

Chemical Grouting: Control Infiltration and Sustain Existing Sewer Collection System Assets

WEF Webcast, September 18, 2013

<http://www.wef.org/ChemicalGrouting/>

Responses to Questions Asked by Attendees

Q: Has anybody dealt with scale formation in the collection system with vitrified pipe clay pipe diameter of 18-24"? If so, could you explain the methodology to remove scale formation and seal leaking joint?

A: Dick and Daniel: Maybe talk with a large line contractor, if you have a local one, or call a national firm like National Power Rodding out of Chicago (they have a sister company in California called National Plant). A lot of questions come from your question i.e., how often and how many joints have scale, only at the joints, what have you tried so far, is man entry practical, are you going to grout these joints or put in an internal seal ring, how hard is the scale, and do you have a sample.

Q: Any particular soil conditions (i.e. pH, electric conductivity, etc.) or other chemicals dumped into sewers that may affect the grout life or stability?

A: Daniel: Acrylamide grout is very "forgiving", and works well in a wide range of environments. It works best when injected into a pH environment of 7-10. Chemical resistance data may be found online at: http://www.avantigrout.com/images/stories/products/CaseStudiesandLit/Literature/Chemical_Resistance_Data.pdf

Q: Any plans in the works for a training program to certify grout truck operators?

A: Dick: Yes, NASSCO and ICGA are now planning on developing a grout school with some form of testing and certification. You can attend an Aries grout school. Just go to www.sewergrouting.com, and look up the training program schedule.

A: Daniel: This idea is currently being discussed.

Q: Are bypass pumping procedures required?

A: Marc: Mainline packers have flow thru capabilities and will accommodate some of the flows in order to perform the test & seal procedures. If the flows are too high, and do not allow for good visual, it becomes difficult to work. Lateral packers 6 - 12-inch do not have flow thru capabilities, and normally only stay inflated for a couple of minutes. If one needs to let some of the flow go by, he can deflate the

mainline bladders and thereby allow some of the flow to go by the deflated packer. One does need to know, understand, and monitor that part of the collection system if plugging is required.

Q: Are there certain types of soils or backfill that limit or prevent grouting?

A: Dick: Grout is a soil sealing chemical that flows out through the failed joint area and between the grains or particles of pipe and supporting soil immediately adjacent to the leak area. It will flow into mud, silt, gravel, and/or sand. The grout must have a longer set time and be under sufficient pressure to drive it through the soil.

A: Daniel: The chemical grout fills the voids outside the pipe. The larger the void space, the less strength the gel/soil matrix will have. If there is clay back fill, you will not be able to permeate it (in such a short time with such low grouting pressure), but the grout will follow the path of least resistance and cure. If there is groundwater getting through cracks in the clay the grout will push the water back and cure in those same cracks, stopping the water.

A: Marc: Chemical grouting in collection systems is a soil sealing process. Where low viscosity solution grouts are used, they will travel in those multiple channels on the outside of the pipe. Penetration and saturation will be easier in soils that are less dense.

Q: Can roots grow through the cured grout?

A: Dick: Yes, but the time span for growth can be extended using root inhibitor. They can eventually grow thru especially if they are "thirsty" in a dry climate, and find the sewer trench a source of food and moisture.

A: Daniel: The roots are looking for water/nutrients and will follow the path of least resistance. Therefore, rather than try to break through a gel/soil matrix, roots will likely follow a different path. Recommendation: after a chemical root control program to remove roots from the mainlines and laterals, add a root-inhibitor to the grout when sealing the joints and laterals. This root inhibitor helps prevent future root growth for 2 to 3 years, causing the roots to seek a source of nutrients somewhere other than inside the sewer.

Q: Can the lateral packer be smooth to obtain better flows?

A: Marc: I assume you are referring to the flow thru on the larger size lateral packers. A lot of piping, hoses, and bracing (motor and structural design) is required within the flow thru of the packers. If flows and/or velocities are too high you may have to look at the possibility of flow control (reducing flows, blocking flows, flow diversion, and/or bypass pumping).

Q: Can we dig through the grout after it has cured?

A: Dick: Yes, the soil is easily dug up.

A: Daniel: Yes, you could. That is why they are able to use it in front of tunnel boring machines. It will stabilize the soil and control the groundwater, but will not become rock-hard.

Q: In FRP or thin polymer manholes, is there a concern with grouting pressure, and how do you address issues with pressure in this type of application?

A: Daniel: Curtain grouting manhole is the process of filling voids and sealing leaks by pumping resin into the soil outside the manhole. If there is a concern about the expansion of a foam you can curtain grout with a non-expansive gel, same acrylic chemical grout used to seal the mainline and lateral. Urethane gels are also non-expansive and may be used.

A: Marc: I have heard of instances in other situations where the contractors have filled up the manholes with water in order to create/compensate grouting pressures from the outside of the manhole structures.

Q: Will lateral grouting reduce pipe cross section?

A: Daniel: There will be a small amount of residual grout left inside the pipe as a result of the small void created between the packer and inside wall of the pipe. Eventually grout left inside the pipe will fall off and flow to the treatment plant. This residual grout is insignificant and does not affect the actual joint seal which occurs outside the pipe.

A: Marc: The chemical grout that remains within the pipe will eventually peel off this inside wall and go down with the flows. The residual grout that we see with the CCTV equipment is not sandwiched in between two layers of pipe and is not in the grout soil matrix. In the worst scenario, light cleaning may be required where there may be sags in the lateral pipe section and long sealing distances in the laterals.

Q: What is the cost of vehicle with equipment?

A: Dick: It ranges from \$275,000 up to \$400,000 depending upon features and vehicle choices. Contractors usually need productivity features and ability to stay out of town for weeks at a time. Cities just want a day truck with limited grouting capacity and pipe sizes.

Q: Can we dig through the grout?

A: Dick: Yes.

A: Daniel: Yes, you could. That is why they are able to use it in front of tunnel boring machines. It will stabilize the soil and control the groundwater, but will not become rock-hard.

Q: Can you compare the abilities of a grout trailer to a full CCTV grout combination truck?

A: Dick: Trailers limit your mobility and I would never get a grout system without an integrated TV system. Combo TV/grout systems are versatile and can do many things. Lateral grouting capability is a must today if you are serious about stopping infiltration.

Q: What different additives can be added to chemical group?

A: Daniel: Possible Additives:

AV-105 Ethylene Glycol - Lowers the freezing temperature of the grouts and helps prevent dehydration.

AV-257 Icoset – Increases tensile strength.

Potassium Ferricyanide (KFe) – Extends gel time (not typically used in municipal applications).

AC 50W - Root Inhibitor - Helps prevent future root growth.

Tracer Dyes - Helps track the grout.

Q: Does NASSCO offer the grouting inspector training in conjunction with PACP and LACP?

A: John: Not at this time.

Q: Chemical grouting appears to be a multi-vendor solution. How does that impact technical support and training for a municipality?

A: Dick: We work together as a team and usually the TV grout system trainer is able to train in all three areas: grout TV, packers, and chemicals.

A: Daniel: The vendors that support municipal grouting have a great history of working together to support grouters. Recommendation: attend multiple vendor trainings and determine who you enjoy working with. Multiple vendors give you various perspectives and ideas. Utilize 24/7 tech support when needed.

A: Marc: Basically you have two components, the chemicals and the delivery system. Training by the vendors will definitely help you better understand all the components in the system and be in a position to pinpoint any issues that may occur. Technical support is available from the suppliers.

Q: Is there a certification program for grouting operators?

A: Dick: Not at this time, but under development by NASSCO.

A: Daniel: This idea is currently being discussed.

Q: That such work the chemical grouting applying it in the presence of water?

A: Daniel: Grouts can definitely perform in the presence of water! If you are using acrylic grouts to seal mainlines with high infiltration, be sure to use less water in the recipe/batch to counter-act the dilution that will occur at the point of injection.

A: Marc: Chemical grouts are designed to work in the presence of water.

Q: Do clay trench dams help?

A: Dick: Good question and they should help because they were intended to reduce trench flow, but I am not aware of any study confirming that. Did the clay dam go all the way to trench bottom or was it placed over bedding materials?

A: Daniel: Any “damming” in the pipe bedding will help block the “French drain” that the bedding creates outside the pipe. In some way, grouting the joints is like creating a dam outside each joint without having to excavate.

Q: Do the gouts stop or seal off root infiltration?

A: Dick: No, grout does not stop roots; root inhibitors mixed into the grout does retard growth for a short few year period.

A: Daniel: The roots are looking for water/nutrients and will follow the path of least resistance. Therefore, rather than try to break through a gel/soil matrix, roots will likely follow a different path. Recommendation: after a chemical root control program to remove roots from the mainlines and laterals, add a root-inhibitor to the grout when sealing the joints and laterals. This root inhibitor helps prevent future root growth for 2 to 3 years, causing the roots to seek a source of nutrients somewhere other than inside the sewer.

Q: Do the speakers feel that the grouting industry has been given a "bad rap" due to the infancy days of the Clean Water Act when everyone did everything while knowing nothing!

A: Dick: Many reasons for grout maybe getting a bad rap include unknowledgeable installers, limited chemical use, and poor contract compensation methods. Many points for discussion, but the new Suggested Grout Standard is a step forward to correct this. More training of all involved parties is needed.

A: Daniel: Not sure what you mean exactly. Now that lining companies acknowledge that there is an annular space between host pipe and liner and engineers recognizing that structural repairs need not be used in structurally sound pipe, the biggest hurdle for the grouting industry today is creating consistent grouting practices whereby the leaking joints and laterals are sealed for long term (pump enough grout), not just the short term.

A: Marc: Chemical grouting was one of the first trenchless rehabilitation technics and many may have assumed that it would solve all the issues present in the sewers. Many theories or combination of theories can be discussed (misunderstood, misapplication, under-designed delivery system, etc.). Over the years, education, training, and experience have a tendency to reduce, even eliminate, many of these theories.

Q: Would you suggest air testing all joints prior to grouting consecutive joints?

A: Dick: Yes, test all joints and grout the leakers as you go, as that will be the most productive method.

A: Daniel: Yes. Even if the joint is not visibly leaking, it might still fail an air test, which means it will leak in the future!

A: Marc: Absolutely! When sealing off infiltration at a leaking joint the passage of groundwater through this joint is stopped, but in no way does it mean that groundwater will not migrate to another joint or service tap connection. The groundwater does not disappear; it travels through the path of least resistance and may end up coming in at a joint nearby.

Q: Why aren't Urethane Foams recommended for service lateral grouting?

A: Dick: Urethane is a very touchy grout to pump and it very aggressively clings and attaches to the lateral plug making it hard to (maybe cannot) vacuum the plug back into the packer body.

A: Daniel: Urethane foams are not as thin as acrylamide grout, are less controllable, are expansive and sticky, which means the packer/equipment could get stuck in place.

A: Marc: Urethane foams are not recommended with lateral packers as the foam is very sticky, and it will be very difficult to remove any residual or excess grout that may remain in the service. Urethane

foams may also continue to expand, especially if the lateral bladder has been removed prematurely, and could cause a blockage in the service lateral.

Q: Does chemical grouting work for offset joints?

A: Dick: Yes, provided the offset still lets the packer proceed thru the pipe joint area, but if the offset is too severe it will limit the packer's ability to form end seals, and then the process will not work.

A: Daniel: Depending on how off-set the joint is, if you can successfully get the packer through the joint, you could grout it. If you have a structural problem, you may need to put in a structural liner.

A: Marc: As long as the offset joints allow for the passage and proper seating of the packer bladders, chemical grout should work. Small injections of grout may be necessary to enhance the packer bladders seating capabilities against the offset sections of pipe.

Q: Does residual grout in the service lateral present any kind of future problem or restriction of flow?

A: Dick: When you use the correct plug size to line size, 4 in 4 or 6 in 6, then the residual grout is insignificant. However, in long lateral runs, you have to make sure grout has not gone out thru a joint and then returned above the end of the packer forming a plug. This requires some post grouting inspection or air testing to confirm lateral opening.

A: Daniel: No, it does not typically present any problems. Be sure to use the appropriate size packer in the mains and appropriate size bladders in the laterals – if not you could end up with more residual grout inside the pipe than is necessary. There will be a small amount of residual grout left inside the pipe as a result of the small void created between the packer and inside wall of the pipe. Eventually grout left inside the pipe will fall off and flow to the treatment plant. This residual grout is insignificant and does not affect the actual joint seal which occurs outside the pipe.

A: Marc: Typically residual grout, as long as the proper lateral bladder is used and proper grouting techniques are performed, will not create problems. When sealing long distances into the lateral and sags are present, it may be good practice to remove residual grout from the inside of the lateral pipe so that residual grout will not accumulate in the sag. The thin layer of grout left of the inside of the pipe will eventually wash out, as it is not sandwiched in between two layers of pipe and not part of the grout/soil matrix, and go down with the sewer flow.

Q: Does the acrylic gel create a structural fix for voids around pipes, or does it just seal a leak?

A: Dick: It creates a stabilized and sealed soil mass outside the pipe stopping the water from getting to the joint. It is not a gasketing process, it is a soil sealing and stabilizing process, and it is not rehabilitation of the joint gasket.

A: Daniel: The primary use of acrylics in the municipal market is for stopping infiltration and controlling groundwater. While grout may provide support of the pipe from the outside, acrylamide grout is typically not intended for use as a structural support. At a standard 10% concentration, acrylamide grout with no soil or sand can hold 7psi, equal to 16 feet of head pressure. When injected into sand, the compressive strength of acrylamide grout and sand goes up to 119 pounds per square inch, or 275 feet of head pressure.

Q: How effective are chemical grouts for prohibiting subsequent root intrusion?

A: Daniel: Recommendation: after a chemical root control program to remove roots from the mainlines and laterals, add a root-inhibitor to the grout when sealing the joints and laterals. This root inhibitor helps prevent future root growth for 2 to 3 years, causing the roots to seek a source of nutrients somewhere other than inside the sewer.

Q: Does the sewer flow need to be stopped during the grouting operation?

A: John: No, most grouting packers allow for the flow to move through them during the operations, thus eliminating the need for bypass.

A: Marc: Mainline packers have flow thru capabilities and will accommodate some of the flows in order to perform the test & seal procedures. If the flows are too high and do not allow for good visual, it becomes difficult to work. Lateral packers 6 - 12-inch do not have flow thru capabilities and normally only stay inflated for a couple of minutes. If one needs to let some of the flow go by, he can deflate the mainline bladders, and thereby allow some of the flow to go by the deflated packer. One does need to know, understand, and monitor that part of the collection system if plugging is required.

Q: If all 3 acrylic grouts have similar uses, is there any value (other than cost) in specifying a particular type for a given project?

A: Dick: Acrylamide is the norm and standard used. It is a very forgiving grout and performs under diluting conditions. Acrylamide's cost is about half of the others.

A: Daniel: Acrylamide, Acrylic, and Acrylate grouts are all used in similar applications, each is pumped at a 1:1 ratio, each require the same PPE, and each use triethanolamine as a catalyst and persulfate as an

initiator. The differences between them primarily have to do with how much acrylamide is in the grout. Project considerations may include: 1.) projected life-span based on 3rd party testing (the 38-page US Department of Energy testing/report of longevity in the soil is available online); 2.) case studies and length of use in the US (60-year history for acrylamide grout and 30-year history for acrylic and acrylate grouts); 3.) product cost of the respective grout and the associated catalysts (acrylates require more catalyst to achieve the same gel time as acrylamide and acrylic grouts); and 4.) shipping costs (acrylamide is available in a granular form as well as liquid form, acrylics and acrylates are available in a liquid form).

Q: During the Rehabilitation Demonstration Project in Houston, we found lateral leaks throughout the lateral from the house to the main line. A sealing project needs to address not only the main line leaks, but the lateral and service line leaks. What is the best procedure for sealing all leak sources?

A: Dick: You have to make some economic evaluations as to conditions encountered. In Houston, where lines are shallow and near the surface, it may be best to dig and replace the service pipe and only grout or line the service connection and pipe when it drops down deeper to connect to main. No one answer to this question (logic and common sense) will dictate what you do.

A: Daniel: If the lateral is structurally sound, you can grout the lateral to main connection and up the lateral (30 feet up the lateral is the longest to date). You can also use push-packers from the clean-out to grout/seal the lateral 5 feet at a time.

A: Marc: The test & seal process through pressure injection of chemical grouts, and monitoring injection pressures and volume of grout placed is proving to be very effective. Is it realistic to attack all sources of infiltration thinking that all the issues will be resolved? I think addressing the issues that will allow the best return on investment are to be considered.

Q: How does it compare in cost and effectiveness to CIPP?

A: Dick: CIPP is a new pipe process, and grouting is a joint maintenance process for sustaining your existing pipes by stopping infiltration and stabilizing soil bed, preventing ground water from destabilizing the segments and joints, generating more leaks and pipe failure. If your pipes are in good condition and the joints leak, grout it. If the pipes are broken and fractured, put in a new pipe use CIPP. Grouting is much less in cost, running at 1/3 to 1/5 lining costs.

A: Daniel: It depends where you are in the country, the contractor's costs to mobilize, and what additives you use, but a range for grouting may be about \$6 to \$9 per linear foot of 8-inch mainline pipe. \$250 to \$500 per lateral connection (based on quantity and the market). You can compare that to your local cost to line the main and line the lateral connection, but it is typically much less expensive to grout. Please keep in mind that these two technologies (grouting and lining) work together, not separately: If you have a structural problem, grout the leaking joints, then line the pipe, then grout the lateral

connections. If you do not have a structural problem and your only goal is to stop the infiltration, then there is no need for lining and grouting may be used.

A: Marc: CIPP can easily be 3-4 times the cost of chemical grouting, but they do not fix the same issues. CIPP will provide the owners with a new pipe. The ends of the liner and the reinstated laterals should be sealed from infiltration in order to provide a groundwater tight system. The injection of chemical grout will saturate the pipe bedding at and near the defects providing some kind of support against future degradation of the pipe caused by the washout of the fine backfill particles, which can eventually create voids around the defects and failure of the system.

Q: What is a ballpark price for grout and seal of a 4 x8 ft. deep MH?

A: John: \$600-\$900 depending on the type of construction and market.

Q: How is the cost of a job determined?

A: Dick: Many factors: site preparation, pipe cleaning, access- condition, location of manholes, expected amount of grout to be used, pipe conditions as to breaks, protruding laterals to cut off, frequency of joints, pipe lengths, labor rate considerations, street conditions including traffic and work hours, security, traffic control, weather seasons, competition, quality and specification requirements, customer knowledge, and considerations for the work complexity, etc.

Q: How far up into the lateral can a packer launch from the main for lateral grouting?

A: Daniel: 2 to 30 feet.

A: Marc: The longest effective sealing distance that has been performed in the field is 30 feet from the connection. It is imperative that CCTV work and cleaning in the lateral be performed prior to attempting this effective sealing distance in the laterals. The equipment chosen must be adequate for this kind of work (grout delivery system, air compressor and vacuum system, gel times, and void injection pressure monitoring) and an experienced and knowledgeable contractor.

Q: How long would the grouting last?

A: Daniel: If the grout is mixed properly and a sufficient amount of grout is injected into the soil, it should last the life of the structure or pipe. Use manufacturers mixing recommendations. The US Department of Energy did a study comparing the longevity/lifespan of 7 different types of grouts; that report is available online and/or upon request.

A: Marc: The repairs done by chemical grouting when applied correctly and in the right situations have proven to be effective for a long time. Revisiting work that has been completed by some contractors 20 years ago has shown this kind of result.

Q: Using sealed pipes for storm would be better?

A: Dick: Certainly, if you expect a lot of surcharging and know where the sewer lines and trenches intersect the sewer system. Once water is outside the storm drain pipes and flowing in the trench, it can destroy the storm pipe bedding and lead to pipe settlement and misalignment with more washing all the time, until the above ground surface subsides and slumps.

A: Daniel: You can seal storm pipes with chemical grout.

A: Marc: In many places storm sewers are now being installed, inspected, and sometimes tested to be watertight at the joints. Will this become a standard practice? It could surely help prevent washout of the fines in times of high groundwater.

Q: How many gallons of grout are typically used to seal a lateral connection in a lined pipe versus an unlined pipe lateral connection?

A: Dick: If you are only pumping in the annulus of a lined pipe at the connection, then 1 to 3 gallons. If it is the annulus plus a few lateral joints and it is unlined, it may take more if the joint has active infiltration as the space outside the joints and connection could be filled with water, then the grout will be diluted at initial injection and the gel time will go up to 1 or 2 minutes. The grout flow will continue and you have to stop after 2 to 4 gallons, allowing maybe 2 to 3 minutes for gelling, then pump again trying to stage the grout. Longer gel times will take more grout, but staging with longer rest periods for gelling will help, instead of just pumping continuously. It is critical to monitor your grout chamber void pressure, as this will tell you what is going on and if the grout is starting to gel. Stop pumping when you see the void pressure rise from 1 to 2 psi up to 12 to 16 psi as the grout gels. Once it is gelled, let it cure 1 to 2 minutes, and then try again and watch the void pressure. To seal leaks for the long term, you have to be committed to pumping more grout than you have traditionally used.

A: Daniel: You don't know how big/long the annular space between the host pipe and the liner is, so you could approach the connection as if it was unlined. It could take a little more grout when grouting the annulus, but it is typically not a lot of volume. A rule of thumb is 1/3 gallon per inch diameter of the mainline per connection and 1 gallon per foot up the lateral. For example, to grout 2 feet up the lateral the contractor would try to pump 5 gallons of grout (3 gallons for the main plus 2 gallons based on how many feet up the lateral). Be sure to use the appropriate size packer/bladder, inflated per the NASSCO spec, or you will use more grout unnecessarily.

A: Marc: On average a lateral connection in 8-inch pipe will take approximately 3 gallons to seal and 1 gallon per vertical foot from the connection. In lined pipe it is not un-frequent to see these numbers rise as the grout is travelling in the annulus and may be re-entering the sewer at either a manhole or other tap connection located a few feet away from the tap connection being sealed. When continuous pumping does not provide a seal, then the technique of stage pumping should be used.

Q: What additives (if any) should be used when sealing lateral connections?

A: Daniel: You don't HAVE to use additives if they are not necessary. Possible additives include:
AV-105 Ethylene Glycol - Lowers the freezing temperature of the grouts and helps prevent dehydration.
AV-257 Icoset – Increases tensile strength.
Potassium Ferricyanide (KFe) – Extends gel time (not typically used in municipal applications).
AC 50W - Root Inhibitor - Helps prevent future root growth.
Tracer Dyes - Helps track the grout.

A: Marc: Reinforcing agents, such as latex, have been and are being used when sealing tap connections in relined pipes. The residual grout will remain in the lateral for a longer time, as it becomes more difficult for that thin layer of grout to peel off and break away from the inside lateral wall, due to the reinforced and stickier nature of the finished layer.

Q: Reiterate the formula for determining the air test pressure at which the joint should be tested.

A: Daniel: Please see NASSCO/ICGA spec.

A: Marc: The answer can be found in section 3.6 of the NASSCO/ICGA suggested specification, and basically says 0.5 psi per vertical foot of pipe depth + 2psi, and not to exceed 10 psi.

Q: What would you suggest to seal manholes that have been set in a very porous substrate such as sands or large rock that take an absorbent amount of material to create the grout curtain?

A: Daniel: Consider curtain grouting from inside the manhole, or probe-grouting from the surface using an expansive foam. The foam will help fill the voids, stabilize the substrate, and stop the infiltration.

Q: What additives can be used to prevent root regrowth?

A: Daniel: AC 50W - Root Inhibitor - Helps prevent future root growth.

A: Marc: The additive commonly used in the United States is dichlobenil, and it must be mixed and kept in suspension on the grout side.

Q: The idea is to seal the pipe from the inside out.

A: Marc: The idea is to seal the outside of the defect while performing the work from within the pipe. The existing leaking joint or defect is the pathway through the pipe.

Q: How many gallons are typically needed to seal an 8" pipe?

A: Daniel: A general rule of thumb for sealing mainline sewer joints is to pump a ½ gallon of material, per inch diameter of pipe. For example, if you were sealing a joint in an 8-inch line, you would try to pump 4 gallons around that joint. This rule of thumb is important because the material does its work by creating an impermeable gel/soil matrix; it needs the soil. Some joints might take more grout; some might take less depending on the void space in the soil. Follow the gel-time/pumping equation in the NASSCO/ICGA spec.

A: Marc: A good rule of thumb is to pump anywhere from ¼ gallon to ½ a gallon of grout per inch pipe diameter. So an 8" pipe joint should be anywhere from 2-4 gallons of grout when using a low void packer. Void pressures should be monitored and pumping until refusal should give good results. Stage pumping may be required if continuous pumping does not seal the joint. Refer to section 3.9.E of the Nassco/ICGA Suggested Specification.

Q: Should a longer gel time be used when sealing CIPP lateral connections?

A: Marc: I do not believe it should, the volume between the two pipes is relatively small. The mixed grout solution may travel a long distance from the point of injection in the annulus. I believe that stage grouting is necessary when sealing laterals in relined pipes.

Q: Should the laterals be brushed prior to grouting?

A: Daniel: Yes, always.

A: Marc: Laterals should be fully opened and brushed at the tap connection in relined pipes. If they are not, they may be the cause of cuts and damages on the lateral bladders.

Q: Will grout rehydrate if it dries out?

A: Daniel: If not dehydrated completely, acrylic grouts will absolutely rehydrate in the presence of water, and they can do this over and over. Keep in mind, it does not take much to prevent dehydration. IF there is simply humidity (a little moisture) in the soil, the grout will not dehydrate. Acrylic grouts are used in very arid environments, but there is still enough moisture in the soil to prevent dehydration.

Q: How many laterals can be grouted in a day on average?

A: Dick: Here is my estimate with lateral connections, only 20, 5 feet up 15, more than 5 feet 5. Allow one day a week for recovery from one problem or another.

A: Daniel: This will depend upon the crew and the conditions.

A: Marc: Depending on site conditions, pipe sizes, and effective sealing distances in the lateral, that number will greatly vary. Typically in 8 inch pipe sealing up to 3-5, feet production rates of an experienced crew in a 9 hour should be performing two setups (manhole runs). The number of laterals found within two manhole runs can vary, and one can assume 7-12 laterals sealed in a day, 15 or more on good days, and 0 on bad days.

Q: Why is there a pipe drawn from the storm drain to the sanitary sewer?

A: Dick: Very good question and I am glad you asked. You never know what is down there until you inspect the system to understand what is there. Over the many years these pipes have gained connections that we all question, so do not be surprised what you find. It was put in to cause this discussion. Thanks for bringing it up.

A: Daniel: These drawings were created to show what is found in various parts of the US. They are not typically a "legal" connection, however many communities do have combined sewers for which this type of connection is common.

Q: If we have CSO system set up, is grouting required?

A: Daniel: In order to stop the leaks, you can grout any kind of gravity (non-pressurized) pipe whether it is sanitary or storm sewer.

Q: Is it any difference between acrilamide, acrylic and acrylate to use them as grouts?

A: Daniel: Acrylamide, Acrylic, and Acrylate grouts are all used in similar applications - each is pumped at a 1:1 ratio, each require the same PPE, and each use triethanolamine as a catalyst and persulfate as an initiator. The differences between them primarily have to do with how much acrylamide is in the grout. Project considerations may include: 1.) projected life-span based on 3rd party testing (the 38-page US Department of Energy testing/report of longevity in the soil is available online); 2.) case studies and length of use in the US (60-year history for acrylamide grout and 30-year history for acrylic and acrylate grouts); 3.) product cost of the respective grout and the associated catalysts (acrylates require more catalyst to achieve the same gel time as acrylamide and acrylic grouts); and 4.) shipping costs

(acrylamide is available in a granular form as well as liquid form, acrylics and acrylates are available in a liquid form).

Q: Is the roof drain connection to a sanitary sewer allowed in the USA?

A: John: No, they are typically not a "legal" connection in the US, however many communities still have combined sewers to which this type of connection is common.

Q: Is there an issue with the residual grout in the lateral falling into the invert and obstructing flow from the home? Especially if it peels off in a large piece?

A: Dick: No, go to the Avanti booth at the next trade show and feel the grout when it is not in the soil. It crumbles in your hands outside the soil matrix.

A: Daniel: No, even if the grout "peels off in a large piece" it has very little strength and will be broken into bits by the movement of water in the main.

A: Marc: Typically the volume of grout between the inflated lateral bladder and inside pipe wall is approximately 0.16 US gal/foot in 4" pipe and 0.24 US gal/foot in 6" pipe when the appropriate bladders and inflation pressures and procedures are used. The longer the effective sealing distance, the more residual grout will be left in the lateral. That thin layer usually does not peel off all at once and the geometry of the pieces change as they are carried down the pipe by the flows (smaller pieces).

Q: Is trenching required to use the chemical grouting?

A: Daniel: No, chemical grouting is trenchless. The grouting equipment is generally inserted in one manhole and winched to the next by an operator in the grout truck. Each joint in that section of pipe is air tested and if it is shown to be leaking, it is grouted.

Q: Lining of pipe doesn't stop water infiltration. Water between the liner and the host pipe migrates to the lateral connection and infiltrates at these points. We always suggest lateral grouting after lining jobs.

A: Dick: Good.

A: Daniel: Good idea!

Q: What document is Daniel talking about? Can a copy be downloaded or requested from NASSCO?

A: John: Yes, it is available. I recommend contacting him directly at daniel.magill@avantigrout.com.

Q: What is the typical approach to estimating and costing a chemical grouting job? What are typical costs per foot or volume of repair?

A: Daniel: The “rule of thumb” for estimating the amount of grout needed for a joint is the radius of the pipe in gallons. For example, an 8 inch pipe might require 4 gallons of chemical grout. Follow the gel-time/pumping equation in the NASSCO/ICGA spec. Consider the cost of mobilization and your time per linear foot plus material usage.

A: Marc: The NASSCO/ICGA Suggested Specification has a sample payment schedule along with a section on typical bid items that can help you estimate test & seal projects.

Q: Do these grouts complicate future excavation and replacement of a structure or pipeline on which it was used?

A: Daniel: Hopefully grouting will remove the need for excavation and replacement. Chemical grout will produce a grout ball in the area of a leak, but it should not impede the ability of the crew to remove the pipe if needed in the future.

Q: What are some advantages and disadvantages of grouting laterals verse lining laterals?

A: Dick: If pipes are failing and roots are tearing up the joints, then they need to be replaced or lined. If the pipe is in good condition, then grout them, as it will be significantly less cost in most cases.

A: Daniel: If the pipe is structurally sound, grouting will be less expensive than lining.

A: Marc: Both technologies have an important place in the industry and they often complement each other. Lateral grouting in structurally sound sewers can be performed on actively leaking laterals. Pre and post air tests are performed within the initial process. Production rates are very decent. Costs are usually significantly lower than lining. It is a very forgiving process if things go wrong. It stabilizes the soil around the defect. When structural issues are present, then lining is definitely a way to go and will provide the owner with a new pipe. Stopping important leaks that may jeopardize the installation of the liner should be considered.

Q: What are the relative costs?

A: Daniel: Costs vary based on the project conditions, but a current range is \$6 - \$9 per mixed gallon.

A: Marc: Costs vary geographically and depend on site conditions, mainline pipe sizes, effective sealing distances in the lateral, quantities to be sealed, density of laterals in manhole runs, etc.

Q: What are typical grouting test pressures?

A: Dick: The only meaningful pressure testing can be done by directly monitoring the void area, and grouting requires pumping to refusal, which usually generates 12 to 16 psi in the void chamber. I believe testing should be in PSI equal to the depth in feet below grade. This forces a test pressure about double the submersion pressure of the line. There may be other circumstances which may change this.

A: Daniel: An average may be 10 psi. It will vary based on the spec and depth of the line. See NASSCO/ICGA spec.

A: Marc: Typical grouting pressures are usually in function of the pipe depth and groundwater levels above the crown of the pipe. It is not unfrequent to find grouting pressure in excess of 15 psi on mainline joints and 10-12 psi on lateral connections. Test pressures are well defined in the suggested specification, and are usually under 10 psi, as it becomes harder to achieve a seal with the packers to hold these air test pressure ranges.

Q: Our experience with grouting laterals is the I/I will reoccur after 5 years, as evidenced by flow monitoring. We suspect that ground movement is cracking the grout allowing I/I to resume. Are we using the wrong type of grout or is the installation faulty? Or other problem?

A: Dick: I suspect you just did not get enough grout into the soil and annulus the first time. What grouting records do you have? Did they pump to refusal and stage grout, or use a one shot pass. Did you keep any pressure test records? Think about the idea of cracking, what does it mean? Grouted soil is a mass, and yes, there could be some cracking, but the amount of water thru cracked grout mass would be less than 5% if it was not grouted and this makes me believe you are just not getting enough grout into the soil.

A: Daniel: Regular inspection and maintenance is the answer. Be sure to test each joint, not just the leaking joints, and keep the data about which joints were sealed, how much grout was used, etc. You need to determine if the flow is coming from a new point of entry (higher up the lateral or a joint which was not previously leaking). If a joint that was previously grouted is now leaking, was it grouted per the NASSCO/ICGA spec? Latex will give the grout more tensile strength if there is a lot of expected ground movement.

A: Marc: Not knowing all the details of the prior work performed and in which conditions, it is very difficult to answer this question. Keeping a log book of the work that has been performed can always be used by the contractor and the owner to back track any issues that may have occurred. If you would like to share more information, please call me at 1-800-246-5988.

Q: Last two grouting ASTMs did not have alpha prefix. Please show the ASTMs again.

A: Marc:

ASTM F 2454

ASTM F 2414

ASTM F 2304

Q: What is the average life span of chemical grout?

A: Daniel: If the grout is mixed properly and a sufficient amount of grout is injected into the soil, it should last the life of the structure or pipe. Use manufacturers' mixing recommendations. The US Department of Energy did a study comparing the longevity/lifespan of 7 different types of grouts and determined a 362-year half-life in the soil for acrylamide grout. The complete DOE report is available online and/or upon request.

Q: What is the pressure head that the chemical grout can withstand?

A: Dick: In grouted bedding soil and mud, 20 to 50 psi, and more in sand and fine gravel. Pure grout has not real pressure resistance, but it is the grout between the soil grains that forms the grout matrix and this is what provides the seal and strength.

A: Daniel: The answer will depend upon the environment and void space into which the grout is injected. At a standard 10% concentration, acrylamide grout with no soil or sand can hold 7 psi, equal to 16 feet of head pressure. When injected into sand, the compressive strength of acrylamide grout and sand goes up to 119 pounds per square inch, or 275 feet of head pressure. Mines commonly use acrylamide grout thousands of feet below the surface to hold back several hundred psi because they are injecting into superfine cracks.

Q: What is the largest diameter of packers available?

A: John: 102" pipe is the largest manufactured to date, but larger ones could be made.

A: Marc: The largest joint test & seal packer made by Logiball was for 144" pipe. We have recently built a packer for 108" pipe back in 2012.

Q: What is the price difference per LF of the chemical grout versus a Cured-in-Place Pipe Liner?

A: Daniel: As a comparison to other means of restoration, Miami-Dade County spends approximately:

\$2,500 per segment on grouting

\$8,000 - \$10,000 per segment on lining

\$22,000 - per segment on dig/replace

A: Marc: Typically chemical grouting per linear foot can be 1/3 the cost of lining. That may vary with the length of joint spacing, pipe sections, etc.

Q: What is the typical cost of grouting a lateral?

A: John: \$250 to \$500 per lateral depending on quantity and market.

A: Marc: Costs vary geographically and also depend on site conditions, mainline pipe sizes, effective sealing distances in the lateral, quantities to be sealed, density of laterals in manhole runs, payment for grout materials, preparatory work, etc.

Q: What pressure is used to pump to refusal?

A: Dick: Take an 8 to 24 inch VCP joint (typical for 80% of US sewer footage), using a packer correctly sized for the line (ends inflated to 45 to 50 psi as recommended), then you will be able to pump into the packer void. As the grout flows out and gelling is happening both in the void and in the soil, grout mixes at initial injection with trench soil water. As pumping continues, the full strength grout displaces the initial injection and the void pressure begins to rise. It will go up slowly to 3, 4, 5, and 6 psi, and then in a few pump strokes or seconds it will shoot up to 15 to 20 psi. That is refusal, and you stop pumping and let it gel for 2 minutes.

A: Marc: Refusal is defined in the NASSCO/ICGA proposed specification in section 3.9.C

Q: What quality control is involved in the production of the chemical grout, and is there a "use by date"?

A: Daniel: We can't speak for other grouts on the market. Regarding Avanti grouts: when stored properly, acrylamide grout essentially has no shelf-life. Acrylics and acrylates typically need to be used

within 6 months of purchase. When exposed to moisture, persulfates (the oxidizer) will lose potency over time, so be sure to keep them well sealed and in original containers.

Q: What size access would be required for a 30-inch mainline packer for lateral grouting?

A: Marc: The outside diameter of this 30 inch lateral packer is approximately 25.5 inches.

Q: What's the design life of these grouts?

A: Daniel: If the grout is mixed properly and a sufficient amount of grout is injected into the soil, it should last the life of the structure or pipe. Use manufacturers' mixing recommendations. The US Department of Energy did a study comparing the longevity/lifespan of 7 different types of grouts and determined a 362-year half-life in the soil for acrylamide grout. The complete DOE report is available online and/or upon request.

Q: Where are the ports installed and why? Above the leak or below?

A: Daniel: In manholes, the starting location should be at the lowest point of the vertical crack. If the crack or joint runs horizontally, start at the narrowest end. You will be stitch grouting (V-PAT method), alternating sides of the crack, so top or bottom or left or right is irrelevant.

A: Marc: The grout delivery ports are installed in between the expandable bladders on the packer. Their clockwise position in the pipe has no significant difference as the grout will fill the packer/pipe void prior to exiting the pipe. Grout will first fill up the bottom of the pipe.

Q: How do you estimate the costs of grouting for bid proposals? Nobody knows the state of the surrounding soil.

A: Daniel: For manholes? Consider the cost of mobilization and your time per linear foot, plus material usage. Another option is to conduct exploratory grouting; set up a demo and see what you find. A demo is normally much cheaper than ground penetrating radar, or a hiring a geotechnical engineer.

A: Marc: You are absolutely right. This is a reason where I believe that a responsible arrangement must exist between the owner and contractor when bidding. Section 3.9 E of the Suggested Specification proposes such an arrangement.

Q: Which pipe materials can we use chemical grout?

A: Daniel: When injecting into the soil outside the pipe or manhole, any type of pipe material can be chemically grouted.

A: Marc: Pretty much any pipe materials that are structurally sound. The pipe joints are simply a passage to the exterior of the pipe. Mainline brick sewers cannot be sealed with remotely operated packers as it is practically impossible for the expanded rubber bladders to seat and seal against this surface.

Q: Maximum angle of packer?

A: Marc: If and when mainline packers cannot negotiate bends or changes in direction, custom packers can be built.

Q: Will roots grow through the grout?

A: Daniel: Recommendation: after a chemical root control program to remove roots from the mainlines and laterals, add a root-inhibitor to the grout when sealing the joints and laterals. This root inhibitor helps prevent future root growth for 2 to 3 years, causing the roots to seek a source of nutrients somewhere other than inside the sewer.

Q: What is the pressure level in a packer to keep it from fracturing a pipe, but still sealed to hold in grout?

A: Dick: Do not inflate the ends if the pipe has a longitudinal crack because you do not know what the soil is behind the pipe to support it, and it could fail. Typically the ends are inflated at 45 psi

A: Marc: Depending on the pipe materials and condition of the pipe, pressures applied on the pipe walls may or may not damage the pipes. Typically a pressure of 10 - 20 psi is applied on the pipe wall in order to hold grouting pressures commonly used (this will vary according to pipe roughness, packer rubber material, and grouting pressures in the void). Different packers require different inflation pressures to expand the bladders against the pipe. Once this contact pressure has been attained, any additional inflation pressure is the pressures applied against the pipe wall. Always verify with packer manufacturers

Q: With pipe subject to h₂s corrosion, does the grouting process provide protection to the internal surfaces after the laterals has been sealed?

A: Daniel: Unfortunately, no. The grout is not designed to stay on the inside of the pipe, but rather on the outside of the pipe.

A: Marc: No.

Q: You mentioned that grout has a half-life of 300+ years, but we have been told from contractors that when there is excess left in the laterals that it will break down and wash away. But we have also been told that the grout injected outside of the sewer pipe will stay for a very long time, which is correct?

A: Daniel: Both! The grout is designed to be injected into the soil surrounding the pipe or lateral. When it gels in the soil, it creates a gel/soil matrix that is both long lasting and impermeable. The small amount of gelled grout left inside the pipe or lateral does not have the soil for structure and is designed to be weak, so that it will break up when the packer is moved. From the lateral it will fall into the main line and be broken into small particles that will be easily moved through the pipe by normal sewage flow.