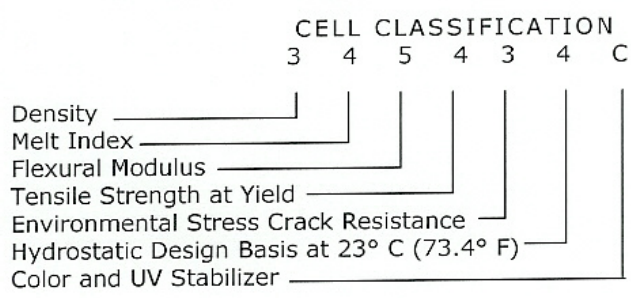
# DISCUSSION OF THE POLYETHYLENE PIPE CELL CLASSIFICATIONS
## (AS PER ASTM D 3350)

All plastic pipes have a Cell Classification that dictates the primary properties of the resin material. Polyethylene plastic pipe compounds are classified according to density, melt index, flexural modulus, tensile strength at yield, environmental stress crack resistance, hydrostatic design basis at 23° C (73.4° F), color and ultraviolet stabilizers.

The order of these various properties does not change, meaning that the density rating is always first, the melt index number is always second, etc. For example, a Cell Classification might be listed as follows:




EXPLANATION OF
CELL CLASSIFICATION VALUES (see Table 1)

3 = 0.0941 to 0.955

4 = <0.15

5 = 110,000 to < 160,000 psi

4 = 3000 to < 3500 psi

3 = Condition C/ 192h; 20% Max Failure

4 = 1600 psi

C = Black with 2% Min Carbon Black

Table 1 of ASTM D 3350 lists the primary properties of the Cell Classification and paragraph 6.2 of D 3350 indicates the color and UV stabilizer codes.

Table 1 Primary Properties - Cell Classification Limits

| Property | Test Method | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| Density, g/cm | D1505 | - | 0.910-0.925 | 0.926-0.940 | 0.941-0.955 | >0.955 | - | - |
| Melt Index | D1236 | - | >1.0 | 1.0 to 0.4 | <0.4 to 0.15 | <0.15 | A | B |
| Flexural modulus, $MP_s$(psi) | D790 | - | <136 (<20000) | 136-<276 (20000 to <40000) | 276-<552 (40000 to <80000) | 552<758 (80000 to <110000) | 758-<1103 (110000 to <160000) | 1103 <160000) |
| Tensile strength at yield, $MP_s$ (psi) | D538 | - | <15 (<2200) | 15-<18 (2200-<2600) | 18-<21 (2600-3000) | 21-<24 (3000-<3500) | 24-<28 (3500-<4000) | >28-(>4000) |
| Environmental Stress Crack resistance:<br>a. Test Condition<br>b. Test Duration, h<br>c. Failure, max % | D1693 | - | <br>A<br>48<br>50 | <br>B<br>24<br>50 | <br>C<br>192<br>20 | - | - | - |
| Hydrostatic design basis, $MP_s$ (psi), (23°C) | D2537 | NPRc | 5.52(800) | 6.89(1000) | 8.62(1250) | 11.03(1600) | - | - |

A. Refer to 10.1.4.1 B. Refer to 10.1.4.2 C. NPR = Not Pressure Rated

| Code Letter | Color and UV Stabilizer |
|---|---|
| A | Natural |
| B | Colored |
| C | Black with 2% min. carbon black |
| D | Natural with UV stabilizer |
| E | Colored with UV stabilizer |

While all cell classification properties are important, particular attention should be given to those properties that directly affect the structural performance of:

- Flexural Modulus
- Tensile Strength at Yield
- Environmental Stress Crack Resistance
- Hydrostatic Design Basis (HDB)

The values presented for flexural modulus and tensile strength at yield are **initial values** only and do not reflect long-term properties. The long-term values are **substantially** reduced.

Plastics, when tested in an unstressed condition (i.e., immersion test), typically perform quite well. However, when stressed, the same material may fail by cracking in a short period of time.

The environmental stress crack resistance test addresses that characteristic. A major manufacturer of high density polyethylene (HDPE) resins states:

> "HDPE exhibits excellent resistance to most chemicals. However, under conditions of applied external or internal stress in the presence of certain liquids, cracks may form in the material, causing it to fail. This phenomenon is called environmental stress cracking (ESC)."
>
> "Although the material may be able to withstand the actions of either the chemical agent or the load separately, the combined forces result in material failure. Typical chemicals which are considered ESC agents include polar liquids such as wetting agents, soap and detergent solutions, some organic acids, and aromatic and halogenated hydrocarbons."[(1)]

The hydrostatic design basis (HDB) test is a most important property evaluation. This test evaluates the long-term properties of the material. Pipe lines typically are designed for a service life of 50 to 100 years and this basic property test is used to determine the long term property values that the design engineer needs to assess anticipated performance.

[(1)] "Fortiflex HDPE General Properties", page 12, Solvay Polymers, Inc. 9/91.