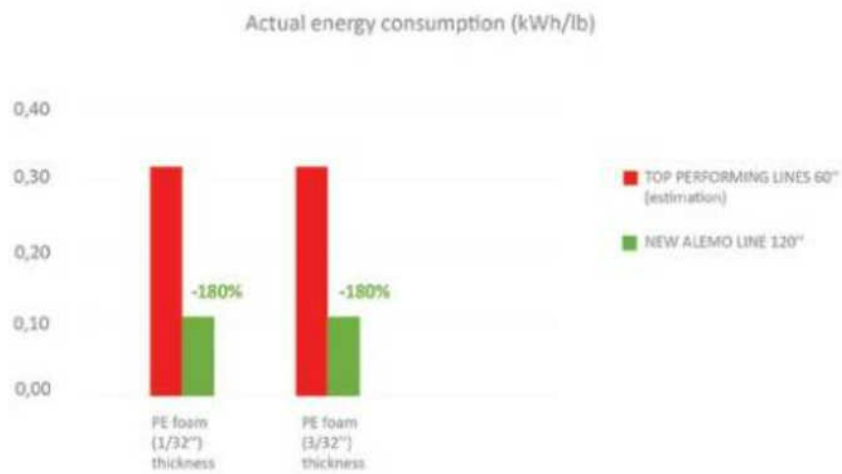
The following is a comparison of raw material and energy consumption between a high-performance extrusion line producing foam at 60-inch widths and an Alemo technology line that produces EPE thin foam sheet at a 120-inch width. The subject of this comparison is the quantity of raw material and energy consumption needed to produce one unit of product. The red column data were collected as an estimate and the green column data measured directly and taken from production reports.



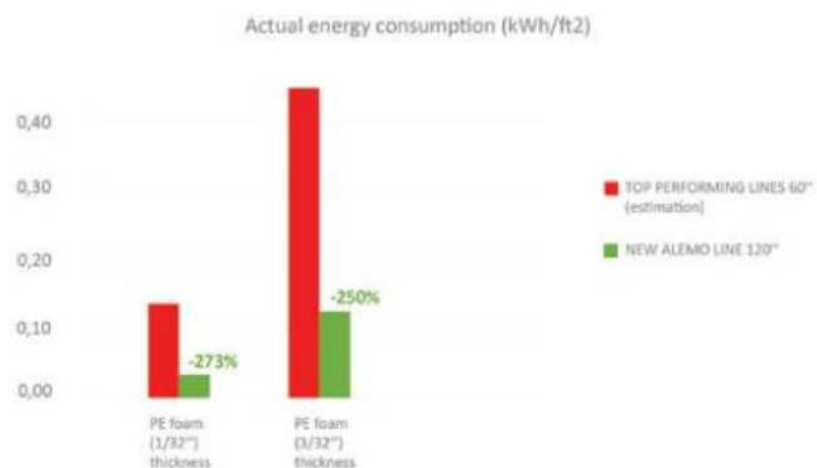
The main source of raw material reduction, which is not included in the graph, is in scrap required for die change starts and stops. With 95- to 120-inch widths regulated by an expandable mandrel, all widths required by the market can be produced without any line starts and stops and die changes but with only a slitting change.

The raw material consumption for producing 1 square foot of EPE foam of 1/32-inch thickness on the new Alemo line is 25 percent lower compared with conventional high-performing lines worldwide. As the graph data note, the raw material consumption for producing 1 square foot of EPE foam sheet of 3/32-inch thickness on the line is 22 percent lower compared with top-performing lines around the world.





The actual productivity of 1/32-inch-thick EPE foam in terms of square feet per hour of the Alemo line is 127 percent higher compared with top lines around the world. The actual productivity in terms of square feet per hour (3/32-inch-thick EPE foam) of the line is 117 percent higher compared with top lines around the world.



The energy consumption, measured in kWh, for producing one pound of EPE foam of 1/32-inch thickness on the line is 180 percent lower compared with top lines around the world. The energy consumption for producing one pound of 3/32-inch-thick EPE sheet is 180 percent lower than with top lines around the world.

The energy consumption for producing one square foot of EPE foam of 1/32-inch thickness on the Alemo line is 273 percent lower compared with top-performing lines around the world. The energy consumption for producing one square foot of EPE foam sheet of 3/32-inch thickness on the Alemo line is 250 percent lower compared with top lines around the world.

From the above graphs we may understand more clearly about the volume of raw material, lower carbon footprint and cost savings that could be achievable due to technology improvements. For example: How much carbon footprint could be reduced worldwide if already available new technologies could be applied to all PE foam producing factories? If we estimate that an average factory produces about 1.1 million pounds (about 500 metric tons) of EPE thin foam per year and requiring 350,000 kWh of power, this represents 297,500 pounds (around 133 metric tons) of CO₂ based on 0.85 pounds of CO₂ emissions per kWh (<https://www.eia.gov/tools/faqs/faq.php?id=74&t=11>). By using the Alemo technology, we believe the carbon footprint of each factory could be reduced to just 106,250 pounds (47.5 metric tons) of CO₂ per year, while producing the same amount of product.

<https://7998076a.flowpaper.com/SPEPEMagazineMay22/#page=26>

article in SPE Magazine PLASTICS ENGINEERING about how to reduce raw material, energy consumption and carbon footprint in EPE foam production

Road to Circularity

As mentioned in the beginning, it is challenging for foam manufacturing to reduce its carbon footprint and meet new environmental standards. Quality and stable foam production are already demanding activities when using virgin raw materials, and the reuse of recycled plastics represents a challenge.

The new goal is not only to have technology that can reuse 100 percent post-industrial recycled foam in new products but being able to reuse PCR material from households or commercial waste, most of which is found in packaging.

PCR, as noted, has higher levels of contaminants that need to be filtered out for good foaming results. To meet this need, an improved mixing and continuous melt filtration technology is necessary to guarantee a stable and reliable foam extrusion process. Higher rates of contamination removal and keeping melt flow index rates at stable levels require an enhanced mixing screw design and improved filtration process without losing the economy, productivity, quality and product safety of the process.

Alemo has been involved in these challenges for more than a year and achieved promising results with foams produced on our extruders with up to 15 percent PCR content.

Even better results are expected with new grades blended with PCR and virgin resin to create compounds with PCR levels of up to 30 percent, which have recently been launched by some polymer suppliers. These more stabilized compounds have better processability and may increase the percentage of PCR content incorporated in an application and expand their range. According to an internal life-cycle analysis study³ by resin producer Sabic, these compounds offer potentially significant reductions in carbon footprint of up to 25 percent and in energy consumption of up to 30 percent compared with virgin material alone.

Conclusion

Foam manufacturers compete in an environment with increasing raw material prices, rising energy costs and ever more demanding environmental regulations. This ongoing pressure on companies to reduce their carbon footprint is driving technology development. Better technology is the only solution to reach environmental standards and reduce production costs.

In the future, it will not be enough to reuse only some percentage of in-house recycled foam. The foam industry will need to move to a circular business model, retaining its value through recycling and reusing materials with benefits that come at no cost to the planet.

This article was reviewed and edited by Plastics Engineering. For more information, contact Egon Lesizza, Alemo d.o.o., Mednarodni prehod 6, 5290 Šempeter pri Gorici, Slovenia-EU. Tel: + 386 5 39 32 485; email: info@alemo.eu; web site: alemo.eu

¹ <https://www.euronews.com/green/2019/12/12/europe-has-a-plastic-problem-only-30-of-plastic-waste-is-recycled>

² Specific data are available from Alemo.

³ <https://www.sabic.com/en/news/24779-sabic-expands-post-consumer-recycled-engineering-thermoplastics-portfolio>

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