Chapter 49

Medium Density Polyethylene

Heated Tool Welding

DuPont: Aldyl (product form: pipe)

Welds made using standard (material manufacturer recommendations) and non-standard (to study the effect of increased plate removal time) conditions could be distinguished in terms of structural and morphological behavior, but not always on the basis of tensile strength. Poor tensile strengths were associated with the lack of a region of deformed spherulites at the weld/ pipe interface, a wide weld, and a reduced amount of flow in the direction of the weld. Welding slightly decreases the crystallinity in the polyethylene welds. Welding reduced the amount of crystalline phase orientation parallel to the pipe axis.

Transmitted light microscopy did not always show morphological changes which were revealed by scanning electron microscopy (SEM) examination of etched samples such as the extent of heat affected zones (HAZ), or by Fourier Transform Infrared Spectroscopy (FTIR) such as annealed regions. The mode of etching (acid and solvent) involved the removal of disordered material between the lamellae and at the spherulitic boundaries.

Table 49.1: Welding details and tensile results for hot plate welded medium density polyethylene pipes.

Weld	Material	Total Heating Time seconds	Plate Temperature °C	Heating and Welding Pressure MPa	Plate Removal Time seconds	Tensile Strength MPa
Weld 1	polyethylene	45	205	0.25	2	15.7
Weld 2	polyethylene	45	205	0.25	20	11.1
Weld 3	polyethylene	45	205	0.25	20	2.3
Parent Material	polyethylene					14.8

Reference: Stevens, S.M., *Structure Evaluation of Polyethylene and Polypropylene Hot Plate Welds,* ANTEC 1994, conference proceedings - Society of Plastics Engineers, 1994.

Electrofusion Welding

MDPE

High-speed tensile tests and Charpy impact tests were conducted on fusion-joined pipe specimens to evaluate the short-term performance of fusion butt joints. Fatigue tests were carried out to evaluate the long-term performance of fusion joints. The changes in impact strength of fusion joints obtained by varying the heating conditions and material combination were discussed. The degree of crystallinity and orientation of fusion zones are different from those of the pipe substrate. As a result, joints subjected to rapid loadings do not seem to be able to undergo significant plastic deformation before fracture. The reduction in impact strength of fusion joints was larger than that of the substrate.

The reduction in impact strength and the strength of fused joints depends on the resin grade. The joint strength of PE having a high molecular weight was greatly reduced. This reduction may be caused by the weak flow of the molten resin at the fusion interface. It was shown that the fusion strength is affected by the heating conditions. For PE resin, with 0.935 g/cc density and 0.21 g/10 min. melt flow rate, impact strength decreased when the heating temperature was below 179°C and/or the heating time was less than 30 seconds, and/or the applied pressure exceeded a certain value.

Reference: Narisawa, I., Nishimura, H., *Short- and Long-Term Properties of Fusion-Jointed Polyethylene,* ANTEC 1993, conference proceedings - Society of Plastics Engineers, 1993.