Paratube Extrusion: Achieving Consistency with a Unique Process

Background

Paratubes are two single-lumen tubes that are joined longitudinally during extrusion. Typically used for fluid conveyance, paratubes are manufactured in varying durometers for a range of specific applications. The conjoined tubes are easier to position and handle during medical equipment assembly and can improve handling and identification in more direct patient care applications.

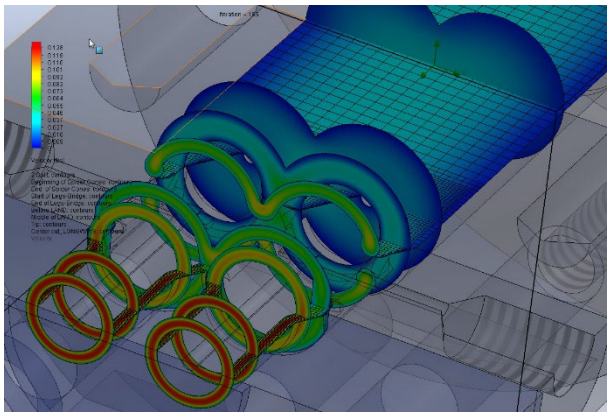
Teel developed a custom paratube extrusion process for a medical customer that relies on precise dual die design and a unique in-line joining system. The process was developed for the customer's flexible PVC product but can also be used with other paratube materials.

Paratubes present several extrusion challenges. Controlling the dimensions of both single lumens in one process and ensuring they maintain center to center alignment is critical. Another critical element is creating a precise peel force (the force required to separate the conjoined tubes) by marrying the tubes at a specific level of adhesion during production. To accommodate their assembly equipment and ensure there were no jagged edges on the tubes when separated, Teel's customer requested a tight peel strength tolerance of +/- 2 pounds of force.

Teel Paratubes

Using Melt Flow Analysis to Create a Single Die

While most processors use two separate extruders to produce each tube, Teel used melt flow analysis to create a dual die head that requires only one extruder to produce both tubes, helping to consistently meet our customer's dimensional and peel strength requirements. Teel's melt flow analysis saved considerable time in development by accurately modeling the dimensions of a die to achieve consistent melt velocity for each tube and eliminate dead spots.



An image from Teel's paratube melt flow analysis modeling software showing melt velocity distribution points.

Producing the paratubes through a single die and extruder offers several advantages. First, the melt temperature for both tubes is consistent, which not only helps control the dimensional consistency of each tube but is also important for creating consistent adhesion at the marriage point. Second, as the tubes leave the die head, they are stretched at the same

rate, maintaining a consistent drawdown for further dimensional consistency. The need for operator adjustment and control of the process is also minimized, helping to prevent errors.

Developing a Unique Joining System

Downstream from the die head, Teel uses a non-contact lumen management system to control peel force as the tubes are joined. As they exit the die, the tubes are “frosted” by passing through a controlled flow air curtain before entering a custom-designed cooling and sizing system that accurately controls the joining force, resulting in the final peel strength of the product. This joining system allows for a wider processing window that can achieve the narrow peel force value required and results in a marriage point of only an eighth of an inch.

Conclusion

As paratube applications range from respiratory therapy, blood transfer technologies, and endoscopic applications, the extrusion system developed for this customer may not suit all needs and end-uses. However, Teel’s process is a new alternative that demonstrates the value of customer engagement and a willingness to use tools and concepts outside the norm to design the right system for a customer’s needs.