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Thermoplastic pipes — Universal wall thickness table

Tubes en thermoplastique — Tableau universel des épaisseurs de paroi

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FOREWORD

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4065 was developed by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, and was circulated to the member bodies in June 1976.

It has been approved by the member bodies of the following countries :

Australia	Ireland	Portugal
Belgium	Israel	Romania
Chile	Italy	Spain
Denmark	Japan	Sweden
Finland	Korea, Rep. of	Switzerland
France	Mexico	Turkey
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The member bodies of the following countries expressed disapproval of the document on technical grounds :

Canada
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Thermoplastic pipes — Universal wall thickness table

1 SCOPE AND FIELD OF APPLICATION

This International Standard sets out a universal wall thickness table for thermoplastic pipes.

2 REFERENCES

ISO 161, *Thermoplastics pipes for the transport of fluids — Nominal outside diameters and nominal pressures.*

ISO 497, *Guide to the choice of series of preferred numbers and of series containing more rounded values of preferred numbers.*

3 BASIC THEORY

Generally speaking, the wall thickness of thermoplastic pipes can be expressed as follows :

$$e = f\,(d_e; A; B; C; D) \qquad \ldots(1)$$

where

e is the nominal wall thickness;

d_e is the nominal outside diameter;

A represents the physical influences (temperature, time);

B represents the mechanical influences (internal pressure, external forces);

C represents the chemical influences (contact reactions);

D represents the material properties (long-term behaviour, temperature dependence, chemical resistance).

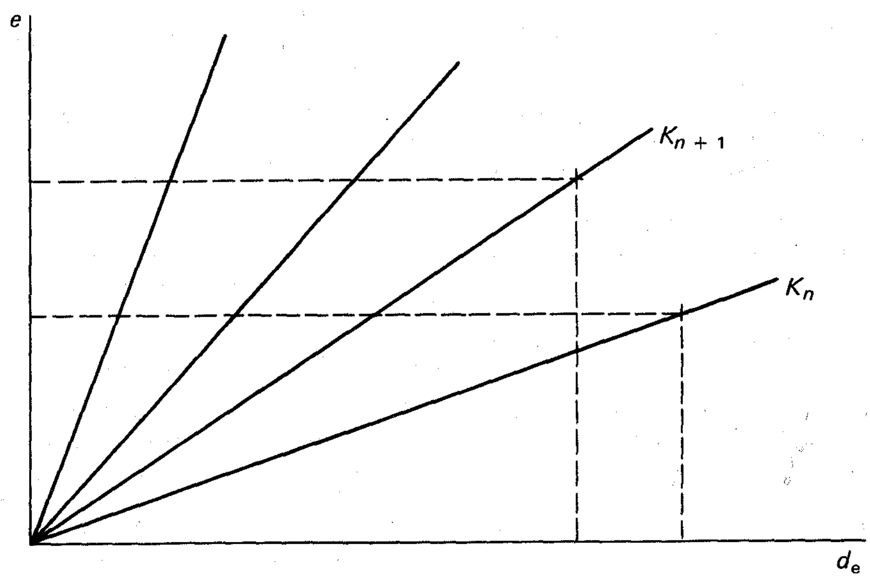
The simplest and (as will be shown later), for standardization purposes, a particularly apt version of equation (1) is :

$$e = K \times d_e \qquad \ldots(2)$$

where K represents all application and material dependences A, B, C and D mentioned in equation (1).

However, equation (2) can also be intrepreted as a combination of purely geometrical values (e; d_e), K being a parameter.

As the graph below shows, any combination of e and d_e can be obtained by varying the value of K.



From the point of view of standardization, this fact implies the necessity of finding a minimum number of values for K covering all pipe applications. Regarding these applications, the multitude of subjects under discussion in the working groups of TC 138 may be considered as representative. These subjects can be subdivided into the following two main groups :

a) *Pipes predominantly subject to internal pressure*

1) Pipes for the transport of cold water (pipes for water supply).

2) Pipes for the transport of water at elevated temperatures (hot water installations).

3) Pipes for the transport of fluids other than water (pipes for the chemical industry; pipes for the transport of gaseous fuels, except those operating at working pressures which are inadequate to overcome the influence of the external load).

b) *Pipes not subject to internal pressure*

This group comprises especially soil and waste pipes above ground as well as drainage and sewer pipes under earth load, transporting waste water or other fluids by gravity, not only at temperatures up to 20 °C but also at elevated temperatures.

4 PIPES PREDOMINANTLY SUBJECT TO INTERNAL PRESSURE

According to ISO 161, the wall thickness formula

$$e = \frac{1}{(2\,\sigma/p) + 1} \times d_e \qquad \ldots (3)$$

where

σ is the induced stress, and

p is the pressure of the fluid,

applies originally only to subgroup a) 1) as defined in clause 3.

Equation (3) can also be considered as valid for subgroups a) 2) and a) 3) if the value of σ is chosen appropriate to the particular application. In this case, σ and p comprise all application and material dependences A, B, C and D mentioned in equation (1). By expressing these dependences merely as a summary value $\sigma/p = S$, equation (3) may be transformed into :

$$e = \frac{1}{(2\,S) + 1} \times d_e \qquad \ldots (4)$$

An identity between equations (2) and (4) requires that all values of K can be converted into corresponding values of S in agreement with the equation

$$K = \frac{1}{(2\,S) + 1} \qquad \ldots (5)$$

This knowledge facilitates the selection of values of K for group a), namely :

As already mentioned, in the case of group a), S has the meaning of σ/p. In accordance with ISO 161, the values of p have to be preferred numbers of the R 10 series for determining wall thicknesses of thermoplastic pipes. The values of σ used in the past for calculation are fortunately also numbers of the R 10 series. Hence S is always the quotient of two numbers of the R 10 series and therefore in principle is itself a number of the R 10 series. This is the key to the reduction of the numerous combinations of σ and p to a small selection of values of S.

Since preferred numbers are rounded off from theoretical values (calculated values : see ISO 497), quotients of preferred numbers cannot basically be identical either with preferred numbers or with their theoretical values. The latter, however, may be considered as mean values of all corresponding quotients. Therefore, a universal wall thickness table mathematically built up on the theoretical R 10 values for S guarantees a minimum of deviations from wall thicknesses already laid down in existing standards and in papers of working groups.

The table on page 4 is the result of calculations based on the above procedure.

The nominal wall thicknesses (e) are expressed in millimetres to one decimal place and rounded up to the nearest 0,1 mm, if the second decimal is higher than zero.

5 PIPES NOT SUBJECT TO INTERNAL PRESSURE

The numerous pipe applications to be classified into group b), according to clause 3, are characterized only partially by a strictly linear relationship between e and d_e for pipes of identical material and similar conditions of use. Group b), therefore, does not represent the same justifying background for equation (2) as does group a). Yet, in many cases at least an approximately linear relationship between e and d_e is given. Moreover, the available basis for determining dimensions is very often much too rudimentary to permit convincing motivation for the creation of specific pipe series.

These facts justify the hope that an analogous method of selecting values for K as developed for group a) might also be appropriate for group b). This assumption is actually true.

In consequence, there is no reason why pipes of group b) should be classified differently from those of group a).

6 CONCLUDING REMARKS

The practice of selecting minimum wall thicknesses higher than the theoretical values (if technical reasons are given), as well as the possibility of switching over, within the same application, to other series of the universal table, guarantee that the latter will provide a satisfactory solution to any future demand. Neither are complications to be expected from new materials for pipes, owing to the fact that in view of values of σ to be used for determining dimensions of pressure pipes, the R 10 series of preferred numbers offers a sufficiently differentiated selection to meet all technical and economic aspects. The assumption that a closer graduation in the σ-selection could lead to economical advantages is an error. The ratio $\left(\sqrt[10]{10} \approx 1,26\right)$ characterizing the R 10 series is adequate in view of the known scattering results of long-time tests as well as of the problems raised by their extrapolation and the determination of suitable factors of safety. Hence, a closer graduation of the σ-selection would be beyond the possibility of a serious differentiation.

For those exceptions where the general rule is not applicable for technical reasons, it may be necessary to take into account limited variations of wall thickness when preparing documents for these specific applications.

The advantage of a designation of series by means of K or its reciprocal value lies in the additional information concerning the relationship d_e/e.

The mentioned advantage is also given for the designation of series with S being in accordance with equation (4) :

$$S = \frac{1}{2}\left(\frac{d_e}{e} - 1\right) \approx \frac{1}{2} \times \frac{d_e}{e} \qquad \ldots (6)$$

Thus, any pipe can easily be classified on the basis of d_e and e.

In addition, the S-values have the specific advantage of not forming a number series by chance but a pure series R 10. Furthermore, S has in the case of pipes belonging to group a) the meaning of σ/p. That involves advantages for the dimensioning of hot water installations, and industrial pipes in particular. In consequence, there is no doubt that the designation of pipe series as used in the following table represents the optimal solution.

It will be of interest to note that the principles contained in this document have been used for a number of years in the United States of America in the form of the Standard Dimension Ratio (SDR) series. The relationship between the "SDR" and the "S", as defined in this document is given by the equation :

$$\text{SDR} = \frac{d_e}{e} = 2\,S + 1 \qquad \ldots (7)$$

TABLE – Nominal wall thicknesses (*e*), in millimetres, of the pipes series

Nominal outside diameter d_e mm	Pipe series *S*														
	2,5	3,2	4	5	6,3	8	10	12,5	16	20	25	32	40	50	63
2,5	0,5														
3	0,5	0,5													
4	0,7	0,6	0,5												
5	0,9	0,7	0,6	0,5											
6	1,0	0,9	0,7	0,6	0,5										
8	1,4	1,1	0,9	0,8	0,6	0,5									
10	1,7	1,4	1,2	1,0	0,8	0,6	0,5								
12	2,0	1,7	1,4	1,1	0,9	0,8	0,6	0,5							
16	2,7	2,2	1,8	1,5	1,2	1,0	0,8	0,7	0,5						
20	3,4	2,8	2,3	1,9	1,5	1,2	1,0	0,8	0,7	0,5					
25	4,2	3,5	2,8	2,3	1,9	1,5	1,2	1,0	0,8	0,7	0,5				
32	5,4	4,4	3,6	2,9	2,4	1,9	1,6	1,3	1,0	0,8	0,7	0,5			
40	6,7	5,5	4,5	3,7	3,0	2,4	1,9	1,6	1,3	1,0	0,8	0,7	0,5		
50	8,3	6,9	5,6	4,6	3,7	3,0	2,4	2,0	1,6	1,3	1,0	0,8	0,7	0,5	
63	10,5	8,6	7,1	5,8	4,7	3,8	3,0	2,4	2,0	1,6	1,3	1,0	0,8	0,7	0,5
75	12,5	10,3	8,4	6,8	5,5	4,5	3,6	2,9	2,3	1,9	1,5	1,2	1,0	0,8	0,6
90	15,0	12,3	10,1	8,2	6,6	5,4	4,3	3,5	2,8	2,2	1,8	1,4	1,2	0,9	0,8
110	18,3	15,1	12,3	10,0	8,1	6,6	5,3	4,2	3,4	2,7	2,2	1,8	1,4	1,1	0,9
125	20,8	17,1	14,0	11,4	9,2	7,4	6,0	4,8	3,9	3,1	2,5	2,0	1,6	1,3	1,0
140	23,3	19,2	15,7	12,7	10,3	8,3	6,7	5,4	4,3	3,5	2,8	2,2	1,8	1,4	1,1
160	26,6	21,9	17,9	14,6	11,8	9,5	7,7	6,2	4,9	4,0	3,2	2,5	2,0	1,6	1,3
180	29,9	24,6	20,1	16,4	13,3	10,7	8,6	6,9	5,5	4,4	3,6	2,8	2,3	1,8	1,5
200		27,3	22,4	18,2	14,7	11,9	9,6	7,7	6,2	4,9	3,9	3,2	2,5	2,0	1,6
225			25,1	20,5	16,6	13,4	10,8	8,6	6,9	5,5	4,4	3,5	2,8	2,3	1,8
250			27,9	22,7	18,4	14,8	11,9	9,6	7,7	6,2	4,9	3,9	3,1	2,5	2,0
280				25,4	20,6	16,6	13,4	10,7	8,6	6,9	5,5	4,4	3,5	2,8	2,2
315				28,6	23,2	18,7	15,0	12,1	9,7	7,7	6,2	4,9	3,9	3,2	2,5
355					26,1	21,1	16,9	13,6	10,9	8,7	7,0	5,6	4,4	3,5	2,8
400					29,4	23,7	19,1	15,3	12,3	9,8	7,8	6,3	5,0	4,0	3,2
450						26,7	21,5	17,2	13,8	11,0	8,8	7,0	5,6	4,5	3,6
500						29,6	23,9	19,1	15,3	12,3	9,8	7,8	6,2	5,0	4,0
560							26,7	21,4	17,2	13,7	11,0	8,8	7,0	5,6	4,4
630							30,0	24,1	19,3	15,4	12,3	9,8	7,9	6,3	5,0
710								27,2	21,8	17,4	13,9	11,1	8,8	7,1	5,6
800								30,6	24,5	19,6	15,7	12,5	10,0	7,9	6,3
900									27,6	22,0	17,6	14,0	11,2	8,9	7,1
1 000									30,6	24,5	19,6	15,6	12,4	9,9	7,9