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HDPE versus PVC PIPE

1 INTRODUCTION

After the era of Galvanised Steel (Iron) pipes and Asbestos Cement (AC) pipes, **PVC (PolyVinylChloride)** became established (in the 1960s) as the pipe material of choice for irrigation systems. Nowadays, **HDPE (High Density PolyEthylene)** is used more frequently.

Your choice of PVC or HDPE will depend on where it is being used, the technical advantages that apply to each situation and the costs.

Now, let us sort some of the fact from the fiction…

2 IRRIGATION MAINLINE - On Golf Courses

While for the most part HDPE mainline is technically superior to PVC mainline, it is simply too expensive for consideration except in exceptional cases.

I have only seen one golf course project (out of several hundred) installed with HDPE mainline. We have tendered HDPE mainlines on several occasions. ***The cost of HDPE mainline is (indicatively) double that of Rubber Ring Jointed PVC mainline (with ductile iron fittings). In almost all situations, the money would be better invested elsewhere.*** An exception may be when pumping water with a high salt content.

3 IRRIGATION MAINLINE - Landscape

Where the landscape is set amongst a lot of hardscape (such as in buildings and sometimes resorts), the cost of the materials becomes a significantly smaller part of the overall irrigation budget. In such situations, the higher cost of HDPE pipe may be outweighed by the advantages of HDPE pipe. In these instances, we would typically prefer butt-welded or electro-fusion joints, particularly where there are other services running with the mainline.

In more open landscapes, Rubber Ring Jointed PVC pipe (typically) will be preferred.

The decision on the choice of mainline pipe material are quite straight forward.
So **the rest of this article only considers the issues of HDPE or PVC laterals.**

4 IRRIGATION LATERALS - On Golf Courses

4.1 Higher Cost of HDPE Laterals

While it can vary significantly between regions, the cost of HDPE laterals is about 25% more expensive than PVC laterals. This has about a 2 to 3% impact on the overall supply and install price of a Golf Course Irrigation System. This may seem a relatively low cost, but when developers are looking after every last cent of their up-front budget, it is normally sufficient to choose PVC laterals.

4.2 Situations Where HDPE Laterals (Typically) Should Be Used

In some situations, the advantages of HDPE pipe clearly outweigh the slightly higher cost:

4.2.1 Large areas when the native soil has rock, shale or lava.

4.2.2 Ground freezing, especially with heaving.

4.2.3 Earthquake prone areas.

4.2.4 Unstable ground

a) Unstructured soils (e.g. Marine clay)

b) Expansive soils

c) Improperly compacted fill areas (e.g. Old rubbish dumps)

4.3 Contractor Familiarity

Sometimes the Contractor(s) is not familiar with PVC Solvent Weld Jointing. e.g. Many European Contractors. Furthermore, European primers and cements are not sufficiently aggressive (due to European Union legislation) and therefore not as effective as products from the United States of America or Australia. Legislation is gradually encroaching on the effectiveness in these countries also.

So in areas where the irrigation materials and Contractor is from Europe, HDPE laterals should generally be considered. Equally, if a Contractor's experience is with PVC pipe, then that should also be a consideration.

4.4 Type of Lateral Fittings for Golf Courses

At time of writing this article, there are only two brands of HDPE lateral fittings that we have seen survive the higher pressures of Golf Course Irrigation Systems. That is the Philmac (Metric Series - PN16) and the Plasson (PN16) fittings.

All fittings used must be compression fittings. We have not seen a tapping saddle used reliably on HDPE laterals on golf courses (but we have seen plenty of failures).

If tapping saddles are being considered on laterals, the tapping saddle must have at least 4 bolts (points of clamping). And it should have a keying mechanism to ensure it does not move along the pipe. In any case, we consider the bore hole (say 32 mm or 1.25") infringes too much on the integrity of the pipe (50 mm or 2" internal diameter). And the seals are problematic.

5 IRRIGATION LATERALS - Landscape

The cost factors with HDPE laterals for landscape are different than a golf course. As a result, there is not such a large difference between the cost of HDPE and PVC laterals. So the choice of HDPE or PVC for the laterals often becomes more of a personal preference rather than an outright technical consideration.

6 THE COST OF FITTINGS

6.1 The Cost of Pipe, Fittings and Laterals

Note that I keep referring to the cost of HDPE laterals rather than HDPE pipe (a careful distinction). We are primarily interested in the overall cost of the HDPE laterals; that is the cost of the HDPE pipe ***plus*** the cost of the HDPE fittings.

- HDPE pipe is cheaper than PVC pipe.
- HDPE fittings are more expensive that PVC fittings
- HDPE laterals (the combined cost of pipe and fittings) are more expensive than PVC laterals.

6.2 Cost of Fittings - Golf Courses

The cost of a HDPE fitting is higher than the equivalent PVC fitting. This is particularly true on Golf Course Irrigation System where the cost of good quality HDPE fittings is high.

One problem is the use of landscape or agricultural fittings (which operate of significantly lower pressures) being used (and failing) on Golf Courses.

HDPE fittings (often made from Polypropylene) are (almost unbelievably) bulkier and complex than PVC fittings. Compare the
63 mm (2.5") HDPE Compression Tee (list price of $ 16) with the equivalent
50 mm (2") PVC Solvent Weld Jointed Tee (list price of $ 4) in this photo:

6.3 Cost of Fittings - Landscape

In landscape, the cost difference between HDPE and PVC lateral fittings is not so significant since the operating pressure is significantly lower.

7 MANUFACTURE

7.1 Pipe

HDPE pipe is more tolerant of poor manufacturing processes than PVC due to its thicker pipe wall and higher ductility. An inclusion in PVC pipe is a larger portion of the wall thickness and it is in a more brittle material.

7.2 Fittings

HDPE lateral fittings are not so tolerant of poor manufacturing processes. Quality control is important due to the higher complexity of the fittings.

While we often use local HDPE pipe, the fittings are always an international level of product.

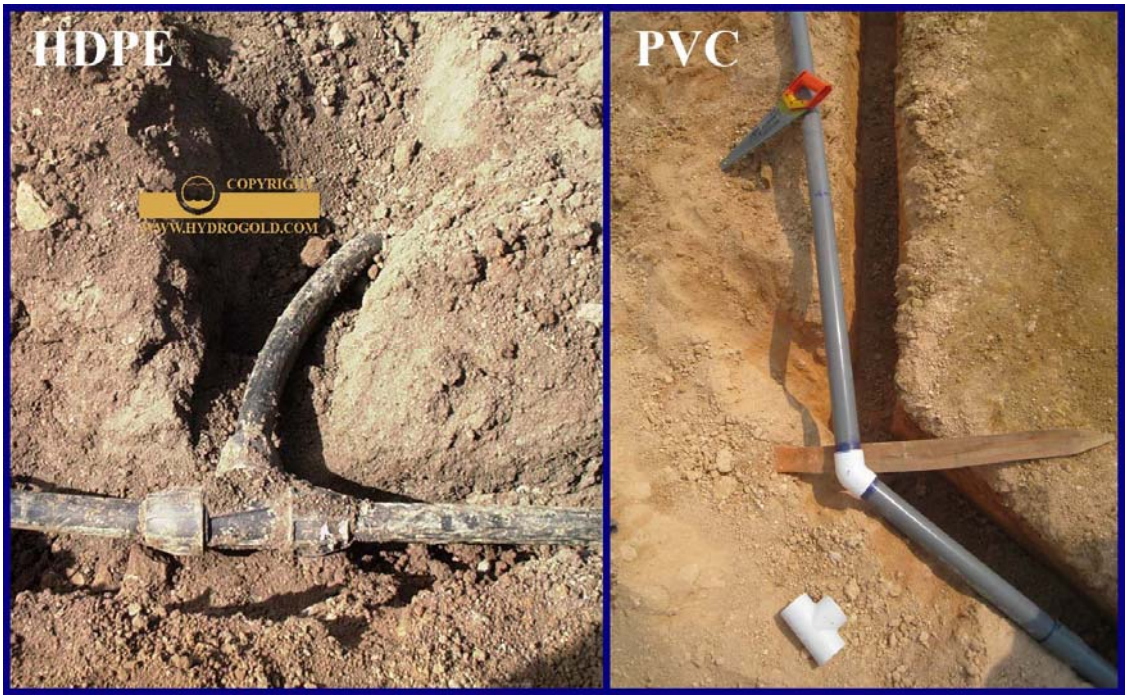
8 INSTALLATION

8.1 Stressing of Pipe and Fittings

HDPE lateral are more tolerant of poor installation.

My mantra for pipework is: "***You can stress the pipe but never the joint***".

Below are two examples of stressed joints.



This HDPE pipe is severely bent and stress put on the joint. Despite such a poor installation, this joint will last many more years than the PVC elbow to the right.	This PVC elbow is about to be stressed when it is forced into the trenches that are at the wrong angle. It is certain to fail in the short term due to the more brittle nature of PVC joints.

8.2 Flexibility versus Rigidity

8.2.1 HDPE is more flexible than PVC pipe. This makes it easier to "*snake*" the pipe (especially handy around greens).

8.2.2 HDPE pipe (for laterals) comes in coils which do not fully uncoil. This is particularly a problem in colder climates.

8.2.3 On landscape project, the rigidity of PVC pipe (which comes is typically 6 m or 20 ft lengths) makes for easier handling on site.

8.2.4 When being suspended (e.g. From the basement ceiling in a building), the more rigid PVC requires fewer suspension brackets.

8.2.5 HDPE pipe (typically) tolerates a spade better than PVC pipe.

8.3 Solvent Weld Jointing

PVC Solvent Weld Jointing is messier (chemically obnoxious primer and solvent) than coupling HDPE pipes. It is also more affected by weather (particularly temperature and humidity).

9 PIPE SUBSTITUTION TRICKS (and how to avoid them)

One trick used of unscrupulous Contractors to make HDPE laterals cheaper than PVC laterals is to make an improper substitution.

> Without advice from their Irrigation Consultant, too many Owners have allowed the Contractor to substitute 50 mm (2") HDPE pipe for 50 mm (2") PVC pipe. This seems logical. However, we need to understand that (in most standards):
> **PVC pipe is measured on the nominal <u>inside</u> diameter** whereas
> **HDPE pipe is measured on the nominal <u>outside</u> diameter**.

The (normally) correct substitution is 63 mm (2.5") HDPE pipe for 50 mm (2") PVC pipe.

Another common and incorrect substitution is to use HDPE PN10 pipe for PVC PN12.

When making any pipe substitution (not just 50 mm or 2"), the following factors must be considered:

9.1 The substitute pipe must be of equal or greater **<u>inside</u>** diameter. The inside diameter is critical since it is the carrier of the water and will determine the water velocity (and subsequent frictional losses and water hammer).

9.2 The correct pressure rating must be selected. e.g. Substituting HDPE PN10 pipe for PVC PN12 is not correct.

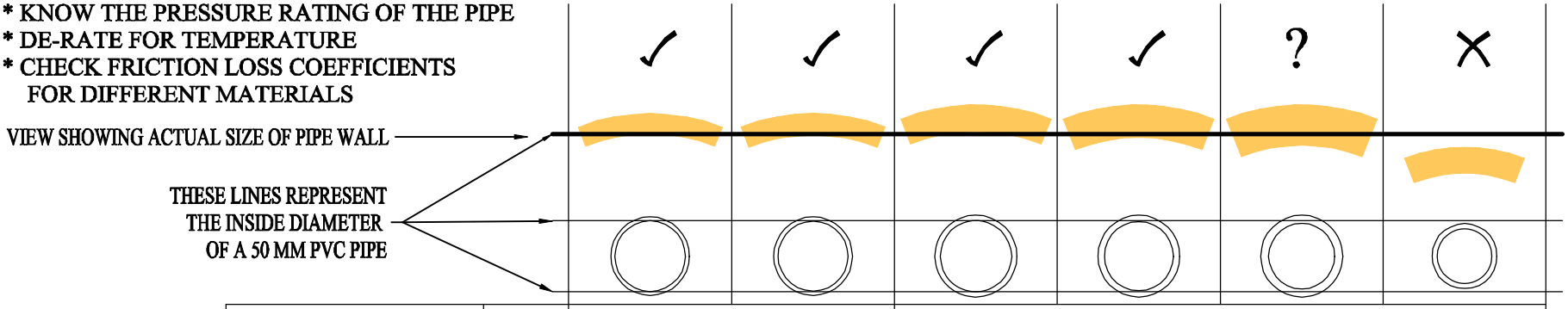
9.3 Both PVC and HDPE pipes often need to be de-rated for temperatures. The older HDPE resins had a much higher de-rating factor and the particular resin being used should be checked.

9.4 Where there are long lengths of pipe involved, the coefficient of friction for the different pipe materials may be a significant factor. How long does it have to be for it to be significant? - Check the particular situation with your Irrigation Consultant.

Refer to the sketch over page.

WHEN MAKING PIPE SUBSTIUTIONS, WE NEED TO:

* CHOOSE A PIPE WITH EQUAL OR GREATER INSIDE DIAMETER - OUR PRIME CONCERN IS THE INSIDE (NOT OUTSIDE) DIAMETER.
  (IT IS WHAT DETERMINES THE FLOW CAPACITY OF THE PIPE)
* KNOW THE PRESSURE RATING OF THE PIPE
* DE-RATE FOR TEMPERATURE
* CHECK FRICTION LOSS COEFFICIENTS
  FOR DIFFERENT MATERIALS



Material		PVC		HDPE			
Measured on		Inside Diameter		Outside Diameter			
Standard		ASTM	AS1477	AS4130 (PE 100)			
Class		200	PN12	PN10	PN12.5	PN16	PN12.5
Nominal	mm	50	50	63	63	63	50
Diameter	inches	2.0	2.0	2.5	2.5	2.5	2.0
Actual	mm	60.33	60.35	63.00	63.00	63.00	50.00
Outside Diameter	inches	2.38	2.38	2.48	2.48	2.48	1.97
Actual	mm	54.10	53.70	54.80	53.00	50.60	42.00
Inside Diameter	inches	2.13	2.11	2.16	2.09	1.99	1.65
Pressure Rating	Bar	13.79	12.00	10.00	12.50	16.00	12.50
(Without De-Rating)	PSI	200	174	145	181	232	181
Pressure Rating	Bar	11.31	10.44	8.70	10.88	13.92	10.88
(At 30 C or 86 F)	PSI	164	151	126	158	202	158

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NOT TO SCALE

FILE: SK_MISC

DRAWING No 1335-A4

PIPE SUBSTITUTIONS -
50 MM (2") PVC AND 63 MM (2.5") HDPE

10 COMPARISON TABLE

Feature	HDPE	PVC	Comment
Manufacture of Pipe	More tolerant of poor manufacturing processes due to thicker pipe walls and higher ductility.	Control of resins and re-grinds more important.	Can often use local HDPE pipe but not PVC pipes.
Manufacture of Lateral Fittings	Manufacturing processes important due to complexity of fitting.	Manufacturing processes important due to (relative) brittleness of PVC and deceptively simple but complex stress points.	Fittings are critical for both HDPE and PVC pipe fittings.
Ductility	Ductile. More forgiving of poor manufacture and installation.	(Relatively) Brittle. Withstands higher earth bearing pressures (more rigid).	
Sunlight	Tolerant	Needs to be protected from UltraViolet radiation (sunlight) that embrittles PVC.	
Pipe Wall	Thicker	Thinner	Thicker walls are more tolerant of rocks and other hardcore materials.
Coefficient of Friction	Typically 140 (rougher)	Typically 150 (smoother)	PVC pipe has lower friction losses but typically this is only significant over longer distances.
Cost of Pipe	Lower	Higher	
Cost of Fittings	Higher - Bulkier and more complex.	Lower	Cheap fittings fail for all pipe types.
Overall Cost	Higher	Lower	HDPE laterals 10 to 20% higher cost depending on market.
Installation	More tolerant of poor installation	Must not stress Solvent Weld Joints.	HDPE is more reliable
Flexibility	Flexible. Pipe can be "snaked" easier. However, coils of pipe do not fully uncoil (especially in colder weather).	(Relatively) Rigid. Pipe can be easier to handle (not supplied in coils).	
Expansion	Larger Expansion/Contraction with temperature.	Expansion/Contraction is still a factor.	
Repairs	Can pressurise immediately after repair. Joints can be taken apart and reassembled.	Must wait 24 hours before pressurising a Solvent Weld Joint. Joints are permanent.	

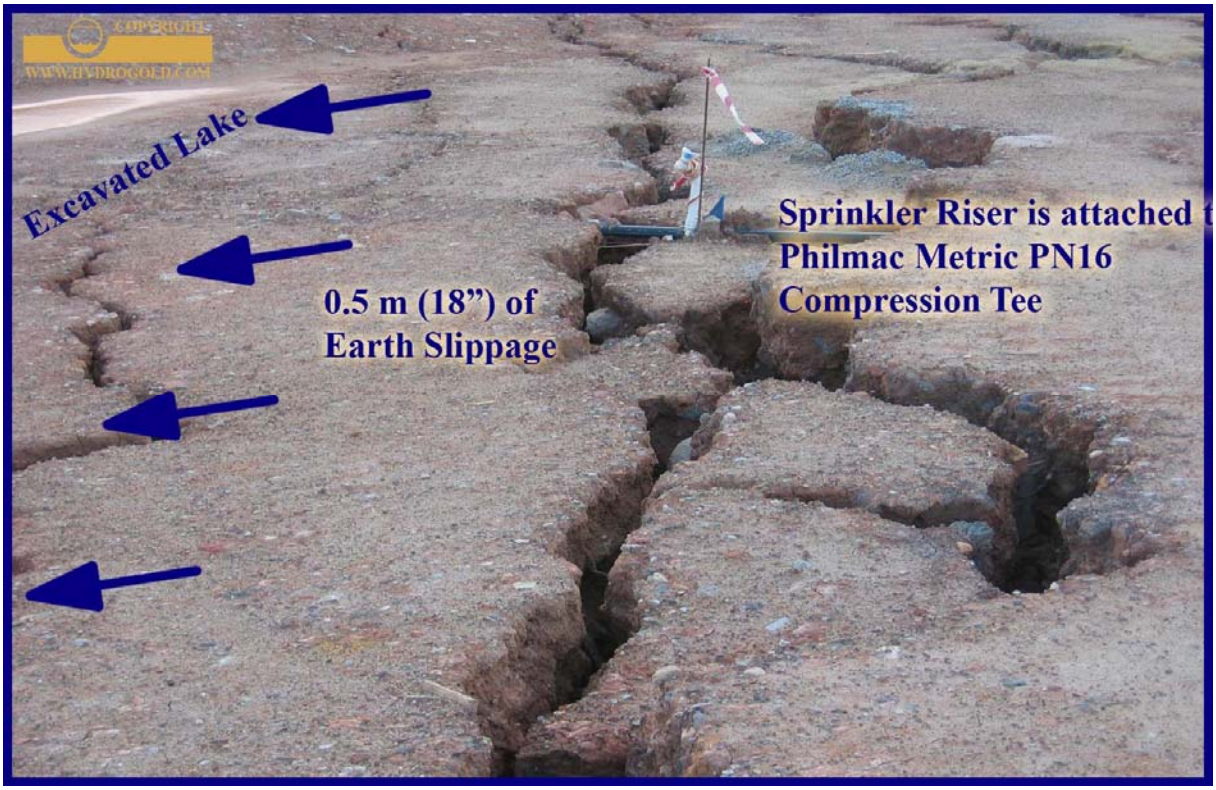
11 IN SUMMARY…

From a technical perspective, HDPE is normally preferred to PVC because of its physical properties and better tolerance of poor manufacture and installation.

From a cost perspective, HDPE mainlines are nearly always prohibitive on golf courses. On landscape projects where there is a lot of hardscape, the balance can often be in favour of HDPE mainline.

With laterals, the cost difference is less significant. In many situations, HDPE laterals are the much preferred choice regardless of the cost.

In my opinion, HDPE laterals will become more common until eventually (say 20 years) they will replace PVC as the preferred material for laterals. It will take longer for HDPE mainline to be more accepted due to its significantly higher cost and difficulty of installation.



This is a ***photo of Marina Bay Golf Course in Singapore*** during construction in 2005. The site was built on land reclaimed from the ocean and was known to be unstable.

Hydroscapes Pte Ltd (Hydrogold's Singapore sister company) had designed just about every Golf Course Irrigation System in Singapore since 1991 (17 in total). All these projects had used PVC pipe. However, we recognised that this was a different situation and persuaded our Client to pay the extra cost of HDPE laterals using the Philmac Metric Series of compression fittings (no tapping saddles!), a first for Singapore.

In another first for Singapore, Rubber Ring Jointed PVC pipe with a Leemco Joint Restraint System was used for the mainline since the ground was not stable enough for thrust blocks.

One morning, the unstable earth had slid 0.5 m (18") sideways into an unfilled excavated lake. The result; not one lateral line (or mainline which was pressurised) was disconnected. A great testimony to the structural integrity of the HDPE laterals and the Leemco Joint Restraint System on the mainline. And for not blindly copying what has been done before.