

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	Terms and definitions	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, k_a	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 e_m , 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 e_m , upset and threaded pipe	51
11.7	Calculated upset mass	51
11.7.1	General	51
11.7.2	Direct calculation of e_m , 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 σ_{eng}	67
16.2.2	Values of σ_{gbtj}	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