Overflow Tabs Improve Weld Line Strength in Reinforced Plastic Components

KetaSpire® PEEK and AvaSpire® PAEK

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In an injection molded structural plastic part, a weld line (also called a knit line) will result in a region of mechanical weakness as soon as the part is submitted to an external load.

The quality of the weld line can be improved through optimized processing conditions, increased mold and melt temperatures, and increased injection speed to reduce the viscosity of the polymer. This leads to a better molecular chain entanglement, which in turn creates a better weld. Proper venting is also required to ensure good weld-line quality.

When the polymer is reinforced with mineral fillers and most notably with fibers, the drop in mechanical properties is dramatic. This is due to an unfavorable orientation of the fillers at the weld line with respect to the load direction, as illustrated in Figure 1.

Materials Evaluated

In order to quantify the improvement, a test specimen mold was modified and then used to mold test samples using Solvay's KetaSpire® PEEK (polyetheretherketone) and AvaSpire® PAEK (polyaryletherketone).

This document reports the results of this study and shows how much weld line strength improved when this technology was applied to these high-performance semi-crystalline polymers.

Test Samples

Three different types of test samples with a 4-mm thickness were molded using a Fanuc electrical injection molding machine (Figure 2). The overflow tab added to the third sample type was designed and positioned slightly off center from the weld line so the end of the flow occurred in the flow tab. This is necessary in order to get an underflow in the molten layer so that the fiber orientation at the weld is disturbed (Figure 3).

Figure 1: Fiber orientation and distribution in 2-gate sample

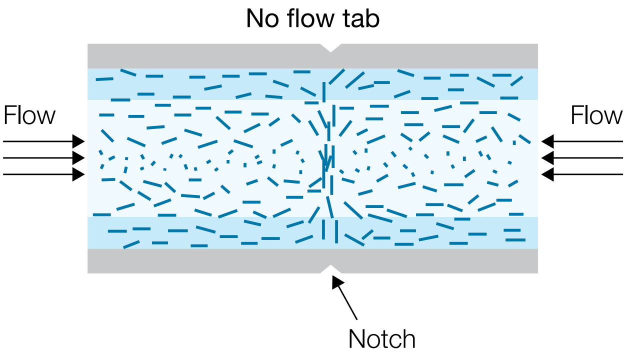


Figure 2: Different types of molded test samples

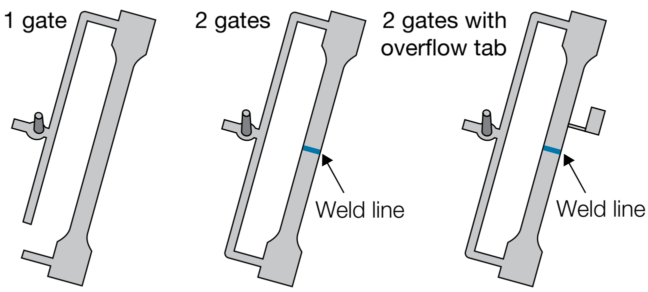
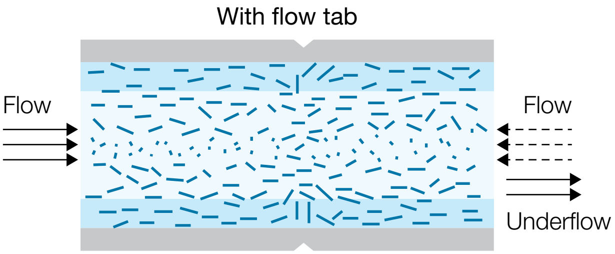


Figure 3: Overflow tab changes fiber orientation and distribution



The overflow tab design was optimized with the Autodesk Simulation Moldflow Insight software. Fiber orientation distribution as well as the thickness of the frozen layer were considered in the design. Test samples showing material flow are shown in Figure 4.

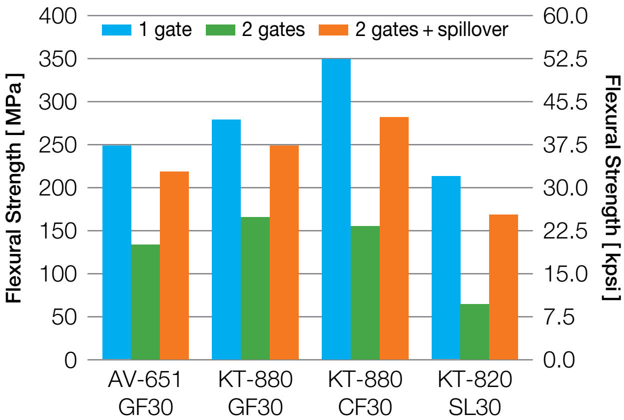
Figure 4: Overflow tab optimizes material flow

2-gate with overflow tab
Overflow tab offset from center of weld line can significantly increase the quality and strength of the weld line.

2-gate with overflow tab
This short shot confirms that the end of the of the flow occurs in the overflow tab.

2-gate without overflow tab
This short shot shows the weld line location.

Figure 5: Flexural strength with and without an overflow tab[1]



(1) *Tensile test specimen (4 mm)*

Measuring Effectiveness

The materials used for the test samples were as follows:

- AvaSpire® AV-651 GF30
  (PAEK, 30 % glass fiber)
- KetaSpire® KT-880 GF30
  (PEEK, 30 % glass fiber)
- KetaSpire® PEEK KT-880 CF30
  (PEEK, 30 % carbon fiber)
- KetaSpire® PEEK KT-820 SL30
  (PEEK, carbon fiber, graphite, PTFE)

A classic 3-point bending test was used to evaluate the quality of the weld line on five samples of each configuration (ISO 178, 23 °C). Averaged results are reported in Figure 5.

The effectiveness of the overflow tab was assessed by determining the percent increase in flexural strength of 2-gate samples with tab vs. 2-gate samples with no tab.

Strength increased by more than 50 % for all materials and increased 160 % for KetaSpire® KT-820 SL30, a friction and wear grade.

In all cases, the flexural strength of 2-gate samples with tabs was only 15 – 20 % less than 1-gate samples with no weld line.

Conclusion

Test results from this study confirm that the strength of a reinforced polymer with a weld line is typically reduced by about 50 % compared to a reinforced polymer with no weld line. To improve the weld line quality of molded parts, optimize processing conditions and consider using an overflow tab. Keep in mind that the position and design of the overflow tab depends on the part design and must be carefully optimized. For more information on this topic, please contact Solvay Specialty Polymers.

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