

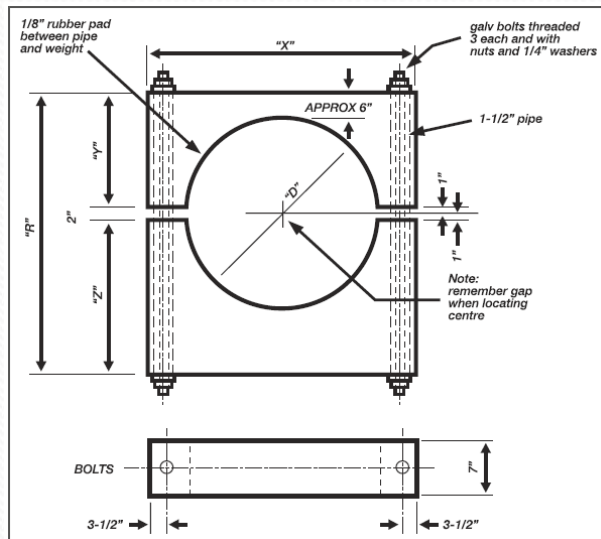
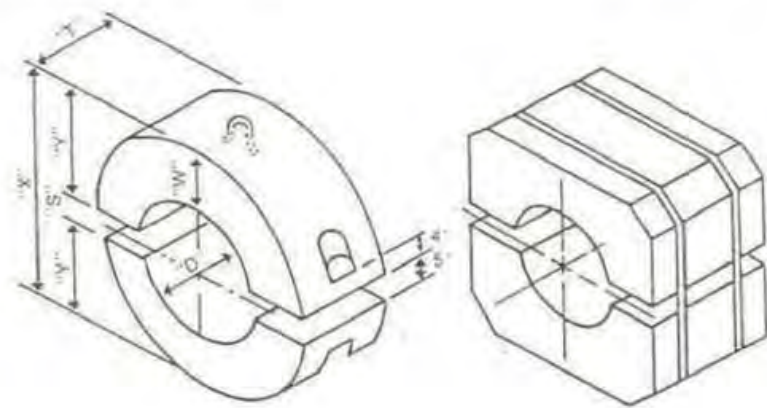
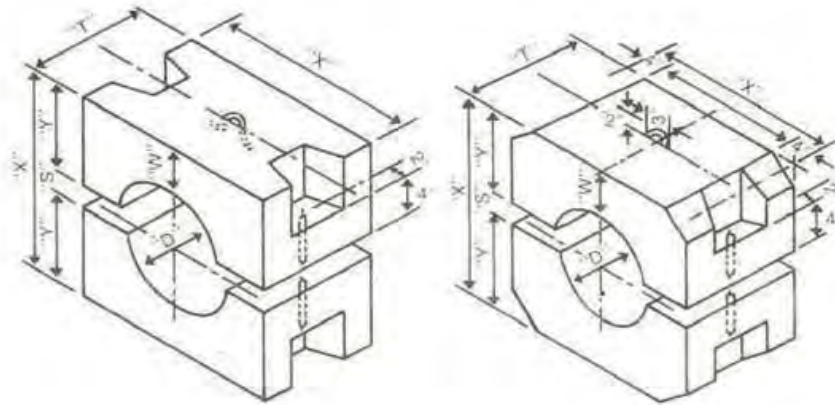
Submarine applications HDPE Pipeline

Concrete weight



Concrete weight and shape have to be designed for suitable with current and laying condition.

Schematics of Concrete Ballast Designs



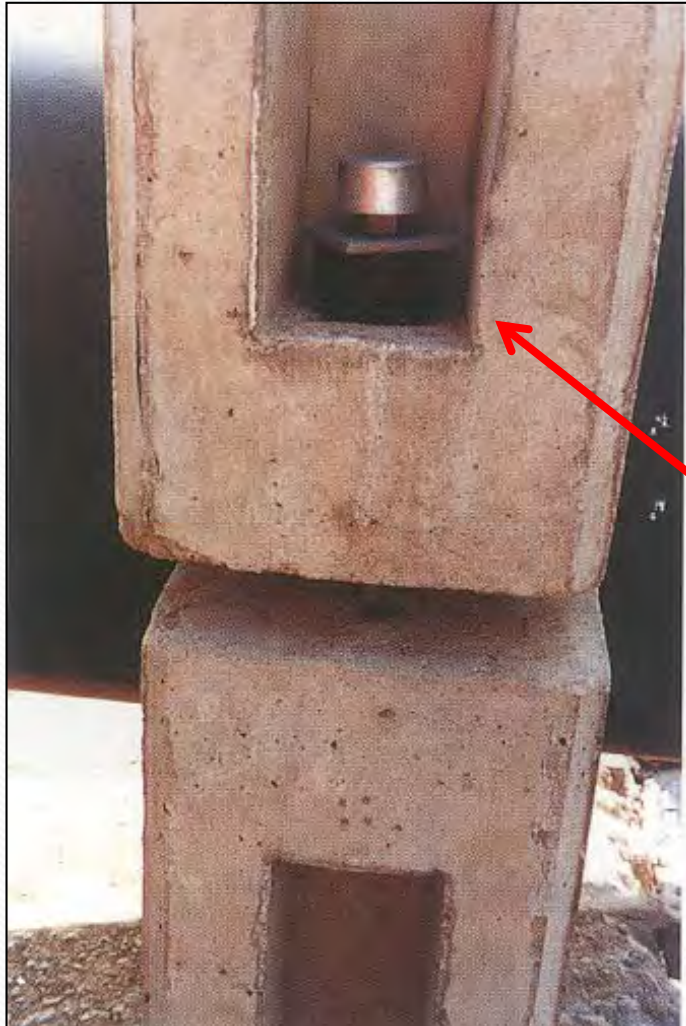
Information contained here in is the guidance only and should not intended to replace the evaluation and judgment of a professional engineer competent in this field

Attaching of Concrete weight



Crane may use to attach Concrete weight in the sea

Attaching of Concrete weight



Galvanized Bolt & Nuts are good enough in general condition

Sacrificial Zinc Anode attach to longer life of Steel parts

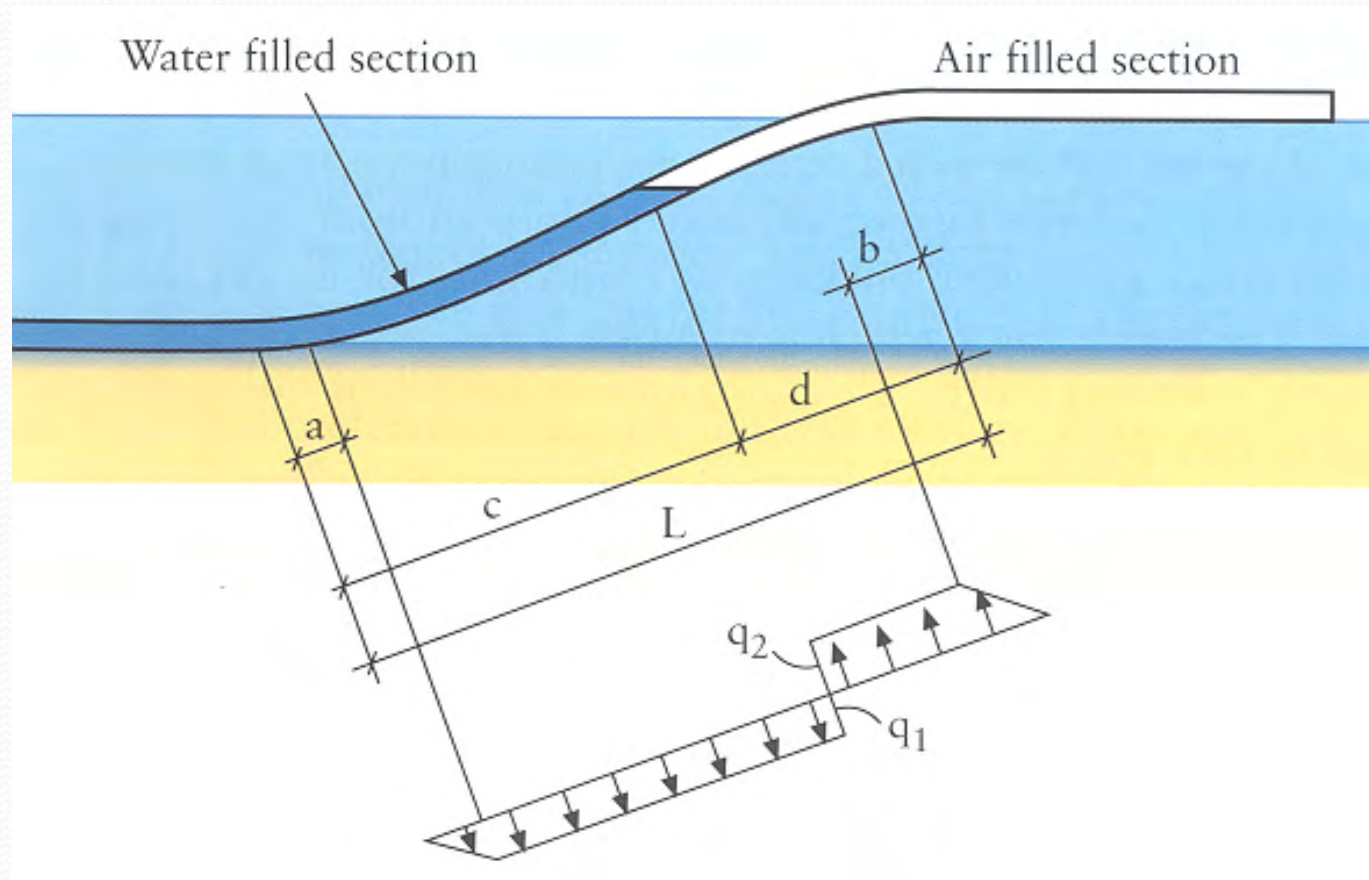


Attaching of Concrete weight



Rubber lining inner to protect HDPE pipe

Submersion of HDPE pipe



Bending radius and sinking rate have to be correlated

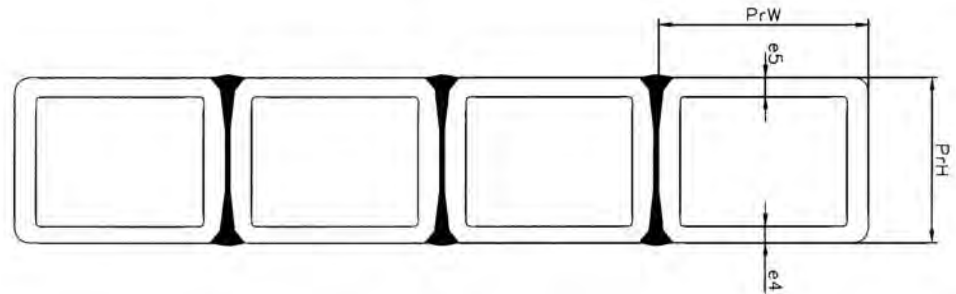
Submersion of HDPE pipe



Sinking rate have to be controlled to prevent buckling

Weholite Non-pressure pipe

- High quality NON pressure structured wall HDPE Pipe
- ID: 300 - 3,000 mm
- Ring Stiffness Class: SN 2, 4, 6, 8
- Standard: EN13476-2 (type A2) and SFS5906
- Application:
 - Drainage, Sewage
 - Storm water
 - Out fall and Intake
 - Rehabilitation
 - Culvert



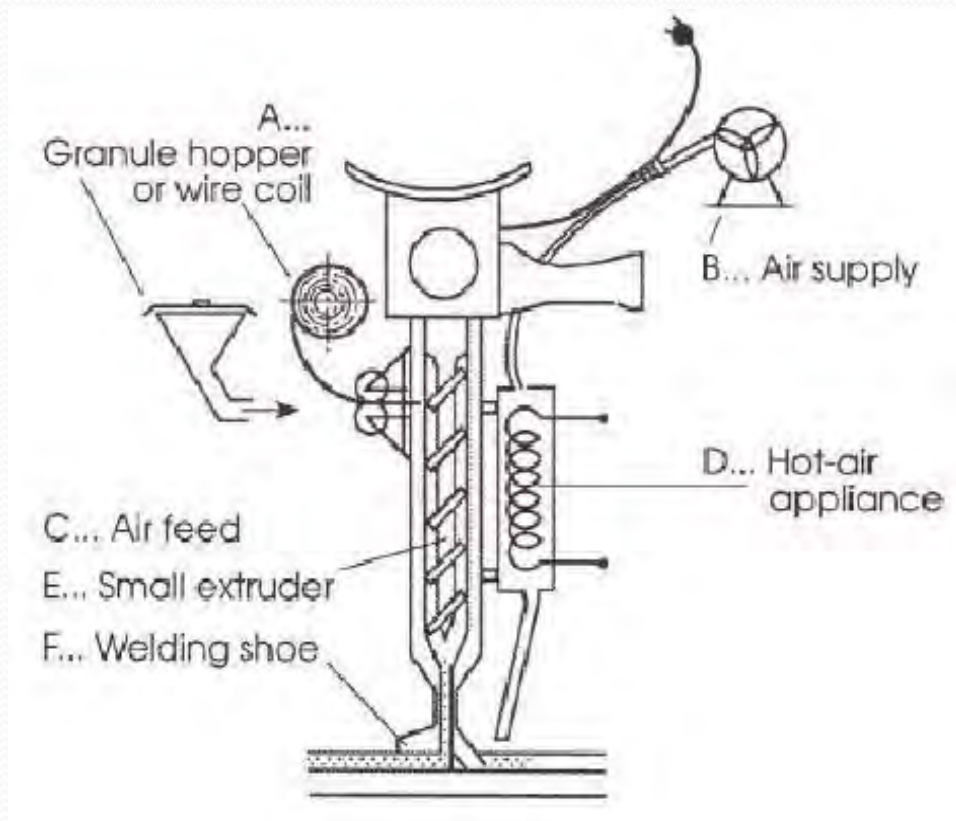
Unique production

- EN13476 Standards Plastics piping systems for non-pressure underground drainage and sewerage – structured -wall piping systems of unplasticized Polyethylene (PE)



Jointing by Hand extrusion machine

- **Welding method:** Hand extrusion welding leak proof guarantee and crack guaranteed



Jointing by automatic machine



Internal welding machine

Durability and Stiffness

- Weholite often use as Road and Construction Culvert



Weholite: Key benefits

- Installation is quick and easy (4x compared with concrete)
- Long life cycle (50 year+)
- Flexibility & Low Friction
- Leak proof guaranteed
- Super light weight material
- Follow EN13476 Standards
- Ring stiffness for underground
- Good abrasion
- Low maintenance



Bangkok's drainage



- Bangkok Metropolis – Pracha Uthit's Drainage:
- Lengths 800 m of Weholite DN/ID 800 SN4
- Drainage system
- Completion 2005

Drainage and Sewage



- Industrial park 304, Rayong:
- Length 8,840 m of Weholite DN/ID 350 - 800 SN4
- Drainage and sewage system
- 20% reduced construction cost and time
- Completion 2007

Flood relief in Municipality



- Chiang Rai Municipality Drainage Project
- Weholite DN/ID 800, 1000 and 1200 mm SN 4
- Drainage pipe
- Completion 2013



Ho Chi Minh City's Outfall



- Ho Chi Minh City Environmental sanitation's project
- Weholite DN/ID 3,000 SN6
- Outfall discharge
- First large scale wastewater treatment plant in Vietnam
- Completion 2012

Petron Bataan Power Plant Intake/Outfall



- Petron Bataan, Indonesia
- 610 m of Weholite DN/ID 2,400 SN 4, Sea water intake
- 450 m of Weholite DN/ID 2,200 mm SN 4, Outfall with diffuser ports
- Marine application
- Completion 2014

Nghi Son Refinery, Vietnam



- Nghi Son refinery, Vietnam
- 2000 m of Weholite DN/ID 2,700 SN 4, Out fall with diffuser ports
- Marine application
- Completion 2015

WehoTank: HDPE water storage unit

- High quality HDPE Water Tank
- Capacity : **1 - 1,000 Cu. m.**
- Ring Stiffness Class: SN **2, 4, 6, 8**
- **Standard: EN13476-2 (type A2) and SFS5906**
- **Application:**
 - Underground & Above Ground Water Tank
 - Waste water and Chemical tank
 - Hygienic
 - Light weight



WehoTank: Key benefits



- Installation is quick and easy
- Leak proof Guaranteed
- Low maintenance
- Hygienic material
- Light weight
- Ready for future expansion and relocate
- Ring stiffness for underground buries

Waste water storage tank



San Miguel– Waste water storage tank:

- DN/ID 1,200 mm of WehoTank
- 12 cu.m
- Completion 2008

Clear water storage tank



Rajaphat Nakorn Sawan – Water storage tank:

- DN/ID 3,000 mm of WehoTank, 50 cu.m
- Completion 2008

Clear water storage tank



Armed Force Academy Nakorn Nayok – Water storage tank:

- DN/ID 2,500 mm of WehoTank
- 50 cu.m

Clear water storage tank



PWA Nakorn Sri Thammaraj – Water storage tank:

- DN/ID 3,000 mm of WehoTank
- 2 Units of 50 cu.m and 2 Unit of 25 cu.m.

Clear water storage tank



Siam Yamato Steel– Water storage tank:

- DN/ID 3,000 mm of WehoTank
- 2 Units of 60 cu.m
- Pure White Color

Clear water storage tank



Thammasat University Dormitory – Water storage tank:

- DN/ID 3,000 mm of WehoTank
- 5 Units of 80 cu.m 1 for each building

Clear water storage tank



Marukkatayawan Royal – Water storage tank:

- DN/ID 2,500 mm of WehoTank
- 2 Units of 30 cu.m
- Completion 2009



Clear Water storage tank



Amata City, Rayong – Clear Water storage tank:

- DN/ID 3,000 mm of WehoTank
- 6 Units of 80 cu.m and 1 Unit of 20 cu.m.
- Total Capacity 500 cu.m

Biogas Scrubber



Uni Vanich – Biogas scrubber tank:

- DN/ID 3,000 mm of WehoTank
- 6 Units of 12 cu.m
- Completion 2008

Biogas Scrubber



Prai Praya & Lumtub – Biogas scrubber tank:

- ID 3,000 mm of WehoTank
- 4 Units of 84 cu.m
- Completion 2009

Pumping station



Tank for potable water: Finland. Pumping station included inside the tank, with separating wall

Chemical Storage tank



Tank for Water treatment chemicals, Finland

Chemical Storage



Tanks for cleaning printing chemicals, Sweden

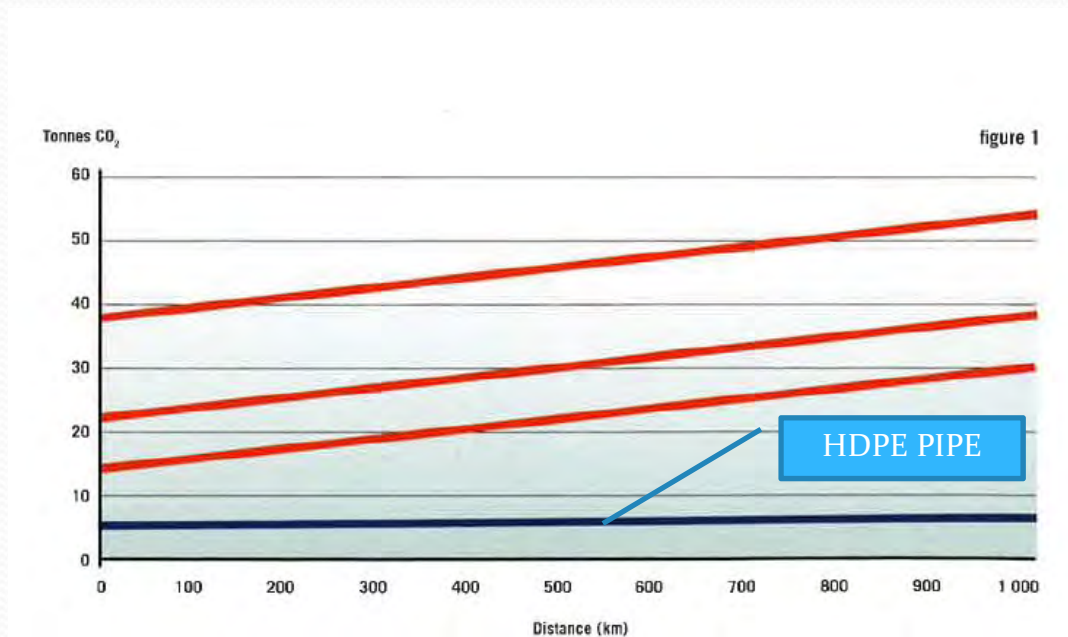
Attenuation Tank



Stormwater buffer tank, UK.

Carbon footprint

- Carbon dioxide emission during transportation
- The carbon foot print of the large diameter PE pipe was only 15% of concrete pipe.



PE-HD PIPE VS CONCRETE

- 2 100 mm PE-HD Pipe
- 2 100 mm Concrete Pipe



140 metres of pipes are nested inside one another and are delivered to site in a single load.

Source : Pipe world volume 11

Attenuation Tank for flood alleviation



Containerized tank



Sewage tank, Denmark



Containerized tank, Oman

Other structures

- Rain water collection system



Other Structures

- Rainwater harvesting – pressure head from structure (no need for pumps)



Tunnel

- Tunnel DN/ID 2400 mm, 34 m length, 600 mm under road



Other Structures

- Connection tunnel between office building DN/ID 2400 mm



Manholes



Manholes: Poland





Sewage manholes: Oman



Advantages of PE piping system

Non-Corrosive

Length and Dimension

Good Abrasion Resistance

Long Life Span

Flexible Pipe

Low Friction Loss

**Leak Proof butt-fusion
Jointing**

Low Maintenance

Non Toxicity

Green solution



Non Corrosive

Non-Corrosive & Good Abrasion Resistance



HDPE pipe can be laid underground as well as underwater.

HDPE pipe can withstand corrosion by chemical solution.

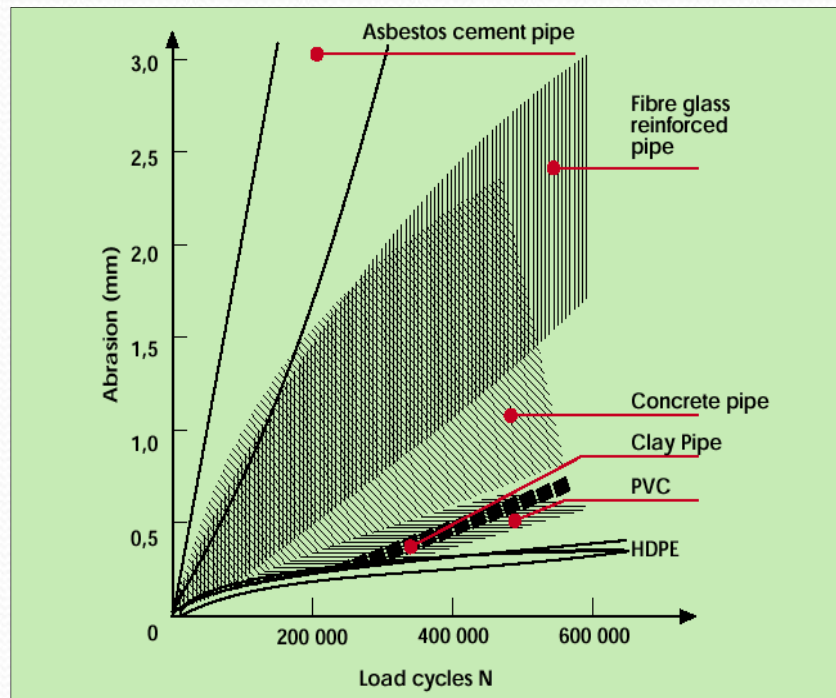
Length & Dimension of HDPE pipe



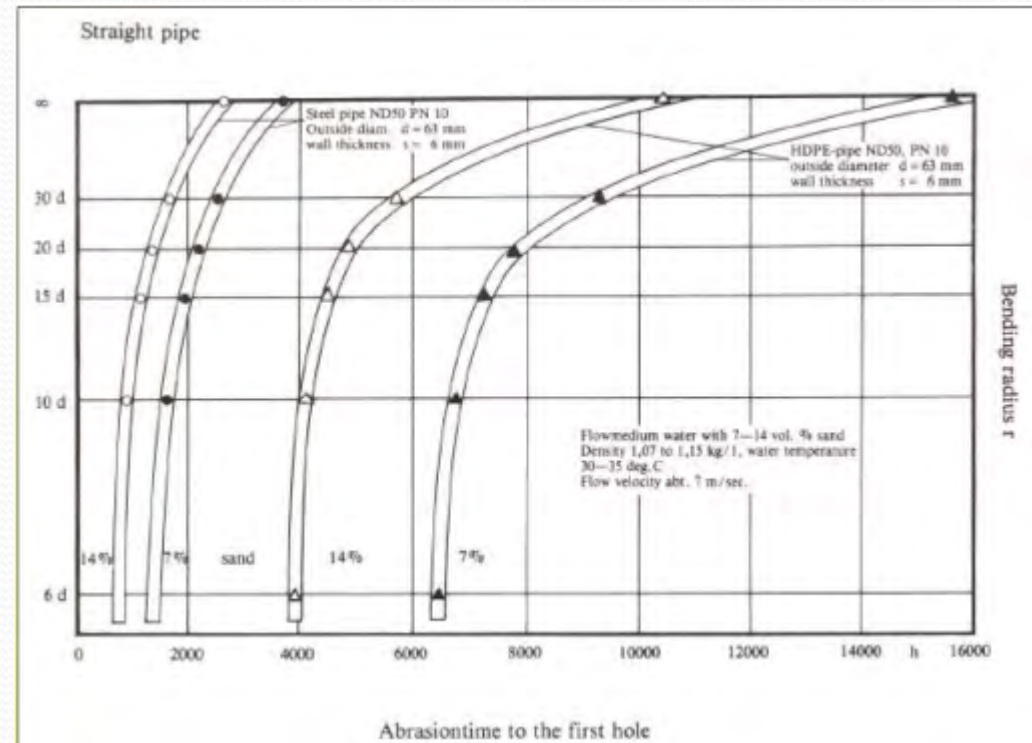
HDPE pipe available in 6 -15 meters custom length also possible

HDPE pipe up to 110 mm can be produced and supplied as a coil as desired length

Good Abrasion Resistance



Better abrasion properties
compared to traditional
materials



HDPE bends are superior to
steel bends

Flexibility and leak proof joint

Flexibility



Due to its flexibility, HDPE pipe can fit to the contour of physical environment without utilizing extra joint of fitting. HDPE pipe's radius of curvature is approximate 25-40 times of the diameter.

This characteristic makes HDPE pipe suitable for submarine project or any rough condition.

Leak proof at butt fusion jointing



Typical jointing method for HDPE pipe. Pipe and welded joint are homogeneous, and the strength of the welded joint is equal or more than the pipe.

Welding can be done aboveground beside the trench, thus, avoid the problems associated with underground welding including water and old pipe obstructions.

Flexibility



The pipe's flexibility can be utilized both for on-land and underwater installations, minimising the need for elbow fittings

Leak-proof butt fusion joint



Butt fusion welding is versatile and dependable for all types of installations

PE Characteristic

Low Friction Loss



With low friction, HDPE pipe can transport more quantity of water compare to the other pipes with the same diameter.

With the same flow rate requirement, one can substitute smaller HDPE pipe for the said purpose.

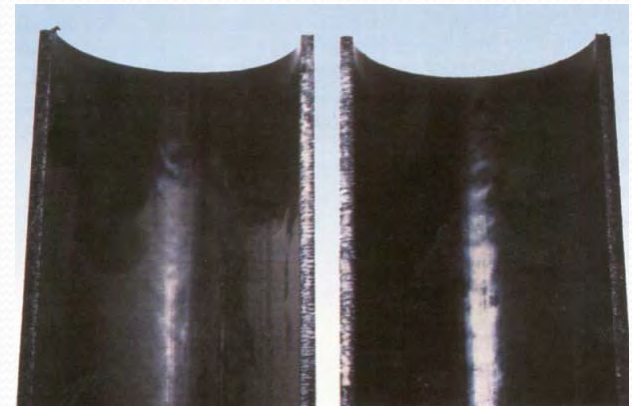
Light weight



Compare with the same pipe dimension, HDPE pipe is approximately four times lighter than concrete and steel pipe.

This characteristic saves transportation cost and installation and improve speed of work at site.

Low Friction Loss



BEFORE

AFTER

- 20 Years old HDPE Water Line. Left side before cleaning

The friction coefficient is very low and does not change over time

Light weight



Even large diameters and long lengths
are easy to handle

PE Characteristics

Longer Life Span & Low Maintenance



With high quality certified HDPE material by KWH Group's laboratory combined with our best production experience, our HDPE pipe system and products can last longer than 50 years which made customer worry free about the maintenance.

We always promised our client with the best quality of product and services and worth for your investment.

Longer life span & Low maintenance



Fig. 5. A "historical test bench" still in operation at R&M Industrieservice Höchst GmbH

Page 1 of 10

A vision becomes true – 50 years of pipes made from High Density Polyethylene

Ulrich Schulte, Basell Polyolefine GmbH, Frankfurt am Main, Germany

After the discovery of the low-pressure process for the production of polyethylene with the aid of Ziegler catalysts, only another year went by before pipes were being extruded in high-density polyethylene. In the same year, at the end of 1954, Hoechst had already begun to carry out long-term failure tests on HDPE pipes under internal hydrostatic pressure at temperatures of between 20 and 80 °C. Consistent continuation of the long term test has shown that even the first pipes to be made of HDPE more than exceeded the former design service life of 50 years. Through intensive material developments, the long term hydrostatic strength ascertained in long-term failure tests on HDPE pipes rated for 50 years' service meanwhile exceeds 10 MPa.

The lifetime of today's PE-HD materials have been proven to be more than 100years

Long life span



First HDPE pipe in the world installed in Stockholm, Sweden since 1955 still under normal operation.

**“ท่อ HDPE เส้นแรกของโลก
ที่เมืองสต็อกโฮล์ม พ.ศ.
2498” ปัจจุบันท่อชิ้นนี้ยัง
สามารถใช้งานได้ปกติ**

Earthquake resistance

<http://www.news.cornell.edu/stories/Aprilo6/pipe.earthquake.kr.html>

"If a gas pipe breaks during an earthquake it can cause a fire," said Palmer. "If the nearby water pipe also breaks, the ability to control the fire is greatly reduced."



Jason Koski/University Photography

Grid lines reveal soil displacement during a test of a four-foot fault on an underground pipe. Copyright © Cornell

University

In the test, the researchers placed the pipe in two large test basins and secured the pipe at each end. The two basins, resembling large waste bins at construction sites, were filled with sand. One basin was held in place while the other was moved four feet in four minutes to simulate a sideways-sliding fault, called a strike-slip.

The pipe, buried three feet below the surface, did not break during the test, but the sand, which had a white grid painted on it, shifted, bulged and cracked and created webbed lines on the surface as the pipe bent.

The test was one of 10 in a four-year, multimillion-dollar project. In the first test with the polyethylene pipe, no sand was used; the second test had the same conditions as the April 6 test, except that a laser-mounted robot traveled inside the pipe before and after the test and measured how the pipe ovaled under stress. The next set of tests will duplicate these experiments with a steel pipe.

High-density polyethylene is thick plastic that bends and reforms. Low-density polyethylene is the material that goes into plastic lawn bags, for example. The commonly used pipes can withstand five to 10 feet of displacement without breaking.

Earthquake Tsunami Flood

Performance of Pipes During Earthquakes

Camille George Rubeiz, PE
Plastics Pipe Institute, USA
"The 2005 Thailand Tsunami reported about the prevalent use of HDPE for potable water and the piping system performed 'very well with few failures'".

Lowest Vulnerability to earthquakes

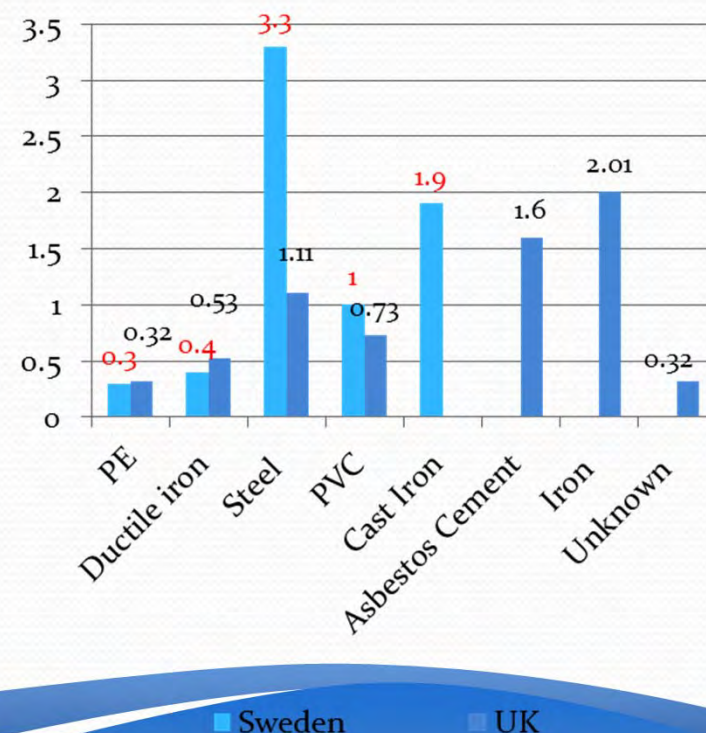
- The ASCE 2002 document tabulated the vulnerability to earthquakes of various pipe materials:

Pipe material	Vulnerability to earthquake
PE	Low
Ductile iron	Low and Low-moderate
Steel	Low and high
Concrete cylinder	Low-moderate, to High
PVC	Low-moderate, to Moderate
Cast Iron	Moderate-high, to High
Vitrified Clay	Moderate-high, to High
Asbestos Cement	High

Failures of pipe in Sweden and UK

- Data from regular (non-seismic) applications in the UK and Sweden
- Failures/10 km of PE pipe is lowest among all pipe materials
 - Approximately 10 times lower than steel pipe

Pipe material	Failures/10 km of pipe in Sweden	Failures/10 km of pipe in UK
PE	0.3	0.32
Ductile iron	0.4	0.53
Steel	3.3	1.11
PVC	1.0	0.73
Cast Iron	1.9	
Asbestos Cement		1.6
Iron		2.01
Unknown		0.32



PPWSA, Cambodia

- The 11th annual Stockholm Industry Water Award was presented to Cambodian, Phnom Penh Water Supply Authority (PPWSA)
- Increasing water coverage from 20% to **90%**
- Reducing leakage rate from 74% to **5.5%**
- Provide 24-hour service to a city of 1.3 million.
- Contribute to visible improvements in public health and reduced constraints in industrial, social and economic development

The 11th annual Stockholm Industry Water Award was presented to the Cambodian, Phnom Penh Water Supply Authority (PPWSA) in Cambodia, which is under the leadership of General Director Ek Sonn Chan. The city of Phnom Penh, which is the capital of Cambodia, suffered greatly during the Vietnam War and after the war, the water supply system, like most other services, was in a very poor condition. But over recent years, the PPWSA has made great strides forward in increasing water coverage from 20% to 90% of the city's population and in reducing leakage rates from 74% to 5.5%. PPWSA today provides a 24-hour service to a city of 1.3 million. It fully recovers its costs and has contributed to visible improvements in public health and reduced constraints to industrial, social and economic developments in Cambodia's capital.

Year 2030 The Urban Challenge

- Focus on “The Urban Challenge”
- Year 2030, it’s estimated that 5 billion people or 60% of the world’s population will inhabit urban areas.
- Demand for Fresh Water
- Ground water sources can no longer meet the demand due to depletion or pollution.
- Raise resource efficiency and make water service provision cheaper and easier to provide for large number of people
- Water management is at the centre of the sustainable city boom.

In 2011, the World Water Week will focus on finding solutions for “The Urban Challenge” because by 2030, it is estimated that 5 billion people, or 60% of the world’s population, will inhabit urban areas. As the number of urban dwellers increases, many major cities have had to draw freshwater from increasingly distant watersheds, as local surface and groundwater sources can no longer meet the demand for water due to depletion or pollution. But with smart planning and technology, increased population density can actually raise resource efficiency and make water service provision cheaper and easier to provide for large numbers of people. Water management is at the centre of the sustainable city boom.

Comparison of HDPE pipe to other pipe materials



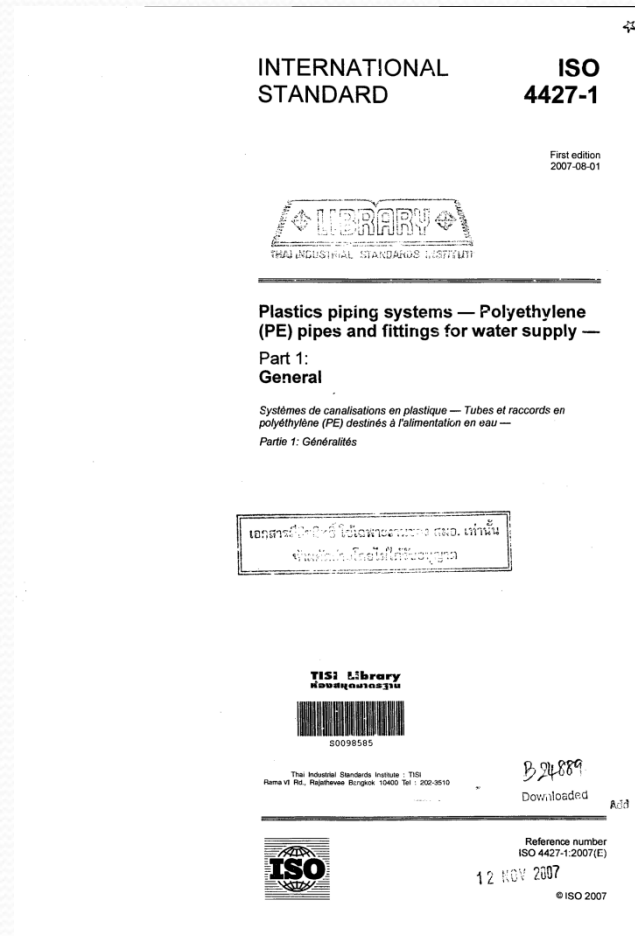
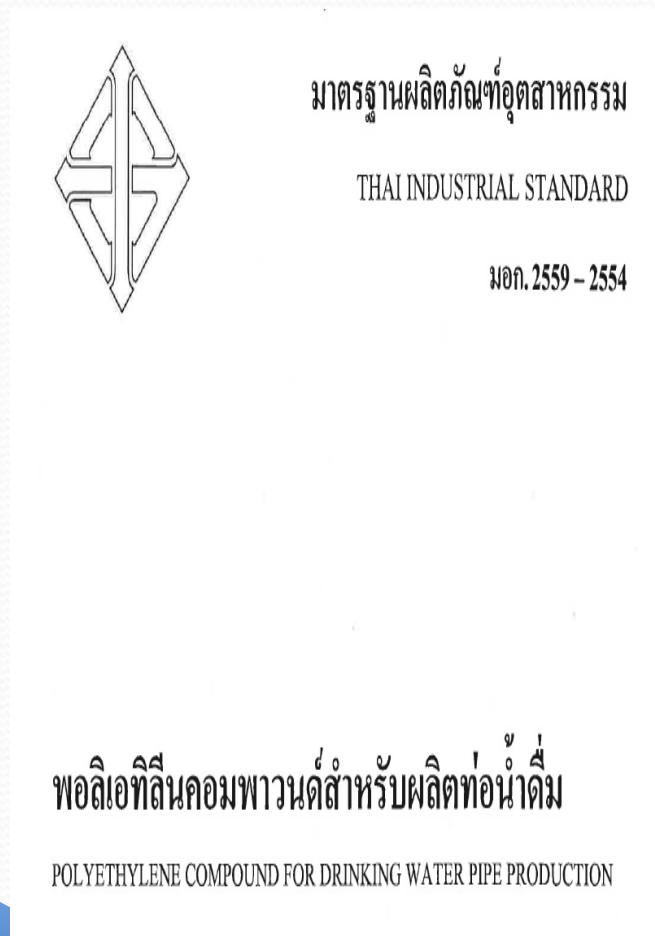
DESCRIPTION	HDPE PIPE	PVC PIPE	AC PIPE	STEEL PIPE
1. PIPE WEIGHT	LIGHT	LIGHT	2-3 TIMES OF HDPE PIPE	7-8 TIMES OF HDPE PIPE
2. TRANSPORTATION	<ul style="list-style-type: none"> - EASY FOR DELIVERY AND HANDLING - CAN INSERT SMALL SIZE IN BIG SIZE PIPE - PIPE OUTSIDE DIMETER UPTO 110 MM. CAN BE COILED 	SAME AS HDPE PIPE BUT CANNOT BE DELIVERED IN COIL	REQUIRE SPECIAL PREPARATION AND TAKING CARE IN TRANSPORTATION	HEAVY WEIGHT, NEED HEAVY EQUIPMENT FOR LOADING AND UNLOADING
3. FLEXIBILITY	25-40 TIMES OF OUTSIDE DIAMETER	CANNOT	CANNOT	CANNOT
4. FLOW PROPERTY	C=150	C=150	C=100	C=100
5. SPEED OF PRESSURE WAVE IN PIPE	200-400 M/SEC	200-400 M/SEC	600-800 M/SEC	1,000-1,200 M/SEC
6. MAXIMUM WORKING PRESSURE	16 KSC. (bar)	13.5 KSC. (bar)	25 KSC. (bar)	50 KSC. (bar)
7. WORKING TEMPERATURE	-40 TO 80 CELCIUS	0 TO 60 CELCIUS	30 TO 45 CELCIUS	100 TO 300 CELCIUS
8. SERVICE LIFE	MORE THAN 50 YEARS	10-20 YEARS	10-20 YEARS	10-30 YEARS
9. INNER SURFACE	NO CORROSION, NO CALCIUM CARBONATE LAYER	SAME AS HDPE PIPE	WATER ABRASION = 20 % CAN BE ATTACHED WITH CALCIUM CARBONATE LATER	CORROSION ATTACHED WITH CALCIUM CARBONATE LAYER
10. CHEMICAL RESISTANCE	HIGH RESISTANT TO ACID AND BASE	ALMOST SAME AS HDPE BUT CANNOT RESIST TO SOME SOLUTION	NON RESISTANT	NON RESISTANT
11. UNDERGROUND INSTALLATION	WELDING ON GROUND AND LAYING INTO TRENCH	JOINTING IN TRENCH	NEED HEAVY EQUIPMENT FOR JOINTING WIDER TRENCH IS REQUIRED (JOINTING IN TRENCH)	SAME AS AC PIPE
12. COST OF TRANSPORTATION AND WELDING COMPARE WITH COST OF PIPE	10%	10%	30% (NOT INCLUDE COST OF DAMAGE FROM PIPE BROKEN)	30%

Standard references

PE compound standard

TIS 2559-2011

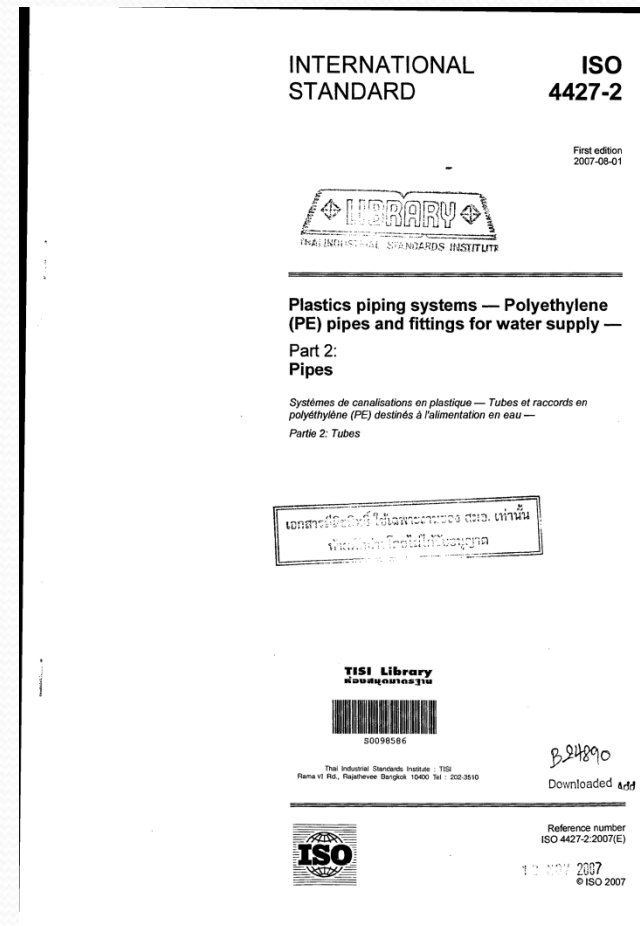
ISO 4427-1



PE pipes for drinking water

TIS 982-2013

ISO 4427-2



Standard references for PE pipe

ISO 4427-2 : 2007 covered following types of pipe

- Black color pipe
- Black with blue stripes
- Blue color pipe
- Multilayer pipe
 - Coextruded pipe
 - Coated pipe $d_n + 2e_{\text{coating}}$

TIS 982 : 2013 followed the same principle as ISO 4427-2.



What is pre-compound resin?

Natural resin

Natural resin +
Carbon black
master batch

Pre-compound
= Fully formulated resin



Pre-compound resins

- Fully formulated resin



Blue color for
Water supply

Natural Resin
(Not use)

Black color
resin for
Water supply

Orange color
for GAS Pipe

Contain 2.0-2.5% Carbon
black content by mass.

Poor carbon black dispersion

- Poor carbon black dispersion

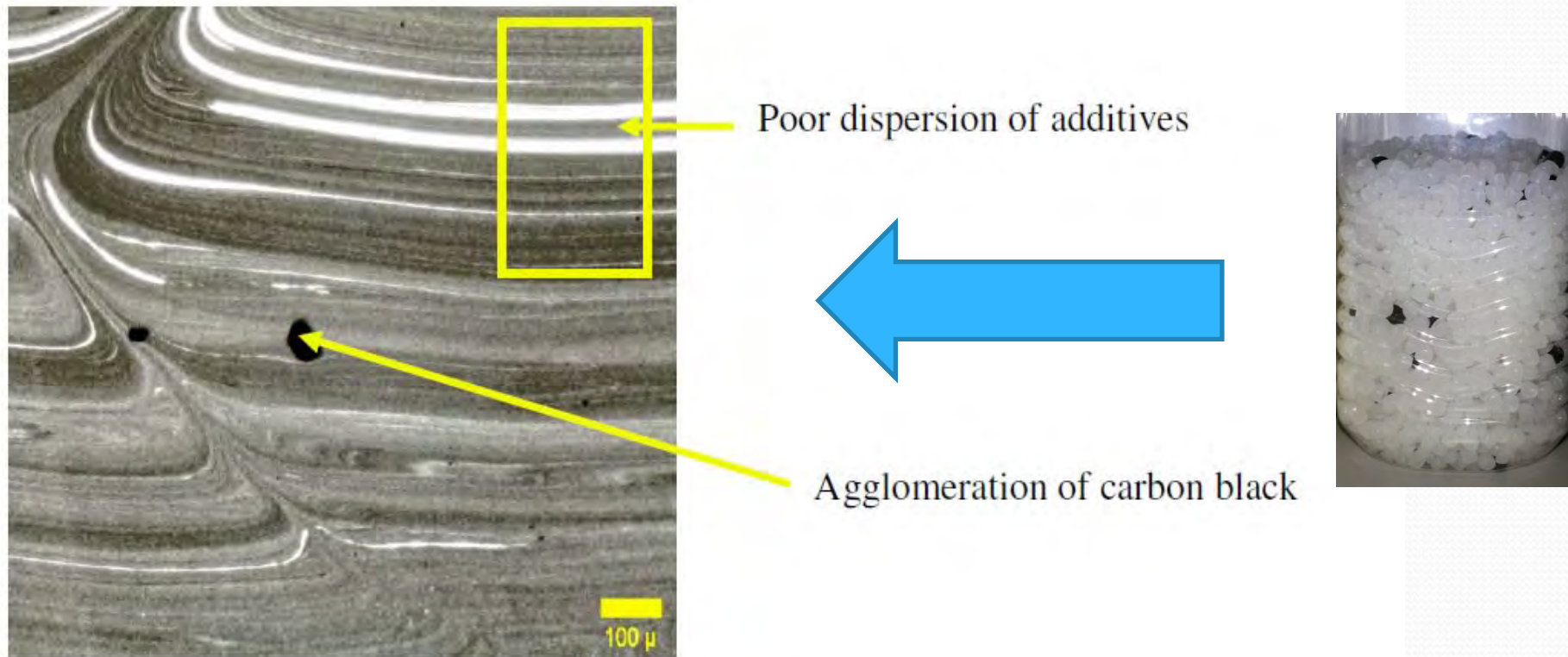
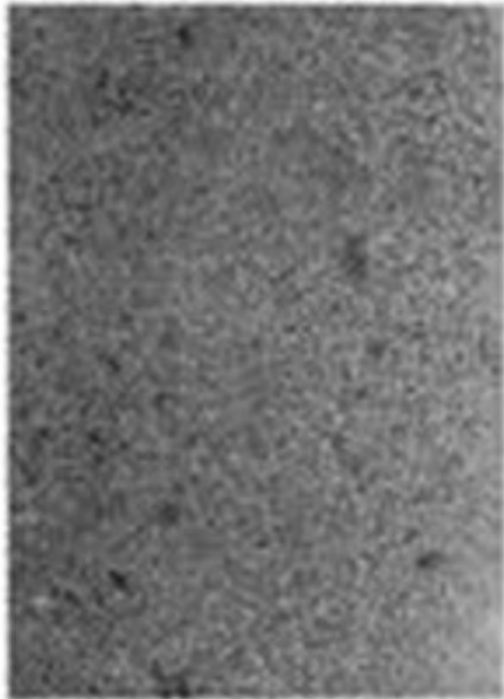


Fig.1. Poor dispersion of additives in polyethylene

<http://www.pe10oplus.com/PE-Pipes/materials/compounds,i294.html>

Good vs Bad Carbon black dispersion

64 x magnification



Good dispersion
Typical for ready-made compound

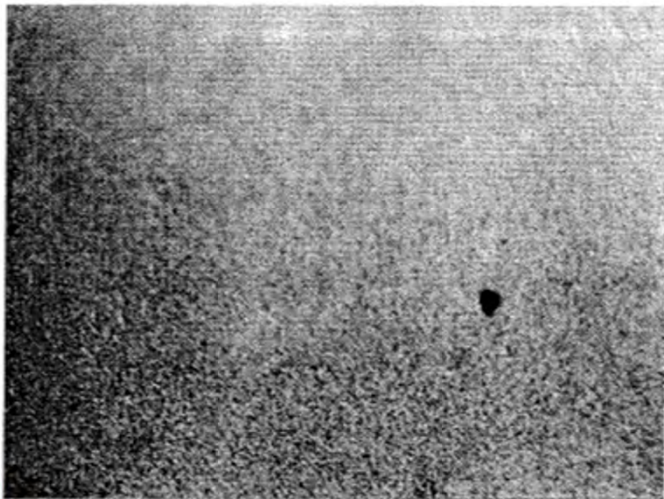


Bad dispersion
Typical for Carbon Black
addition to natural base
material during pipe
extrusion process

- Tested as per ISO 18553
- Acceptance criteria \leq grade 3

Carbon black dispersion (Grading)

- Carbon black dispersion
- Tested as per ISO 18553
- Microscopic examination
- Magnification x70
- Acceptance criteria \leq grade 3



A2

Table A.1 — Grades based on the largest dimensions of the particles and agglomerates

Grade	Dimensions μm														
	5 to 10	11 to 20	21 to 30	31 to 40	41 to 50	51 to 60	61 to 70	71 to 80	81 to 90	91 to 100	101 to 110	111 to 120	121 to 130	131 to 140	>140
	Maximum number of particles and agglomerates														
0															
0,5	1														
1	3	1													
1,5	6	3	1												
2	12	6	3	1											
2,5		12	6	3	1										
3			12	6	3	1									
3,5				12	6	3	1								
4					12	6	3	1							
4,5						12	6	3	1						
5							12	6	3	1					
5,5								12	6	3	1				
6									12	6	3	1			
6,5										12	6	3	1		
7											12	6	3	1	

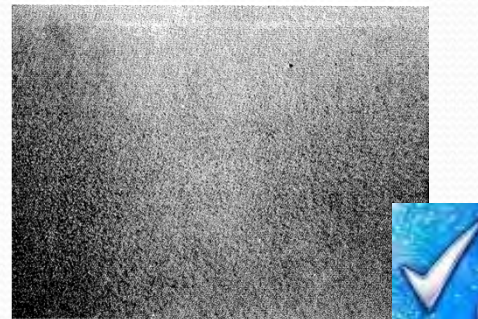
NOTE 1 7 μm corresponds to 0,7 mm under a magnification of $\times 100$ and to 0,49 mm under a magnification of $\times 70$. Similarly, 60 μm corresponds to 6 mm under a magnification of 100.

NOTE 2 All empty upper right cells in the table mean that no particles in the size range are acceptable for the grade in that row.

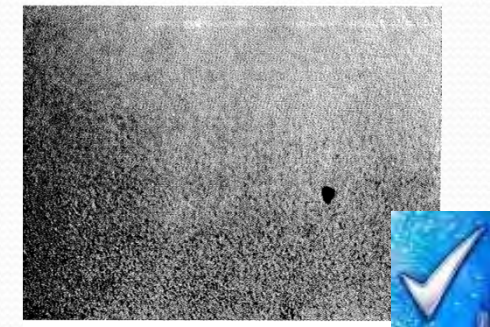
NOTE 3 All empty lower left cells mean no limit to the number of particles in the size range.

Carbon black dispersion (Appearance)

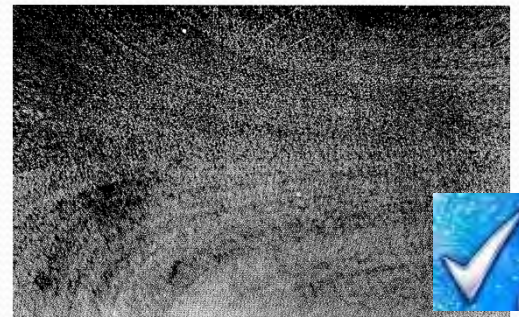
- Carbon black dispersion
 - Acceptance dispersion, accept if A1, A2, A3, B.



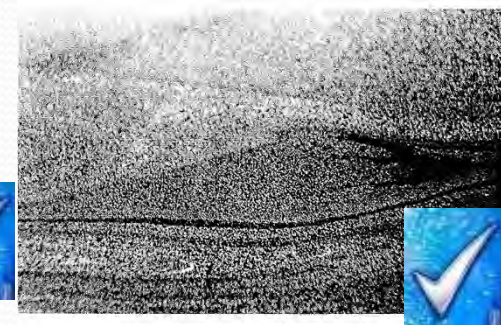
A1



A2



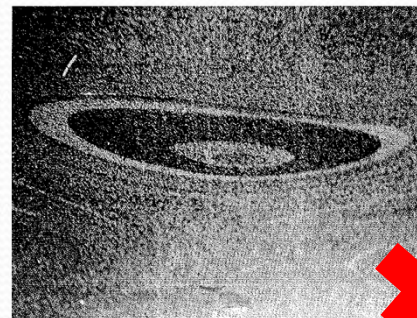
A3



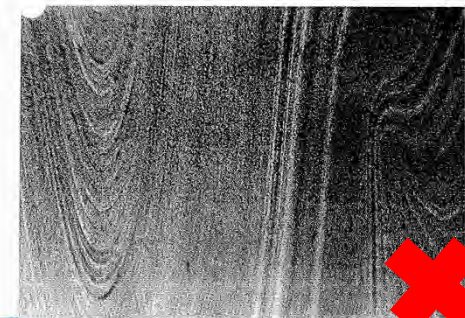
B



D



C2



C1

Sample specification PE80 PE100 resin

- **--- Only pre compounded resin shall be used**
- **--- All resin shall be 100% virgin (New material), no reprocessed or recycled materials shall be used in the manufacture of any pipe or fittings**
- **--- No Natural coloured resins shall be used for any pipe and fitting manufacture**

Thailand PE compound suppliers



Other PE compound suppliers

Name of Supplier	Raw material Grade : BLACK (Water)	
	PE80	PE100
IRPC	POLIMAXX BM3245PC	POLIMAXX AM3245PC
SCG	EL-LENE H5211PC	EL-LENE H1000PC
PTT	INNOPLUS HD6366MB	INNOPLUS HD8100MB

Name of Supplier	Raw material Grade : YELLOW/ORANGE (Gas)	
	PE100	
Total	HDPE XS10 Orange YCF	
INEOS	ELTEX® TUB 125 N2025	

Name of Supplier	Raw material Grade : BLUE (Water)	
	PE100	
Total	HDPE XS10H	
Hostalen	Hostalen CRP100 (blue)	
INEOS	ELTEX® TUB 124 N2025	
SCG	EL-LENE H1000PBL	



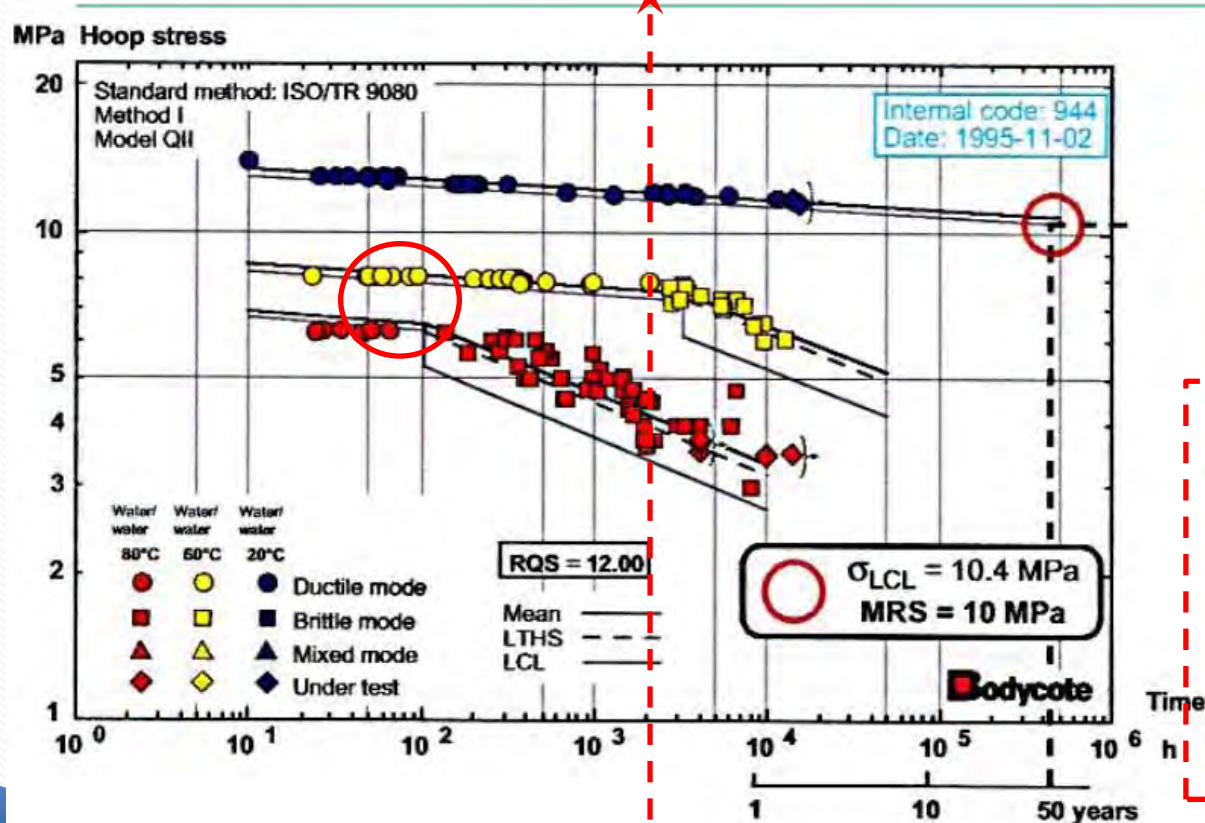
Properties of PE100 vs PE80

Properties	PE80 Black	PE100 Black
Minimum Required Strength, MRS (MPa)	8.0	10.0
Density (g/cm ³)	0.954-0.956	0.957-0.961
Melt Flow Rate @ 190 °C, 5.0 kg (g/10minute)	0.4-0.7	0.2-0.4
Oxidative Induction Time @ 200 °C / 210 °C (minutes)	≥ 40	≥ 40
Carbon Black Content (%wt)	2-2.5%	2-2.5%
Carbon Black/Pigment Dispersion, Rating	≤ 3	≤ 3
Tensile Strength at Yield (MPa)	18-20	20-25
Elongation at Break (%)	≥ 600%	≥ 600%
Resistance to Slow Crack Growth (Hrs)	≥ 500	≥ 500
Tensile for butt fusion	Ductile failure	Ductile failure

Regression analysis of PE resin

- Tested as per ISO 9080, long term testing
- The newly develop resins are now without Knee point.

5,000 ชั่วโมง



■ Meet the requirements of the appropriate ISO, EN or national standards eg. ISO 4427

■ Have no brittle failure 'knee' before 5000hrs @ 80°C when tested in accordance with ISO 9080

Sample of PE 100 resin curve

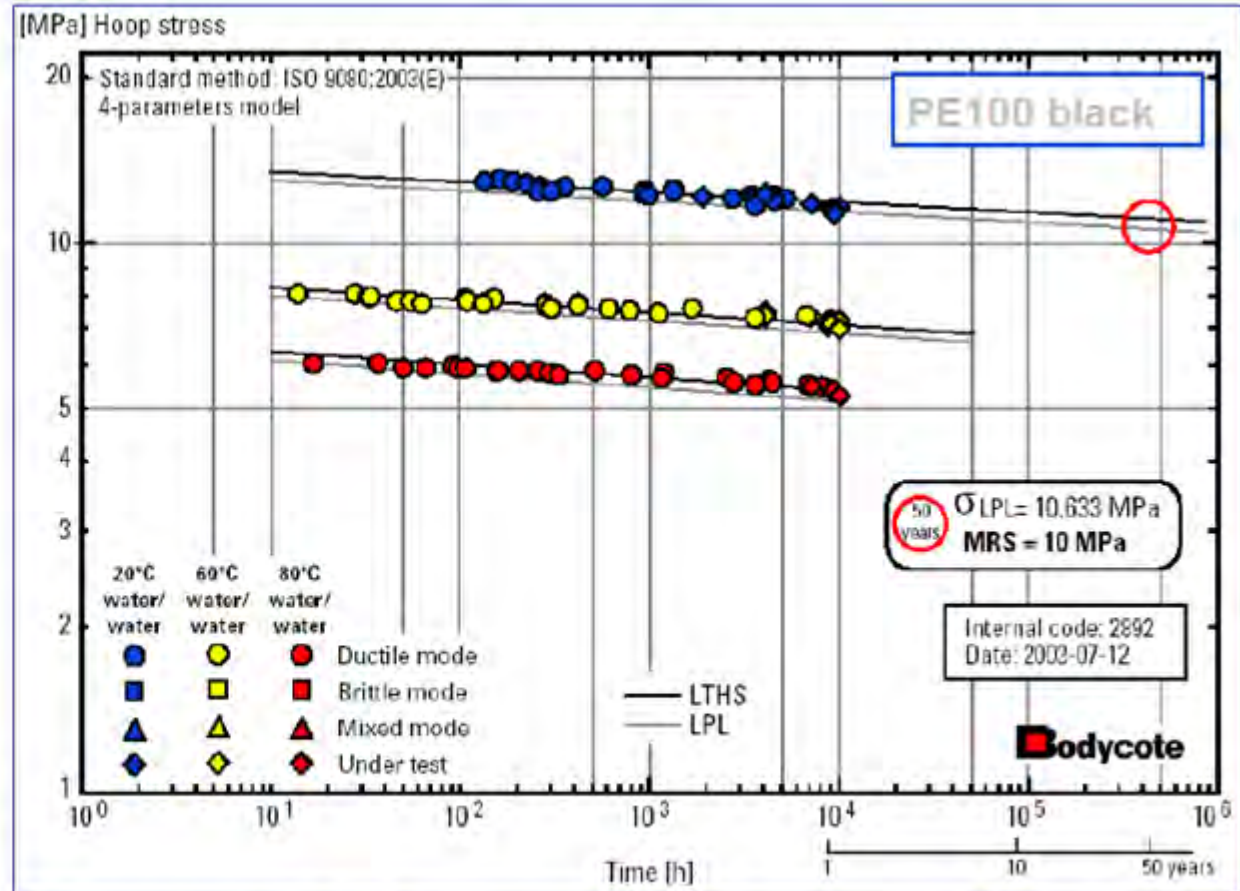
σ_{LPL} = lower confidence limit hydrostatic strength

50 years = 10.633 MPa

100 years = 10.50 MPa

High quality PE100 still exceeds the MRS after 100 years at **20°C**

Average annual temp. in Bangkok is **27.8°C** hence some derating is required but the pipe should still have a life of **100 years**.

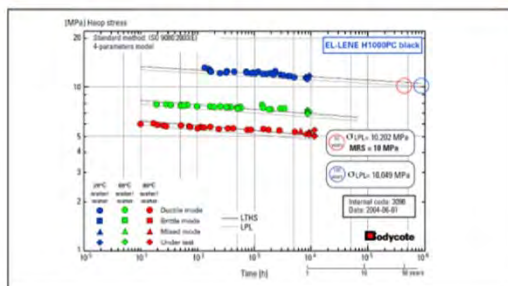


50 years = $10^{5.64}$ hours

100 years = $10^{5.94}$ hours

Sample of Regression test result

Client: Thai Polyethylene Co., Ltd.
Regression analysis according to ISO 9080 of the
PE pipe grade EL-LENE H1000PC black



Introduction

Bodycote Polymer offers accredited testing and evaluation according to ISO 9080, i.e. hydrostatic pressure testing followed by evaluation of the long-term hydrostatic strength and MRS-classification according to ISO 12162.

Task

The aim was to use the Standard Extrapolation Method (SEM) according to ISO 9080 in order to obtain a classification of the PE pipe grade EL-LENE H1000PC black from Thai Polyethylene Co., Ltd.

The work covers hydrostatic pressure testing at 20, 60 and 80°C and a SEM-evaluation according to ISO 9080:2003.

Results obtained

The evaluation was performed in accordance with ISO 9080:2003. The 4-parameter model gave the best fit.

Number of observations

Temp °C	60°C	80°C
30	30	30

Extrapolated strength values

Temp °C	Time yrs	σ_{LPL} MPa	σ_{LTHS} MPa
20	50.0	10.202	10.687
20	100	10.049	10.537
60	7.36	6.223	6.588
80	1.23	4.775	5.060

Classification: **MRS = 10 MPa**

Please contact us for further information!

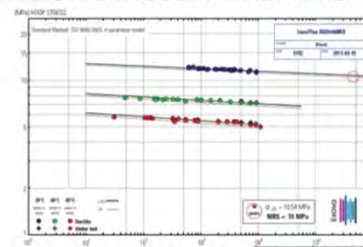
Bodycote POLYMER

Bodycote Polymer SE-611 82 Nykøbing SVENSKEN
phone +46 155 22 14 76 fax +46 155 26 31 25
www.bodycotepolymer.com info@bodycotepolymer.com

Polymer, coatings & composite
Testing & Technologies

Exova

Client: PTT Chemical Public Company Limited
REGRESSION ANALYSIS ACCORDING TO ISO 9080
OF THE PE PIPE GRADE InnoPlus HD8100MB



INTRODUCTION

Exova offers accredited testing and evaluation according to ISO 9080, i.e. hydrostatic pressure testing followed by evaluation of the long-term hydrostatic strength and MRS-classification according to ISO 12162.

TASK

The aim was to evaluate the compound according to ISO 9080 in order to obtain a MRS-classification according to ISO 12162 of the PE pipe grade InnoPlus HD8100MB from PTT Chemical Public Company Limited.

RESULTS OBTAINED

The evaluation was performed in accordance with ISO 9080:2003. More information can be found in Exova Report P.11/59.

EXTRAPOLATED STRENGTH VALUES

Temp [°C]	Time [hrs]	σ_{LPL} [MPa]	σ_{LTHS} [MPa]
20	50.0	10.54	10.81
20	100	10.41	10.69
60	6.41	6.56	6.78
80	1.07	4.97	5.15

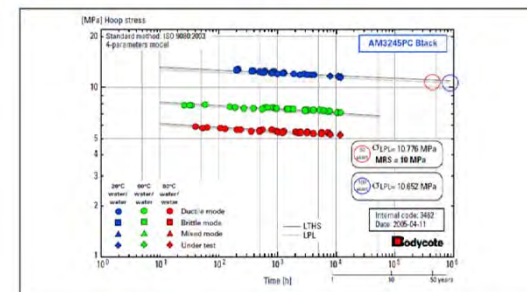
CLASSIFICATION
MRS = 10 MPa

Exova Polymer
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www.exovapolymer.com



1 of 10 (3 of 30)

Client: IRPC Public Company Limited
Regression analysis according to ISO 9080 of the
PE pipe grade AM3245PC Black



Introduction

Bodycote Polymer offers accredited testing and evaluation according to ISO 9080:2003, i.e. hydrostatic pressure testing followed by evaluation of the long-term hydrostatic strength and MRS-classification according to ISO 12162.

Task

The aim was to use the Standard Extrapolation Method (SEM) according to ISO 9080 in order to obtain a classification of the PE pipe grade AM3245PC Black from IRPC Public Company Limited.

The work covers hydrostatic pressure testing at 20, 60 and 80°C and a SEM-evaluation according to ISO 9080.

Results obtained

The evaluation was performed in accordance with ISO 9080. The 4-parameter model gave the best fit.

Number of observations

Temp °C	60°C	80°C
30	30	32

Extrapolated strength values

Temp °C	Time yrs	σ_{LPL} MPa	σ_{LTHS} MPa
20	50.0	10.776	11.031
20	100	10.652	10.910
60	6.34	6.643	6.837
80	1.08	5.053	5.216

Classification: **MRS = 10 MPa**

Bodycote POLYMER

Bodycote Polymer SE-611 82 Nykøbing SVENSKEN
phone +46 155 22 14 76 fax +46 155 26 31 25
www.bodycotepolymer.com info@bodycotepolymer.com

Sample of Technical datasheet

SCG
CHEMICALS

EL-Lene

PE 100 Black HDPE Compound

H1000PC

Product Description

EL-Lene H1000PC is a black, bimodal technology, high density polyethylene compound classified as a MRS 10.0 material (PE100) providing superior mechanical properties and processability. EL-Lene H1000PC also shows excellent resistance to rapid crack propagation and slow crack growth. In addition, it includes a good dispersion of carbon black pigment and anti-oxidant to ensure excellent long term in UV resistance and thermal stability.

Typical Application

- Potable water pipes
- Gas pipes
- Drainage pipes
- Sewerage pipes
- Industrial pipes
- Corrugated pipes

Product Characteristics

- Good processing
- Excellent thermal stability
- High resistance to slow crack growth
- Resistance to rapid crack propagation
- Low sagging

International specification

- PE 100+ Association
- PIRA, Australia
- INGTA-CERT Mark, Sweden
- NF Mark, France
- SIRIM, Malaysia
- AENOR, Spain
- Belgaqua, Belgium
- TIGI, Thailand

Physical properties

Property	Test Method	Value	Unit
Melt Flow Rate	ISO 1133 @ 190°C, 5.0 kg	0.25	g /10 min
Density (Compound)	ISO 1183	0.959	g / cm ³
Tensile Strength at Yield	ISO 527 @ Crosshead speed 100 mm/min	23	MPa
Tensile Strength at Break	ISO 527 @ Crosshead speed 100 mm/min	> 30	MPa
Elongation at Break	ISO 527 @ Crosshead speed 100 mm/min	> 600	%
Carbon Black Content	ISO 6964	2.25	% wt
Carbon Black Dispersion	ISO 18553	± 3	-
Oxidative Induction time	NF EN 728 @ 200°C	≥ 60	min.
Flexural Modulus	ASTM D 790	1,000	MPa
Hardness	ASTM D 2240	64	Shore D
ESCR	ASTM D 1693	>10,000	Hrs, F ₈
Resistance to slow crack growth	ISO 13479 @ 80°C	≥ 500	Hrs
Rapid crack propagation	ISO 13477	≥ 10	d/cr
Resistance to gas constituents	ISO 1167	≥ 20	Hrs

The given values are typical value measured on the product. Values herein are not to be construed as a product specification.

Processing Guidelines

Processing of EL-Lene H1000PC will depend on equipment used, size and wall thickness of the pipe produced. In general, melt temperature should be in the range of 200 - 220 °C. Drying before use at 80 - 90 °C for 1-2 hour is recommended.

Product Technical Assistance

For technical assistance or further information on this product or any other SCG Chemicals' products, please contact your technical service or at the email address, pipe_products@scg.co.th. The address or telephone number are specified below.

Product Available Form

- Black pellet

Product Packaging

- 25 kg loose bag
- 750 kg big bag or Sea bulk

SCG Plastics Company Limited / SCG Performance Chemicals Company Limited

1 Siam Cement Road, Bangsue, Bangkok, 10800 Thailand.

Tel. +66 2586 2922, +66 2586 5375, +66 2586 5511 Fax +66 2586 5376

www.chemicals.scg.co.th

Rev. Aug'13 Valid until next revision

InnoPlus			
HD8100M / HD8100MB			
High Density Polyethylene Resin			
Product Description			
InnoPlus HD8100M is a natural color-high density polyethylene pipe grade. InnoPlus HD8100MB is a black compounded-high density polyethylene pipe grade which is certified as PE100. Both are bimodal resins exhibit excellent creep resistance and chemical resistance properties. They are suitable for high quality pressure pipes, produced by conventional pipe extrusion process.			
Typical Application : High pressure and High temperature pipes; Drinking water pipes, Industrial pipes and Sewer pipes.			
Typical Properties :			
Properties	Typical Value		Test Method
	HD8100M	HD8100MB	
Physical Properties			
Melt Flow Rate (190 °C, 5 kg)	0.25	0.25	g/10 min ASTM D1238
Density	0.952	0.962	g/cm ³ ASTM D1505
Vicat Softening Point @ 10 N, 50 °C/hr	124	124	°C ASTM D1525
Melting Point	128	128	°C ASTM D3418
Mechanical Properties			
Tensile Strength @ Yield	250	240	kg/cm ² ASTM D638
Tensile strength @ Break	420	370	kg/cm ² ASTM D638
Elongation @ Break	750	780	% ASTM D638
Stiffness	7800	8000	kg/cm ² ASTM D747
Flexural Modulus	11000	11500	kg/cm ² ASTM D790
Notched Izod Impact Strength	48 (NB)*	50 (NB)*	kg.cm/cm ASTM D256
Durometer Hardness	64	64	Shore D ASTM D2240
ESCR, F ₈ (Condition B, 35 % Igepal)	>1000	>2000	hrs ASTM D1693
Other Properties			
Carbon Black Content	-	>2.0	% ASTM D4218
Oxidative Induction Time (OIT, 200 °C)	-	>50	Minutes ASTM D3895
Classification	-	PE100	- ISO12162
*NB = Non Break			
Recommendation :			
Preheat condition : 2 hours at 80 °C (For HD8100MB) Extruder temperature : 180 - 200 °C Die temperature : 190 - 220 °C			
FDA Statement :			
HDPE under the brand InnoPlus complies with U.S. FDA 21 CFR 177.1520 regulation for polyethylene used in articles that contact food except for articles used for packaging or holding food during cooking.			
Note : Properties reported here are typical values of the product, not to be considered as specifications. PTT Global Chemical makes no representations as to the accuracy or completeness of the information contained herein.			
PTT Polymer Marketing Company Limited Energy Complex Building A, 9/Thon, 5591 Vibhavadi Rangsit Road, Chulachok, Bangkok 10950 Tel: 66 2140 4488 Fax: 66 2140 4333 Revised Date : March, 2012			

AM3245 PC
HIGH-DENSITY POLYETHYLENE

CHARACTERISTICS : GOOD EXTRUSIBILITY
HIGH PRESSURE PIPE FOLLOW-UP MINIMUM REQUIRED STRENGTH OF 10.0 MPa
(BASED ON ISO 15085 CLASSIFICATION FIELD)
BLACK COLOR COMPOUND
APPLICATIONS : PIPE EXTRUSION
SUITABLE FOR WATER SUPPLY PIPE, PRESSURE PIPE, DRAINAGE AND SEWAGE PIPE,
CONDUIT PIPE AND SUBMURGED PIPE
PROCESSING TEMPERATURE : 190 - 240 °C

PROPERTIES	UNIT	VALUE	TEST METHOD
MELT FLOW INDEX (2.16 kg/190 °C)	g/10min	0.05	ASTM D 1238
MELT FLOW INDEX (5 kg/190 °C)	g/10min	0.25	ASTM D 1238
DENSITY	g/cm ³	0.959	ASTM D 792
TENSILE STRENGTH AT YIELD	MPa	25	ASTM D 638
TENSILE STRENGTH AT BREAK	MPa	38	ASTM D 638
ULTIMATE ELONGATION	%	1600	ASTM D 638
HARDNESS SHORE - D		64	DM 53505
CHARPY NOTCHED IMPACT STRENGTH	kJ/m ²	14	DM 53453
ENVIRONMENTAL STRESS CRACKING RESISTANCE (CONDITION B, F ₈)	hours	>1000	ASTM D1693
CARBON BLACK CONTENT	%	2.5	ASTM D1603

REMARK : THE VALUES PRESENTED ON THE ABOVE ARE TYPICAL LABORATORY AVERAGE, NOT TO BE CONSIDERED AS SPECIFICATIONS
THESE VALUES ARE BASED ON THE DATA OBTAINED FROM THE TESTS CONDUCTED ON THE MATERIALS PROVIDED BY THE MANUFACTURER
ON THE ASSUMPTION OF OUR PRODUCT CANNOT BE GUARANTEED BECAUSE THE CONDITIONS OF USE ON THE PART
OF OUR USERS ARE BEYOND OUR CONTROL.

Sample TIS certificate for PE compound

แบบ มอ. ๒

ใบอนุญาตที่ (3) 2396-1/2559



ใบอนุญาต
แสดงเครื่องหมายมาตรฐานกับผลิตภัณฑ์อุตสาหกรรม
อาศัยอำนาจตามความในพระราชบัญญัติมาตรฐานผลิตภัณฑ์อุตสาหกรรม พ.ศ. ๒๕๕๑
คณะกรรมการมาตรฐานผลิตภัณฑ์อุตสาหกรรม
ออกใบอนุญาตฉบับนี้ให้
บริษัท ไทยโพลีเอทิลีน จำกัด

แสดงเครื่องหมายมาตรฐานกับผลิตภัณฑ์อุตสาหกรรม พอลิเอทิลีนคอมพาวนด์สำหรับผลิตท่อน้ำดื่ม


.....ตามรายละเอียดแนบท้ายใบอนุญาต
ที่ถูกต้องตามมาตรฐานผลิตภัณฑ์อุตสาหกรรม พอลิเอทิลีนคอมพาวนด์สำหรับผลิตท่อน้ำดื่ม

มาตรฐานเลขที่ มอก. 2559-2554

เครื่องหมายการค้า.....
พื้ที่โรงงานชื่อ.....บริษัท ไทยโพลีเอทิลีน จำกัด
ตั้งอยู่ที่อาคารเลขที่ 271 นิคมอุตสาหกรรมมาบตาพุด.....ต.รอก/ชอช.....
ถนน.....สุขุมวิท.....หมู่ที่.....ตำบล/แขวง.....มาบตาพุด.....อำเภอ/เขต.....เมืองระยอง
จังหวัด.....ระยอง.....ทะเบียนโรงงานเลขที่.....น.42(1)-11/2540-ญ.พ.

ทั้งนี้ ต้องปฏิบัติตามเงื่อนไขในการอนุญาตที่คณะกรรมการกำหนด

ออกให้ ณ วันที่ 14 พ.ค. 2556 พ.ศ.....


(นางสาวศุภมา รวออาจิม)
รองปลัดกระทรวงอุตสาหกรรม รักษาการแทน
เลขาธิการสำนักงานมาตรฐานผลิตภัณฑ์อุตสาหกรรม

สำนักงานมาตรฐานผลิตภัณฑ์อุตสาหกรรม
กระทรวงอุตสาหกรรม

เลขประจำตัวผู้เสียภาษี.....
ผู้รับใบอนุญาต 0105552033905

ทำเดือน.....
ผู้รับใบอนุญาตต้องปฏิบัติตามเงื่อนไขที่คณะกรรมการกำหนด

รายละเอียดแนบท้ายใบอนุญาตแสดงเครื่องหมายมาตรฐานกับผลิตภัณฑ์อุตสาหกรรม
ที่ (3) 2396-1/2559

รายการที่	รายละเอียดของผลิตภัณฑ์อุตสาหกรรมที่ได้รับอนุญาต (โดยระบุประเภท/แบบ/ขนาด/ชิ้น/และอื่นๆ)
1	ชั้นคุณภาพ PE 80 สีดำ
2	ชั้นคุณภาพ PE 100 สีดำ


(นายนิลิตร์ พิณกิตแทน)
นักวิชาการมาตรฐานชำนาญการพิเศษ
รักษาการแทน ผู้อำนวยการสำนักงานมาตรฐาน 3
พนักงานเจ้าหน้าที่

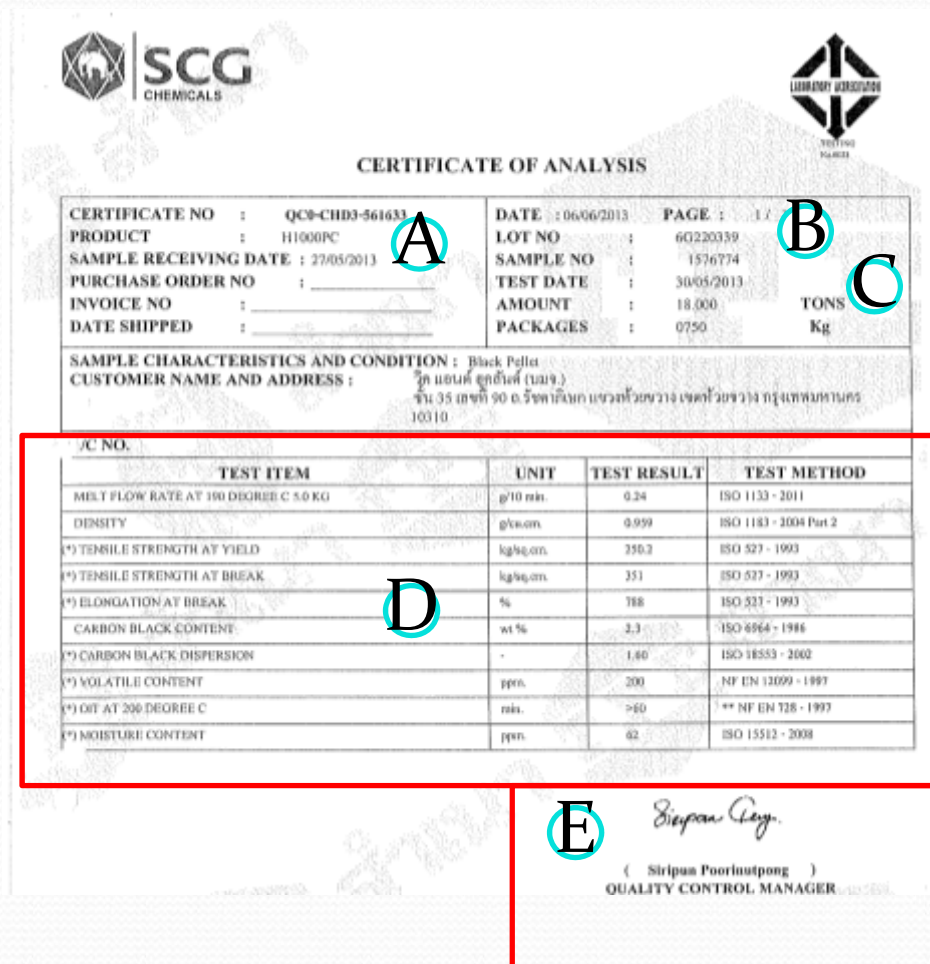
TIS 2559-2554 Polyethylene compound for drinking water pipe

มอก. 2559 : 2554 “พอลิเอทิลีนคอมพาวนด์สำหรับผลิตท่อน้ำดื่ม”

Sample of certificate of analysis

- COA Certificate of Analysis of resin
- It is generally issued by resin suppliers every delivered resin LOT.

- A**-Resin grade name
- B**-Resin Lot number
- C**-Amount of supply
- D**-Test results
- E**-Signature



SCG CHEMICALS

CERTIFICATE OF ANALYSIS

CERTIFICATE NO : QC8-CHD3-561633 **A**

PRODUCT : H1000PC **B**

SAMPLE RECEIVING DATE : 27/05/2013

PURCHASE ORDER NO : _____

INVOICE NO : _____

DATE SHIPPED : _____

DATE : 06/06/2013

PAGE : 1/1

LOT NO : 60220339 **C**

SAMPLE NO : 1576774

TEST DATE : 30/05/2013

AMOUNT : 18,000 TONS

PACKAGES : 0750 Kg

SAMPLE CHARACTERISTICS AND CONDITION : Black Pellet

CUSTOMER NAME AND ADDRESS : บริษัท เอสซี เคมิคอล จำกัด (มหาชน)
 35 หมู่ 90 ต.วังทอง อ.วังทอง จ.พิจิตร 36000

TEST ITEM	UNIT	TEST RESULT	TEST METHOD
MELT FLOW RATE AT 190 DEGREE C 5.0 KG	g/10 min.	0.24	ISO 1133 - 2011
DENSITY	g/cm ³	0.999	ISO 1183 - 2004 Part 2
(*) TENSILE STRENGTH AT YIELD	kg/cm ²	350.3	ISO 527 - 1993
(*) TENSILE STRENGTH AT BREAK	kg/cm ²	351	ISO 527 - 1993
(*) ELONGATION AT BREAK	%	788	ISO 527 - 1993
CARBON BLACK CONTENT	wt %	3.3	ISO 4564 - 1986
(*) CARBON BLACK DISPERSION	-	1.40	ISO 18553 - 2002
(*) VOLATILE CONTENT	ppm	200	NF EN 12099 - 1997
(*) OIT AT 200 DEGREE C	min.	>60	** NF EN 128 - 1997
(*) MOISTURE CONTENT	ppm	62	ISO 15512 - 2008

E *Siripon Pong*
 (Siripon Pongnupong)
 QUALITY CONTROL MANAGER