WHEN SYSTEMS COLLIDE

THERE ARE SIGNIFICANT ISSUES IN THE MARKET PLACE AFFECTING THE PERFORMANCE OF PP-R PIPE SYSTEMS IN COMBINATION WITH COPPER IN HOT WATER RECIRCULATION SYSTEMS. **JONATHAN JACKSON** SPEAKS WITH HYDRAULIC CONSULTANT DAVID STEBLINA ABOUT THOSE ISSUES AND HOW THEY CAN BE WORKED AROUND.

Hydraulic consultants and plumbing practitioner's world-wide are well versed in the implications of contact between dissimilar metals. The by-product of this relationship is an increased risk of corrosion, particularly when an electronic current has been introduced into the water system.

This phenomenon has been identified in metal pipework systems and as such the appropriate design and installation methods to overcome an increased rate of corrosion are well covered in Standards and design guidelines.

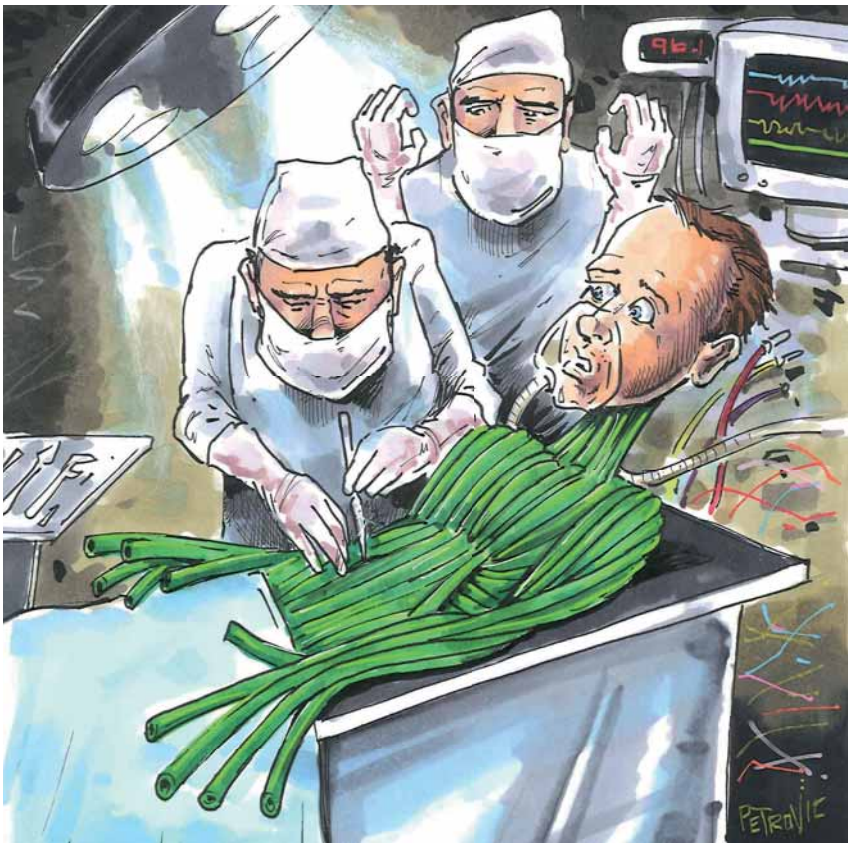
Recently, hydraulic consultants and the plumbing community in Australia have been advised of failures occurring within PP-R (Polypropylene Random Copolymer) systems arising in hot water recirculation systems.

On advice from Aquatherm Australia, it should be noted that there is no evidence of incompatibility between these materials in cold, rain and recycled water applications.

With the increase of polymer pipework entering the Australian market around 15 years ago, consultants and contractors have been rapidly coming to terms with differing methods of design and installation techniques.

The Australian market has generally progressed with some indifference towards polymer piping and has been very slow on the uptake for installations above 25mm (domestic rough-ins are the exception).

One of the world leaders in the production of PP-R pipework has been at the forefront of providing training programmes and demonstrations for consultants and contractors to understand the 'unfamiliar' jointing technique required for this system.



PP-R pipe and fittings systems are manufactured from a high grade polypropylene, first developed and marketed over 40 years ago in Germany and widely available as a fusion-weld jointing system in Australia for around 20 years.

PP-R has stood the test of time in Europe and elsewhere in the world; however, more recently on home soil – failures have become apparent in mixed PP-R/copper hot water recirculation systems.

Not surprisingly, market leader Aquatherm displayed their alarm and worked quickly to mount an investigation as to why this problem was occurring in Australian hot water recirculation installations.

A spate of tests were conducted, in Australia, by Professors of Polymer Science/Fracture Mechanics and Doctors of Metallurgy with overseas experts brought in to help understand why this was happening in Australia and nowhere else in the world.

The initial reasons of possible failure were identified. Investigations focused around incorrect clipping and accommodation of polymer expansion in installation, recirculation hot water design velocities together with

excessive water temperatures.

The German manufacturer had not experienced this issue previously and duly labelled it the 'Australian Phenomenon'.

David Steblina is NSW president of the local AHSCA chapter and hydraulics principal at Wood & Grieve Engineers. David has taken a keen interest in this issue, as he has specified PP-R on a number of projects where the product has been successfully installed and operated. David has an inherent passion for ensuring the correct information is being debated by the relevant parties and industry bodies.

"Polymer and metal experts were engaged and found that there was not one key element causing random failures of PP-R fittings. During the initial investigation the findings appeared to have been a cocktail of incorrect bracketing causing pipework stress, inadequate expansion and pressure provision, temperatures greater than 70˚C and high water velocities."

That investigation ultimately led to an interesting finding: large amounts of metal/copper ions were being harvested on the inside of the PP-R pipes and fittings where PP-R was located downstream from copper.

"When PP-R was developed and tested originally, it was understood that copper/metal irons could adversely affect polymer in extreme conditions, thus a metal deactivator was added to the polymer compound, to resist such ions."

The expert results and external studies concluded that the introduction of metal gave cause for the pipe to be depleted of its stabilisers and when coupled with unaccommodated expansion caused the pipe to suffer oxidative stress cracking. The combination of excessive temperature, pressure and incorrect clipping, coupled with attendant chlorine and aggressive copper ions all constantly recirculating at high velocity and stimulated by entrained air were found to be the causes of the chemical cocktail causing the PP-R systems to suffer degradation when associated with a hot water recirculation system.

Further scientific appraisal advised such operating conditions would also adversely affect other polyolefin potable water pipe systems. PP-R became the manifestation of the issue as it was the only large bore polymer pipe to work with copper in ring main applications. ➤

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European produced PP-R has the highest level of metal deactivators added to the polymer, as allowed for under drinking water standards.

One of the defining outcomes of the expert reports was a commentary written on the design velocities expressed within AS/NZS 3500.

"Our Australian Standards state a maximum design velocity of three metres per second," says David.

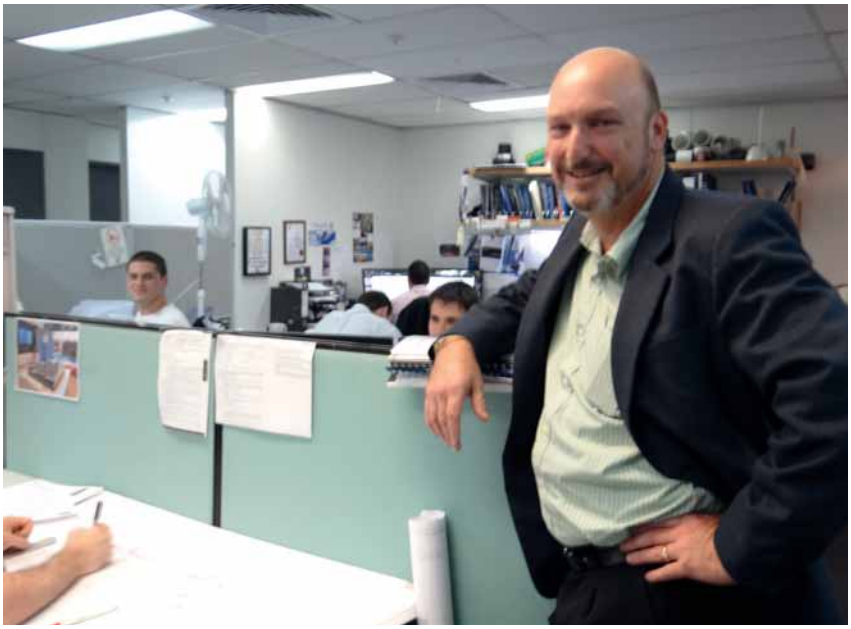
"Apart from the findings on the key contributors for failure, the report highlighted an ambiguity within the Standard that gave the consultant license to design a water system with unacceptable velocities. It is known that high velocities cause scouring, water hammer and have a long term detrimental effect on all types of water systems regardless of materials."

This is amplified at excessive water temperatures.

Copper has become an unwitting player in the expert findings, because the Australian Standard has an acceptable velocity of three metres per second. Copper is a soft material and although it has been widely used and is an approved material for water services, it is susceptible to internal erosion and corrosion under certain conditions.

AS/NZS 3500 does not seem to be in line with world-wide acceptable standards which make differentiation between maximum velocities and temperature of water being delivered.

In Europe and the US, the velocity for copper in hot water recirculation is widely recognised as being between 0.5m/s to 1.0m/s with 0.9m/s (absolute maximum) in temperature of water > 60˚C and 1.5m/s for cold. The question is: why is there this difference between Australia and these mature markets? Part of the answer is found in AS 3500 itself – the provision for 3.0m/s in Part 4 Heated Water Services is for non-circulatory heated water services – there is no provision for hot water recirculation. The Australian Standard has grown from a domestic code of practice; it did not provide for hot water recirculation in further revisions. This explained why copper hot water velocities differed so markedly with other international markets.



David Steblina has an inherent passion for ensuring the correct information is being debated by the relevant parties and industry bodies.

Rather than wait for gazetted change, some consultants are adopting international velocity and temperature guidelines in both mixed and pure copper hot water recirculation.

"This is the advice the AHSCA has been broadcasting," says David

When polymer systems were introduced to the Australian Standard, velocities were not addressed. It was left to the industry to advise consultants about how to properly manage their products.

Maximum velocities are therefore left to the designer's discretion. Unfortunately, this means that contractors will also install at their own discretion to meet cost restraints and may reduce a pipe to fit a space which could be to the detriment of a building and the performance of the pipe system within it.

Clear guidelines are a necessity.

"The building industry requires longevity of materials that are designed and installed and we need to ensure that these materials operate for the right reasons," David says.

Which brings us back to the issue of copper and PP-R.

Buildings with a copper hot water recirculation system which experience high velocities and scouring provide an outcome for waterborne copper ions to be harvested into the PP-R systems.

"Consultants and installers need to have an understanding and an appreciation for the shortcomings of the compatibility of materials they are dealing with," David says. "Gone are the days when we can rely on the fact that if a WaterMark Licence says a material is approved and that product group is recognised under the Plumbing Standard, then it automatically follows that all such products are compatible under varying operating conditions.

"PP-R is approved for hot water systems around the world, but it doesn't say that you can't use it when it is combined or exposed to a copper

system when temperatures and velocities are excessive. We have to rely on what the manufacturers are telling us and this means we have to be technically more aware of the incompatibility in some cases of the materials on offer.

This is not to say that we shouldn't consider a material because it has failed under certain circumstances, we just need to understand why it failed and design and install in a manner that ensures no excessive operating conditions. We also need to ensure that it is designed and installed in accordance with the manufacturer's guidelines."

The incompatibility of PP-R and copper at certain hot water recirculation velocities and temperatures is just one case in point. Indeed, manufacturers, and Standards are on a learning curve and part of that curve is to learn to work with designers.

"As a designer I manage risk for my client and company. If I am not comfortable about a product, I won't specify it. A designer always needs to look at alternatives.

Manufacturers will agree that in Europe more engineering consideration goes into the study of material selection and they accommodate the shortcomings in the design. I want to be able to make a decision based on my experience and I will design a system that poses the least amount of risk for my client and my company."

For any engineer or designer that means specifying product that fits the brief and understanding any shortcomings. It still means there is a place for PP-R in buildings where there is copper, on the condition that the design and installation takes into account the matters noted above.

This also points out that Australia must adopt world Standard practice. This would ensure compatibility between PP-R and copper as is evidenced elsewhere in the world.

As a side note, Aquatherm should be congratulated for meeting this issue face on and openly encouraging discussion within the industry.

Through the work David has encouraged, he applauds the Australian Copper Development Association for instigating their own review and acknowledgment that there needs to be a more transparent guideline available to industry on the velocities with a copper water system.

Producing pipe and fittings, as well as designing and installing systems within established operational parameters is not always the simple science it might seem.

As a postscript, the matter of international alignment of pipe material velocities in hot water recirculation is presently before Standards Australia.

It would be expected that the Standard will be amended to table the desirable velocities for hot and cold reticulation and circulation for differing types of materials and temperatures. With collaborative input from manufacturers this long awaited amendment will be a benefit to the industry at large. ■

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