Queensland University of Technology

EXPERT OPINION

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Performance of polyolefin (PP-R, PEX and PB) piping and fittings in recirculating hot water systems under Australian operating conditions

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1.1 Polypropylene-Random (PP-R), polybutene (PB) and crosslinked polyethylene (PEX) piping and fittings are successfully used in Australian domestic and dead-leg applications, reflecting experience in Europe.

1.2 The use of these materials and the test methods for them are covered in national and international standards (eg. *AS/NZS 3500.4.2:1997 National plumbing and drainage - Hot water supply systems - Acceptable solutions*; *ASTM F877 - 11a Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems*)

1.3 These materials have been successfully used in recirculating hot water loops in Europe where temperatures rarely exceed 65^{o}C and operating pressures and velocities are controlled.

1.4 In Australia it has been found that the use of polymer pipes together with copper in recirculating hot water loops needs to be carefully monitored as there has been a history of running at much higher temperatures (above 70^{o}C for prolonged periods) and higher velocities (up to 3 m/s) than in Europe and elsewhere in the world. There is also a greater use of chlorine and related disinfection agents at higher concentration than in Europe.

1.5 The consequence of this combination of factors is that erosion/corrosion of copper pipes and fittings in series with the polymer pipe and fittings results in deposition of copper salts on the polymer components. This outcome has been known as the “Australian phenomenon”.

1.6 This results in damage to the polymer, in particular a high rate of degradation, consumption of the stabilizer system and a shortened lifetime of pipes and fittings. The unique Australian conditions in a mixed copper/polymer pipe recirculating loop means that the stabilizers are continuously leached from the polymer and the high temperature and presence of copper catalyses the oxidation of the polymer pipe. This leads to crack formation that propagates under applied thermal and mechanical stress leading to failure.

1.7 Study by me of mixed copper/PPR systems that have failed has found the following features:
(i) Continuous temperatures in service above 70^{o}C;

(ii) Extensive copper pipe and fittings present in the recirculating loop
(iii) High velocities (above 0.9m/s)
(iv) Use of chlorine or related disinfection agents at high concentration
(v) Mechanical stress in the pipes and fittings due to poor workmanship.

1.8 Where several of the above factors, particularly points (i) and (ii) are present in a recirculating hot water loop then the lifetime of the pipework and fittings will be reduced below the warranted period.

1.9 In my opinion polymer pipes and fittings should only be used in recirculating hot water loops where the factors in section 1.7 can be eliminated. This is a consequence of the sensitivity of all polymers used in potable water applications to prolonged thermal degradation catalysed by copper salts.

1.9 Present pipe and fitting formulations contain the maximum level of stabilizers permitted for potable water applications so it is not possible to increase stability any further. It is my opinion that all polyolefin pipes (PEX, PB and PP-R), regardless of manufacturer, will be susceptible to damage when subjected to the conditions in section 1.7 above.

1.10 I have no such concerns in the use of polymer pipes and fittings in:

- cold water supplies
- dead-leg systems where exposure to elevated temperatures is intermittent over the life cycle of the pipe and fittings
- complete (copper-free) PPR and temperature-controlled hot water recirculation systems.

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