DIN EN 1591-1:2014-04 (E)

Flanges and their joints - Design rules for gasketed circular flange connections - Part 1: Calculation

Contents

Page

Foreword 5

1 Scope 7

2 Normative references 7

3 Notation 7
3.1 Use of figures 7
3.2 Subscripts and special marks 7
3.2.1 Subscripts 7
3.2.2 Special marks 9
3.3 Symbols 9
3.4 Terminology 14
3.4.1 Flanges 14
3.4.2 Loading 14
3.4.3 Load conditions 14
3.4.4 Compliances 14

4 Requirements for use of the calculation method 22
4.1 General 22
4.2 Geometry 22
4.3 Material 23
4.4 Loads 23

5 Checking the assembly for a specified initial tightening bolt force (or torque) 23

6 Calculation parameters 24
6.1 General 24
6.2 Flange parameters 24
6.2.1 General 24
6.2.2 Flange ring 25
6.2.3 Connected shell 26
6.2.4 Flexibility-related flange parameters 27
6.3 Bolt and washer parameters 28
6.3.1 General 28
6.3.2 Effective cross-section area of bolts 28
6.3.3 Flexibility modulus of bolts 28
6.3.4 Geometric parameters for washers and contact surfaces 28
6.3.5 Flexibility modulus of washers 29
6.4 Gasket parameters 29
6.4.1 General 29
6.4.2 Theoretical dimensions 29
6.4.3 Effective dimensions 29
6.4.4 Axial flexibility modulus of gasket 30
6.4.5 Lever arms 32

7 Forces 33
7.1 General 33
7.2 Applied loads 33
7.2.1 Assembly condition (l = 0) 33
7.2.2 Subsequent conditions (l = 1, 2 .....) 33

7.3 Compliance of the joint 34
7.4 Minimum forces necessary for the gasket 35
7.4.1 Assembly condition (l = 0) 35
7.4.2 Subsequent conditions (l = 1, 2, ...) 35
7.5 Internal forces in assembly condition (l = 0) 35
7.5.1 Required forces 35
7.5.2 Accounting for bolt-load scatter at assembly 36
7.6 Internal forces in subsequent conditions (l = 1, 2, ...) 37

8 Load limits 38
8.1 General 38
8.2 Bolts 38
8.3 Gasket 39
8.4 Integral flange and collar 39
8.5 Blank flange 41
8.6 Loose flange with collar 42

Annex A (informative) Dimensions of standard metric bolts 43

Annex B (informative) Tightening 44

B.1 Scatter of initial bolt load of a single bolt -- Indicative values 1- and 1+ for a single bolt ... 44
B.2 Scatter for the global load of all the bolts 44
B.3 Manual uncontrolled tightening 45
B.4 Assembly using torque wrench 45
B.5 Assembly using bolt tensioner 46

Annex C (informative) Flange rotations 48

C.1 General 48
C.2 Use of flange rotation 48
C.3 Calculation of flange rotations 48

Annex D (informative) Use of the calculation method 50

D.1 Calculation method principle 50
D.2 Mechanical model 51
D.3 Required checks 52
D.4 Calculation sequence 52

Annex E (informative) Gasket/flange face friction coefficients examples 54

Annex F (normative) Determination of eGc,l based on a given PQR 55

F.1 Determination of the deflection occurring during a PQR test 55
F.2 Determination of the deflection to be taken into account in the calculation 56

Annex G (informative) Sealing gasket parameter when no leakage rate is specified 57

Annex H (informative) Alternative calculation procedure taking into account the plastic deformation of the gasket in subsequent load conditions procedures (after assembly) 58

H.1 Introduction 58
H.2 Calculation procedure 58
H.2.1 General description 58
H.2.2 No additional plastic deformation 59
H.2.3 Additional plastic deformation 59
H.3 Flat gaskets 59
H.3.1 Flat gaskets with small or median deformations 59
H.3.2 Flat gaskets with greater deformations 61
H.4 Metal gaskets with curved surfaces (Figures 3b, c, e, f) 62
H.5 Metal gaskets with octagonal section (Figure 3d) 62

Annex I (informative) Available, incomplete models for conversion of the leakage rates in different conditions (based on certain flow models) 63

I.1 Introduction and warning 63
I.2 Flow theory fundamentals 63
I.2.1 Transport modes 63
I.2.2 Case of gases 64
I.2.3 Case of liquids: Parallel capillary model 65
I.3 Factors of influence on the leakage rate of gaskets and gasketed joints 65
I.3.1 List of identified factors 65
I.3.2 Limits and restriction of the proposed models 65
I.3.3 Dependence on pressure 66
I.3.4 Dependence on temperature 67
I.3.5 Dependence on the type of fluid 68
I.3.6 Influence of the gasket thickness 68
I.3.7 Influence of gasket width 69
I.3.8 Influence of gasket stress 69
I.3.9 Influence of other factors 69
I.3.10 Conclusion on the factors of influence 70
I.4.1 General 70
I.4.2 Determination of a trend for the leakage rate for the flange connection in "actual" from "reference" conditions 71
I.4.3 Determination of a trend for the leakage rate for the flange connection in "reference" from "actual" conditions 72

Annex ZA (informative) Relationship between this European Standard and the Essential Requirements of EU Directive 97/23/EC 74

Bibliography 75