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Thermal Expansion

Because of the temperature of the flowing media or the surrounding ambient temperature (including solar gain and wind chill), all vessels and pipes ensure a direct proportion of expansion or contraction. This rate of expansion or contraction can be mathematically calculated via this formula:

$$X = L \times (T_1 - T_2) \times C_{Exp}$$

Where:
X = Expansion or contraction (m)
L = Length of pipe or vessel (m)
T_1 = Starting temperature (°C)
T_2 = Final temperature (°C)
C_{Exp} = Coefficient of Thermal Expansion

The table to the right shows the Coefficients Of Thermal Expansion for various common materials.

Coefficients Of Thermal Expansion For Common Pipe Materials			
Metals		Plastics	
Material	Coefficient	Material	Coefficient
Copper	16.4×10^{-6}	ABS	100×10^{-6}
Carbon Steel	12.2×10^{-6}	PVCU	80×10^{-6}
Stainless Steel (Austenitic)	16.3×10^{-6}	PVCC	70×10^{-6}
Stainless Steel (Ferritic)	10.9×10^{-6}	PE	200×10^{-6}
Cast Iron	11.0×10^{-6}	PP	150×10^{-6}

EXAMPLES

Examples of thermal expansion rates over a temperature range of 0°C to 82°C:

Carbon Steel = 1.00mm/mtr
Copper = 1.34mm/mtr
Stainless Steel (Austenitic) = 1.34mm/mtr.

Expansion rates of the common materials shown in the table above, after various temperature changes, are as follows:

Temperature Change	Rates Of Thermal Expansion For Common Pipe Materials (mm/m)								
°C	Copper	Carbon Steel	Stainless Steel	Cast Iron	ABS	PVCU	PVCC	PE	PP
10	0.16	0.12	0.16	0.11	1.00	0.80	0.70	2.00	1.50
20	0.33	0.24	0.33	0.22	2.00	1.60	1.40	4.00	3.00
30	0.49	0.37	0.49	0.33	3.00	2.40	2.10	6.00	4.50
40	0.66	0.49	0.65	0.44	4.00	3.20	2.80	8.00	6.00
50	0.82	0.61	0.82	0.55	5.00	4.00	3.50	10.00	7.50
60	0.98	0.73	0.98	0.66	6.00	4.80	4.20	12.00	9.00
70	1.15	0.85	1.14	0.77			4.90		10.50
80	1.31	0.98	1.30	0.88			5.60		12.00
90	1.48	1.10	1.47	0.99					
100	1.64	1.22	1.63	1.10					
110	1.80	1.34	1.79	1.21					
120	1.97	1.46	1.96	1.32					
130	2.13	1.59	2.12	1.43					
140	2.30	1.71	2.28	1.54					
150	2.46	1.83	2.45	1.65					
160	2.62	1.95	2.61						
170	2.79	2.07	2.77						
180	2.95	2.20	2.93						
190	3.12	2.32	3.10						
200	3.28	2.44	3.26						
210		2.56	3.42						
220		2.68	3.59						
230		2.81	3.75						
240		2.93	3.91						
250		3.05	4.08						
260		3.17	4.24						
270		3.29	4.40						
280		3.42	4.56						
290		3.54	4.73						
300		3.66	4.89						