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Builder Insight

TECHNICAL BULLETIN

Alternatives to Domestic Water Re-Piping

BC HOUSING

Builder Insight is a series of bulletins and companion videos designed to provide practical information on new technologies, research results, good building practices and emerging technical issues in residential construction to Licensed Residential Builders and others in the industry.

This bulletin was prepared based on research conducted by Integral Group.

BACKGROUND

A number of BC municipalities, including the City of Vancouver, are known to have aggressive water. Aggressive water has higher acidity due to low pH and is characterized as soft water, with high dissolved oxygen and carbon dioxide content, free chlorine concentrations and low hardness. It is corrosive to copper pipes, and often leads to premature copper pipe failures, usually in domestic hot water systems.

The best technique for dealing with a failing plumbing system is to re-pipe, an expensive and disruptive solution for an occupied building. This bulletin looks at two alternatives to re-piping, epoxy pipe lining and water management systems.

Contributing Factors

Water Quality

Water supplies coming from surface water and snow melt are characterized as soft water and tend to be acidic. In contrast, water supplies from deep ground water extracted via boreholes, referred to as hard water, tend to be rich in dissolved solids due to water flow through rock strata. Soft water has lower pH values due to lack of exposure to rock formation flow and requires additional treatment.

A number of municipalities address this soft water that is acidic and aggressive at water treatment plants. Once a set of measures are in place, pipework system life is extended, reducing pinhole leak problems.

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Water Velocity

The term "flow velocity" refers to the speed at which water moves through various components of a plumbing system, such as pipes and valves. As water flow velocity increases, the abrasive effect grows inside the copper pipe wall resulting in erosion. The extent of this "erosion corrosion" caused by excessive flow velocities is dependent upon the physical characteristics of the tube materials or to impediments to flow on the tube wall, such as burrs on the tube ends, blobs of solder, or mineral deposits.

Flow velocity limitations in domestic water plumbing systems are governed by the pipework manufacturers. The British Columbia Plumbing Codes prior to 1992 did not mention flow velocity. The current British Columbia Plumbing Code 2012 (Clause 2.6.3.5) states "*The maximum permitted water velocities shall be those recommended by the pipe and fitting manufacturer*". The Canadian Copper and Brass Development Association maximum recommended velocities are:

- 5 feet per second (1.5 m/s) for domestic cold water, and
- 4 feet per second (1.2 m/s) for domestic hot water not exceeding 140°F (60°C).

Copper Pipe Thickness

Copper pipe thickness is divided into three categories: Type K, Type L and Type M. Type K is the thickest, Type L is in the middle and Type M is the thinnest pipe. Although permitted in some Canadian regions, Type M piping is not used in BC due to the region's aggressive water. While the plumbing industry recommends a minimum use of Type L copper pipe in BC, this thinner piping is still vulnerable to the onset of pinhole leaks and resulting pipe failures. A thicker walled copper pipework system such as Type K is recommended as its use prolongs durability before pinhole leaks form.

Pipe Corrosion and Health

For many years, lead was a common component of water distribution systems. Many older Canadian neighbourhoods continue to be serviced by lead service lines. The National Plumbing Code permitted lead as an acceptable material for pipes until 1975 and in solder until 1986. Lead was also found in leaded-brass fixtures, such as faucets and valves. Over time, as these items corrode or break down, they can cause lead concentrations to increase in drinking water. This problem is exacerbated in hot water systems, especially re-circulating hot water systems in large buildings, where green staining and early pipe failures appear more significant.

If there are lead service lines or other lead-based materials in your plumbing system, explore tap water lead content tests. Some municipalities have established sampling programs while others test upon request. In some areas, you may have to arrange for your own sampling and an accredited laboratory analysis.

There are several approaches to reduce exposure to high lead levels in tap water. Running cold water for five minutes first thing in the morning, or any other time the plumbing system hasn't been used in several hours, flushes the lead out. Alternatively, flush the toilet, take a shower or start your laundry, then run the water until it gets cold (roughly one minute)

before using that tap's water for drinking or cooking. Always use cold tap water for drinking or cooking, hot water increases the leaching of lead. Additionally, use certified household water filters and water treatment devices that remove lead from tap water. Lead exposure from showering, bathing, dishwashing or cleaning is not a concern as lead is not well absorbed by the skin or through breathing.

Epoxy Pipe Lining

Epoxy pipe lining is an alternative solution to re-piping metallic pipework systems with corrosion and associated pinhole leaks. This process applies a lining to an existing copper pipework system to provide a water tight seal within a pipework infrastructure. To implement this solution, the building is surveyed to map the original pipes to plan the epoxy lining into manageable sections, from small to large diameter pipes. This usually requires the installation of additional isolation valves to different pipe sections. These valves are left in place after the epoxy lining application, an advantage allowing many options for isolation and future repairs.

Once the repair area is identified and isolated, it is dried with warm compressed air. A safe, abrading agent is blown through the pipe system, removing rust and corrosion with the pipe by-products collected in a disposal holding unit. To remove fine particles, compressed air is applied again and the internal pipework surfaces are cleaned resulting in an "as new condition".

Optimal internal pipe surface temperature is created by blowing compressed air through an electric heater into the pipework prior to epoxy coating. A calculated amount of epoxy is prepared for injection into the pipework system, providing an evenly coated barrier between metal pipe walls and waterflow. Conditioned air is then introduced into the pipe to uniformly distribute the epoxy coating throughout the pipe segment.

The lined pipes generally come with a limited warranty against leaks, pressure failures, and delamination under normal operating conditions.

A section of pipe is completely coated when epoxy is witnessed leaving at the discharge point to the system under test. Following the coating application, continuous controlled air flows through the piping for a minimum number of hours to facilitate epoxy curing. Each pipework system section is pressure tested to one hundred pounds per square inch of pressure to ensure zero leaks before the water is turned on. This test, in conjunction with a visual inspection, confirms lining integrity and volume, while flow tests confirm system functionality.

The lined pipes generally come with a limited warranty against leaks, pressure failures, and delamination under normal operating conditions. There are minor limitations on the system:

- The pipework should not be exposed to temperatures in excess of 140°F (60°C), or pressure above 150 psi.
- Future pipework system modifications should be carried out by a certified plumbing contractor using mechanical jointing techniques, not soldering.
- Epoxy relining is not suitable for plastic pipework systems.
- The application must meet applicable code requirements, including maximum water velocities.

Water Management System

A water management system is a water chemistry adjustment technique that injects minerals to the water supply as the domestic cold water enters the building. This technique adds naturally occurring hard water minerals to incoming, domestic cold water, creating a biofilm on the inside of the pipework, limiting further attack to the copper pipework. Additional pH correction of the water supply further assists this process.

Water systems utilise a water meter to measure domestic cold water consumption in the building, allowing two pumps to inject a predetermined amount of minerals into the drinking supply. The demand of water is automated and dosing pumps are locked to prevent tampering after installation. Government certified treatment minerals are safe to use, as per standard NSF-60. A number of safeguards are included to the monitoring and control system to prevent problems and ensure water quality. This includes a pulse splitter to protect dosing pumps, and sampling points connected to alarms.

The water management system service providers typically provide a warranty on their equipment including: meter, pumps, dosage equipment, etc. There are also service contracts available to maintain equipment and provide the minerals necessary for the system. There are no special requirements for the pipework downstream of the water treatment equipment and pipework can be modified as required.

There are a few limitations on the system:

Image of the injection point of minerals into the domestic cold water supply.

- When the overall pipe condition is poor, this system may not be effective.
- Overall pipe thermal imaging may be required to identify problem areas to replace prior to installing a water management system.
- A water consumption survey is recommended to evaluate overall water use and estimate how long it will take to completely coat the pipes.
- The system typically does not come with a warranty against leaks or pressure failures. The intensity and frequency of leaks gradually decrease as the coating inside the pipe is established.

Building Code

Although both techniques have been used in BC, neither are covered under the current (2012) BC Plumbing Code. The application of these techniques falls under the Authority Having Jurisdiction (AHJ). Consult with your AHJ before proceeding with any project.

EVALUATING ALTERNATIVES		
	Epoxy Pipe Lining	Water Management System
Time Scale/Schedule	Depending on the building and how it has been piped. Can take 8-12 weeks to complete.	This is a straight forward installation, takes 3-4 days to complete with minimum building disruption to occupants.
Costs	More expensive than water treatment but cheaper than a re-pipe. Costs increase if the building fabric contains asbestos.	Capital costs are less expensive, there are ongoing monthly costs per suite. Overall life cycle cost is relatively less than lining and significantly less than a re-pipe.
Building Suitability	More suitable for pipework in poor condition as installation scours, cleans and relines pipework. Not suitable if large portions (>50%) of the building have PEX/CPVC pipework systems. Original pipework must have design and velocity capacity for a 10% increase in velocity so lined pipework is not excessive when relined.	If pipework is old and in very poor condition water treatment can struggle with multiple pinhole leaks. In the future, complete sections of pipework may need to be replaced before continuing with the water management system.

Costs

Cost and building disruption are factors in choosing a water system repair process. A pipe relining project is roughly 2/3 of the cost of a full re-pipe with a shorter construction schedule delivering less disruption to building occupants. A water management project is closer to 1/4 of the cost of a full re-pipe if the cost is taken over a 10-year period and typically has one or two days of building disruption.

The epoxy lining is a one-time, single upfront cost, compared to the multiple costs of a water management system. System costs include: an initial first-time equipment installation fee, an equipment maintenance contract cost and the purchase of consumables which can be charged on a monthly basis based on the number of suites being serviced.

The following table provides a cost comparison between a water management system and a pipe relining using 2015 fees for two buildings. These costs were developed for specific buildings and products, costs will vary for different buildings and systems.

The best technique for dealing with a failing plumbing system is to re-pipe.

	Epoxy Lining	Water Management System		
	First Cost with 10 Year Warranty	First Cost Plus Consumables for 3 Years	Maintenance and Consumables for Next 7 years*	Total Anticipated Cost for 10 Years
36-unit building with 3" DCW	$139,000	$30,500	$26,500	$57,000
48-unit building with 3" DCW	$245,400	$32,000	$35,300	$67,300

Alternatives to Copper Piping

Re-piping and new construction projects have a number of alternative pipework options not susceptible to corrosion: crosslinked polyethylene (PEX) pressure tubing, chlorinated polyvinyl chloride (CPVC) water pipe, polypropylene (PPR) pressure pipe and stainless steel or a mix of these systems. To date, these different materials are more resistant to corrosive attack/ pipework erosion providing reduced pipe work failure due to pinhole leaks.

Non-metallic pipework systems and placement in a potable water system are listed in British Columbia Plumbing Code 2012 Table A-2.2.5, 2.2.6 and 2.2.7.

Non-metallic pipework requires special attention, it introduces a combustible material in non-combustible construction. Where it penetrates a fire resistant separation, associated detailing can become difficult and expensive. One common approach is to mix pipework systems where metallic pipework is used for distribution crossing fire barriers and other non-metallic pipework is used elsewhere. For example: copper pipework risers with distribution down the corridor to individual residential suites with final runouts to the fixtures in PEX. This approach is cost effective and is often used although it runs the risk of pinhole leaks in common distribution areas.

Other short falls of non-metallic systems are: the restriction of temperatures/pressures, greater thermal expansion, limitations on recirculation, additional pipework supports and greater sound transmission from plastic pipework. In December 2015, a thin-wall stainless steel system (Type 304 schedule 10 conforming to ASTM A312/A312M, and Type 316/316L conforming to ASTM B36.19M) was added to the Plumbing Code. This material has the advantage of not being affected by pinhole leaks, is easy to work with and can sustain a higher flow velocity of (8 ft/s [2.4 m/s]) compared with 4 ft/s (1.2 m/s) for copper/PVC. This allows a smaller pipework size to be used allowing some off-set in cost and saving of riser space.

More Information

Health Canada, 2007. *Minimizing Exposure to Lead from Drinking Water Distribution Systems*, ISBN: H128-1/07-513E. Available at http://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/water-talk-minimizing-exposure-lead-drinking-water-distribution-systems.html

2012 BC Plumbing Code. Available at: www.bccodes.ca.

Building and Safety Standards Branch, 2012. *Potable water – "Safe for Human Consumption"*, Information Bulletin No. B12-01-R. Available at www2.gov.bc.ca.

Condominium Home Owners Association of BC, 2004. *Corrosion of Copper Water Pipe in the Lower Mainland*. Available at www.choa.bc.ca.

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