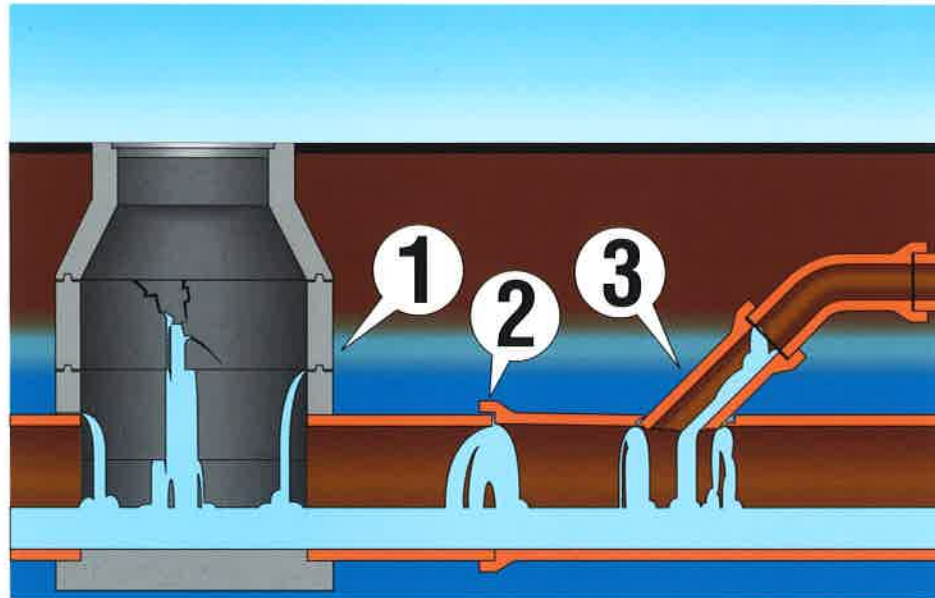


How to Plan a Chemical grout Program



Most infiltration enters sewer systems through manholes (1), pipe joints (2), service connections and the first few feet of the service line (3).

CHEMICAL grout was the first trenchless pipeline rehabilitation process and, when properly applied, it is still the best cure for infiltration of groundwater. Left unchecked, infiltration can lead to multi-million dollar problems including pipe collapse, overburdened sewage treatment plants, and surcharged systems.

Last month we examined the misconceptions some public works professionals have about grout, and the dramatic results some cities have achieved through chemical grout programs.

It is important to realize that grout is not a structural repair. However, when faced with a leaking sewer system which is structurally sound, no other rehabilitation technology can match the efficiency or cost-effectiveness of chemical grout.

In a structurally sound system, most infiltration occurs at manholes, pipe joints, service connections, and the first few feet of the service line. The remaining portion of the service line is usually above the water table, so leaks there do not contribute significantly to total infiltration. Studies have shown that even complete relining of pipes seldom reduces infiltration by more than 50%. Tight-fitting lining systems can stop leaks at joints, cracks, and other defects, but groundwater can quickly migrate to other openings such as service connections and manholes. Obviously, these leaks need to be sealed but, until recently, the technology did not exist to handle service laterals efficiently or cost-effectively.

During the last two years, new inspection, testing, and application equipment has emerged which allows these leaks to be permanently stopped (20 to 30 years according to an EPA study) with chemical grout. An understanding of the current state of the grouting art may be needed.

Planning Your Grouting Program

According to Don Mack, Technical Director, Avanti International, Webster, TX, the three most important aspects of a successful grouting program are; (1) well-written specifications, (2) a skilled applicator, and (3) a planned grouting program which applies a methodical approach to each drainage basin in your system.

Mack recommends that anyone considering a grouting program contact the National Association of Sewer Service Companies (NASSCO) at 140 Circle Dr., Suite 103, Maitland, FL 32751, and get a copy of their publication, *Specification Guidelines for Sewer Collection System Maintenance & Rehabilitation*. As the title implies, this publication covers many pipeline rehabilitation processes including chemical grouting.

The membership list included in the NASSCO Guidelines could be useful in locating a qualified applicator in your area, but Mack also suggests other sources. Grout suppliers and manufacturers of related equipment such as cameras,

packers, and TV, Test, and Seal vehicles maintain lists of customers – both contractors and municipalities – who use chemical grouts extensively. People who have developed effective grouting programs can give you invaluable advice which can help you get your program started right.

Choosing a Grout

The term Grout may be a little misleading when applied to chemicals used to stop leaks in sewer lines. Webster's dictionary defines grout as "a thin mortar used to fill cracks and crevices in masonry," but that is not how chemical grouts work. Chemical grouts do not stop sewer leaks by filling joints. Instead, grouting chemicals are forced through joints into the soil surrounding a pipeline. (In the case of manholes, the chemicals are injected through holes bored in the manhole wall.) Once the chemicals mix, they gel with the soil and the mass becomes impermeable to water and cannot be extruded back through the defect.

This water-tight collar adheres to the outer surface of the pipe or manhole where it will stay indefinitely unless removed by excavation or exposed to ultraviolet rays from the sun for long periods of time. If groundwater pressures increase, the collar will be pressed even more tightly against the joint, increasing its ability to stop water. If the humidity in the soil declines for a long period, the grout may begin to dry, also. However, when the soil humidity returns, the grout will absorb moisture and return to its original condition. The soil humidity around leaking manholes and sewers is almost always high enough to prevent any significant shrinkage of the gel.

Grout Comparison Table

GROUT	COST PER GALLON (RELATIVE)	VISCOSITY (CENTIPOISE)	CATALYST	REACTION TIME	BEST USE	VOLUME SOLD (RELATIVE)
Acrylamide	1	1-2 cps (Very low)	Chemical	10 sec.- hours	Sewer	10
Acrylic	2.4	1-2 cps (Very low)	Chemical	10 sec.- hours	Sewer	6
Acrylate	2.4	1-2 cps (Very low)	Chemical	30 sec.- 1 hour	Sewer	1
Urethane Gel	2.4	10-20 cps (Low)	Water	20 sec.- 5 min.	Sewer	3
Urethane Foam	8	150-500 cps (Medium)	Water	30 sec.- 10 min.	Manholes	2

All grouts gel as a result of catalytic action. For some grouts the catalyst is water. For others it is another chemical. In either case, the catalyst and the reactant must be kept separated until they are injected into the soil.

(See Grout Comparison Table)

Experience is Essential to Success

Whether a municipality uses its own crews to apply chemical grout or hires independent contractors, experience is essential to success. Bob Farrar, Vice President, TRB Specialty Rehabilitation, Gambrills, MD, explained that experience is very important because applicators cannot see what is happening outside the pipeline or manhole as grout is applied. However, as operators gain experience, they develop the ability to interpret the constant feedback from their equipment to understand what is happening beyond their sight.

In addition to on-the-job training, much can be learned at trade shows and seminars. Avanti International holds at least two, two-day seminars every year at their headquarters in Webster, a suburb of Houston, TX. The first day is dedicated to classroom instruction during which experts pass along technical information about products, equipment, and application techniques. The second day is spent outside, where the theories are converted to reality with "hands-on" demonstrations.

The University of Houston has set up an industry/university consortium called the Center for Innovative Grouting Materials and Technology. They hold an annual trade show as well as various seminars throughout the year. The university maintains a research library and laboratory where Dr. Kumaraswamy Vipulanandan (Dr. Vipu) and his graduate students study existing grouting materials as well as conduct experiments on possible new grouts.

Farrar says that public works professionals should insist upon pre-qualification of all potential grouting contractors. The references of each contractor should



MODERN grout vehicles control and record every aspect of the grouting operation

be checked carefully. It is also important to know that they are bonded, have modern equipment, have good training and have a good safety record.

The Art of Grout Application

While the concept of chemical grouting is simple, its application equipment is highly sophisticated. The command center for chemical grouting is most often housed in an air-conditioned room of a high-tech vehicle. A properly equipped grout vehicle should allow for absolute control of every aspect of the sewer line television inspection, joint testing, and sealing operations, as well as the ability to record all of the steps on videotape.

The Importance of Cleaning and Inspecting

Dick Schantz, General Manager, Aries Industries, Sussex, WI, a leading developer, manufacturer, and marketer of inspection, testing, and sealing equipment, knows the importance of properly cleaning and inspecting pipeline systems before rehabilitation. "When I say a line should be clean," he said, "I don't mean it should just be free of obstructions. I'm saying use a high-pressure water jet to dislodge any material buildup on the walls and joints and wash it completely out of the pipe. If a pipe is not clean to the very bottom, the best camera and operator in the world can't see the tell-tale signs which show what is really happening in the pipe. On the other hand, an experienced operator with a good camera can read pipeline stains and mineral deposits like a book. In most cases he can tell what caused the stain or deposit, where it's coming from, and how long the condition has existed."

With modern equipment, the preliminary inspection allows all interested parties to see the exact condition of a piping system. Pan-and-tilt cameras may be turned toward any point in the pipeline for a close-up inspection. These, and other specialized cameras, can be used to look directly into service laterals and determine their condition. Based on a thorough inspection, the most appropriate rehabilitation technology can be chosen. The videotape of the preliminary inspection also serves as a permanent record of the condition of the pipe before rehabilitation.

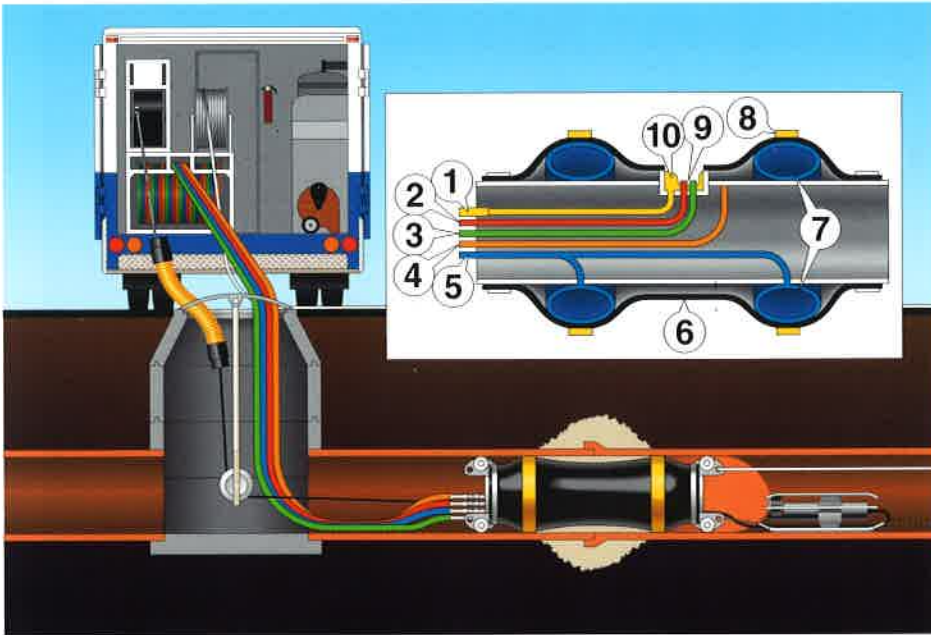
Testing

Testing for leaks in sewers is done with the test and seal packer and closed-circuit video camera in the pipeline. The packer is positioned so the midpoint of its length aligns with the joint to be tested. Once positioned, the end-seals of the packer are inflated until they press tightly against the surface of the pipe. This creates an isolated void around the "waist" of the packer. Air is then introduced into the void until a pre-determined pressure is achieved (about 1/2 psi for every foot of sewer line burial depth). If the pressure drops quickly (more than 2 psi within 15 seconds per NASSCO guidelines), it is obvious that the joint leaks and should be sealed.

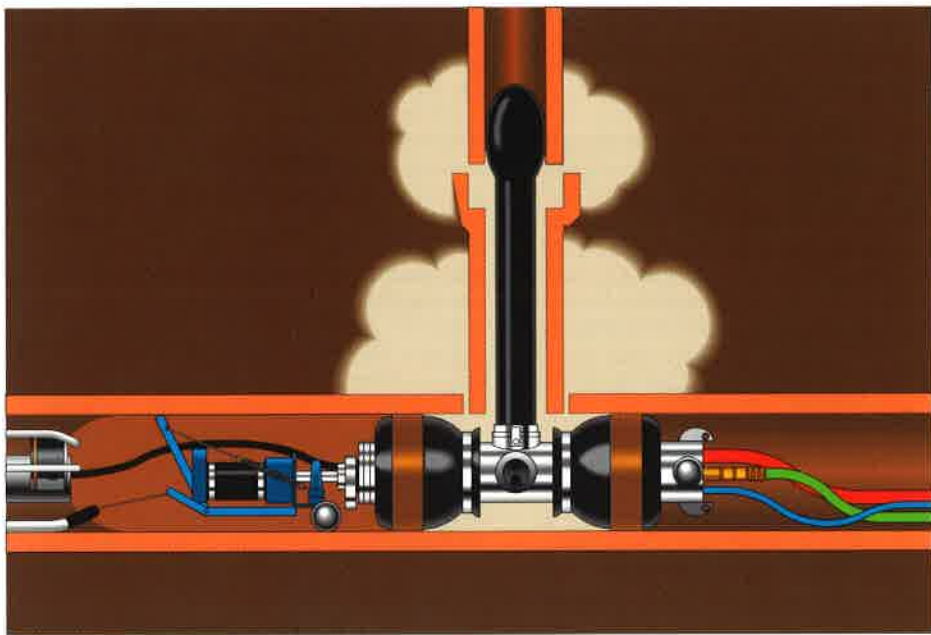
Even if the pressure does not drop dramatically, an experienced operator may choose to grout the joint if he is able to "read" stains or other signs that the pipe might leak under certain conditions.

Grout Application

When a joint fails the air test, it is grouted. From his control room, the operator con-



Modern injection packers are very sophisticated, consisting of; (1) Pressure Sensing Line, (2) Chemical "A" Line, (3) Chemical "B" and Air Pressure Line, (4) Sleeve Air Line, (5) End Seal Air Line, (6) Sleeve, (7) End Seal Elements, (8) Sealing Pads, (9) Chemical Injection Ports, (10) Pressure Sensor Element.



New injection packers can seal lateral connections and the first few feet of service lines with chemical grout quickly and cost-effectively.

controls the injection of chemicals into the void created by the packer. As the void fills, the chemicals are forced through the pipe joint into the surrounding soil. To reduce waste and avoid leaving excess grout in the pipeline, the packer sleeve is inflated to eliminate the void and force the chemicals out of the pipe.

After waiting for the prescribed gel time, the air test is repeated to determine if the joint has been sealed. If the pressure does not hold, additional grout is added. This cycle of test-seal-test is repeated until the joint passes the air test. At that point, the packer and camera are advanced to the next joint where the

procedure is repeated.

If modern equipment is being used by the operator, a videotape of the entire test and seal operation is created. This tape shows the pressure reading of each test and seal operation, thus providing an audit trail to prove the job was executed properly.

A Cure for Leaking Laterals

Infiltration at lateral connections has been a problem for pipeline owners for years. Even full-length lining of mains does not stop these leaks. In fact, liners often increase the flow through lateral connections because they block normal entry through joints and breaks. As groundwater pressure increases, flow can quickly migrate to the lateral connections.

Fortunately, new grout packers have been developed to address this problem. Roger Bissonnette, President, American Logiball, Ste-Foy, Quebec, reports excellent results with their new lateral injection packer. The center section of this packer can be rotated to align with the service lateral. Once aligned, air pressure propels a special bladder several feet into the lateral line. The forward end of the bladder seals against the wall of the lateral, but the rest of the body allows the passage of chemical grout. When the grout is injected, it flows out of the lateral at breaks, cracks, and joints, and gels with the soil. After the grout has cured, a vacuum retracts the deflated bladder and the packer can be advanced to the next connection.

New injection packers can seal lateral connections and the first few feet of service lines with chemical grout quickly and cost-effectively.

Improvements for the Future

The ability to seal leaks at service connections and in the first few feet of service lines solves a serious infiltration problem in sewer lines. As a result, some municipalities are now requiring that all service connections be sealed as a part of any mainline rehabilitation project. Most often, this means that the first trenchless pipeline rehabilitation process, chemical grout, will be used in conjunction with the very newest technologies. This kind of teamwork will inevitably lead to additional improvements in all trenchless technologies and, therefore, to significant improvements for a vital part of America's infrastructure.