# PE (Polyethylene)

## What is PE (as in HDPE, MDPE, LDPE, LLDPE, etc.) and what are some of its uses?

Polyethylene (PE) is a thermoplastic material belonging to a group of polymers called polyolefins. It is usually categorized by its density as indicated in the abbreviations; HDPE (high density PE), MDPE (medium density PE), LDPE (low density PE), and LLDPE (linear low density PE). Depending on its specific grade and properties, it is used in a wide range of plastic products from milk bottles and plastic bags to high performance **plastic pipes**.

## What is used to make PE or HDPE?

All polyethylene is made from petroleum feedstocks also known as hydrocarbons. Both the feedstocks (and raw materials) and polyethylene are composed of only hydrogen and carbon (hydrocarbon). In North America, the feedstock is typically natural gas.

## What is a polymer?

A polymer, by definition, is a long chain molecule composed of smaller parts called monomers. The derivation of the term is the combination of poly (meaning many) and mer (meaning parts). Monomers are generally very simple molecules which are chemically combined or polymerized many times until it attains the final desired properties as a polymer.

## What is a stabilizer (thermal / ultraviolet)?

Stabilizers are added to polymer resins to enhance and extend their ability to resist natural, and environmental stresses. Antioxidants retard oxidation of the polymer, ultraviolet stabilizers reduce UV or sunlight degradation, and thermal stabilizers improve behavior in high temperature exposure.

## What is TiO2?

TiO2, titanium dioxide is essentially an inert white pigment which whitens and opacifies plastics. Its additional benefit is it acts as a very effective UV “sunscreen”, protecting the pipe.

## What is carbon black?

Carbon black is a black pigment, which can also enhance mechanical properties and act as an excellent UV blocker when properly compounded into a plastic or rubber. Sufficient quantities allow the use of some pipe above ground.

## Are PE pipe and fittings safe for use in potable water systems?

Yes, PE is safe and commonly used in potable water systems when the plastic has received approval to NSF International's standards health effects applications by a third party certifying agency. Examples of such standards are NSF 14 and NSF 61. Polyethylene is also commonly used for food containers (milk bottles, plastic food bags, etc.)

## What is ASTM?

**ASTM** (American Society for Testing & Materials) is an independent, not-for-profit standards writing organization. It promulgates standards in many diverse technical disciplines. ASTM is the forum for a majority of standards in the US, especially those related to plastic materials and products testing. ASTM writes the standards that plastic piping and other products are manufactured to meet. ASTM does not conduct testing, listing, certifying, or enforcement of its standards. This is done by other organizations.

## What is ASTM D 3350?

This is an ASTM Standard which provides a cell classification method for classifying plastics by their properties to help identify products. When classified under D 3350 the plastic material receives an alphanumeric designation, which identifies its mechanical and chemical properties. It is a shorthand method for describing a plastic material.

## What is NSF?

**NSF** (NSF International) is an independent, private, not-for-profit, 3rd party certification, testing, and standards writing organization. NSF International is accredited by ANSI, (the American National Standards Institute), RvA, (the Dutch Raad voor Accreditatie), and SCC, (the Standards Council of Canada) for its testing, standards writing, and certification programs. NSF International also writes consensus standards for product, material, and system assessment. NSF International provides an array of testing services to many different industries and provides the plumbing industry listing services and inspections for items such as pipes, fittings, valves, pumps, water heaters, sinks, showers, toilets, faucets, controllers, filters, materials, and ingredients.

## What is NSF Standard 14?

ANSI/NSF Standard 14, “Plastic Piping System Components and Related Materials”, is a consensus standard promulgated by NSF International. This standard enables comprehensive assessment of plumbing system products, materials, and ingredients for health effects, quality control, quality assurance, marking, material property requirements, long term strength evaluation via PPI TR-3, and short term product performance to various standards such as ASME, ASTM, ASSE, etc.

## What is NSF Standard 61?

ANSI/NSF Standard 61, “Drinking Water System Components-Health Effects”, is a consensus standard promulgated by NSF International. This standard enables in depth assessment of a variety of drinking water system products and materials for health effects. This standard is used to evaluate a product for health effect concerns only.

## What is PPI?

**PPI** (The Plastics Pipe Institute) is a trade organization whose members include plastic manufacturing companies, plastic piping product manufacturing companies, related equipment and chemical suppliers and educators and consultants to the plastic pipe industry. PPI typically deals with design stress, chemical resistance, and buried and municipal piping systems outside the building envelope.

## What is PPI TR3?

Plastic Pipe Institute's Technical Report 3, or PPI TR3, is a standard published by PPI which describes the testing, calculations and theory by which plastic materials are tested to determine their long term strength properties primarily for pressure piping applications. These long-term strength properties (up to 50 years or more) are published, by material, in PPI TR4, which lists this property as an HDB or hydrostatic design basis. These values are then used by engineers in designing plastic piping products for excellent long term service.

## What does PE 4710 mean?

PE 4710 is a new designation for improved high performance PE materials. To understand the new PE 4710 designation and its commercialization, we must first explain the older PE 3408 designation and its use in the design of polyethylene piping. The term PE 3408 is based on the standard thermoplastics pipe material designation code defined in ASTM F 412 and it has been referenced extensively within the North American piping industry since the early 1980's.

The standard thermoplastic pipe material “code” for polyethylene consists of an abbreviation for the type of plastic followed by 4 numbers that describe its key properties. The last two numbers refer to the hydrostatic design stress (HDS) for that material in units of 100 psi with any decimal figures dropped.

| | |
|---|---|
| PE | PE designation refers to polyethylene |
| 3 | Density cell class 3 per D3350, > 0.940 – 0.947 g/cc |
| 4 | SCG cell class 4 per D3350, ESCR, condition C, F20 > 600 hours; or PENT value > 10 hours |
| 08 | 800 psi hydrostatic design stress for water at 73° F1 |

In the chart above the term PE 3408 identifies the piping product as a polyethylene grade PE34 with a density cell class of 3, a “slow crack growth” cell class of 4 (both in accordance with ASTM D3350-04), and an 800 psi maximum hydrostatic design stress at 73°F as recommended by the Plastics Pipe Institute (PPI).

In the mid-1980’s, extensive research further improved on the recognized performance of polyethylene piping materials. The result of this research was the introduction of a new significantly improved polyethylene resin that was designated as PE 100 in

accordance with the ISO standards used outside of North America.

In order to commercialize the high performance PE resins within the North American market, ASTM had to expand its coding system in ASTM D3350-06 to properly represent the improvements made and PPI's Hydrostatic Stress Board (HSB) had to define the high performance criteria in utilizing a new design factor to establish the hydrostatic design stress for water at 73°F. Based upon the actions in ASTM and the PPI-HSB, a new standard thermoplastics pipe material designation code of PE 4710 resulted. The chart below illustrates how this pipe material designation code provides a basis for recognition and identification of the higher performance capability of these new piping products.

| | |
|---|---|
| PE | PE designation refers to polyethylene |
| 4 | Density cell class 4 per D3350-06, >0.947 – 0.955 g/cc |
| 7 | SCG cell class 7 per D3350-06, PENT value > 500 hours |
| 10 | 1000 psi hydrostatic design stress for water at 73° F2 |

1 1600 psi hydrostatic design basis (HDB) X 0.5 design factor (DF) = 800 psi hydrostatic design stress (HDS) for water at 73°F 2 1600 psi hydrostatic design basis (HDB) X 0.63 design factor (DF) = 1000 psi hydrostatic design stress (HDS) for water at 73°F.

## Why are there two markings on the new PE4710 pipe?

ASTM expanded its coding system in ASTM D3350-06 to properly represent the improvements in PE resins to create PE 4710. Pipe producers responded in various ways although most chose to use both the old and new pipe material designation codes on the product where it applies. Some requirements, specifications and regulations reference the older versions of the standard. Pipe meeting these older versions may still carry the PE3408 designation. Most PE pipe will carry dual (PE3408/PE4710) or even triple markings (PE3408/PE4710 - PE100) as long as required by requirements, specifications and regulations.

## What is PE3408/PE3608 marked pipe?

This dual marking is for the older resin materials. This pipe maintains the same characteristics of PE3408 pipe.

## What is PE3408/PE3710 marked pipe?

This dual marking is for a resin material with an improvement over PE3408 in the hydrostatic design stress (HDS) category.

## What is PE-100?

You may also find PE pipe product marked “PE3408/4710-PE100” or “PE4710- PE100”. The “PE100” is the ISO, or European, designation for higher performance PE pipe material.

## Can old PE fittings be used with the new PE4710 pipe?

Yes, they are generally compatible. However, the system design must be based on the ratings of the lowest rated component of the system.

## Can we fuse PE4710 pipe with the other types of PE pipes?

Yes, the new PE4710 pipe can be fused into other PE systems, and the resins are compatible, but the design pressure would have to remain within the ratings of the other PE system.