Date: 13.12.2011	**Technical Information**	**Wieland-Werke AG**
Technical Marketing Industrial Tubes	**Subject:** **Calculation of allowable operating pressures or** **required wall thicknesses according to AD2000 code**	Frank Trefzger Tel.: +49 (0)731 944 6337 Fax.: +49 (0)731 944 4753 frank.trefzger@wieland.de

Design rules for heat-exchanger tubes and piping subjected to internal overpressure according to the AD 2000 code in case of

    a) ratio $d_a/d_i \leq 1.2$ or
    b) outside diameter $d_a \leq 200mm$ and a ratio $d_a/d_i \leq 1.7$

The formula for the calculation of the **minimum required wall thickness** is:

$$s = \frac{(d_a \cdot p)}{20 \cdot \frac{K}{S} \cdot v + p} + c_1 + c_2$$

For the calculation of the **working pressure** the equation must be converted as follows:

$$p_{zul} = \frac{20 \cdot \frac{K}{S} \cdot v}{\frac{d_a}{(s - c_1 - c_2)} - 1}$$

with:
	s	:	Wall thickness [mm]
	d_a	:	Outer diameter [mm]
	d_i	:	Inside diameter [mm]
	p	:	Pressure [bar]
	p_{zul}	:	Working pressure [bar]
	K	:	Value of resistance related to calculation temperature [MPa]
	S	:	Safety factor related to calculation temperature [-]
	v	:	Factor considering attenuation due to join connection (for example welding)
	c_1	:	coefficient considering undershooting wall thickness (**at inside pressure load** of **non-ferrous** metal unconsidered **$c_1= 0$**)
	c_2	:	coefficient considering wear (**generally on non-ferrous metal $c_2= 0$**)
	$R_{p1.0}$	:	1.0% offset yield strength [MPa]
	R_m	:	Tensile strength [MPa]

Safety factors S for Wieland K65 and Cu-DHP according to AD2000 code:

K	$R_{p1.0}$	[N/mm²]
	1.5	[--]
v	1	[--]
c1	0	[mm]
c2	0	[mm]

K	R_m	[N/mm²]
S	4	[--]
v	1	[--]
c1	0	[mm]
c2	0	[mm]

Coefficients for design of alloy
Wieland K65 according to AD2000 code
and VdTÜV material data sheet 567 (12/2010)

Coefficients for design of alloy **Cu-DHP**
according to AD2000 leaflet for brazed
vessels

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According to these safety factors, the following table shows the allowable stress levels **"K/S" for Wieland K65** (referring to VdTÜV material data sheet 567, version 12/2010):

Operating Temperature [°C]	-100	20	50	100	150
Allowable Stress Level $R_{p1.0}$/1.5 [MPa]	100	100	97	93	93

The next table shows the maximum allowable stress **"K/S" for seamless tubes made of Cu-DHP** in different tempers and temperature ranges ("Tafel 13.2" of AD2000 leaflet W 6/2):

Seite 18   AD 2000-Merkblatt W 6/2, Ausg. 03.2009

Tafel 13.2   Zulässige Spannung *K/S* für nahtlose Rohre

Temperatur °C	Zulässige Spannung Cu-DHP			
	R200	R200[1]	R220	R220[1]
	up to bis 100 000			
20/50	57	50	63	55
100	57	50	63	55
110	56	49	62	54
120	54	48	60	53
130	53	46	59	51
140	51	45	57	50
150	50	44	56	49
160	49	43	54	48
170	47	41	53	46
180	46	40	51	45
190	44	39	50	44
200	43	38	49	43
210	41	36	47	41
220	40	35	46	40
230	39	34	44	39
240	37	33	43	38
250	36	31	41	36

1) gelötet

Table 13.2   Allowable stress K/S
for seamless tubes

Allowable stress K/S in MPa

Temper

Design duration in hours

1) brazed

Calculation of theoretical **burst pressure "p_{berst}":**

$$p_{berst} = \frac{20 \cdot R_m \cdot v}{\dfrac{d_a}{(s - c_1 - c_2)} - 1}$$

Please feel free to contact us if there are open questions.

Wieland-Werke AG
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