

WHITE PAPER

REDUCING EDGE WEAVE AND IMPROVING NECK-IN PERFORMANCE IN EXTRUSION COATING

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Find out what causes edge weave and neck-in and how they can be minimised in the extrusion coating process
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Edge weave describes the variations that can occur in the width and thickness of the edge of the polymer web as it leaves the die, resulting in an uneven coating on the end product. Such fluctuations may be compensated for by over-coating which comes at a cost to the manufacturer. Neck-in is the reduction in the width of the molten polymer web as it leaves the die, reducing the amount of substrate that can be covered with the coating. Neck-in is a dynamic deformation and significant changes (such as adjusting the position of the die) may be required to improve the neck-in performance however these changes can often lead to other issues.

POLYETHYLENE CAN BE APPLIED AS A COATING TO A SUBSTRATE SUCH AS PAPER TO MAKE IT MORE DURABLE, WATERPROOF, FOOD-SAFE AND HEAT-SEALABLE, CREATING PACKAGING OPTIONS THAT IMPROVE PRODUCT PRESENTATION AND INCREASE SHELF-LIFE. AWARENESS OF SOME OF THE CHALLENGES THAT CAN ARISE WHEN COATING A MATERIAL WITH POLYETHYLENE WILL ASSIST IN MINIMISING ANY WASTAGE THAT MAY OCCUR IN THE PROCESS.

Extrusion coating is one of the most commonly used processes for coating a range of materials with polyethylene (PE). It involves applying a thin, molten web of extruded polymer at high speed (hundreds of meters/minute) onto the substrate which is then passed through a nip-roll assembly to cool and consolidate the structure into one laminated product.

The high speed coupled with having to manage the material being in a molten state makes it difficult to maintain dimensional stability.

Edge weave and neck-in are two common issues that can impact the quality of the coated substrate and have the potential to contribute to significant levels of product waste.

WHAT IS EDGE WEAVE?

Edge weave refers to the variations in the coating width and thickness of the edge of the polymer web as it leaves the die. The magnitude of this change is significantly smaller than the area being coated. These cyclical variations in the thickness and width (typically < 20 mm) of the polymer web edge result in an uneven coating on the end product and can leave areas of the substrate uncoated. This can result in unsellable rolls of product that need to be discarded. Therefore to compensate for edge weave the substrate needs to be over-coated which is an added material cost and a secondary trimming operation is required before downstream processing can occur. The trim from over-coating cannot be re-feed into the extrusion coating machine as it contains various materials (such as paper) and therefore must go to waste. Not only do such inconsistencies result in wastage of materials and significant expense, they may also increase the amount of work that needs to be done post-production in order to create a commercially viable product.

Edge weave is mainly a function of the melt strength of the material. Melt strength refers to the ability of the molten material to absorb the demands of the high speed process by enabling the molten product to better resist distortion.



MINIMISING EDGE WEAVE AND NECK-IN IS A CRUCIAL CONSIDERATION FOR ANY EXTRUSION COATING OPERATION

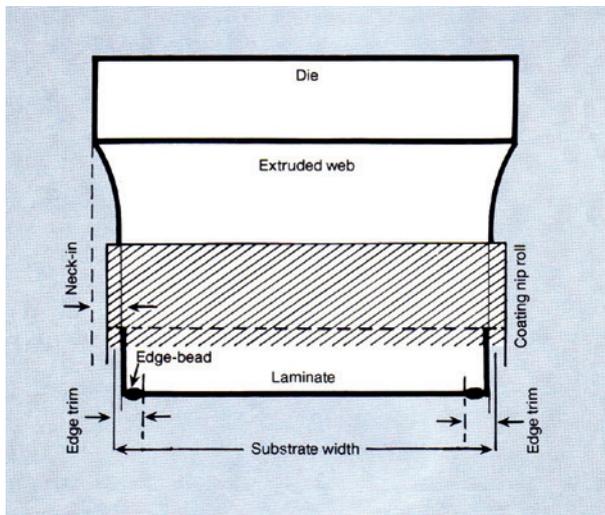
REDUCING EDGE WEAVE

There are a number of potential solutions to overcome edge weave issues.

- Reducing the draw ratio¹ by either decreasing the gap between the die and the substrate (die gap), which can affect the adhesion performance and/or increasing the coating weight, which will result in additional cost
- Reducing the melt temperature of the polymer may also improve edge weave, however it can significantly affect other factors such as adhesion to the substrate
- Using a higher melt strength polymer can significantly reduce the extent of edge weave – contact your resin supplier for further assistance and advice

WHAT IS NECK-IN?

Neck-in is the reduction in the width of the molten polymer web as it leaves the die and before it is applied to the substrate which is being coated. It is measured as half the difference between the width of the coating at the nip and the width of the die, as indicated in the figure below. Edge weave and neck-in performance are related properties although changes in neck-in performance are potentially more significant (up to 50 mm) and affect processing as well as the final product.



Neck-in can arise as a result of surface tension as the polymer leaves the die, as well as due to melt elasticity effects that occur during the process. The problem with neck-in is that it significantly reduces the amount of substrate that can be covered with the coating. Any reduction in width as the polymer leaves the die will leave areas of the substrate without a coating. The area that isn't covered is unusable and will need to be discarded, leading to a significant amount of waste.

1. Ratio of the thickness of the die opening to the final thickness of the product

There are a number of potential root causes for this problem, most of which can also cause edge weave. These include high melt temperatures, high draw ratio and the melt strength of the polymer being inadequate for the draw down speed of the process. It should be noted that some of these changes (including adjusting the position of the die) may create other issues in the extrusion coating process.

IMPROVING NECK-IN PERFORMANCE

There are a range of different ways to improve the neck-in performance, with many of these also used to solve edge weave.

- Reducing the draw ratio by increasing the coating weight, which will result in additional material costs or decreasing the air gap (distance between the die and the nip to chill roll contact point), which may impact on adhesion to the substrate
- Reducing the melt temperature however it is recommended to conduct additional testing to ensure that adhesion to the substrate is still adequate
- Trial a polymer with an increased melt strength to improve neck-in performance – once again contact your resin supplier for further assistance and advice
- Adjust the line speed to cope with the neck-in performance

For further information please refer to the Qenos Technical guide for extrusion coating and lamination (Book 4) including the troubleshooting guide.

EXTRUSION COATING: A FINE BALANCING ACT

It is clear to see that with the right materials, set-up and processing conditions, manufacturers can certainly improve edge weave and neck-in performance. However, expert guidance is strongly recommended as this usually involves compromises, and it can be a challenge striking the right balance between performance aspects.

For example, increasing the melt temperature can improve adhesion to the substrate, however, increasing the melt temperature too much may impact on the odour of the material, sometimes even causing smoking or surging in the extruder.

Extrusion coating is a balancing act. It involves the careful management of parameters and variables to get a great result and avoid unnecessary post-production work and minimise waste. Beginning with a high-quality resin is an important first step in getting this balancing act right.



IN SOME CASES, CUSTOMERS HAVE SEEN A 50% IMPROVEMENT IN THE EDGE WEAVE AND NECK-IN PERFORMANCE IN CONJUNCTION WITH AN IMPROVEMENT IN THE LINE SPEED

CHOOSING THE RIGHT EXTRUSION COATING RESIN

Low Density Polyethylene (LDPE) is ideally suited to the extrusion coating process and delivers exceptional moisture barrier properties, tear, scuff and puncture resistance and resistance to grease, oil and chemicals. LDPE also provides excellent adhesion between multiple substrates and high aesthetic qualities.

Alkathene® LDPE is commonly used in extrusion coating to produce a range of packaging from aseptic to flexible and paperboard applications. Alkathene® LDPE has been engineered to include long-chain molecular branching to provide high melt strength that makes it an ideal resin for extrusion coating purposes. By tailoring its Alkathene® LDPE resin Qenos has produced extrusion coating grades that offer substantial performance advantages.

Exceptional neck-in performance: The high melt strength of the polymer, with its unique melt properties and processibility, enables it to achieve a lower propensity for neck-in.

Good drawdown: This essentially means that the polymer can coat evenly including to low coating weights without breaking

Excellent organoleptic properties: Alkathene® LDPE extrusion coating resin is additive-free making it an ideal packaging material for foodstuffs. If optimal processing temperatures are applied then problems such as odour and taint from excessive oxidation should not arise.

Outstanding heat seal characteristics: The strength of the seal while still hot is important particularly with high speed automatic filling and packaging machines, where the product is introduced into the package almost immediately after the seal has been formed.

Higher melt strength: This gives the polymer far greater edge weave control and improved neck-in performance.

Reduction in material waste: Limited edge weave reduces the need to over-coat the substrate, meaning far less material is going to waste.

Production efficiency: Predictable processing requires less adjustment, faster line speeds may be obtained and less post-operational finishing is required.

HOW THE RESIN SUPPLIER CAN HELP

The Qenos technical service team has assisted many customers in overcoming issues related to edge weave and neck-in on their extrusion coating equipment. In some cases, customers have seen a 50% improvement in the edge weave and neck-in performance in conjunction with an improvement in the line speed.

At its Technical Centre in Melbourne, Qenos has an extensive range of physical, analytical and processing equipment to allow the process simulation of key segments in the Australian PE market. This local support, in conjunction with Qenos' highly experienced technical service specialists, is utilised to directly assist application development and troubleshooting for customers.

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