Espiroflex
FÁBRICA DE TUBERÍA FLEXIBLE

C/. VIC S/N POL. IND. LA FLORIDA 08130 STA. PERPETUA DE LA MOGODA
TEL: 935602400 FAX : 935602626 Web: http://www.espiroflex.com E-mail : info@espiroflex.com

Santa Perpetua Mogoda, 27 July 2009

Dear Sirs

Our product ***"Hidrotubo"*** pipe is designed to withstand service pressure up to 7 bar when the liquid inside is at 23ºC temperature, depending of the dimensions of the pipe, according with the next table:

∅ INT. mm	∅ **EXT. mm**	Service Pressure bar	Minimum Burst Pressure bar
13	**16**	7	22
16	**20**	7	22
20	**25**	7	22
25	**32**	7	22
26	**32**	5	16
27	**32**	5	16
34	**40**	5	16
35	**40**	5	16
42	**50**	5	16
43	**50**	5	16
55	**63**	5	16
65	**75**	4	12,5
80	**90**	4	12,5
100	**110**	3	9,5
110	**125**	3	9,5

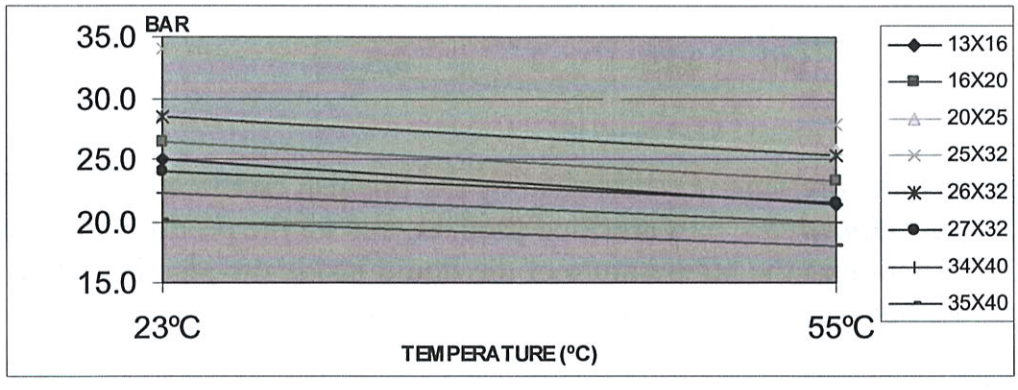
The minimum burst pressure is established by the Spanish certification authority, AENOR, since ***"Hidrotubo"*** is a certified product, and all the production is monitorized by AENOR. As long as the temperature of the liquid inside the pipe is growing, the service and the bursting pressure are diminishing as well. When the liquid inside is at 55ºC temperature, the minimum bursting pressure and service pressure established by AENOR is given by the following table

Espiroflex
FÁBRICA DE TUBERÍA FLEXIBLE

C/. VIC S/N POL. IND. LA FLORIDA 08130 STA. PERPETUA DE LA MOGODA
TEL: 935602400 FAX : 935602626 Web: http://www.espiroflex.com E-mail : info@espiroflex.com

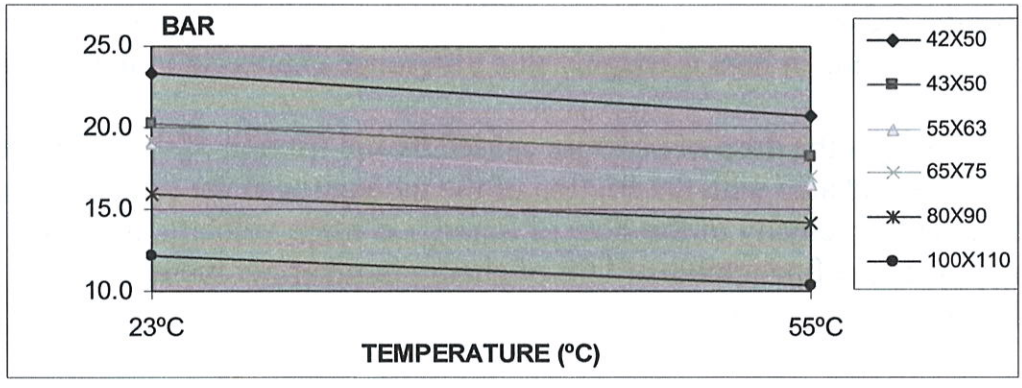
∅ INT. mm	∅ **EXT. mm**	Service Pressure bar	Minimum Burst Pressure bar
13	**16**	2.0	6.5
16	**20**	2.0	6.5
20	**25**	2.0	6.5
25	**32**	2.0	6.5
26	**32**	1.5	4.5
27	**32**	1.5	4.5
34	**40**	1.5	4.5
35	**40**	1.5	4.5
42	**50**	1.5	4.5
43	**50**	1.5	4.5
55	**63**	1.5	4.5
65	**75**	1.0	4.0
80	**90**	1.0	4.0
100	**110**	0.8	3.0
110	**125**	0.8	3.0

Following the requirements from AENOR, samples of all the production orders are bursted at 23ºC and at 55ºC temperature conditions at Espiroflex laboratory. The average bursting pressure of all these tests is summarized in the following graphics and table:



Espiroflex
FÁBRICA DE TUBERÍA FLEXIBLE

C/. VIC S/N POL. IND. LA FLORIDA 08130 STA. PERPETUA DE LA MOGODA
TEL: 935602400 FAX : 935602626 Web: http://www.espiroflex.com E-mail : info@espiroflex.com



DIAMETER	Burst pressure at 23ºC (bar)	Burst Pressure at 55ºC (bar)
13X16	25.0	21.4
16X20	26.5	23.2
20X25	28.7	25.7
25X32	34.0	27.9
26X32	28.5	25.3
27X32	24.0	21.5
34X40	22.3	19.9
35X40	20.0	18.0
42X50	23.3	20.7
43X50	20.2	18.2
55X63	19.0	16.5
65X75	19.2	17.0
80X90	15.9	14.2
100X110	12.1	10.3

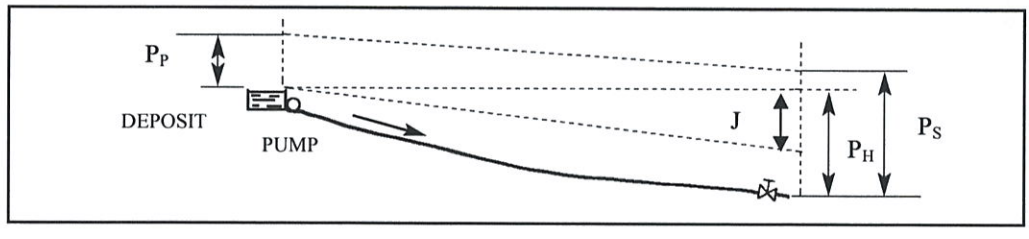
As you can see, the experimental values of bursting pressure obtained by the ***"Hidrotubo"*** pipes are much higher than the minimum required. **Nevertheless, Espiroflex does not recommend exceeding the nominal service pressure.**

You have to keep in mind that the service pressure at one point of the installation is actually the sum of the hydrostatic pressure (pressure when there is no circulation of liquid) and the dynamic pressure supplied by the pump system, minus the loss of charge of the pipes.

Espiroflex
FÁBRICA DE TUBERÍA FLEXIBLE
C/. VIC S/N POL. IND. LA FLORIDA 08130 STA. PERPETUA DE LA MOGODA
TEL: 935602400 FAX : 935602626 Web: http://www.espiroflex.com E-mail : info@espiroflex.com

The hydrostatic pressure is caused by the difference in altitude between the two extreme of the circuit. Its value in bars is roughly this difference expressed in meters, divided by ten.
The loss of charge is the drop of pressure caused by the friction of the liquid with the walls of the pipe and also with the friction of the molecules of the liquid among them. It is depending on the velocity of the flow of liquid, i.e. more velocity, more loss.
In the annex, you can find a table of loss of charge in mbar per meter of tube, for several internal diameter and velocity of liquid.

In the following diagram, you can see these concepts:



P_S: service pressure (down at tap)
P_H: hydrostatic pressure
P_P: pumping pressure
J: lost of charge

Finally you have to consider that when the opening and closing maneuvers of valves and pumps are done, high transitorial peaks of pressure can be reached, especially when these operations are abrupt, what is known as waterhammer effect. These peaks can overcome the bursting pressure, causing the failure of the tube.

Espiroflex
FÁBRICA DE TUBERÍA FLEXIBLE

C/. VIC S/N POL. IND. LA FLORIDA 08130 STA. PERPETUA DE LA MOGODA
TEL: 935602400 FAX : 935602626 Web: http://www.espiroflex.com E-mail : info@espiroflex.com

The waterhammer effect is difficult to calculate without proper software, but when the maneuver is slow enough, the overpeak over the service pressure can be estimated by the known as Michaud's formula:

ΔP (bars) $= \pm 2 L v / (g t)$

Where
L= length of the circuit (m)
v= velocity of liquid (m/s)
g= 9.8 m/s^2
t= maneuver time

Espiroflex
FÁBRICA DE TUBERÍA FLEXIBLE

C/. VIC S/N POL. IND. LA FLORIDA 08130 STA. PERPETUA DE LA MOGODA
TEL: 935602400 FAX : 935602626 Web: http://www.espiroflex.com E-mail : info@espiroflex.com

ANNEX

Friction Lost (mbar/m) for Hidrotube According to Hazen-Williams equation

	Speed (m/s)									
Ø int (mm)	0,5	1	1,5	2	2,5	3	3,5	4	4,5	5
13	3,50	12,63	26,76	45,58	68,91	96,59	128,50	164,56	204,67	248,77
16	2,75	9,91	21,00	35,78	54,09	75,81	100,86	129,16	160,65	195,26
20	2,12	7,64	16,19	27,58	41,69	58,44	77,75	99,56	123,83	150,51
25	1,63	5,89	12,48	21,26	32,14	45,05	59,93	76,75	95,46	116,02
26	1,56	5,63	11,92	20,31	30,70	43,03	57,25	73,32	91,19	110,83
27	1,49	5,38	11,41	19,43	29,38	41,18	54,79	70,16	87,26	106,06
34	1,14	4,11	8,72	14,85	22,45	31,47	41,87	53,62	66,69	81,06
35	1,10	3,98	8,43	14,36	21,71	30,43	40,48	51,83	64,47	78,36
42	0,89	3,22	6,81	11,61	17,55	24,60	32,72	41,90	52,12	63,35
43	0,87	3,13	6,63	11,29	17,07	23,93	31,84	40,77	50,71	61,63
55	0,65	2,35	4,97	8,48	12,81	17,96	23,89	30,60	38,05	46,25
65	0,54	1,93	4,09	6,97	10,54	14,78	19,66	25,18	31,32	38,06
80	0,42	1,52	3,21	5,47	8,28	11,60	15,43	19,76	24,58	29,88
100	0,32	1,17	2,48	4,22	6,38	8,94	11,90	15,23	18,95	23,03
110	0,29	1,05	2,22	3,78	5,71	8,00	10,64	13,63	16,95	20,61