



Irrigation Modernization and Design of Pipe Distribution Networks

TYPES AND CHOICE OF PIPES AND PIPE DIMENSIONS



- Pipe types (materials include mild steel, ductile iron, stressed steel cylinder, glass-fiber reinforced plastic, polyvinyl chloride, high density polyethylene, and reinforced and prestressed concrete).
- Choice depends (i) size, (ii) pressure, (iii) design life under operating conditions, (iv) cost, and so on.
 - Plastic pipes (uPVC and HDPE) are likely to be cheaper and suitable for systems where diameters are < 500 mm (uPVC) and < 1000 mm. HDPE is more suited to medium/ higher pressure systems due to greater resilience to transient pressures (water hammer/ surge).
 - GRP may be suited particularly if low friction is required. Careful handling and bedding is required.
 - For larger diameters, and for high external loading, mild steel pipes may be suitable. However, these need protection against corrosion (inside and out) which may be by concrete, painting, galvanizing, other.
 - Ductile iron has greater resistance to corrosion than steel.
 - Prestressed concrete pipes are usually cheaper than DI and mild steel.



Larger schemes likely to adopt mild steel/ DI/ prestressed concrete/ bar wrapped steel cylinder/ GRP/ other, for larger diameters and HDPE and/ or uPVC for smaller diameters.

HDPE and uPVC pipes

- Both manufactured in Pakistan by different companies
- Low friction. Roughness coefficient $k_s=0.030-0.060$ (concrete pipes $k_s=0.150-0.300$).
- Long life (>100 years) if buried underground - resistant to bacteriological growth and corrosion
- Wall thickness depends on pressure class required
- Easy to handle
- HDPE pipes more able to accommodate transient pressures (pumping, rapid valve shut down, etc)
- Pipeline connections: (i) HDPE by heat fusion, (ii) uPVC by solvent cement or rubber gaskets (easier)



nhc

water resource specialists

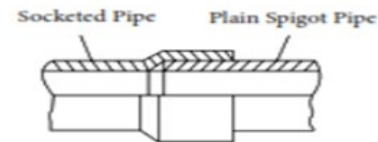


PVC pipes jointing

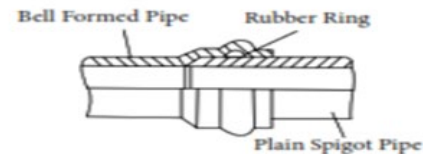
- Solvent cement
- Rubber ring gaskets
- Flange – to connect to fittings, pumps, steel pipes, etc.



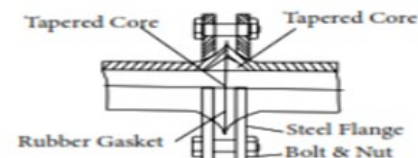
a. Solvent Cement Joint



b. Rubber Ring Joint



c. Tapered Core And Flanged Joint



HDPE Pipes jointing

- Heat fusion (by butt fusion, socket fusion, or electro-fusion)
- Time required (for heating and cooling) depends on dia. of pipe; 150 mm pipe requires 10-12 minutes
- Mechanical joints (eg flanges for fittings, etc.)



Design considerations

- Buried depth: ~1.0 m cover is sufficient to protect against light traffic loads
- Minimum bend radius (HDPE): $34 \times \text{OD}$ (for SDR 26)
- Friction factor: Hazen-Williams C factor 155 (150). Negligible change over time. For design adopt 140 allowing for minor losses for bends.
- Strength of HDPE pipes reduces with temperature.
- Flow velocity:
 - Min: 0.3 - 0.5 m/s (to avoid sedimentation)
 - Max: 1.5-1.7 for uPVC and 2.0-2.5 m/s for HDPE (to avoid excessive surge/ water hammer pressures)

HDPE pipe wall thickness & pressures

- Rated Pressure (RP) of a pipe (PN value) =< usual working pressures (with temperature correction if required)
- Safe peak pressure = 1.5 x RP for recurring surge pressure, and 2.0 x RP occasional surge
- Rated pressure depends on pipe material (PE 100, PE 80 or PE 60) and DR (pipe thickness)
- DR (dimensionless ratio) = average outside diameter/ minimum wall thickness

Rated pressures (PN values) for HDPE pipes for different SDRs and material classes

SDR	PE100	PE80	PE63
41	4	3.2	2.5
33	5	4	3.2
26	6.3	5	4
21	8	6.3	5
17	10	8	6.3
13.6	12.5	10	8
11	16	12.5	10
9	20	16	12.5
7.4	-	20	16

Adopt PE 80 or PE 100. When doing pipe systems designs check pressures (i) full flow, (ii) no flow, (iii) other scenarios.

Table 4 Standard Dimension Ratio (SDR) and Corresponding Wall Thicknesses (e) of Pipes
(Clauses 7.4 and E-4.3)

SDR	SDR 41		SDR 33		SDR 26		SDR 21		SDR 17		SDR 13.6		SDR 11		SDR 9		SDR 7.4		SDR 6		
	Nominal Pressure (PN) Bar																				
	PE 63	PN 2	PN 2.5	PN 3.2	PN 4	PN 5	PN 6	PN 8	PN 10	PN 12.5	PN 16	PN 20	PN 25	PN 32	PN 40	PN 50	PN 63	PN 80	PN 100	PN 125	PN 160
Nominal OD d_n , mm	Wall Thicknesses																				
	e_{min} mm	e_{max} mm	e_{min} mm	e_{max} mm	e_{min} mm	e_{max} mm	e_{min} mm	e_{max} mm	e_{min} mm	e_{max} mm	e_{min} mm	e_{max} mm	e_{min} mm	e_{max} mm	e_{min} mm	e_{max} mm	e_{min} mm	e_{max} mm	e_{min} mm	e_{max} mm	
16																					
20																					
25																					
32																					
40																					
50					2.0	2.3	2.4	2.7	3.0	3.4	3.7	4.2	4.7	5.3	5.8	6.5	7.0	7.8	8.6	9.6	10.5
63					2.5	2.9	3.0	3.4	3.7	4.2	4.7	5.3	5.8	6.5	7.0	7.8	8.6	9.6	10.5	11.7	12.5
75	1.9	2.2	2.3	2.6	2.9	3.3	3.6	4.1	4.5	5.1	5.6	6.3	6.9	7.7	8.4	9.3	10.2	11.3	12.5	13.9	15.0
90	2.2	2.5	2.8	3.2	3.5	4.0	4.3	4.8	5.3	5.9	6.7	7.5	8.2	9.1	10.0	11.1	12.2	13.5	15.0	16.6	18.4
110	2.7	3.1	3.4	3.8	4.3	4.8	5.9	6.6	7.4	8.2	9.2	10.2	11.4	12.8	14.2	15.6	17.3	19.0	21.0	23.4	25.8
125	3.1	3.5	3.8	4.3	4.8	5.4	6.0	6.7	7.4	8.2	9.2	10.2	11.4	12.8	14.2	15.6	17.3	19.0	21.0	23.4	25.8
140	3.5	4.0	4.3	4.8	5.4	6.0	6.7	7.5	8.3	9.2	10.3	11.4	12.8	14.2	15.6	17.3	19.0	21.0	23.4	25.8	28.5
160	3.9	4.4	4.9	5.5	6.2	6.9	7.7	8.6	9.5	10.6	11.8	13.1	14.6	16.2	17.8	19.7	21.7	24.0	26.7	29.5	33.1
180	4.4	4.9	5.5	6.2	7.0	7.8	8.6	9.6	10.6	11.8	13.3	14.7	16.4	18.1	20.0	22.1	24.4	26.9	30.0	33.1	36.8
200	4.9	5.5	6.1	6.8	7.7	8.6	9.6	10.7	11.8	13.1	14.7	16.3	18.2	20.1	22.3	24.6	27.1	29.9	33.4	36.8	41.4
225	5.5	6.2	6.9	7.7	8.7	9.7	10.8	12.0	13.3	14.7	16.6	18.4	20.5	22.7	25.0	27.6	30.5	33.7	37.5	41.4	46.0
250	6.1	6.8	7.6	8.5	9.7	10.8	12.0	13.3	14.7	16.3	18.4	20.3	22.8	25.2	27.8	30.7	33.8	37.3	41.7	46.0	51.5
280	6.9	7.7	8.5	9.5	10.8	12.0	13.4	14.8	16.5	18.3	20.6	22.8	25.5	28.2	31.2	34.4	37.9	41.8	46.7	51.5	57.9
315	7.7	8.6	9.6	10.7	12.2	13.5	15.0	16.6	18.6	20.6	23.2	25.6	28.7	31.7	35.0	38.6	42.6	47.0	52.5	57.9	65.2
355	8.7	9.7	10.8	12.0	13.7	15.2	16.9	18.7	20.9	23.1	26.1	28.8	32.3	35.6	39.5	43.6	48.0	52.9	59.2	65.2	73.5
400	9.8	10.9	12.2	13.5	15.4	17.0	19.1	21.1	23.6	26.1	29.5	32.6	36.4	40.1	44.5	49.1	54.1	59.6	66.7	73.5	82.6
450	11.0	12.2	13.7	15.2	17.3	19.1	21.5	23.8	26.5	29.3	33.1	36.5	40.9	45.1	50.0	55.1	60.9	67.1	75.0	82.6	91.8
500	12.2	13.5	15.2	16.8	19.3	21.3	23.9	26.4	29.5	32.6	36.8	40.6	45.5	50.2	55.6	61.3	67.6	74.5	83.4	91.8	102.8
560	13.7	15.2	17.0	18.8	21.6	23.9	26.7	29.5	33.0	36.4	41.2	45.4	50.9	56.1	62.3	68.6	75.7	83.4	93.4	102.8	115.6
630	15.4	17.0	19.1	21.1	24.3	26.8	30.0	33.1	37.1	40.9	46.4	51.1	57.3	63.1	70.0	77.1	85.2	93.8	105.0	115.6	130.3
710	17.3	19.1	21.6	23.9	27.3	30.1	33.9	37.4	41.8	46.1	52.2	57.5	64.6	71.2	78.9	86.9	96.0	105.7	118.4	130.3	146.0
800	19.5	21.6	24.3	26.8	30.8	34.0	38.1	42.0	47.1	51.9	58.9	64.9	72.8	80.2	88.9	97.9	108.2	119.1	134.0	146.0	163.0
900	22.0	24.3	27.3	30.1	34.7	38.3	42.9	47.3	53.0	58.4	66.2	72.9	81.9	90.2	100.0	110.1	121.7	134.0	146.0	163.0	181.0
1 000	24.4	26.9	30.3	33.4	38.5	42.5	47.7	52.6	58.9	64.9	73.6	81.1	90.9	100.1	111.2	122.4	134.0	146.0	163.0	181.0	200.0
1 200	29.3	32.3	36.4	40.1	46.2	50.9	57.2	63.0	70.6	77.8	88.3	97.2	109.1	120.1	132.0	144.0	157.0	170.0	184.0	200.0	220.0
1 400	34.1	37.6	42.5	46.9	53.9	59.4	66.7	73.5	82.4	90.7	103.0	113.4	127.0	139.0	152.0	166.0	180.0	195.0	210.0	220.0	240.0
1 600	39.0	43.0	48.5	53.5	61.6	67.9	76.2	83.9	94.2	103.7	117.7	129.6	145.0	159.0	174.0	189.0	205.0	220.0	230.0	240.0	260.0
1 800	43.9	48.4	54.6	60.2	69.3	76.3	85.8	94.5	105.9	116.6	132.0	145.0	162.0	178.0	195.0	212.0	228.0	245.0	255.0	260.0	280.0
2 000	48.8	53.8	60.6	66.8	77.0	84.8	95.3	104.9	117.7	129.6	147.0	162.0	180.0	198.0	216.0	234.0	252.0	265.0	270.0	280.0	300.0

NOTES

- 1 Tolerances calculated from $(0.1 e_{min} + 0.1)$ mm rounded up to the next 0.1 mm.
- 2 All pressure ratings are calculated at 27°C and rounded up to nearest pressure class.
- 3 Considering operational problems, maximum wall thickness of pipes are considered around 130 mm.

HDPE Pipes

Thank you

