

# Contents

<b>Foreword .....</b>	5
<b>List of authors .....</b>	7
<b>1. Introduction to Polyethylene .....</b>	19
<i>Wolfgang Huszar, Dr. Mary McCarthy, James McGoldrick and Werner Rothhöft</i>	
1.1 Chemical Structure of PE-HD .....	19
1.2 Relation structure and properties .....	20
1.2.1 Crystallinity and Density .....	23
1.2.2 Flowability (MW, MWD, MFR) .....	26
1.2.3 Creep behaviour .....	26
1.2.4 Process of Slow Crack Growth (SCG) .....	28
1.3 Polymerisation Processes of PE 100 .....	29
1.4 Benefits of PE 100 .....	30
1.5 Ongoing development .....	31
<b>2. Pipe Properties .....</b>	32
<i>Wolfgang Huszar, Dr. Mary McCarthy, James McGoldrick and Werner Rothhöft</i>	
2.1 Hydrostatic Pressure Resistance .....	32
2.1.1 100 Years Service Life .....	34
2.2 Resistance to Slow Crack Growth .....	35
2.2.1 Behaviour of Notched Pipes - Notched Pipe Test (NPT) .....	35
2.2.2 Full Notch Creep Test - FNCT .....	36
2.2.3 Other tests methods describing the Resistance to Slow Crack Growth .....	37
2.2.3.1 Pennsylvania Notch Tensile Test – PENT .....	37
2.2.3.2 Notched Ring Test (NRT) .....	38
2.2.3.3 Point Loading Test – PLT .....	39
2.2.3.4 Fatigue crack growth testing .....	39
2.2.3.5 Strain hardening modulus .....	39
2.3 Resistance to Rapid Crack Propagation .....	40
2.3.1 Full Scale Test .....	42
2.3.2 Small Scale Steady State Test - S4 Test .....	42
2.4 Installation and operational aspects .....	43
2.4.1 Behaviour of buried pipes .....	43
2.4.2 Chemical Resistance .....	44
2.4.3 Abrasion Resistance .....	47
<b>3. Pipe dimensioning .....</b>	48
<i>Heiner Brömstrup and Werner Rothhöft</i>	
3.1 Pipe classification .....	48
3.2 Internal pressure loads .....	48

3.2.1	Calculation of pipe wall thickness .....	52
3.2.2	Calculation of internal pipe pressure .....	52
3.2.3	Calculation of effective service-life .....	53
3.2.4	Calculation of safety factor .....	53
3.2.5	Hydrostatic strength diagrams for PE 100 and PE 80 pressure pipes .....	54
3.2.6	Pipe series in accordance with the SDR (Standard Dimension Ratio) ..	54
3.2.7	Intermittent exposure to internal pressure .....	56
3.2.8	Pressure-surge loads .....	58
3.3	External pressure loads .....	60
3.4	Hydraulic calculation .....	60
3.4.1	Fundamental equation of pipe flow .....	60
3.4.1.1	Mean velocity of flow .....	61
3.4.1.2	Reynolds number .....	61
3.4.1.3	Laws of resistance .....	61
3.4.1.4	Moody diagram .....	62
3.4.2	Calculation applying the individual concept .....	62
3.4.3	Calculation applying the global concept .....	63
3.4.4	Codes, rules and standards .....	64
<b>4.</b>	<b>Production of pipes and shapes .....</b>	65
	<i>Thomas Frank and Dr. Thorsten Späth</i>	
4.1	Pipe production .....	65
4.2	Production of fittings .....	67
4.2.1	Injection moulding .....	67
4.2.2	Fittings produced from pipe .....	70
<b>5.</b>	<b>Quality Assurance .....</b>	74
	<i>Ulrich Schulte and Thomas Frank</i>	
5.1	Quality assurance requirements for producers of pipe extrusion compounds .....	74
5.1.1	Quality Management .....	74
5.1.2	Quality Control .....	74
5.1.3	The PE 100+ Association quality tests .....	75
5.1.3.1	Test schedule .....	75
5.1.3.2	Test requirements .....	76
5.1.3.3	Tests .....	77
5.1.3.4	The PE 100+ Association "List of Quality Materials" .....	77
5.2	Quality assurance requirements for the pipe and fittings producer .....	78
5.2.1	Incoming goods inspection .....	78
5.2.2	Quality criteria .....	78
5.2.3	Tests on the product .....	79
5.2.4	Inspection certificates .....	80
5.2.5	Marking and traceability .....	82