Technical Note 845-TN Fusion Appearance of Molded Fittings

Scope

The butt fusion melt pattern of molded fittings and fitting-side fusion bead may display irregularities due to molded part cooling and knit lines. Appearances such as a dimple in the melt bead or melt pattern shown in Figure 1 or melt surface unevenness shown in Figure 2 are artifacts of the molding process and do not represent a defect in the fitting, or an error in the fusion joining procedure. The appearance has no bearing on the quality and performance of the part. This technical note covers the reason for the appearance and the requirements for accepting the fusion bead. The note also documents the test results that show compliance with federal guidelines for joining qualification.

Figure 1 Example of dimple in the melt pattern

Figure 2 Example of melt surface unevenness

Requirements

The ASTM fusion standard, ASTM F2620, 'Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings' and Performance Pipe fusion procedures recognize that the fitting bead may differ from the published bead appearance requirements. The procedures state that the fusion bead is acceptable if the pipe side bead matches the published bead appearance requirements, even if the fitting fusion bead is different. The following is an excerpt from Performance Pipe PP750 'Heat Fusion Procedures and Qualification Guide'.

7. ***Inspect.*** On both sides, the double bead should be rolled over to the surface and be uniformly rounded and consistent in size all around the joint. Butt fusion bead dimensional guidelines can be seen in **Figure 2**.

- **When butt fusing to molded fittings, the fitting-side bead may have an irregular appearance due to the molded part cooling and knit lines. This is acceptable provided the pipe-side bead is correct.**
- **One bead may be larger than the other when fusing two dissimilar materials. This is acceptable provided both bead sizes are uniform around their respective pipes.**
- **It is not necessary for the internal bead to roll over to the inside surface of the pipe.**

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Figure 3 Excerpt from Performance Pipe Heat Fusion Qualification Guidelines

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Reason for the Appearance

Performance Pipe's molded fittings are produced by injection molding. During the injection process, molten resin fills the mold cavity, wrapping around tooling cores, and rejoins together. Pressure is applied to 'pack' the mold. Where the polymer rejoins is termed a 'knit line'. Due to differential cooling during the mold filling process, mold pack variations and the presence of knit lines, it is possible for the memory of the polymer to result in a different fusion melt appearance than that of a pipe where the extrusion process is continuous axially down the length of the pipe. Where a knit line occurs, the fusion bead can show a dimple in the bead appearance.

The presence of melt surface irregularities for molded fittings and amount of the dimple that is visible can vary with changes in resin lots and processing conditions. Tests are conducted during production to ensure that the strength of the fitting body is consistent across the knit line.

Test Results

To confirm that the melt appearance of the fitting does not affect the part performance, a series of tests were conducted. All of the tests passed showing confirmation that the melt bead appearance does not impact the fusion bead performance.

- **Quick Burst**

  The quick burst test assesses the short-term strength of the part. It was performed without a pipe fusion to show the strength of the fitting. The test was also performed fused to a pipe to show that the joint strength is stronger than that of the pipe or fitting.

Test	Standard	Test Result	Requirement	Result
Quick burst - Fitting Only	ASTM D1599 and 49 CFR 192.283	Burst at 760psi in 68 seconds	Minimum Burst of 552psi in 60-70 seconds	Pass
Quick burst – Fitting fused to pipe	ASTM D1599 and 49 CFR 192.283	Burst at 697psi in 67 seconds outside of knit line	Minimum Burst of 552psi in 60-70 seconds	Pass
Quick burst – Fitting with melt appearance shown in Figure 2	ASTM D1599 and 49 CFR 192.283	Burst at 686 psi in 65 seconds	Minimum Burst of 552psi in 60-70 seconds	Pass

- **Crush Test**

  The crush test involved flattening the fitting in a press with the knit line located in the 'ears' of the flattened fitting. The test is a stringent measure of the strength of the knit line.

Test	Standard	Test Result	Requirement	Result
Crush Test	ASTM D3261	No cracking, crazing or separation.	No cracking, crazing or separation when the fitting is pressed flat with the knit line in the outer edge of the squeeze	Pass

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- **Elevated Temperature Sustained Pressure Test**

  The elevated sustained pressure test confirms the long-term pressure capabilities of the fitting and fused fitting assembly. The test accelerates failure through elevated temperature and higher stresses.

Test	Standard	Test Result	Requirement	Result
Elevated Temperature Sustained Pressure Test.	ASTM D2513 and 49 CFR 192.283	No failure after 270 hours at 80 deg C and 670 psi	Exceed 170 hours at 80 deg C and 670 psi	Pass
		No failure after 211 hours at 80 deg C and 670 psi	Exceed 170 hours at 80 deg C and 670 psi	Pass

- **Tensile Test**

  the tensile test assesses the short-term strength as measure by the tensile at yield. It also assesses the ductility of the pipe and fusion joint.

Test	Standard	Test Result	Requirement	Result
Elongation of Tensile at Yield	ASTM D638 and 49 CFR 192.283	Tensile at Yield exceeded 350% and failure occurred adjacent to and outside of the fusion zone.	Must exceed 25% and fail outside of the fusion zone.	Pass

Figure 4 Burst Test

Figure 5 Crush Test

Figure 6 Tensile Test

Conclusion

When fusing molded fittings, the melt and bead appearance on the side of the molded fitting may contain melt surface irregularities including melt surface unevenness and a dimple or inconsistency at the point of the knit line on the fitting. This is recognized by industry standards and is acceptable provided the pipe-side melt and bead is correct. Fusion made with molded fittings showing these appearances have been tested and shown to pass the fusion requirements, including those in 49CFR192.283.

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