UDC 66.025 : 621.642 : 621.18 DEUTSCHE NORM January 1993

Ellipsoidal dished ends

DIN 28 013

Gewölbte Böden; Korbbogenform

Supersedes May 1987 edition.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

Dimensions in mm

1 Scope and field of application

This standard specifies dimensions and technical delivery conditions for one-piece ellipsoidal dished ends ('ends', for short). It applies to ellipsoidal dished ends with or without weld that have an outside diameter, d_a, of up to 4000 mm and a wall thickness, s, of up to 50 mm. It covers ends of dimensions satisfying the following conditions:

$r_1 = 0{,}8\ d_a$ $\quad r_2 = 0{,}154\ d_a$ $\quad h_1 \geq 3\ s$[1)] $\quad h_2 = 0{,}255\ d_a - 0{,}635\ s$

This standard may apply by analogy to ends in larger sizes. Particularly for ends made of segments, tolerances should be subject to agreement.

For torospherical dished ends, see DIN 28 011.

The wall thickness may be designed, for example, on the basis of the *Technische Regeln Druckbehälter* (Codes of practice for pressure vessels) or the *Technische Regeln Dampfkessel* (Codes of practice for steam boilers).

2 Dimensions and designation

2.1 Dimensions

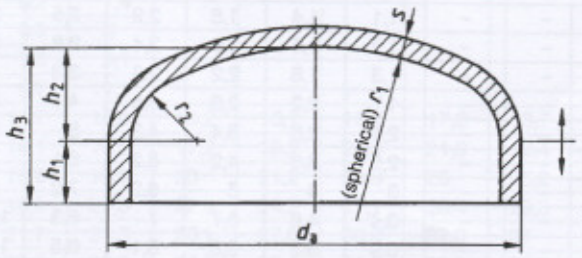

Figure 1: Ellipsoidal end

The volume and surface area of ends (disregarding h_1) shall satisfy the following conditions:

volume of dished part, $V \approx 0{,}1298\ (d_a - 2\ s)^3$;

external surface area of dished part, $A_a \approx 1{,}08\ d_a^2$;

internal surface area of dished part, $A_i \approx 1{,}08\ (d_a - 2\ s)^2$.

The datum line is defined by the height, h_1, as specified in table 1. When ordering, it may be agreed that this line be marked on the dished end.

For 1), see page 2.

Continued on pages 2 to 11.

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Table 1

Wall thickness, s[2]			3	4	5	6	3	4	5	6	7	8	9	10
Flange height, h_1[1]			9	12	15	18	20				25		30	
d_a[3]	r_1	r_2	Mass, in kg[4]											
● 26,9	21,5	4	0,06	–	–	–	–	–	–	–	–	–	–	–
30	24	4,5	0,06	0,07	0,07									
31,8	25,5	5	0,07	0,09	0,09									
● 33,7	27	5	0,07	0,09	0,09									
38	30,4	6	0,08	0,11	0,11									
● 42,4	34	6,5	0,1	0,13	0,13									
44,5	35,6	7	0,11	0,14	0,14									
● 48,3	38,6	7,5	0,11	0,15	0,15									
51	40,8	8	0,16	0,22	0,27									
57	45,5	9	0,19	0,26	0,32									
● 60,3	48	9,5	0,21	0,27	0,35	0,48								
63,5	51	10	0,22	0,3	0,37	0,51								
70	56	11	0,26	0,35	0,43	0,58								
● 76,1	61	11,5	0,29	0,39	0,49	0,66								
82,5	66	12,5	0,33	0,44	0,55	0,74								
● 88,9	71	14	–	–	–	–	0,37	0,5	0,62	0,83				
101,6	81	15,5	–	–	–	–	0,46	0,62	0,77	1,02				
108	86	16,5	–	–	–	–	0,51	0,68	0,85	1,12				
● 114,3	92	17,5	–	–	–	–	0,56	0,75	0,94	1,22				
127	102	19,5	–	–	–	–	0,67	0,9	1,12	1,45				
133	106	20,5	–	–	–	–	0,73	0,97	1,21	1,56	1,82	2,39		
● 139,7	112	21,5	–	–	–	–	0,79	1,06	1,32	1,69	1,98	2,58		
152,4	122	23,5	–	–	–	–	0,92	1,12	1,43	1,86	2,19	2,8		
159	125	24,5	–	–	–	–	0,99	1,2	1,5	2	2,3	3		
● 168,3	135	26	–	–	–	–	1,1	1,4	1,8	2,2	2,5	3,2	3,6	4
177,8	142	27	–	–	–	–	1,2	1,5	1,9	2,4	2,8	3,5	4	4,4
193,7	155	30	–	–	–	–	1,3	1,8	2,2	2,8	3,3	4	4,6	5
● 219,1	175	34	–	–	–	–	1,7	2,2	2,8	3,5	4,1	5	5,6	6,3
244,5	196	38	–	–	–	–	2,1	2,8	3,4	4,3	5	6,2	6,8	7,6
● 273	218	42	–	–	–	–	2,5	3,3	4,2	5,2	6,1	7,4	8,4	9,2
300	240	46	–	–	–	–	3	4	5	6,2	7,2	8,8	9,8	10,9
● 323,9	254	50	–	–	–	–	3,4	4,6	5,7	7	8,3	10	11,2	12,4
350	280	54	–	–	–	–	3,9	5,3	6,6	8,1	9,5	11,6	13	14,3
● 355,6	284	55	–	–	–	–	4,1	5,5	6,8	8,4	9,8	11,9	13,3	14,7
400	320	61	–	–	–	–	5,2	6,8	8,5	10,5	12,2	14,7	16,5	18,3
● 406,4	325	62	–	–	–	–	5,3	7	8,7	10,8	12,5	15,2	16,9	18,8
450	360	70	–	–	–	–	6,4	8,5	10,6	13,1	15,2	18,3	20,5	22,7
● 457	365	70	–	–	–	–	6,6	8,8	10,9	13,4	15,6	18,8	21,1	23,3
500	400	77	–	–	–	–	7,8	10,3	13	16	18,5	22,2	24,9	27,6
● 508	406	78	–	–	–	–	8	10,7	13,3	16,4	19	22,9	25,6	28,4
550	440	85	–	–	–	–	9,4	12,4	15,5	19	22,2	26,5	29,7	32,9
559	446	86	–	–	–	–	9,7	12,9	16,1	19,7	22,8	27,3	30,6	33,9
600	480	92	–	–	–	–	11,1	14,7	18,4	22,4	26,2	31,1	35	38,7

● Series 1 pipe, outside diameter as in DIN 2448.

1) The flange height shall not be less than 3 s. It need not, however, exceed the following dimensions.

Wall thickness	Flange height
$s \leq 50$	150
$50 < s \leq 80$	120
$80 < s \leq 100$	100
$100 < s \leq 120$	75
$120 < s \leq$	50

Any other flange heights shall be subject to agreement.

2) See subclause 3.4.5.

3) For d_a greater than 4000 mm, the other dimensions, volume and surface area shall be calculated in line with clauses 1 and 2.

For 4), see page 3.

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11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
40			45		55			60		70			75	
Mass, in kg[4])														
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4,8	5,2	5,9	6,2	7,4										
5,3	5,7	6,5	6,9	8										
6,1	6,6	7,4	7,9	9,1										
7,5	8,1	9,1	9,7	11,2										
9	9,8	10,9	11,7	13,4	14,2	15,1	16,9	17,8	18,7	20,8	21,7	22,6	24,9	25,7
10,9	11,8	13,2	14,1	16,1	17,2	18,2	20,4	21,3	22,4	24,9	26	27	29,7	30,8
12,8	13,9	15,5	16,6	18,9	20	21,2	23,8	25	26,2	29	30,3	31,6	34,5	35,9
14,6	15,8	17,7	18,9	21,5	22,9	24,2	27,1	28,4	29,8	32,9	34,3	35,8	38,2	40,6
16,7	18,2	20,2	21,7	24,5	26,1	27,6	30,8	32,3	34	37,4	39,1	40,7	44,4	46,2
17,2	18,7	20,8	22,3	25,2	26,8	28,4	31,6	33,2	34,9	38,4	40,2	41,8	45,7	47,4
21,2	23,2	25,6	27,5	30,9	32,9	34,9	38,6	40,7	42,7	46,9	49	51	56	57
21,8	23,8	26,3	28,3	31,8	33,8	35,9	39,7	41,8	43,9	48,1	50	52	57	59
26,2	28,5	31,6	33,9	38	40,4	42,8	47	49,8	52	57	59	63	68	70
27	29,4	32,5	34,9	39	41,6	44	48,6	51	54	59	62	65	69	73
31,7	34,5	38,2	41	45,8	48,7	52	57	61	63	68	72	75	81	85
32,7	35,5	39,3	42,1	47,1	50	53	58	62	65	70	74	77	84	87
37,7	41	45,3	48,7	54	58	62	67	70	75	81	85	88	96	99
38,8	42,4	46,6	50	56	59	63	69	73	77	84	87	91	98	102
44,3	48,2	53,1	57	64	67	72	78	83	88	95	99	103	111	116

4) The (nominal) values given are average values derived from the mass of finished dished ends, which may vary as a result of the manufacturing process. They correspond to the mass calculated from the theoretical geometrical shape of the ends, taking the density as 7,85 kg/dm^3 multiplied by a factor of 1,1.

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Table 1 (continued)

Wall thickness, s[2]			3	4	5	6	7	8	9	10	11	12	13
Flange height, h_1[1]			20				25		30		40		
d_a[3]	r_1	r_2	Mass, in kg[4]										
610	488	94	11,4	15,2	19,9	23,2	26,9	32,1	36	39,9	45,7	49,6	55
650	520	100	12,9	17,2	21,5	26,2	30,5	35,2	40,6	45	51	56	62
660	528	100	13,3	17,7	22,1	27	31,5	37,3	41,9	46,4	53	57	64
700	560	110	14,9	19,8	24,8	30,1	35,2	41,6	46,8	52	59	64	70
711	569	110	15,4	20,5	25,5	31,1	36,2	42,9	48,2	53	61	66	73
750	600	115	17,1	22,6	28,3	34,4	40,2	47,4	53	59	67	73	80
762	610	120	17,6	23,3	29,2	35,5	41,4	48,8	55	61	69	75	83
800	640	125	19,3	25,6	31	39,1	45,4	54	61	67	76	83	90
813	650	125	19,9	26,5	33	40,3	46,9	55	62	69	78	85	94
850	680	130	21,7	28,8	36,1	43,9	51	61	67	75	85	92	101
864	691	135	22,3	29,8	37,2	45,2	53	62	69	77	87	96	105
900	720	140	24,2	32,2	40,3	49	57	67	75	84	95	103	113
914	731	140	25	33,3	41,6	50	59	69	78	86	98	106	117
950	760	145	27	35,9	44,8	54	64	75	84	92	105	114	125
1000	800	155	29,7	39,6	49,5	61	70	83	92	102	116	125	138
1016	812	155	30,7	40,9	51	62	73	85	95	106	119	130	142
1050	840	160	32,8	43,6	54	66	77	90	101	112	127	138	151
1100	880	170	35,9	47,7	59	73	85	99	111	123	139	151	165
1150	920	175	39,1	52	65	79	92	108	121	134	151	164	179
1200	960	185	42,5	56	70	86	100	117	131	145	163	178	195
1250	1000	190	46	62	77	92	108	127	142	157	177	193	210
1300	1040	200	49,7	66	83	100	117	136	153	169	190	208	277
1400	1120	215	57	77	96	116	135	157	176	196	220	239	262
1500	1200	230	66	88	110	132	154	179	201	224	251	273	298
1600	1280	245	75	99	124	151	175	204	229	254	284	309	338
1700	1360	260	85	112	140	169	197	229	257	286	319	348	381
1800	1440	280	95	125	157	189	221	256	288	320	356	389	425
1900	1520	290	105	140	175	211	245	285	320	355	396	432	471
2000	1600	310	116	154	193	233	272	315	354	393	438	477	520
2100	1680	325	128	171	212	256	299	347	389	432	482	525	572
2200	1760	340	140	187	233	282	328	380	427	474	527	575	626
2300	1840	355	153	204	254	307	359	414	465	517	575	627	683
2400	1920	370	166	221	277	334	389	450	506	562	625	681	741
2500	2000	385	180	240	300	362	422	487	548	608	677	738	803
2600	2080	400	195	260	325	392	457	527	592	658	731	796	868
2700	2160	415	210	279	350	421	492	568	638	708	787	858	934
2800	2240	430	226	300	376	453	528	609	685	761	845	922	1003
2900	2320	445	242	322	403	485	566	662	734	815	905	987	1074
3000	2400	460	259	344	431	519	605	699	785	872	968	1055	1147
3100	2480	475	276	369	460	554	646	755	837	931	1032	1125	1223
3200	2560	490	294	392	490	590	688	793	891	990	1098	1198	1302
3300	2640	510	312	417	520	627	742	843	947	1053	1167	1273	1384
3400	2720	525	331	442	552	666	776	893	1005	1117	1238	1350	1467
3500	2800	540	351	469	585	705	822	946	1064	1181	1310	1429	1553
3600	2880	555	372	495	618	745	869	1000	1125	1250	1385	1510	1642
3700	2960	570	393	523	653	787	917	1056	1188	1319	1462	1594	1733
3800	3040	585	411	549	686	827	966	1111	1250	1388	1539	1678	1824
3900	3120	600	436	581	726	872	1018	1170	1320	1465	1623	1769	1922
4000	3200	615	457	609	761	916	1068	1229	1382	1539	1704	1857	2017

For 1) to 4), see pages 2 and 3.

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14	15	16	17	18	19	20	21	22	23	24	25
45		55			60		70			75	
Mass, in kg[4])											
59	65	69	74	80	85	89	97	101	106	114	119
66	74	78	83	90	96	100	109	113	119	128	133
68	76	80	84	94	98	103	112	117	122	131	136
76	84	89	95	103	109	114	124	130	135	145	152
78	87	92	98	107	112	118	128	133	140	150	155
87	96	101	108	116	123	130	141	147	153	164	171
89	98	105	111	121	128	134	144	151	157	169	176
98	108	114	121	132	140	146	157	165	173	185	191
100	111	118	125	136	143	151	163	169	177	190	198
109	120	128	135	147	155	164	176	184	193	206	215
112	123	132	140	152	161	168	182	189	198	211	220
121	133	142	151	164	173	182	196	205	213	228	238
125	138	146	155	168	178	187	201	210	220	234	244
134	147	157	167	182	191	200	216	226	235	252	262
149	163	173	184	199	210	221	237	248	259	276	287
153	167	178	189	205	216	228	244	255	266	284	296
163	178	189	201	218	230	242	260	272	283	301	314
177	195	207	220	238	251	263	283	296	309	329	342
193	211	226	239	259	272	286	307	321	336	356	371
209	229	244	259	279	295	310	332	348	363	386	402
227	248	264	279	301	318	334	359	375	392	416	433
244	266	284	301	325	342	361	385	404	421	448	465
282	307	327	347	374	394	415	442	463	484	514	535
321	350	373	393	426	449	472	504	528	551	584	608
364	396	421	448	482	508	534	570	596	623	659	686
409	444	474	503	540	570	600	638	669	699	739	769
457	496	529	561	603	636	669	712	745	779	823	857
507	550	586	623	669	705	741	789	826	862	912	949
560	607	648	688	737	778	818	870	911	952	1005	1046
616	668	712	756	810	855	899	955	1000	1045	1103	1148
674	730	779	827	886	934	983	1044	1093	1142	1206	1255
735	796	849	901	965	1018	1071	1137	1190	1244	1312	1366
799	865	921	979	1047	1106	1163	1234	1291	1350	1423	1482
865	936	998	1059	1134	1196	1258	1334	1398	1461	1539	1603
934	1011	1077	1144	1223	1290	1357	1440	1507	1575	1660	1728
1005	1087	1159	1231	1316	1388	1461	1549	1621	1694	1784	1858
1079	1167	1244	1322	1412	1491	1568	1661	1738	1817	1914	1992
1156	1250	1332	1415	1511	1595	1679	1778	1861	1945	2047	2132
1235	1335	1423	1511	1615	1704	1793	1899	1988	2077	2186	2276
1318	1423	1518	1602	1720	1816	1911	2023	2119	2213	2329	2424
1403	1515	1615	1715	1830	1932	2033	2152	2253	2354	2476	2578
1489	1608	1715	1822	1944	2052	2158	2284	2391	2499	2629	2737
1580	1705	1818	1932	2060	2175	2288	2420	2534	2649	2785	2900
1672	1805	1925	2044	2180	2301	2421	2561	2682	2809	2946	3068
1767	1907	2034	2160	2303	2431	2558	2705	2833	2960	3188	3240
1865	2013	2146	2279	2431	2565	2698	2857	2991	3125	3284	3419
1967	2121	2262	2401	2560	2701	2841	3003	3148	3289	3455	3597
2068	2230	2382	2528	2694	2842	2993	3163	3311	3460	3637	3785
2171	2345	2499	2654	2828	2987	3142	3320	3479	3636	3816	3977

For [4]), see page 3.

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Table 1 (continued)

Wall thickness, s[2]			26	27	28	29	30	31	32	33	34	35	36
Flange height, h_1[1]			85			90		100			110		
d_a[3]	r_1	r_2	Mass, in kg[4]										
300	240	46	39,1	40,5	41,8	47,4	48,8	50	52				
● 323,9	254	50	44,2	45,8	47,3	54	55	57	58				
350	280	54	50	52	54	60	62	64	66				
● 355,6	284	55	52	53	55	62	64	66	68				
400	320	61	63	65	67	75	77	79	81				
● 406,4	325	62	64	66	69	77	79	81	84	–	–	–	–
450	360	70	76	79	82	91	94	96	99				
● 457	365	70	78	81	84	93	96	99	102				
500	400	77	90	94	97	108	111	114	118				
● 508	406	78	93	96	100	111	114	118	121				
550	440	85	107	110	114	126	130	134	138				
559	446	86	110	114	117	130	134	138	142				
600	480	92	124	129	133	146	151	156	161	165	169	185	190
610	488	94	127	132	136	150	155	160	165	170	174	190	195
650	520	100	142	147	151	167	173	178	184	189	195	212	217
660	528	100	146	151	157	172	178	183	189	194	200	217	223
700	560	110	162	167	174	190	196	202	209	215	221	240	246
711	569	110	166	172	179	195	202	208	215	221	227	246	253
750	600	115	183	189	196	214	221	228	235	242	249	270	277
762	610	120	188	195	202	220	225	234	242	249	256	277	284
800	640	125	205	212	220	240	248	255	263	270	278	301	309
813	650	125	211	218	226	246	254	262	270	278	286	309	318
850	680	130	228	236	245	266	275	284	292	301	310	334	343
864	691	135	235	243	252	274	283	292	301	310	319	343	353
900	720	140	253	262	272	294	304	314	323	333	342	369	378
914	731	140	260	269	279	303	313	323	333	342	352	379	389
950	760	145	278	289	299	324	334	345	356	366	377	405	416
1000	800	155	305	317	328	354	366	378	389	402	413	443	455
1016	812	155	314	326	337	365	377	389	401	413	425	456	468
1050	840	160	333	346	358	387	400	412	425	438	451	483	496
1100	880	170	363	376	389	420	435	448	462	476	490	524	538
1150	920	175	393	408	423	455	470	485	501	516	531	567	582
1200	960	185	426	441	457	492	508	524	540	557	573	612	628
1250	1000	190	458	476	493	529	547	564	582	600	617	658	676
1300	1040	200	493	512	529	568	587	606	625	644	662	705	725
1400	1120	215	565	586	607	650	672	694	715	737	759	806	828
1500	1200	230	642	667	691	737	762	788	812	836	861	913	938
1600	1280	245	724	751	779	831	858	887	914	942	970	1037	1056
1700	1360	260	811	842	872	940	960	991	1023	1054	1085	1147	1179
1800	1440	280	903	937	971	993	1078	1102	1137	1172	1207	1275	1310
1900	1520	290	1000	1037	1075	1142	1181	1220	1258	1297	1334	1408	1448
2000	1600	310	1101	1143	1185	1257	1299	1342	1385	1427	1470	1549	1592
2100	1680	325	1208	1254	1299	1377	1425	1471	1517	1563	1610	1695	1744
2200	1760	340	1319	1370	1419	1503	1554	1605	1656	1706	1758	1849	1901
2300	1840	355	1436	1491	1544	1635	1690	1745	1801	1856	1911	2019	2066
2400	1920	370	1557	1616	1675	1771	1832	1891	1951	2011	2071	2176	2236
2500	2000	385	1683	1742	1811	1913	1978	2043	2108	2173	2237	2349	2415
2600	2080	400	1814	1883	1951	2061	2131	2201	2290	2341	2410	2529	2599
2700	2160	415	1950	2024	2098	2213	2289	2364	2440	2515	2589	2715	2791
2800	2240	430	2091	2170	2250	2373	2453	2533	2615	2695	2775	2908	2990
2900	2320	445	2236	2321	2406	2537	2622	2709	2795	2881	2967	3108	3194
3000	2400	460	2387	2478	2569	2750	2797	2890	2982	3073	3166	3313	3407
3100	2480	475	2542	2639	2736	2881	2979	3077	3175	3273	3370	3526	3626
3200	2560	490	2703	2806	2908	3061	3165	3269	3374	3477	3582	3746	3851
3300	2640	510	2869	2978	3087	3247	3357	3468	3578	3689	3799	3971	4083
3400	2720	525	3036	3154	3269	3439	3555	3673	3790	3906	4023	4204	4322
3500	2800	540	3214	3336	3458	3636	3759	3883	4006	4131	4254	4443	4568
3600	2880	555	3394	3522	3652	3837	3968	4099	4230	4359	4490	4689	4822
3700	2960	570	3581	3716	3852	4046	4182	4323	4461	4598	4734	4941	5083
3800	3040	585	3765	3912	4055	4256	4403	4547	4692	4839	4983	5198	5347
3900	3120	600	3962	4115	4265	4475	4630	4782	4937	5088	5238	5466	5619
4000	3200	615	4161	4318	4479	4698	4831	5020	5179	5341	5499	5737	5896

For [1] to [4], see pages 2 and 3.

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37	38	39	40	41	42	43	44	45	46	47	48	49	50
120				130			140			150			
Mass, in kg[4])													
–	–	–	–	–	–	–	–	–	–	–	–	–	–
317	326	333	341	358	366	374	383	391	398	407	415	422	430
326	334	343	351	368	376	385	393	401	410	418	426	434	443
352	361	370	379	397	406	415	424	433	442	451	460	469	476
362	371	380	389	408	417	427	436	445	454	464	473	482	491
388	398	408	418	438	448	458	469	479	488	498	508	518	526
400	410	420	430	450	461	471	481	492	502	512	522	533	543
427	438	449	460	481	492	503	514	525	536	547	558	569	585
468	480	492	503	526	538	550	562	574	586	598	611	623	635
480	493	505	517	541	553	566	578	591	603	616	628	640	652
509	522	535	548	573	586	599	612	626	639	652	665	678	691
552	567	581	595	622	636	650	664	679	693	707	722	736	750
598	613	629	644	672	688	703	719	735	750	766	781	797	812
645	662	679	695	725	741	759	775	792	810	826	843	859	876
694	712	730	748	779	798	816	834	852	870	887	906	924	942
745	763	783	803	836	856	875	894	914	934	953	972	991	1011
850	873	895	917	945	977	1000	1022	1044	1066	1089	1111	1133	1155
964	989	1014	1040	1081	1107	1132	1157	1183	1208	1233	1258	1284	1309
1085	1113	1141	1169	1216	1244	1273	1301	1330	1359	1387	1415	1443	1472
1211	1243	1275	1307	1357	1389	1421	1453	1485	1517	1549	1581	1612	1645
1345	1382	1417	1452	1507	1542	1579	1614	1649	1685	1720	1756	1791	1826
1487	1526	1565	1605	1664	1704	1749	1782	1822	1861	1900	1939	1979	2017
1636	1679	1722	1764	1829	1872	1916	1959	2003	2046	2089	2132	2175	2219
1791	1837	1884	1932	2002	2049	2097	2145	2192	2240	2287	2334	2382	2429
1953	2004	2056	2108	2182	2234	2286	2339	2390	2442	2494	2545	2596	2648
2122	2178	2234	2289	2371	2428	2484	2540	2596	2652	2708	2765	2820	2877
2298	2358	2419	2479	2566	2628	2690	2750	2812	2872	2933	2994	3055	3115
2481	2547	2611	2677	2771	2837	2903	2969	3035	3100	3166	3232	3298	3363
2671	2741	2812	2883	2982	3053	3124	3196	3266	3337	3408	3479	3550	3620
2868	2944	3020	3095	3201	3277	3354	3430	3507	3583	3659	3735	3810	3887
3071	3153	3234	3315	3428	3510	3592	3673	3755	3837	3918	4000	4082	4164
3281	3369	3456	3543	3662	3750	3838	3925	4013	4100	4187	4274	4362	4448
3500	3593	3686	3779	3904	3999	4092	4184	4278	4371	4465	4557	4651	4743
3725	3824	3923	4022	4155	4254	4354	4453	4552	4651	4751	4850	4949	5048
3957	4061	4167	4271	4412	4518	4623	4729	4835	4940	5046	5151	5256	5361
4195	4307	4419	4530	4677	4789	4902	5014	5126	5238	5349	5462	5573	5684
4441	4558	4677	4795	4950	5070	5189	5306	5425	5544	5662	5781	5898	6017
4694	4818	4943	5069	5232	5357	5482	5608	5733	5859	5984	6109	6234	6359
4953	5085	5217	5349	5520	5653	5785	5918	6050	6182	6314	6446	6578	6710
5221	5359	5501	5639	5817	5957	6098	6236	6378	6516	6654	6795	6933	7074
5492	5638	5785	5930	6120	6266	6415	6559	6709	6853	7002	7146	7294	7436
5774	5927	6083	6235	6433	6586	6742	6898	7050	7206	7358	7513	7669	7820
6061	6221	6384	6543	6751	6910	7074	7239	7399	7561	7721	7885	8048	8206

For [4]), see page 3.

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2.2 Flange edges

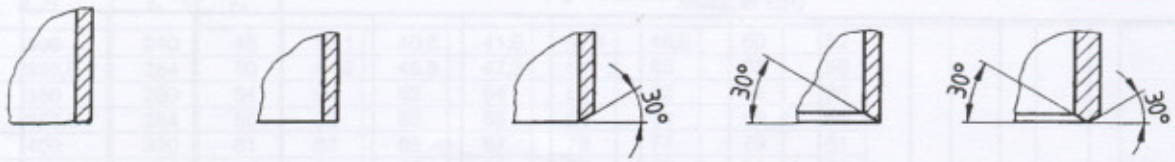
Type R (previously, IR) (unfinished)

Type I (previously, IP) (I-weld, machined)

Type VA (V-weld, external)

Type VI (V-weld, internal)

Type DV (previously, XS) (DV-weld, symmetrical)



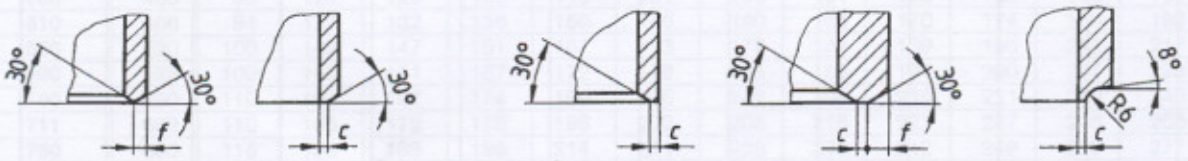
Type 2/3 DV (previously, XA) (2/3 DV-weld, asymmetrical)

Type YA (Y-weld, external)

Type YI (Y-weld, internal)

Type DY (previously, YD) (double Y-weld)

Type U (previously, US) (single U-weld)



Type DU (previously, UD) (double U-weld)

Type BI (internal taper)

Type BA (external taper)

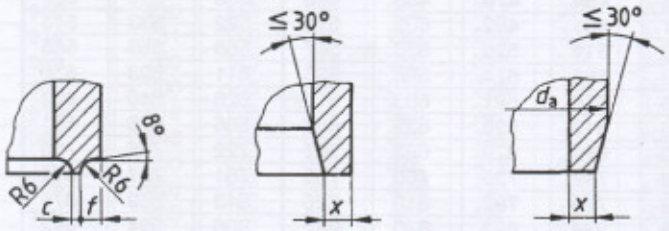


Figure 2: Flange edges

The flange edges shall be made by machining or by flame cutting. Dimensions c, f and x shall be agreed at the time of ordering, as should the angles and radii if they deviate from those shown in figure 2. Any other type of weld shall be subject to agreement, based on drawings, at the time of ordering.

2.3 Designation

Designation of an ellipsoidal dished end made of HII steel as in DIN 17 155, with an outside diameter, d_a, of 600 mm and a wall thickness, s, of 20 mm, with type VA flange edge:

Dished end DIN 28013 – 600 × 20 – VA – HII

Designation of an ellipsoidal dished end made of HII steel as in DIN 17 155, with an outside diameter, d_a, of 600 mm and a minimum wall thickness, s_{min}, of 19,5 mm, with type VA/type BI flange edge tapered inside with $x = 15$ mm:

Dished end DIN 28013 – 600 × 19,5 MIN – VA BI – 15 HII

3 Technical delivery conditions

3.1 Materials

Subject to agreement, the ends shall be made of one of the following materials:

a) hot rolled unalloyed structural steel as in DIN EN 10 025;

b) steel sheet and strip with elevated temperature properties as in DIN 17 155;

c) stainless steel as in DIN 17 440 or in *Stahl-Eisen-Werkstoffblatt* (Iron and steel materials sheet) 400;

d) fine grained structural steel suitable for welding as in DIN 17 102;

e) low-temperature steel;

f) clad steel;

g) high-temperature and heat resisting steels;

} as in DIN Standards, *AD-Merkblätter, VdTÜV-Werkstoffblätter* (VdTÜV Materials sheets) or *Stahl-Eisen-Werkstoffblätter.*

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h) special alloys;
i) nonferrous metals;

} as in DIN Standards, *AD-Merkblätter, VdTÜV-Werkstoffblätter* (VdTÜV Materials sheets) or *Stahl-Eisen-Werkstoffblätter.*

j) materials as in other national and international specifications.

3.2 Manufacture and heat treatment

Ends may either be cold or hot formed, unless a specific type of forming has been explicitly agreed. Heat treatment shall be subject to agreement (e.g. as specified in the *AD-Merkblätter* of series HP 7). If an end has been put together from a number of parts (either before or after forming), this shall be stated by the manufacturer.

3.3 Surface finish

Ends shall be supplied with untreated surfaces. Any specific finish (e.g. descaled, pickled, blasted) shall be subject to agreement.

3.4 Limit deviations

3.4.1 Limit deviations for height h_3

The limit deviations for height $h_3 = h_1 + h_2$ shall be + 0,015 d_a or + 10 mm (whichever is higher) and 0.

These deviations are valid for ends with machined flange edges. Ends with unfinished flange edges (type R) shall be designed so that they can be used to manufacture other types specified in this standard.

3.4.2 Limit deviations for circumference

The limit deviations for the circumference shall be as specified in table 2.

Table 2

Material	Outside diameter, d_a	Limit deviations for circumference
Hot rolled unalloyed structural steel, high-temperature steel, low-temperature steel (ferritic, untempered), fine grained structural steel	$d_a < 100$	± 3 mm
	$100 \leq d_a < 300$	± 4 mm
	$300 \leq d_a < 1000$	± 0,4 %
	$1000 \leq d_a \leq 4000$	± 0,3 %
Stainless steel, high alloy steel, low-temperature steel (austenitic or quenched and tempered), austenitic clad steel	$d_a < 100$	± 3 mm
	$100 \leq d_a < 300$	± 5 mm
	$300 \leq d_a \leq 4000$	+ 0,5 % − 0,7 %
Clad steel (other than austenitic clad steel), nonferrous metals	$d_a < 100$	± 3 mm
	$100 \leq d_a < 300$	± 5 mm
	$300 \leq d_a \leq 4000$	± 1 %

3.4.3 Out-of-roundness

The out-of-roundness, $u = \dfrac{2\,(d_{a\,max} - d_{a\,min})}{(d_{a\,max} + d_{a\,min})} \cdot 100\,\%$ shall not exceed 1 %.

The largest difference in diameter, $d_{a\,max} - d_{a\,min}$, for d_a up to 4000 mm shall not be greater than 30 mm.

3.4.4 Closer tolerances

Where required, closer tolerances for the circumference or out-of-roundness may be agreed.

If ends are to be used in pairs or as inner or outer ends, the limit deviations shall be subject to agreement.

3.4.5 Limit deviations for wall thickness

If the order states the nominal wall thickness only, the actual wall thickness may deviate by the values specified in table 3.

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Table 3

Wall thickness	Permissible lower deviation
Up to 10	−0,3
Above 10 up to 30	−0,5
Above 30 up to 50	−0,8
Above 50	−1,0

If the order requests a minimum wall thickness, the actual wall thickness shall not be smaller. In such cases, instead of referring to the wall thickness, s, the flange height, h_1, shall refer to the minimum wall thickness, s_{min}. (h_1 is equal to the value of s_{min} without decimal fraction.)

In order to ensure adequate or minimum thickness, the thickness of the sheet used for the manufacture shall include an allowance.

A larger wall thickness is permitted, particularly in the flange area (compression). If tapering of the edges is requested, it shall be stated in the order (type BI or BA, as in subclause 2.2.).

3.5 Determining the circumference

3.5.1 Point of measurement

In the case of ends with machined flange edges, the circumference shall be measured along the edge.

In the case of ends with unfinished edges, the circumference shall be measured in the zone defined by the upper and lower limit deviation for h_3 as specified in subclause 3.4.1.

3.5.2 Determining the external circumference

The circumference shall be measured at the point specified in subclause 3.5.1, using a gauged measuring tape as in DIN 6403. When calculating the diameter, π shall be taken to be 3,14159.

3.5.3 Determining the internal circumference (if agreed)

The internal circumference shall either be determined by measuring the external circumference as described in subclause 3.5.2 and deducting the mean wall thickness (i.e. the arithmetical mean of at least three measurements taken along the line used when measuring the circumference). Where d_a exceeds 500 mm, the wall thickness shall be measured at intervals of 500 mm or determined by using a gauged measuring tape.

3.6 Flattening

In the zone of radius r_1, flattening of the curvature shall be permitted in lengths of maximum 15 % of r_1.

3.7 Permissible deflection of flange

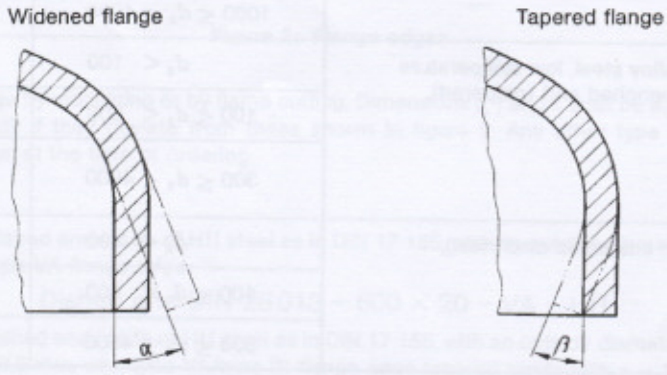

Figure 3: Angles of deflection

See table 4 for the permissible angles of deflection, α and β.

Table 4

d_a	α	β
< 1000	≤ 4°	≤ 2°
≥ 1000	≤ 5°	

In arbitration cases, the measurements shall be taken on the inside.

3.8 Certificates

Any necessary certificates shall be agreed at the time of ordering (e.g. in accordance with the *Technische Regeln Druckbehälter* or *Technische Regeln Dampfkessel*).

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Standards and other documents referred to

DIN 2448	Seamless steel tubes; dimensions and mass per unit length
DIN 6403	Steel measuring tapes with winder frame or winder case
DIN 17 102	Weldable normalized fine grain structural steel; technical delivery conditions for plate, strip, wide flats, sections and bars
DIN 17 155	Steel sheet and strip with elevated temperature properties; technical delivery conditions
DIN 17 440	Stainless steel; technical delivery conditions for sheet, hot rolled strip, wire rod, drawn wire, steel bars, forgings and semi-finished products
DIN 28 011	Torospherical dished ends
DIN EN 10 025	Hot rolled unalloyed structural steel products; technical delivery conditions
AD-Merkblätter of series HP 7*)	
*VdTÜV-Werkstoffblätter***)	
*Stahl-Eisen Werkstoffblätter*****)	
*Technische Regeln Druckbehälter****)	
*Technische Regeln Dampfkessel**)	

Previous editions

DIN 28 014: 10.70; DIN 28 013: 10.70, 05.87.

Amendments

In comparison with the May 1987 edition, the standard has been editorially revised and the reference to other standards updated.

International Patent Classification

B 01 J 3/04
B 65 D 90/02
F 16 J 12/00
F 22 B 37/22

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Table 1

Wall thickness, s[2]			3	4	5	6	3	4	5	6	7	8	9	10
Flange height, h_1[1]			9	12	15	18	20				25		30	
d_a[3]	r_1	r_2	Mass, in kg[4]											
● 26,9	21,5	4	0,06	–	–									
30	24	4,5	0,06	0,07	0,07									
31,8	25,5	5	0,07	0,09	0,09									
● 33,7	27	5	0,07	0,09	0,09									
38	30,4	6	0,08	0,11	0,11	–								
● 42,4	34	6,5	0,1	0,13	0,13									
44,5	35,6	7	0,11	0,14	0,14									
● 48,3	38,6	7,5	0,11	0,15	0,15		–	–	–	–				
51	40,8	8	0,16	0,22	0,27									
57	45,5	9	0,19	0,26	0,32						–	–		
● 60,3	48	9,5	0,21	0,27	0,35	0,48								
63,5	51	10	0,22	0,3	0,37	0,51							–	–
70	56	11	0,26	0,35	0,43	0,58								
● 76,1	61	11,5	0,29	0,39	0,49	0,66								
82,5	66	12,5	0,33	0,44	0,55	0,74								
● 88,9	71	14	–	–	–	–	0,37	0,5	0,62	0,83				
101,6	81	15,5	–	–	–	–	0,46	0,62	0,77	1,02				
108	86	16,5	–	–	–	–	0,51	0,68	0,85	1,12				
● 114,3	92	17,5	–	–	–	–	0,56	0,75	0,94	1,22				
127	102	19,5	–	–	–	–	0,67	0,9	1,12	1,45				
133	106	20,5	–	–	–	–	0,73	0,97	1,21	1,56	1,82	2,39		
● 139,7	112	21,5	–	–	–	–	0,79	1,06	1,32	1,69	1,98	2,58		
152,4	122	23,5	–	–	–	–	0,92	1,12	1,43	1,86	2,19	2,8		
159	125	24,5	–	–	–	–	0,99	1,2	1,5	2	2,3	3		
● 168,3	135	26	–	–	–	–	1,1	1,4	1,8	2,2	2,5	3,2	3,6	4
177,8	142	27	–	–	–	–	1,2	1,5	1,9	2,4	2,8	3,5	4	4,4
193,7	155	30	–	–	–	–	1,3	1,8	2,2	2,8	3,3	4	4,6	5
● 219,1	175	34	–	–	–	–	1,7	2,2	2,8	3,5	4,1	5	5,6	6,3
244,5	196	38	–	–	–	–	2,1	2,8	3,4	4,3	5	6,2	6,8	7,6
● 273	218	42	–	–	–	–	2,5	3,3	4,2	5,2	6,1	7,4	8,4	9,2
300	240	46	–	–	–	–	3	4	5	6,2	7,2	8,8	9,8	10,9
● 323,9	254	50	–	–	–	–	3,4	4,6	5,7	7	8,3	10	11,2	12,4
350	280	54	–	–	–	–	3,9	5,3	6,6	8,1	9,5	11,6	13	14,3
● 355,6	284	55	–	–	–	–	4,1	5,5	6,8	8,4	9,8	11,9	13,3	14,7
400	320	61	–	–	–	–	5,2	6,8	8,5	10,5	12,2	14,7	16,5	18,3
● 406,4	325	62	–	–	–	–	5,3	7	8,7	10,8	12,5	15,2	16,9	18,8
450	360	70	–	–	–	–	6,4	8,5	10,6	13,1	15,2	18,3	20,5	22,7
● 457	365	70	–	–	–	–	6,6	8,8	10,9	13,4	15,6	18,8	21,1	23,3
500	400	77	–	–	–	–	7,8	10,3	13	16	18,5	22,2	24,9	27,6
● 508	406	78	–	–	–	–	8	10,7	13,3	16,4	19	22,9	25,6	28,4
550	440	85	–	–	–	–	9,4	12,4	15,5	19	22,2	26,5	29,7	32,9
559	446	86	–	–	–	–	9,7	12,9	16,1	19,7	22,8	27,3	30,6	33,9
600	480	92	–	–	–	–	11,1	14,7	18,4	22,4	26,2	31,1	35	38,7

● Series 1 pipe, outside diameter as in DIN 2448.

1) The flange height shall not be less than 3 s. It need not, however, exceed the following dimensions.

Wall thickness	Flange height
$s \leq 50$	150
$50 < s \leq 80$	120
$80 < s \leq 100$	100
$100 < s \leq 120$	75
$120 < s \leq$	50

Any other flange heights shall be subject to agreement.

2) See subclause 3.4.5.

3) For d_a greater than 4000 mm, the other dimensions, volume and surface area shall be calculated in line with clauses 1 and 2.

For 4), see page 3.

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