Typical HDPE raw material and pipe test methods

We hereby want to provide an overview of the most common test methods

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Density

Norms	ASTM D 792, ISO 1183
Test of	Raw Material and final products
Test costs	Low
Test Duration	Short

Scope

Quality control measurement to verify confirmed value given from raw material supplier for incoming raw materials. Density is the mass per unit volume of a material and calculated result based on specific gravity measurement.

Test Procedure

A the specimen is weighted in air then weighted when immersed in distilled water using a sinker and wire to hold specimen completely submerged as required.
For Method B the raw material is warmed up and pressed under load through a hopper and weighted.

Melt Index

Norms	ASTM D 1238, D 3364, ISO 1133
Test of	Raw material
Test costs	Low
Test Duration	Short

Scope

There are two technical terms of same values in use. MFI is Melt Flow Index and MFR is Melt Flow Rate.
Melt Flow Rate measures the rate of extrusion of thermoplastics through an orifice at a prescribed temperature and load. It provides a means of measuring flow a melted material

which can be used to differentiate grades as with polyethylene, or determine the extent of degradation of the plastic as a result of moulding.
Degraded materials would generally flow more as a result of reduced molecular weight, and could exhibit reduced physical properties. Typically, flow rates for a part and the resin it is moulded from are determined, and then a percentage difference can be calculated. Alternatively, comparisons between “good” parts and “bad” parts may be of value.

Procedure
The raw material is warmed up to a prescribed temperature and pressed under specified load through a hopper equipment for measurement.

Tensile Properties

Norms	ASTM D 638, ISO 527 for raw material, ISO 6259-3 for pipes
Test of	Laboratory products, Final products, Welded final products,
Test costs	Low
Test Duration	Short

Scope
Tensile properties are one of the most important aspect of qualifying a compound or plastic resin. The
Tensile tests measure the force required to break a specimen and the extent to which the specimen stretches or elongates to that breaking point. Tensile tests produce a stress strain diagram, which is used to determine tensile modulus. The data is often used to specify a material, to design parts to withstand application force and as quality control check of materials.

Test Procedure
Specimens are punched into special form of bars or strips, gripped in the test equipment and pulled under specified test speed until failure. An extensometer is applied in the test equipment to determine elongation and tensile modulus.

Data

- The following calculations can be made from tensile test results:
- Tensile strength (at yield and at break)
- Tensile modulus
- Strain
- Elongation and percent elongation at break
- Elastic Modulus is the ration of the applied stress to the strain produced in the region of linearly proportional to stress
- The tensile result is a load versus deflection or stress versus strain curve. From this data, a number of properties can be calculated such as tensile modulus and yield strength.

Flexural Properties

Norms	ASTM D 790, ISO 178
Test of	Laboratory Products, Final Products, Welded final products,
Test costs	Low
Test Duration	Short

Scope

Flexural properties are an essential factor in the determination of stiffness resulting from a compression or tensile angle.

The flexural test measures the force required to bend a beam under 3 point loading conditions. The data is often used to select materials for parts that will support loads without flexing. Flexural modulus is used as an indication of a material's stiffness when flexed.

Test Procedure

Specimen is fixed on a support span and load is applied by a loading nose producing three points bending at a specific rate. The test parameters of support span, load speed and maximum deflection depend on the specimen thickness

Data

Flexural strength, flexural strength at specified strain levels, and flexural modulus can be calculated.

Flexural test result is a plot of load versus displacement or stress versus strain. From this data, a number of properties can be calculated such as flexural modulus and yield strength.

Izod Impact

Norms	ASTM D 256, ISO 180
Test of	Laboratory Products, Final Products,
Test costs	Middle
Test Duration	Short

Scope

Notched Izod Impact is a single point test that measures a materials resistance to impact from a swinging pendulum. Izod Impact is defined as the kinetic energy needed to initiate fracture until the specimen is broken.

Izod specimens are notched to prevent deformation of the specimen upon impact. This test can be used as a quick and easy quality control check to determine if a material meets specific impact properties or to compare materials for general toughness.

Izod Impact testing is free to be conducted in room temperature as ell as at reduced temperatures e.g. -20°C or -30°C.

Test Procedure

The specimen is clamped into the pendulum impact test fixture with notched side facing the striking edge. The pendulum is released with increasing forces to strike through the specimen until breakage.

Data

Impact strength is calculated by dividing impact energy in J of(ft-lb) by the thickness of the specimen. The test result is typically the average of 5 specimens.
ISO impact strength is expressed in kJ/m². Impact strength is calculated by dividing the average of 10 specimens. The higher the resulting number, the tougher the material.

Charpy Impact

Norms	ISO 179
Test of	Laboratory Products, Final Products,
Test costs	Middle
Test Duration	Short

Scope

Charpy impact is a single point test that measures a materials resistance to impact from a swinging pendulum. Charpy impact is defined as the kinetic energy needed to initiate fracture until the specimen is broken. The values obtained can be used for quality control or to differentiate general toughness.

Test Procedure

The specimen is mounted horizontally and supported unclamped at both ends. A hammer is released with increasing forces to strike through the specimen until breakage.

Data

Impact energy is expressed in joules. Impact strength is calculated by dividing impact energy in joules by the area under the notch. The higher the resulting number, the tougher the material.

Durometer Hardness (Shore Hardness)

Norms	ASTM D 2240
Test of	Laboratory Products, Final Products,
Test costs	High
Test Duration	Short

Scope

Durometer Hardness is used to determine the relative hardness of soft materials, usually plastic or rubber. The test measures the penetration of a specified indenter into the material under specified conditions of force and time.
The hardness value is often used to identify or specify a particular hardness of elastomers or as a quality control measure on lots of material.

Test Procedure

The specimen is placed on a hard flat surface. The instrument intendor is pressed into the specimen for specified time.

Data

The hardness numbers are derived from a scale. Shore A and Shore D hardness scale are common, with the A scale being used for softer and the D scale being used for harder materials.

Friction Coefficient

Norms	ASTM D 1894
Test of	Laboratory Products, Final Products,
Test costs	High
Test Duration	Short

Scope

The test is used to determine the kinetic (moving) and static (starting) resistance of one surface being dragged across another.

Test Procedure

A specimen is attached to a sled of specified weight. The sled is pulled across a second surface at specified speed. The force to get the sled started (static) and to maintain motion (kinetic) is measured.

Data

Both static and kinetic coefficient of friction can be calculated. The static coefficient of friction is equal to the initial force scale reading divided by the sled weight. The kinetic coefficient of friction is equal to the average force reading obtained during uniform sliding of the surfaces divided by the sled weight. All measurements are in grams.

OIT – Oxidation Induction Time

Norms	ASTM D 3895 ISO 10837
Test of	Raw Materials, Laboratory Products, Final Products,
Test costs	High
Test Duration	Short

Scope

Valuable characterization test for assessing long term stabilities of polyolefin materials.

Test Procedure

Differential scanning colormetry (DSC) Equipment measuring heat flow into and out of the heated specimen provide test results to be evaluated.

Data

- Melting points
- Percent crystallinities
- Crystallization time and temperatures
- Thermo-oxidative stabilities
- Effectiveness of anti-oxidantant agents

FNCT – Full Notch Creep Test

Norms	None
Test of	Pressure Pipes of PE 100 material (mainly natural gas pipes)
Test costs	High
Test Duration	Middle

Scope

Determination of high impact resistance of PE 100 pressure pipes (mainly natural gas transportation pipes) to slow crack propagation to evaluate the long term performance within a short test period.

Test Procedure

A squared section bar of the pipe wall with coplanar notches is immersed in water or detergent solution at elevated temperature under constant load until ductile failure.

Data

The result in hours (usually 100-1000 hrs) is evaluated for the final expected performance.

Internal Pressure Resistance Test

Norms	ISO 1167
Test of	Pressure Pipes
Test costs	Middle
Test Duration	Long

Scope

Determination of high pressure resistance of pipes to creep stress on the time under stress.

Test Procedure

A closed pipe length is filled with water under specified pressure for the test duration in a temperature controlled heated water bath. Specimen without time failure is visually checked on surface brittles for good results.

Tightness Test

Norms	Several national association standards
Test of	Pressure Pipes
Test costs	Middle
Test Duration	Short

Scope

Determination of pressure tightness of welded pipe systems by water or air.

Test Procedure

A closed pipe system is filled with water or air to specified internal pressure and time with limited allowed pressure loss within this time. The result is shown on a diagram.