PLASTICS·PIPE·INSTITUTE™

Guidelines for Establishing the Pressure Rating for Multilayer and Coextruded Plastic Pipes

TN-23/2005

1825 Connecticut Ave. NW, Suite 680, Washington DC 20009 P: 202-462-9607 F: 202-462-9779 www.plasticpipe.org

PLASTICS·PIPE·INSTITUTE™

Foreword

This report was developed and published with the technical help and financial support of the members of the PPI (Plastics Pipe Institute, Inc.). The members have shown their interest in quality products by assisting independent standards-making and user organizations in the development of standards, and also by developing reports on an industry-wide basis to help engineers, code officials, specifying groups, and users.

The purpose of this technical note is to provide guidelines for establishing the pressure rating for multilayer and coextruded plastic pipes.

This report has been prepared by PPI as a service of the industry. The information in this report is offered in good faith and believed to be accurate at the time of its preparation, but is offered without any warranty, expressed or implied, including WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Any reference to or testing of a particular proprietary product should not be construed as an endorsement by PPI, which does not endorse the proprietary products or processes of any manufacturer. The information in this report is offered for consideration by industry members in fulfilling their own compliance responsibilities. PPI assumes no responsibility for compliance with applicable laws and regulations.

PPI intends to revise this report from time to time, in response to comments and suggestions from users of the report. Please send suggestions of improvements to PPI. Information on other publications can be obtained by contacting PPI directly or visiting the web site.

The Plastics Pipe Institute, Inc.
http://www.plasticpipe.org

April 2005

PLASTICS·PIPE·INSTITUTE™

Guidelines for Establishing the Pressure Rating for Multilayer and Coextruded Plastic Pipes

1. Scope

1.1 These guidelines address the pressure rating for multilayer and coextruded plastic pipes. The pressure rating for multilayer pipe is based on testing the pipe to determine its pressure design basis (PDB). In this case all of the pipe wall thickness contributes to the pressure rating. The pressure rating for coextruded pipe is typically based on the hydrostatic design basis (HDB) of the individual material(s). In many cases, only a portion of the wall thickness contributes to the pressure rating. Provisions are also made to determine the PDB for coextruded pipe based on testing the entire pipe.

2. Definitions

2.1 Pressure rating (PR) is the estimated maximum pressure that the medium in the pipe can exert continuously with a high degree of certainty that failure of the pipe will not occur.

2.1.1 PR = 2 (HDB) (design factor)/(DR-1)

DR = Dimension Ratio = Average outside diameter/minimum wall thickness. For coextruded pipe, these dimensions are based on the HDB rated material layer only.

2.1.2 PR = PDB (design factor)

2.2 Hydrostatic Design Basis (HDB) is one of a series of established stress values (specified in Test Method D2837) for a plastic compound obtained by categorizing the long-term hydrostatic strength determined in accordance with ASTM Method D2837.

2.3 Pressure Design Basis (PDB) is one of a series of established pressure values for a plastic piping component (multilayer pipe, fitting, valve, etc.) obtained by categorizing the long-term hydrostatic pressure strength determined in accordance with an industry test method that uses linear regression analysis. Although ASTM D2837 does not use “pressure values”, the PPI Hydrostatic Stress Board uses the principles of ASTM D2837 in plotting log pressure vs. log time to determine a “long-term hydrostatic pressure strength” and the resulting “Pressure Design Basis” for multilayer pipe that is listed in PPI TR-4.

2.4 Multilayer pipe – (In the US and Canada, sometimes multilayer pipe is referred to as composite pipe).

TYPE 1: A pressure rated pipe having more than one layer (bonded together) in which at least 60% of the wall thickness is polymeric material that has an HDB (Hydrostatic Design Basis) or MRS (Minimum Required Strength), from which the pressure rating of the pipe is determined.

DISCUSSION: An example of this is coextruded plastic pipe with an outer layer for barrier or color purposes. If this outer layer has the same HDB as the bulk wall, the entire wall thickness is used for pressure calculations; if not, only the bulk wall that has an HDB/MRS rating is used for pressure calculations.

TYPE 2: A pressure rated pipe having more than one layer (bonded together) where at least 60% of the wall thickness is polymeric material, where the pipe pressure rating is determined by pipe size and pipe wall construction, and this pipe rating is listed by a PDB (Pressure Design Basis) or MRP (Minimum Required Pressure).

DISCUSSION: An example of this is PEX/AL/PEX pipe.

TYPE 3: non-pressure rated pipe comprising more than one layer in which at least 60% of the wall thickness is polymeric material.

NOTE: the different layer(s) of multilayer pipe may provide color, barrier, stiffness or other properties according to the intended application.

2.5 Coextruded plastic pipe is manufactured by extruding two or more plastic material layers through a common pipe extrusion die to become one continuously formed pipe. The extrusions may be contiguous circumferential layers, or contiguous single or multiple longitudinal extrusions into the surface of the primary pipe extrusion (stripes) that do not constitute a complete circumferential layer, or combinations thereof.

2.6 Monolithic coextruded plastic pipe is coextruded plastic pipe manufactured from like materials. Like materials are defined as a class of materials that belong to the same polymer family, e.g. PE/PE, PVC/PVC, and have the same HDB as listed in PPI TR-4, “PPI Listing of Hydrostatic Design Bases (HDB), Pressure Design Bases (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe”.

2.7 Bonded coextruded plastic pipe is coextruded pipe manufactured by extruding two or more structural plastic layers that bond via tie layers. Such bonding or tie layers are non-structural for the purpose of pipe pressure rating. A

structural layer is a continuous, circumferential layer of plastic material having a Hydrostatic Design Basis (HDB) shown in PPI TR-4.

3. Pressure Rating of Pipe Based on Establishing a Pressure Design Basis (PDB)

3.1 Manufacturers may establish a PDB for their multilayer pipe products by testing the full pipe. In this instance the minimum, maximum and average pipe sizes of the multilayer pipe product line shall be tested to the guidelines in PPI TR-3. One of these sizes should include the highest DR. The number of pipe sizes to be tested for establishing the PDB may be reduced to less than three, if it can be demonstrated by test data that pipe size has no significant effect on the PDB. This requires a Special Case hearing by the Hydrostatic Stress Board.

3.2 Manufacturers may also establish a PDB for a coextruded plastic pipe product line. This requires considerable testing, but the advantage is that the entire wall thickness of the pipe contributes to the pressure rating calculation.

4. Pressure Rating of Coextruded Pipe Based on the Material HDB

4.1 When only one of the coextruded materials has an HDB listed in PPI TR-4, the pressure rating of the pipe is based on the dimensions (wall thickness and diameter) of the HDB listed layer only. Use these dimensions to determine the DR in Equation 2.1.1. In this instance the dimensional support of the other layer(s) of coextruded material(s) is not considered. An example of this is pipe with an outer layer for color or barrier purposes.

4.2 When coextruded plastic pipe is made from materials having different HDB's, only one of the HDB listed materials is used for the pressure rating calculation. This coextruded plastic pipe is treated as if the other material does not have an HDB listing, as in 4.1.

4.3 When the coextruded plastic pipe is made from materials having the same HDB (monolithic coextruded plastic pipe), this pipe is considered as a single material pipe for pressure rating purposes. In this case the pressure rating is based on the HDB using the entire wall thickness.

4.4 In the case of co-extruded striped pipe intended for pressure applications, the pipe shall be treated as a monolithic plastic pipe and the pressure shall be based on the HDB of the host pipe using the entire wall thickness, provided the base resin used in the striping is the same material used in the host pipe, or is a compatible base resin that is the same polymer type as the base resin used in the host pipe and is used as a base resin in a formulation that has an equivalent or higher cell

classification (including the HDB) than the material used in the host pipe. The resultant pipe must continue to meet all of the stated performance requirements of the particular pressure pipe specification. (For example ASTM D2513 Black Gas Pipe with a yellow stripe must be tested to demonstrate conformance to the elevated temperature hydrostatic pressure testing as stated in paragraph A3.2.1 {Table A3.1}).The maximum amount of color masterbatch used in the stripe shall not exceed 4% by weight. If one or both of these requirements are not met, refer to 4.1 or 4.2 for proper stress rating determination.

4.5 When coextruded layers of HDB rated materials are separated by a layer of material that is not rated (bonded coextruded plastic pipe), the pressure rating of the individual HDB rated layers is calculated based on their dimensions and HDB. The pressure rating for this coextruded plastic pipe is then the highest pressure rating calculated for an individual layer. Contributions from the other material(s) are not considered. To use the entire wall thickness for the pressure rating of this coextruded pipe, the manufacturer would have to determine the PDB based on testing the full pipe as described in Section 3.

5. Interactions

5.1 Additives and other compounds present in coextruded and multilayer pipe layers can migrate between the layers. This includes a migration from bonding layers into structural layers.

5.2 The manufacturer shall ensure that any migration of these additives and compounds does not affect the HDB or PDB of the structural material layers that are used to determine the HDB or PDB of the coextruded or multilayer pipe.