ISO/TR 10400:2018-08 (E)

Petroleum and natural gas industries - Formulae and calculations for the properties of casing, tubing, drill pipe and line pipe used as casing or tubing

Contents

Page

Foreword vi

Introduction vii

1 Scope 1

2 Normative references 2

3 Termsanddefinitions 2

4 Symbols 4

5 Conformance 13
5.1 References 13
5.2 Units of measurement 13

6 Triaxial yield of pipe body 13
6.1 General 13
6.2 Assumptions and limitations 13
6.2.1 General 13
6.2.2 Concentric, circular cross-sectional geometry 14
6.2.3 Isotropic yield 14
6.2.4 No residual stress 14
6.2.5 Cross-sectional instability (collapse) and axial instability (column buckling) 14
6.3 Data requirements 14
6.4 Design formula for triaxial yield of pipe body 14
6.5 Application of design formula for triaxial yield of pipe body to line pipe 16
6.6 Example calculations 16
6.6.1 Initial yield of pipe body, Lamé formula for pipe when external pressure, bending and torsion are zero 16
6.6.2 Yield design formula, special case for thin wall pipe with internal pressure only and zero axial load 18
6.6.3 Pipe body yield strength 18
6.6.4 Yield in the absence of bending and torsion 19

7 Ductile rupture of the pipe body 20
7.1 General 20
7.2 Assumptions and limitations 20
7.3 Data requirements 21
7.3.1 General 21
7.3.2 Determination of the hardening index 21
7.3.3 Determination of the burst strength factor, ka 22
7.4 Design formula for capped-end ductile rupture 23
7.5 Adjustment for the effect of axial force and external pressure 24
7.5.1 General 24
7.5.2 Design formula for ductile rupture under combined loads 25
7.5.3 Design formula for ductile necking under combined loads 26
7.5.4 Boundary between rupture and necking 27
7.5.5 Axisymmetric wrinkling under combined loads 27
7.6 Example calculations 28
7.6.1 Ductile rupture of an end-capped pipe 28

7.6.2 Ductile rupture for a given true axial load 28

8 External pressure resistance 29
8.1 General 29
8.2 Assumptions and limitations 29
8.3 Data requirements 29
8.4 Design formula for collapse of pipe body 30
8.4.1 General 30
8.4.2 Yield strength collapse pressure formula 30
8.4.3 Plastic collapse pressure formula 31
8.4.4 Transition collapse pressure formula 33
8.4.5 Elastic collapse pressure formula 34
8.4.6 Collapse pressure under axial tensile stress 35
8.4.7 Collapse pressure under axial stress and internal pressure 35
8.5 Formulae for empirical constants 35
8.5.1 General 35
8.5.2 SI units 36
8.5.3 USC units 36
8.6 Application of collapse pressure formulae to line pipe 37
8.7 Example calculations 37

9 Joint strength 37
9.1 General 37
9.2 API casing connection tensile joint strength 37
9.2.1 General 37
9.2.2 Round thread casing joint strength 38
9.2.3 Buttress thread casing joint strength 40
9.3 API tubing connection tensile joint strength 42
9.3.1 General 42
9.3.2 Non-upset tubing joint strength 42
9.3.3 Upset tubing joint strength 43
9.4 Line pipe connection joint strength 44

10 Pressure performance for couplings 44
10.1 General 44
10.2 Internal yield pressure of round thread and buttress couplings 44
10.3 Internal pressure leak resistance of round thread or buttress couplings 45

11 Calculated masses 48
11.1 General 48
11.2 Nominal linear masses 48
11.3 Calculated plain-end mass 48
11.4 Calculated finished-end mass 49
11.5 Calculated threaded and coupled mass 49
11.5.1 General 49
11.5.2 Direct calculation of em, threaded and coupled pipe 50
11.6 Calculated upset and threaded mass for integral joint tubing 50
11.6.1 General 50
11.6.2 Direct calculation of em, upset and threaded pipe 51
11.7 Calculated upset mass 51
11.7.1 General 51
11.7.2 Direct calculation of em, upset pipe 52
11.8 Calculated coupling mass 52
11.8.1 General 52
11.8.2 Calculated coupling mass for line pipe and round thread casing and tubing 52
11.8.3 Calculated coupling mass for buttress thread casing 55
11.9 Calculated mass removed during threading 56
11.9.1 General 56
11.9.2 Calculated mass removed during threading pipe or pin ends 56
11.9.3 Calculated mass removed during threading integral joint tubing box ends 58
11.10 Calculated mass of upsets 59

11.10.1 General 59
11.10.2 Calculated mass of external upsets 59
11.10.3 Calculated mass of internal upsets 60
11.10.4 Calculated mass of external-internal upsets 61

12 Elongation 61

13 Flattening tests 62
13.1 Flattening tests for casing and tubing 62
13.2 Flattening tests for line pipe 62

14 Hydrostatic test pressures 63
14.1 Hydrostatic test pressures for plain-end pipe and integral joint tubing 63
14.2 Hydrostatic test pressure for threaded and coupled pipe 64

15 Make-up torque for round thread casing and tubing 64

16 Guided bend tests for submerged arc-welded line pipe 65
16.1 General 65
16.2 Background 67
16.2.1 Values of eng 67
16.2.2 Values of Agbtj 67

17 Determination of minimum impact specimen size for API couplings and pipe 67
17.1 Critical thickness 67
17.2 Calculated coupling blank thickness 68
17.3 Calculated wall thickness for transverse specimens 71
17.4 Calculated wall thickness for longitudinal specimens 71
17.5 Minimum specimen size for API couplings 71
17.6 Impact specimen size for pipe 73
17.7 Larger size specimens 73
17.8 Reference information 74

Annex A (informative) Discussion of formulae for triaxial yield of pipe body 75

Annex B (informative) Discussion of formulae for ductile rupture 88

Annex C (informative) Rupture test procedure 126

Annex D (informative) Discussion of formulae for fracture 128

Annex E (informative) Discussion of historical collapse formulae 135

Annex F (informative) Development of probabilistic collapse performance properties 149

Annex G (informative) Calculation of design collapse strength from collapse test data 188

Annex H (informative) Calculation of design collapse strengths from production quality data 191

Annex I (informative) Collapse test procedure 205

Annex J (informative) Discussion of formulae for joint strength 211

Annex K (informative) Tables of calculated performance properties in SI units 219

Annex L (informative) Tables of calculated performance properties in USC units 221

Bibliography 223