Thermoplastic Pipes

Appropriate Technology

Noble Plastics

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Noble Plastics Pipe Polymers

- **Noble Plastics** are ***like people***:
  - have a unique “fingerprint” – CRRC
  - have a working life – 50 years
  - grow old – regress
  - temperature sensitive – hot or cold
  - suit a particular job – application
- **Noble Plastics** are ***unlike other materials***:
  - have variable attributes – time/temp
  - have superior attributes – short-term
  - have superior niche uses – slurry
  - have less environmental impact – recycle/reuse

Noble Plastics Pipes Design

- Unique ***CRRC*** (Creep Rupture Regression Curve)

  Equation form: $\log t = A + B / T + C.\log \sigma + D.\log \sigma / T$

- ***MRS*** (**M**inimum **R**equired **S**trength) at 50 years and 20°C

  Classification and ***Allowable Design Stress σ*** = MRS / C

- ***Design Coefficient C*** depends on polymer attributes

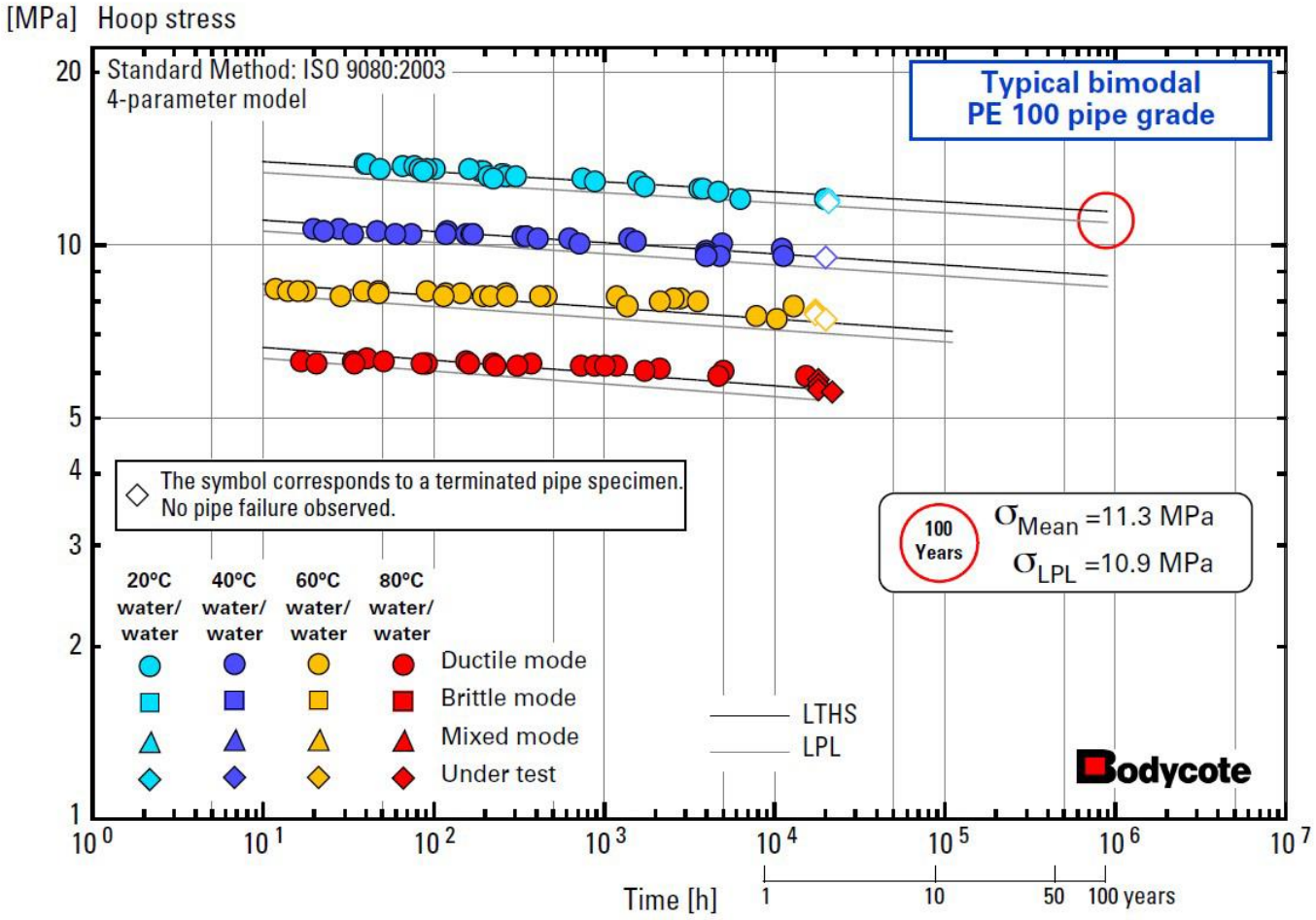
  Lower: strong; tough; ductile**. Higher**: brittle

- ***ISO protocol 50-years*** (438 000 hours) strength attributes

  100-years service life in the future?

Noble Plastics Pipes Design

PE100 Creep Rupture Regression Curves
PE100 80°C no “knee” before 5000 hours



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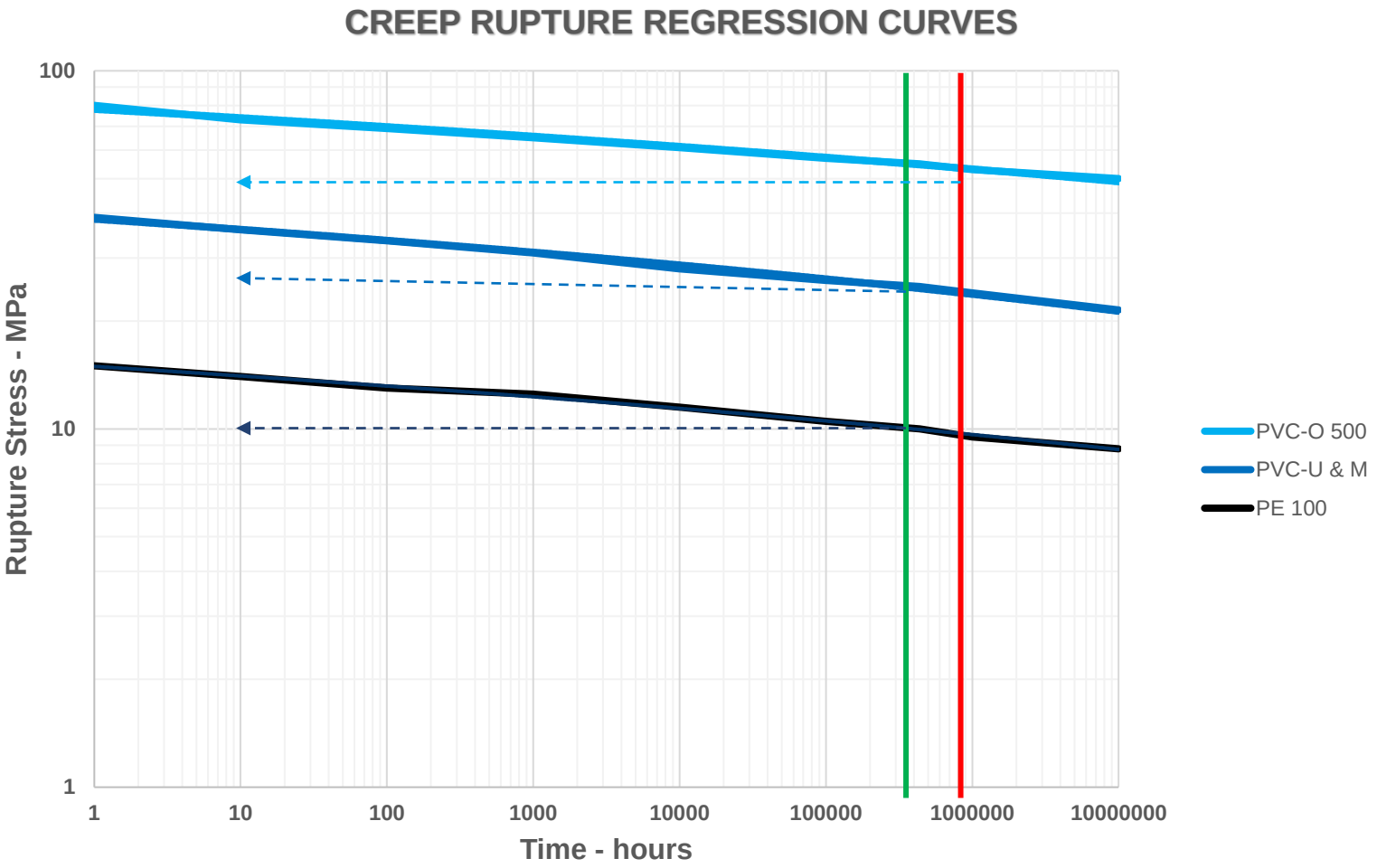
Noble Plastics Pipes Design

PVC-O, PVC-U and PVC-M, PE

TOM®500: 50 years MRS 55 MPa; 100 years 53.8 MPa



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Classification and Variable Attributes

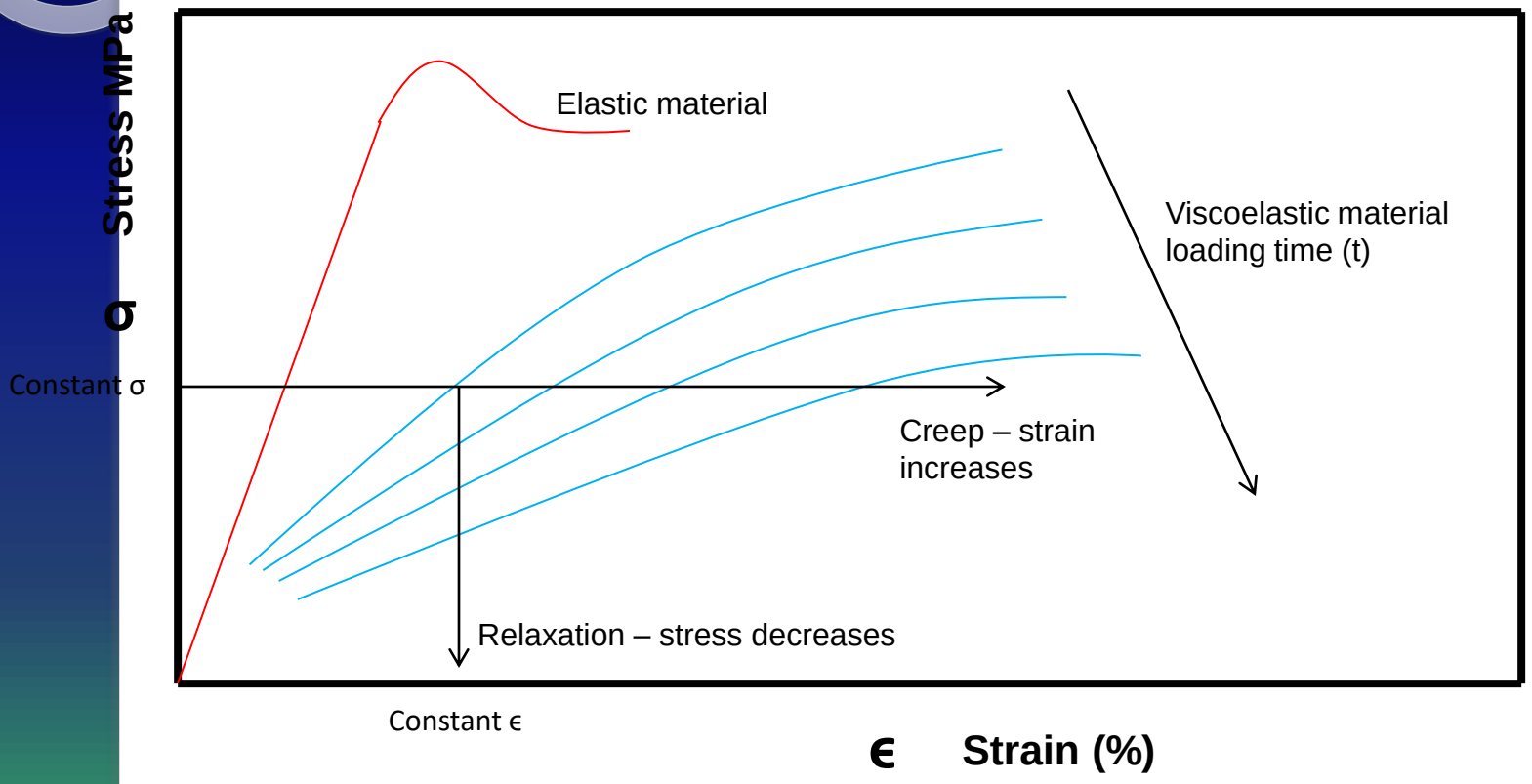
- ***Polymer Classification*** = 10 x MRS
- PE100 MRS = 10, PVC-U MRS = 25, correctly ***"PVC-U 250"***
- ***PVC-O*****:** 5 Material Classifications; 3 Cs; 5 PNs

- Strength attributes – decrease with increasing ***time***
- Strength attributes – decrease with increasing ***temperature***
- Strength attributes – increase with decreased ***time/temp***

- ***CREEP*** – at constant stress, the strain increases
- ***RELAXATION*** – at constant strain, the stress decreases

Stress/Strain Graph
Elastic and Viscoelastic Noble Plastics

Reproduced from *Plastic Pipes* by Prof. L-E Janson



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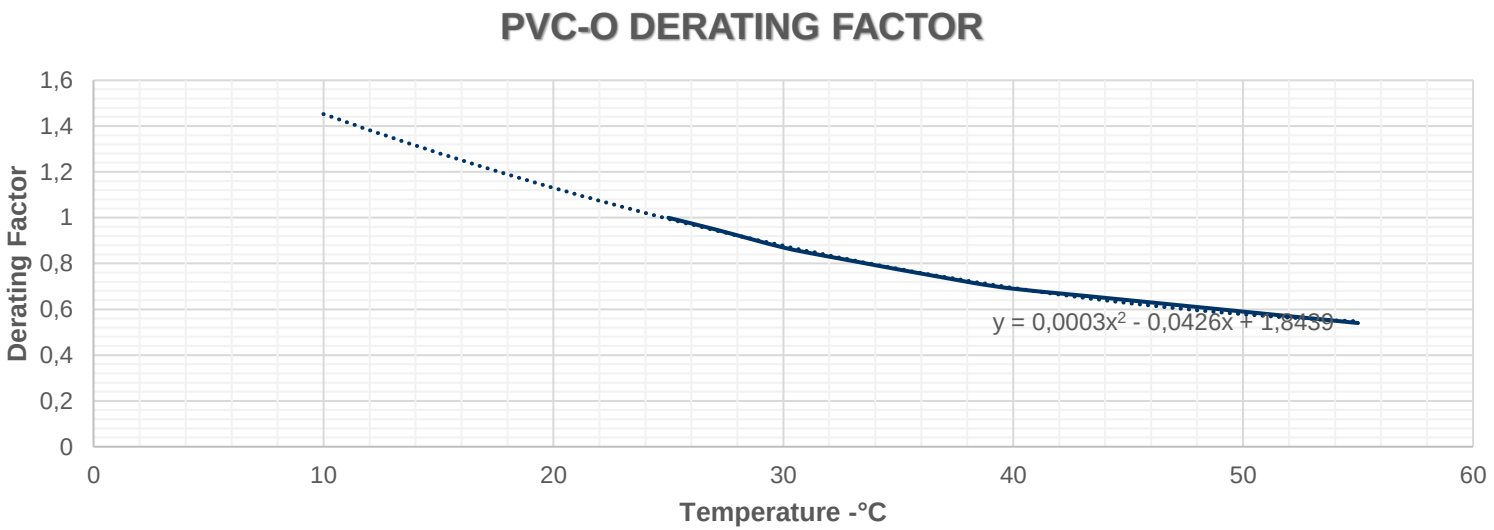
Derating Noble Plastics – PVC-O

- Noble Plastics reference temperature – 20/23°C
- Temperature increases the attributes – decrease



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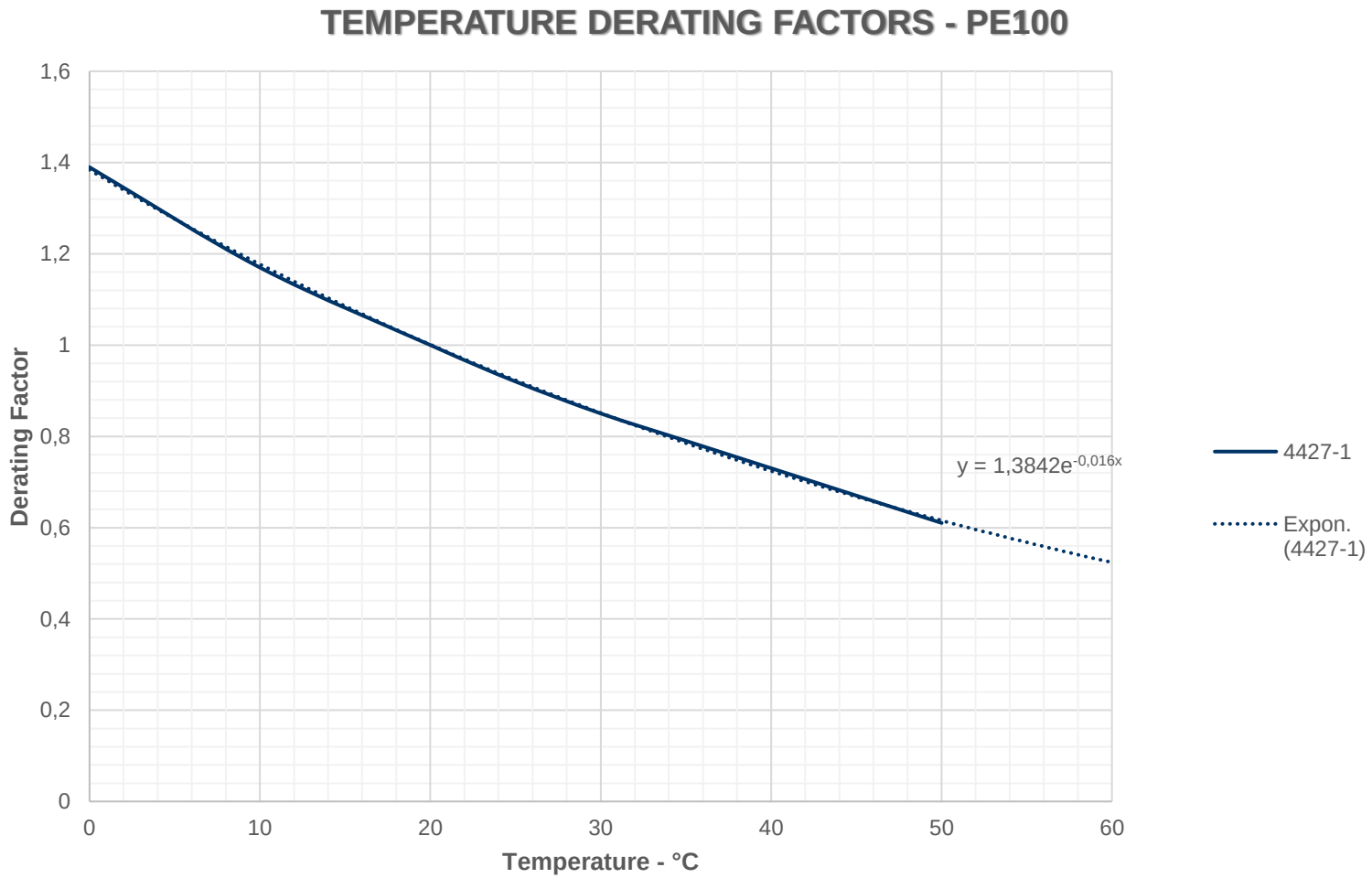
Derating Noble Plastics – PE



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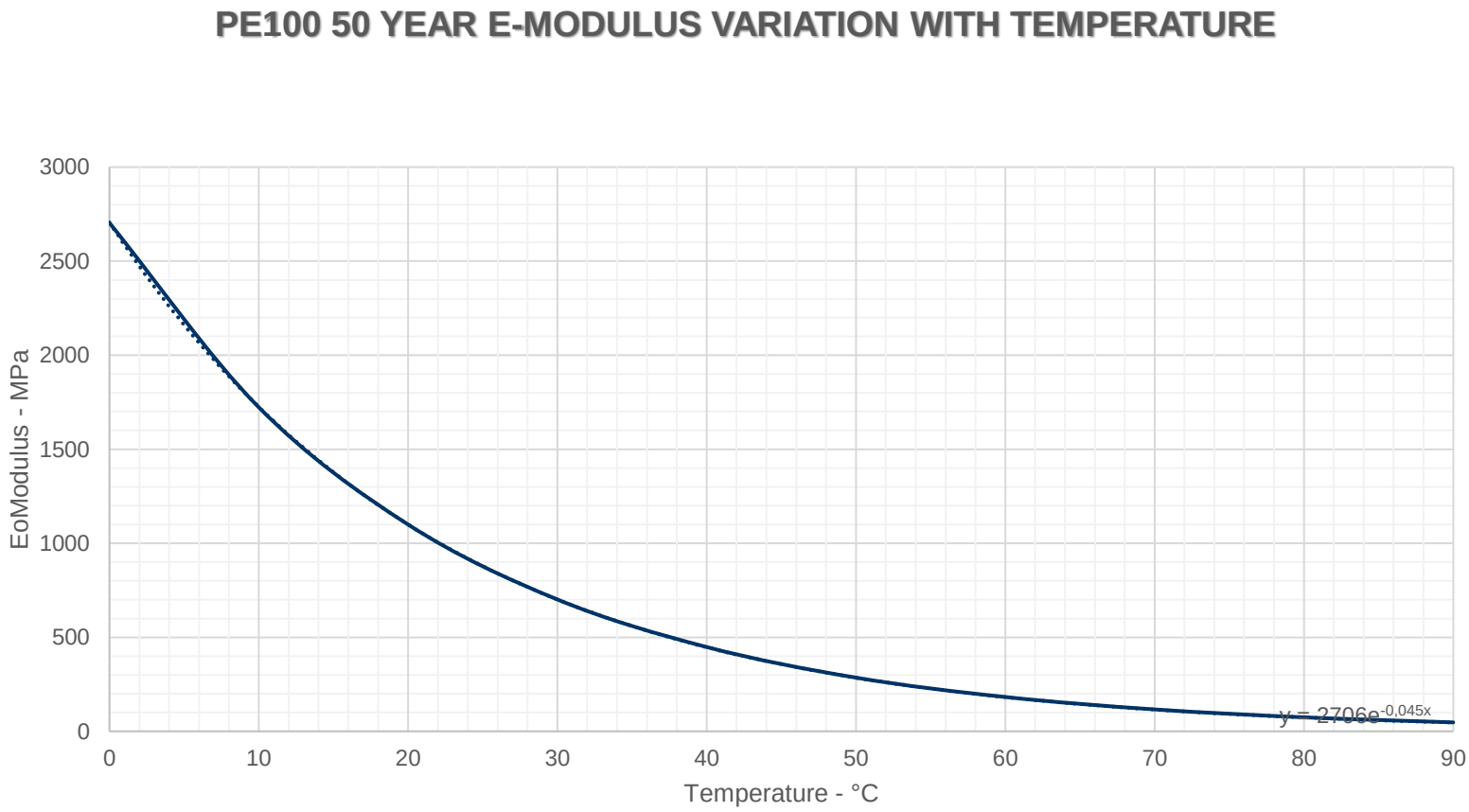
PE E-Modulus Variation



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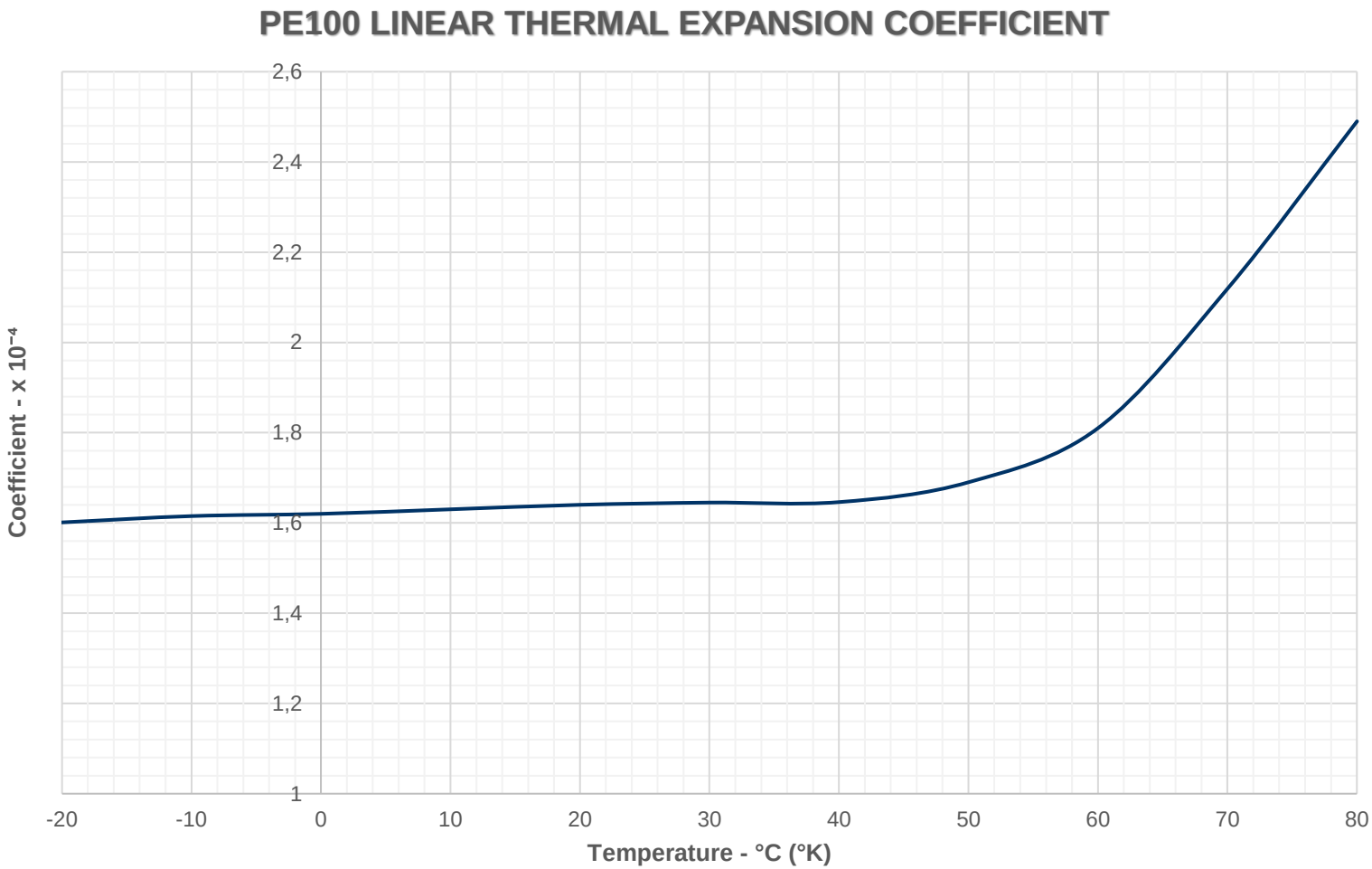
PE Thermal Expansion Varies



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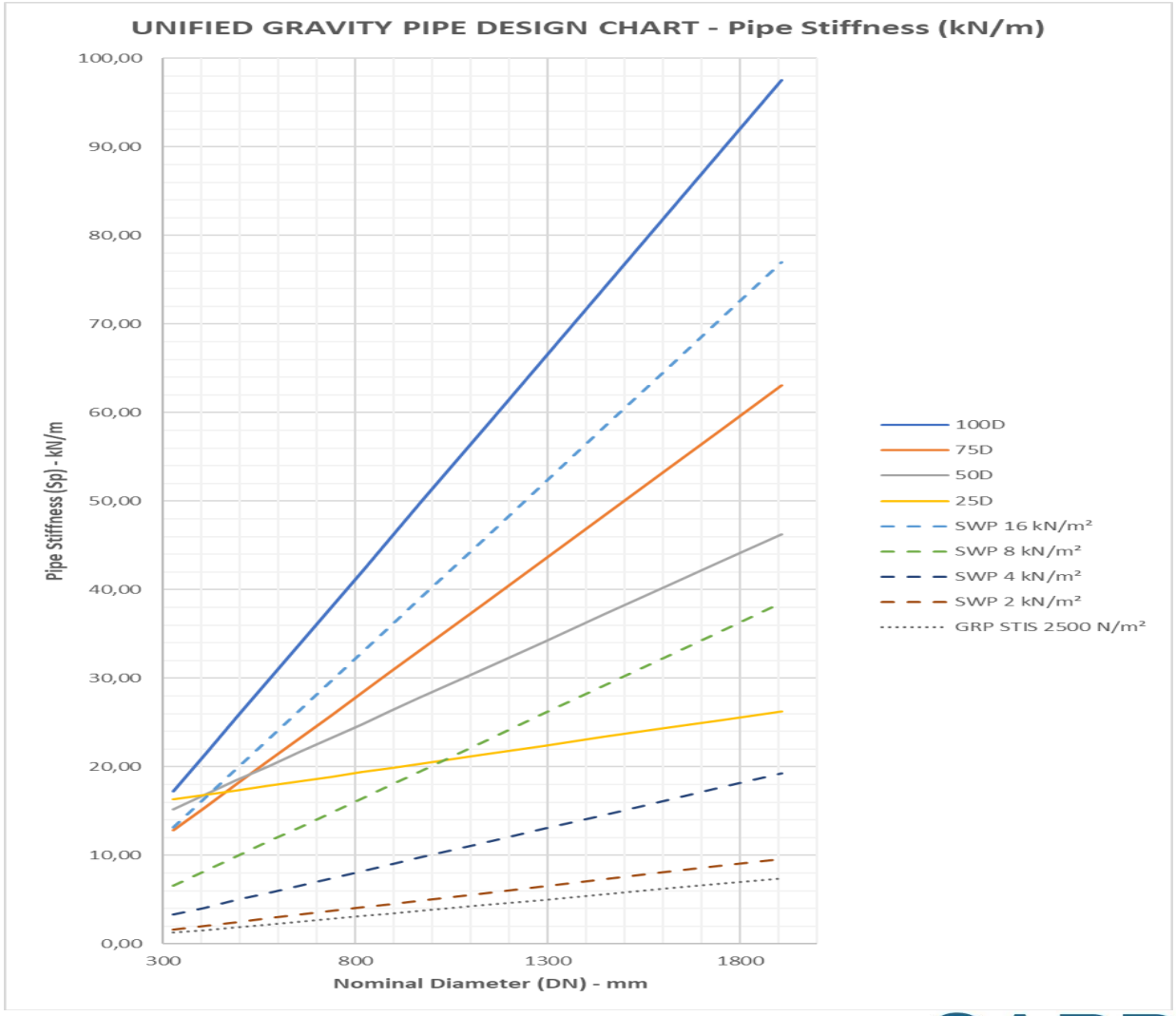
MRS, Classification, σ and Stiffness

- **MRS** determines:
  - Classification - 10 x MRS
  - Allowable Design Stress - $\sigma = MRS / C$
  - Design Coefficient (Safety Factor) - C
  - Ring Stiffness - $S_R = EI/(D-e_n)^3$
  - E decreases with time - regresses
  - E proportional to Classification - MRS
  - e inversely proportional to MRS - $e=P.D/(2\sigma+P)$
- **PVC-O**:
  - 5 material Classifications - 315 – 500
  - 3 Design Coefficients C - 1,4-1,5-2,0
  - 5 pipe pressure classes PN - 10 – 25

Noble Plastics Structured Wall Pipe

RCP (**R**einforced **C**oncrete **P**ipe)	- gravity market
RCP non-homogeneous material	- conduit and structure
SWP only conduit	- structure built on site
“Soil/Pipe” structure conforming	- conforming pipeline
Soil Mechanics critical	- SWP embedment
SANS 2001-DP1 Mod. AASHTO	- road construction
Standard Proctor **Noble Plastics**	- 22% of Mod. force
Qualify tender compaction	- Std. Proctor 95% max.
Casagrande Classification SC	- 90% Mod. = 95% Std.
Pipe Stiffness not Ring Stiffness	- value measured
RCP and **SWP** Pipe Stiffnesses	- Unified Design Chart
SWP zero corrosion	- sewage “eats” RCP
SWP after sales service critical	- conforming pipeline

Unified Gravity Pipeline Design Chart



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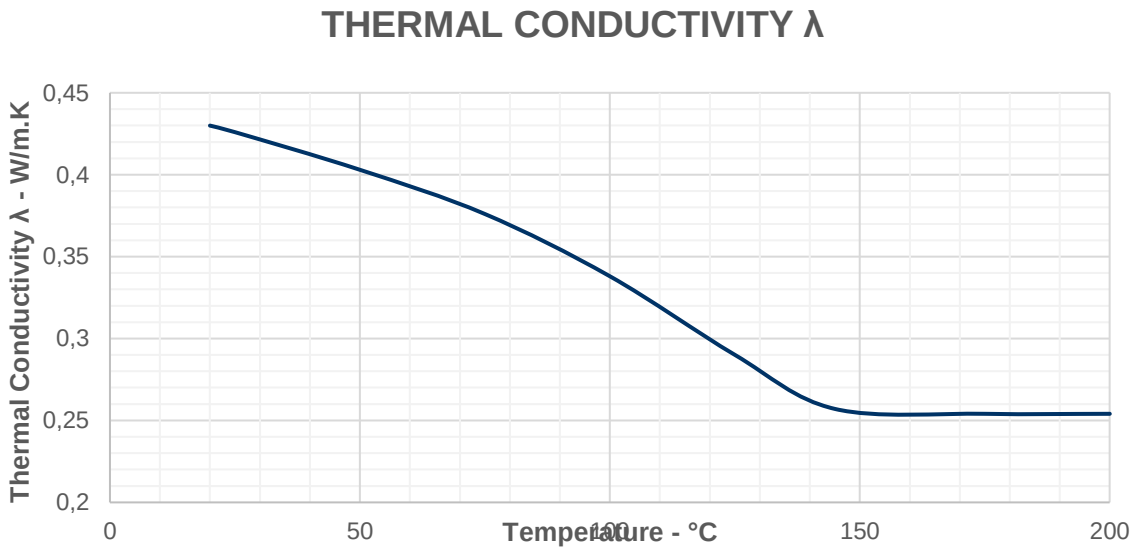
PE Swept Bends

- Conforming **Noble Plastic** pipe must be used
- Oven temperature *Fourie's Formula* $Q = \lambda . A . (\delta\theta / \delta e)$
- Thermal Conductivity (λ) varies with temperature ≤ 150°C



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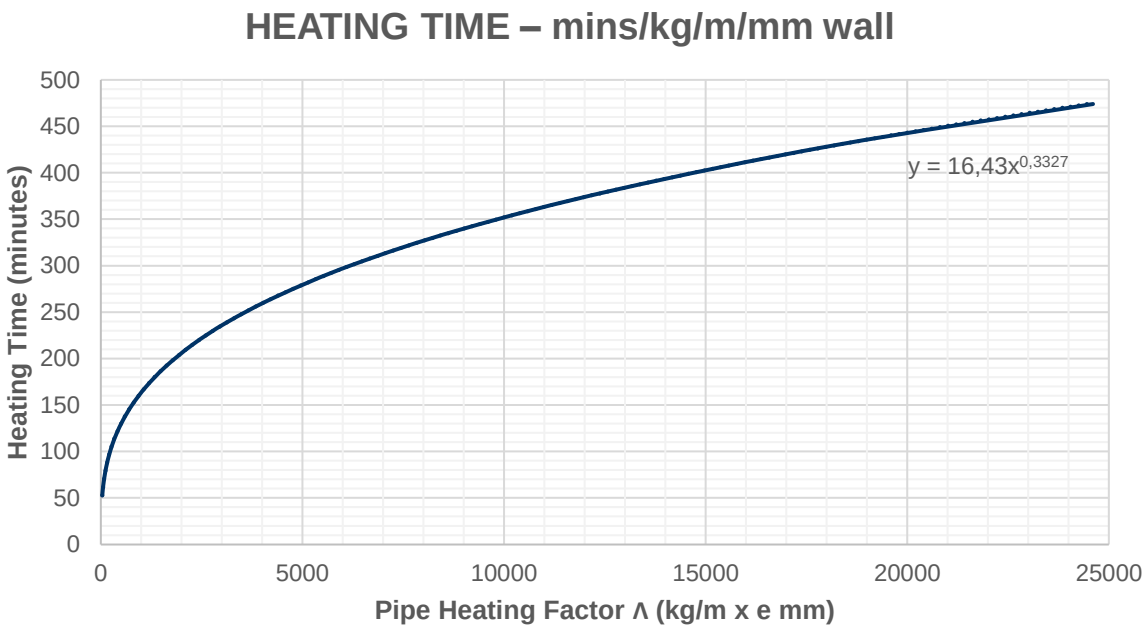
PE Swept Bends

- Heating time $t = 16{,}43 \cdot (\Lambda)^{0'3327}$ at 150°C
- Different fittings, different pipes, different sizes, different mass
- Heating and cooling time changes



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Conclusion

- Noble Plastics pipes are different to other materials
- Different attributes must be engineered for
- Attributes are superior or inferior to other materials
- Superior attributes are why **Noble Plastics** are used
- Inferior attributes are why **Noble Plastics** are not used
- Knowledge of attributes enables good engineering

Thank You for Your Attention

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