Infrastructure

Pipe Rehabilitation: CIPP Provides Low-Cost Alternative

Distribution

Ice Pigging Offers Sustainable Main Cleaning Technology

Nonrevenue Water

AMI Boosts Meter-Reading Accuracy and Revenue

Automated Systems

Can We Make Water Systems Smarter?
Opflow (ISSN 0349-8029) is a monthly publication of the American Water Works Association, 6666 W. Quincy Ave., Denver, CO 80235. Copyright © 2013 by the American Water Works Association. Published in the U.S. Periodicals postage paid at Denver, Colo., and additional mailing offices. Postmaster: Send address changes to Opflow, AWWA, 6666 W. Quincy Ave., Denver, CO 80235-3098. Telephone: 303.794.7711; fax 303.794.7310; email opflow@awwa.org.

American Water Works Association
The Authoritative Resource on Safe Water®
Core competencies:
Advocacy
Communications
Conferences
Education & Training
Science & Technology
Section Services

AWWA is the authoritative resource for knowledge, information, and advocacy to improve the quality and supply of water in North America and beyond. AWWA is the largest organization of water professionals in the world. AWWA advances public health, safety, and welfare by uniting the efforts of the full spectrum of the entire water community. Through our collective strength we become better stewards of water for the greatest good of the people and the environment.

On the Cover: Utilities have several options for repairing or replacing broken or aging water mains, including cured-in-place piping. Photograph courtesy of Aqua-Pipe.

Features
10 Infrastructure
Pipe Rehabilitation: CIPP Offers Low-Cost Alternative
Cities facing pipeline replacement or rehabilitation should consider cured-in-place piping (CIPP), which offers minimal disruptions and is less expensive than many other methods. By Joseph Loiaccono and Michael Davison

14 Distribution
Ice Pigging Offers Sustainable Main Cleaning Technology
Ice pigging demonstration projects illustrate the technology’s ability to clean water distribution mains and sewer force mains effectively, with less water than with traditional flushing. By Randy Moore

18 Nonrevenue Water
AMI Boosts Meter-Reading Accuracy and Revenue
One of the easiest ways to increase revenue is to accurately bill customers for the water they use. To accomplish that goal, however, Enid, Okla., utility personnel knew they needed more than new water meters. By Scott Morris

20 Automated Systems
Can We Make Water Systems Smarter?
Recent advances in smart water network technology have armed control room operators with a comprehensive set of decision-making capabilities that enable system improvement, regulatory compliance, and financial planning. By Paul F. Boulas and Amanda N. Wiley

Columns
6 Question of the Month
When Should I Take My Pumps Out of Service for Inspection?

8 Total Water Management
Reliable Water Service Strengthens the Economy

Depts
2 Intake
4 Tapping in
24 Let’s Talk Safety
26 AWWA Library
28 Product Briefs
30 Business Briefs
34 Certification Corner
36 Finished Water
Ice Pigging Offers Sustainable Main Cleaning Technology

Ice pigging demonstration projects illustrate the technology’s ability to clean water distribution mains and sewer force mains effectively, with less water than with traditional flushing. BY RANDY MOORE

ICE PIGGING, a sustainable cleaning method for potable water distribution mains and wastewater force mains, was developed in the United Kingdom in 2000 and introduced in the United States in 2012. The method involves pumping a slurry of ice into a main through a hydrant, or a 2-in. fitting, and using system pressure to push the ice pig downstream to exit through a hydrant or fitting. The ice slurry, often filling as much as 20–30 percent of a pipe's volume, cleans with shear forces up to 1,000 times greater than with water alone, providing more effective cleaning and using significantly less water than traditional flushing methods.

An ice pig works like a glacier does. Rather than bulldozing sediment and biofilm, it incorporates them into the ice. Because the ice pig enters and exits through a hydrant, specialized launch and retrieval stations aren't required as with mechanical pigging or swabbing. Customer service isolation usually isn't necessary either.

Because the pig is an ice slurry, not a solid pig, it can’t get stuck like traditional mechanical pigs or soft swabs. An ice pig can negotiate pipe bends, diameter changes, broken gate valves, and inline butterfly valves without affecting the cleaning process. The technology was introduced to the US water industry in an AWWA webcast, Main Cleaning: Clean, Pig or Dig in April 2012, and in a presentation at AWWA's 2012 Annual Conference & Exposition. Since that time, demonstration projects, full-scale potable-water distribution system cleaning projects, and a sewer force main cleaning project have been conducted.

DEVELOPMENT HISTORY

Ice pigging technology was developed by Professor G.L. Quarini at the University of Bristol, United Kingdom, and soon thereafter was granted a worldwide patent for its unique cleaning technology, which was primarily applied in cleaning food and beverage industry piping.

Quarini approached his local water company, Bristol Water, to ask if there was a water industry application that could use ice pigging. At the time, Bristol Water flushed its smaller-diameter mains and mechanically pigged the large ones. However, strategic mid-sized pipes
(12–24 in.) were often left uncleaned because they were too difficult to take out of service for several days for conventional pigging.

“In 2006, after seeing some convincing laboratory experiments, Bristol Water decided to take the plunge and see if they could scale up the process to suit the water industry,” said Matthew Stephenson, operations director for the company that owns Bristol Water. “Over the next few years, Bristol Water invested in equipment and testing programs in their own network to prove the process.”

In 2009, Bristol Water got approval from the UK’s Drinking Water Inspectorate, the agency responsible for water quality in England and Wales, according to Stephenson. By 2010, the University of Bristol and Bristol Water’s owner agreed to commercialize ice pigging worldwide. The technology has since been used in the United Kingdom, Holland, Germany, France, Japan, Australia, Chile, Saudi Arabia, and the United States. To date, more than 250 miles of pipe have been cleaned with ice. The longest single run was 2.67 miles of polyvinyl chloride (PVC) pipe in Wales.

**CASE STUDIES**

Several demonstrations and full-scale ice pigging projects have been successful.

**North Carolina.** Stokes County (N.C.) Public Works provides water to the town of Danbury, N.C. The 30-year-old distribution system had a significant buildup of manganese, iron, and sediment, causing customer complaints about discolored water. In addition, there wasn’t sufficient storage capacity to conduct traditional flushing.

Ice pigging was used to clean 18,000 ft of 6-in.-diameter PVC pipe without excavation. Using one-third the volume of water that traditional flushing would have required, the cleaning was performed in four runs in two days. The second run was performed the Saturday morning of Labor Day weekend. A water system wouldn’t usually attempt a project of this type on a holiday weekend. However, the ease of the first run’s operation convinced the team to proceed with the second run.

**Result.** Ice pigging successfully removed more than 350 pounds of sediment—an average of 87 pounds/mile. PVC pipe sections were removed before and after cleaning to allow visual inspection of the degree of cleaning.

“Water quality has been greatly increased, and customer complaints have all but disappeared,” said Mark Delehant, Stokes County’s public works director.

**New Hampshire.** Despite several flushing programs, the city of Keene, N.H., has

---

**Technology Overview**

Ice pigging is a low-risk alternative to other main-cleaning techniques.

<table>
<thead>
<tr>
<th>Planning</th>
<th>Production</th>
<th>Delivery</th>
<th>Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipes and fitting plans and operational requirements</td>
<td>Ice makers (use utility water to make ice)</td>
<td>Delivery units</td>
<td>Instrumentation</td>
</tr>
<tr>
<td></td>
<td>Holding tanks</td>
<td>Support vehicles</td>
<td></td>
</tr>
</tbody>
</table>
been fighting customer complaints about discolored water from a section of its distribution system for more than five years. Heavy iron and manganese deposits and associated sediment and biofilms were the suspected root cause. Ice pigging was proposed as a possible solution. The city developed a two-phase approach; if Phase 1 was successful, Phase 2 would proceed.

In Phase 1, about 4,000 ft of 6- and 8-in. cast- and ductile-iron mains were cleaned successfully. In Phase 2, about 62,000 ft of 6–12-in. cast, cast-iron, cement-lined, and ductile-iron mains were cleaned. Water samples were collected before, during, and after ice pigging. In addition, sediment samples were examined, providing visual confirmation of cleaning effectiveness.

**Result.** Phase 1 removed about 28 pounds of sediment, and Phase 2 removed about 2,400 pounds of sediment.

**Pennsylvania.** Personnel in Dallastown Borough, Pa., were interested in an ice pigging demonstration to clean a wastewater collection system force main. This was the first attempt in the United States to clean a sewer force main. About 1,200 ft of 4-in. cast-iron force main at a pump station was selected for cleaning. Two ice slurry injections through a 2-in. tap were used to clean a section of the main.

**Results.** According to an engineer’s report, ice crystals couldn’t be seen in the waste stream discharge as it was watched, because the wastewater was warm and flow velocity was high. However, the color of the discharge changed from gray to pitch black to gray and finally light brown. In addition, the cleaning improved pump operation, with the average discharge rate increasing by 29 percent.

“The outcome from cleaning the sewer force main by ice pigging exceeded our expectations, and the work was done without having to open-excavate the state highway,” said Richard Resh, a senior manager with the project’s consulting firm.

According to Resh, by removing debris from inside the pipe, friction losses were reduced and operating efficiency improved. The demonstration convinced the municipality to postpone pump station capacity improvements, and construct ice pigging injection ports into future pump station design, according to Resh.

**THE FUTURE**

As these projects demonstrate, ice pigging technology has the potential to become a sustainable best practice for potable water distribution main and sewer force main cleaning in the United States.
Every drop along the way...

Clean. Safe. Sustainable.

Utility Service Co., Inc. has proudly served the potable and industrial water industries for over 50 years. Today's Utility Service Group provides comprehensive condition assessments, rehabilitation services and sustainable asset management solutions throughout the whole water cycle.

Call us to discover how our sustainable and unique solutions can assist you in improving the management of your water system.

Every drop along the way...

855-526-4413 | utilityservice.com