



PRODUCT HANDLING
GUIDE

www.geoproinc.com

A LETTER FROM OUR VICE PRESIDENT

This product handling guide is a collection of solutions for issues that GeoPro has helped contractors solve since we began offering the world's first thermally-enhanced grout, Thermal Grout 85, in 1996. Our intent is not to answer every possible question but we hope you will take the time to thoroughly read this document so that you might be able to avoid some of the same problems that others before you might have experienced.

As always, we are here to help you work through any specific problems you may have. Please give us a call at **(877) 580-9348** and a member of our experienced staff will be available to help.

Sincerely,



Allan Skouby

P.S. This product handling guide and an ever-growing collection of geothermal and thermal grout related resources and tools can be found on our web site. Just go to **www.geoproinc.com** to get free access to all we have available. Also, don't forget to take advantage of our free support services like grout thermal conductivity testing, silica sand analysis and loopfield design assistance.

TABLE OF CONTENTS

GeoPro Family of Products	1
Which Grout is Right For You?	2
General Mixing Guidelines	3
Silica Sand Quality	4
Water Quality	5
Mixing Equipment Capabilities	6
Formation Losses	7
Seasonal Issues	8
Sampling Issues	9
Contact Us	10

GEOPRO FAMILY OF PRODUCTS

Every GeoPro grouting product is designed to meet a specific range of project requirements. Selecting the correct grout for a project will save you time, money and reduce the chances a problem will occur. Below is a brief introduction to our product lineup to help you make the correct choice for your application.

BH20

BH20 is a specially formulated bentonite based grouting product used as a 20-25% solids mixture ideally suited for use in projects where thermal conductivity in the bore hole is not critical.

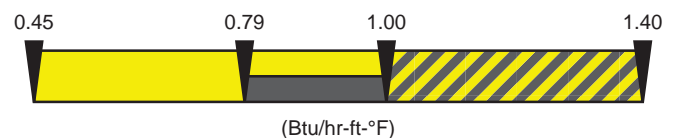
0.40 - 0.42
(Btu / hr-ft-°F)

Thermal Conductivity Increases with % Solids.

TG Lite

TG Lite is the first product in our Thermal Grout line and is designed specifically for geothermal heating and cooling applications where desired thermal conductivities range between 0.45 - 1.00 Btu/hr-ft-°F. When necessary, TG Lite can be used with a combination of silica sand and PowerTEC to achieve thermal conductivity values up to 1.40 Btu/hr-ft-°F.

thermal grout



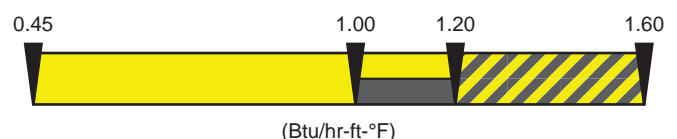
- TG Lite w/ Silica Sand Only
- TG Lite w/ PowerTEC Only
- TG Lite w/ Silica Sand & PowerTEC

For thermal conductivities greater than 1.40, use TG Select.

TG Select

TG Select shares the pumpability and ease of handling exhibited by BH20 and TG Lite but has an increased ability to support silica sand allowing for thermal conductivities in the range of 0.45 - 1.20 Btu/hr-ft-°F. When necessary, TG Select can be used with a combination of silica sand and PowerTEC to achieve thermal conductivity values up to 1.60 Btu/hr-ft-°F.

thermal grout



- TG Select w/ Silica Sand Only
- TG Select w/ PowerTEC Only
- TG Select w/ Silica Sand & PowerTEC

WHICH GROUT IS RIGHT FOR YOU?

GeoPro Grouts DO NOT flash hydrate.

BH20

BH20 is a standard grouting product (not a thermally-enhanced grout), specifically designed to be used as a 20-25% solids mixture.

- Commonly used for residential GSHP applications.
- BH20 is not designed for use at higher than 25% solids concentrations.
- Not designed for use with silica sand.
- When used outside of specified limits, BH20 is designed to become nearly impossible to mix and pump.
- BH20 does not require the use of polymer, soda ash or other mix water additives for proper handling.



TG LITE

Thermal Grout Lite (TG Lite) is GeoPro's mid-range, thermally-enhanced grouting product designed to reach a specific range of thermal conductivity values between 0.45 and 1.00 Btu/hr ft °F.

- TG Lite is commonly used on both residential and commercial applications, as specified by the system designer.
- TG Lite is not designed for use with more than 250 lb of silica sand (per bag) or for thermal conductivity values higher than 1.00 Btu/hr-ft-°F (without the use of PowerTEC).
- When used outside of its specified limits, TG Lite is designed to become difficult to mix and pump.
- It is possible to mix TG Lite at levels below its intended use, but the cost to do so will be higher than using BH20 and there is generally no economic or performance-related benefit to justify doing so.
- TG Lite does not require the use of polymer, soda ash or other mix water additives for proper handling.



TG SELECT

Thermal Grout Select (TG Select) is GeoPro's premium, thermally-enhanced grouting product designed to reach a specific range of thermal conductivity values between 0.45 and 1.20 Btu/hr ft °F.

- TG Select is commonly used on commercial applications, as specified by the system designer.
- TG Select is not designed for use with more than 400 lb of silica sand (per bag) or for thermal conductivity values higher than 1.20 Btu/hr-ft-°F (without the use of PowerTEC).
- It is possible to mix TG Select at levels below its intended use, but the cost to do so will be higher than using TG Lite and there is generally no economic or performance-related benefit to justify doing so.
- TG Select does not require the use of polymer, soda ash or other mix water additives for proper handling.



GENERAL MIXING GUIDELINES

Follow the instructions printed directly on every bag of our products.

As trivial as this statement seems to be, it is extremely important. Follow the mixing instructions printed on the bag to increase the success rate with our products.

MIXING GUIDELINES

- ⊕ For all grouts, do your best to make sure your mix water measurements are accurate.

If you are off by a few inches in water height in the mixing tank, you could be off by 4-5 gallons in mix water quantity (1 inch \approx 2 gallons in Geo-Loop Grouters).

- ⊕ For thermally-enhanced grouts, allow enough time for the grout to thicken before adding sand.

Adding sand to the mixing tank too soon can cause issues with settling. Also, make sure the sand is fully mixed into the slurry before pumping. Lumps of sand can plug a tremie line.

- ⊕ Follow the specified mixing order and mixing times provided on each bag and wear a Particulate Respirator that meets or exceeds NIOSH: N95 approval when mixing.

BH20, Thermal Grout Lite and Thermal Grout Select have been specifically designed to maximize working time without requiring the use of polymers or chemical additives.

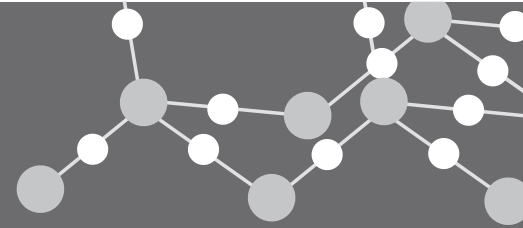
DON'T "THIN IT DOWN"

Accurate mix water measurement will reduce issues in the field and ensure that delivered performance meets specifications (with respect to thermal conductivity and permeability).

Many loop contractors that are new to the industry may not be familiar with the handling of high-solids grouting products, especially thermally-enhanced grouts. Thermal grout will be denser and more viscous than traditional bentonite-based drilling fluid and by nature, more difficult to mix and pump. A common reaction is to add extra water to the slurry to "thin it down". However, over watering thermal grout will cause multiple problems:

- ⊕ Over-watering dilutes the mixture, lowering the overall solids content and reducing the ability of thermal grout to properly seal the bore and transfer heat away from the pipe.
- ⊕ Over-watering reduces ability of thermal grout to suspend the silica sand in the slurry. When this happens, the sand can settle to the bottom of the paddle mixing tank and pack into the piston pump assembly, plugging it completely.

SILICA SAND QUALITY



Even when thermal grout mix specifications are followed exactly, a specific grout thermal conductivity value will only be reached when an appropriate silica sand additive is used.

SILICA DIOXIDE CONTENT IS KEY

With thermal grout, always use high grade silica sand. It should be washed, dried and pre-packaged. In order to reach your target thermal conductivity value, the Silica Dioxide (SiO_2) content of the sand should be greater than 99%.

PARTICLE SIZE

Over a decade of research has shown that the SHAPE of a particle is not as important as its SIZE. Recommended values for grain fineness (**AFS GFN**), a measure of the particle size distribution of the sand, are shown below:

TG LITE
40-60
AFS-GFN

TG SELECT
60-80
AFS - GFN

NO MORE THAN
5%
OF SAND



40
MESH



NO MORE THAN
2.5%
OF SAND



200
MESH



Sands having AFS GFN values lower than the recommended range will be difficult to suspend in the grout slurry and sands having AFS GFN values higher than the recommended range will result in a mixture that is very thick and difficult to pump.

SAND EVALUATION SERVICES

We encourage drilling contractors to explore various sand sources that are close to the project site. While we have already evaluated a large number of commercial high-grade silica sand sources, there may be some sources that have not been fully examined. Simply contact us when interested in using sand from a given source.

If we have already evaluated the sand source, GeoPro will supply you with the necessary information. If we have not evaluated the source in question, we will take the action necessary to determine its suitability for use with our thermal grout products.

In most cases, we will obtain approximately 15 lbs. of the sand and have it sent to our laboratory for a free evaluation. Once the sample is received, we will determine the thermal conductivity range of values that can be obtained with the sand. If necessary, we will offer an adjusted recipe to achieve the target value. In some cases, locally obtained sand may not be able to satisfy the specified thermal conductivity value for your project. In these cases, we will provide alternative recommendations.

When the silica sand for a given project is not approved by GeoPro, we will not take any responsibility for the quality control of the sand or of the final delivered thermal conductivity on the project.

WATER QUALITY



NO ADDITIVES REQUIRED

While water quality is a major issue with certain manufacturers and their respective thermal grout products, Thermal Grout Lite, Thermal Grout Select and BH20 are the only products available that **will not flash hydrate** and **do not require water additives** for proper handling (such as polymer to prevent flash hydration or soda ash to treat water quality), except in extreme situations.

USE POTABLE WATER

Simply use potable water throughout the entire grouting process and issues that stem from water quality will be minimal. Do not use surface water or drilling fluid for mix water. Also, keep in mind that the optimum mix water temperature during grouting is 50-70°F. Refer to **Seasonal Issues** for a complete discussion on the effect of mix water temperature on thermal grout.

pH LEVEL

Typical ground water pH values will range between 5 and 6. In areas where ground water could be contaminated by acid rain, a pH as low as 4 could be seen. Water high in minerals could see pH values above neutral and are typically in the range between 7 and 9. BH20, TG Lite and TG Select will perform best when mix water pH levels are between 5 and 7 but will still provide satisfactory performance with pH values between 7 and 9.

DISSOLVED SODIUM (SALT)

Sodium is naturally present in ground water. The content of sodium in water varies anywhere from a few parts per million to as high as 35 g/L in saltwater. For our purposes, salt concentration in mixing water should not exceed 0.5 g/L.

It should be noted that when BH20, TG Lite or TG Select are mixed with fresh water and then pumped into a formation where salt water exists, grout performance will not be affected. **Salt water will only negatively affect grout characteristics when it is used as mix water.**

CHLORINE CONTENT

BH20, TG Lite and TG Select are not sensitive to chlorine levels in mixing water. As long as the concentration level does not exceed 20 ppm, the presence of chlorine in mixing water will not be an issue. As a frame of reference, heavily chlorinated swimming pool water will contain about 2 - 3 ppm of chlorine. Levels above 5 ppm are not typically seen as such concentrations are deemed a risk to human health.

MIXING EQUIPMENT CAPABILITIES

Any downtime during grout placement due to process inefficiency or inadequate equipment capabilities will increase the chance for a plugged pump assembly or tremie line (or both). Proper mixing and pumping equipment as well as a sufficiently sized tremie line mounted on a reel will greatly reduce equipment-related issues in the field.

A natural property of bentonite is that it reacts with water more rapidly with high rates of shear. In other words the faster you try to move and agitate the material, the faster it will hydrate or “set up”. When grout is exposed to high rates of shear, it will hydrate quickly and can become too thick to mix and pump through a long tremie line. This fact predetermines the kind of mixing and pumping equipment as well as the methods that can be used with our grouting products.

MIXING EQUIPMENT

The method used for mixing grout must be low-shear. Paddle mixing is the recommended method which simply uses rotating paddles in a barrel-like container to agitate and mix the slurry. Jet mixing or recirculation methods are not recommended.

PUMPING EQUIPMENT

As is the case with mixing, the method used for pumping must be low shear. Because of the silica sand in it, thermal grout will be extremely abrasive to most types of positive displacement pumps. Research and field experience has proven that a piston-style pump offers the best results with the least amount of maintenance cost. Use of non-positive displacement pumping equipment (such as centrifugal pumping equipment) is not recommended.

Ensure that the selected piece of equipment is a "grout" pump and not a "mud" pump. "Grout" pumps are designed to deliver the high pressures and low volumes that are typically required for proper placement. "Mud" pumps deliver high volumes at low pressures which are not usually adequate for proper grout placement.

TREMIE LINE

Although a tremie line can be constructed of any material, we highly recommend using one made of flexible material with a high pressure rating for long life and ease of use (such as 2500-psi rated flexible sewer cleaning hose).

The recommended diameter for a tremie line is 1¼" for most applications. However, using a 1" tremie may be possible when BH20 (20% solids, standard high solids grout) is used in shallow bores.

TREMIE REEL ASSEMBLY

A tremie reel is another piece of equipment that can increase efficiency during grout placement. A tremie reel will roll or unroll the coiled tremie line as it is inserted into and removed from the bore during the grouting process. Tremie reels can either be manually or hydraulically controlled.

We recommend using a reel that is mounted on a swivel so that it can be properly aligned with the bore for ease of tremie insertion and subsequent removal.

FORMATION LOSSES

In certain formations, bores will require excessive amounts of BH20 or thermal grout to be completely filled to the top. Some examples would be highly-fractured consolidated (rock) formations, large crevasses, small caverns or flow aquifers, gravel formations, cobbles, etc.

UNCONSOLIDATED FORMATION WITH POROUS GRAVEL OR COBBLE ZONES

PROBLEM

When porous unconsolidated formations are encountered, it is likely that there won't be a specific zone that can be plugged. However, large amounts of grout can still flow into to permeable soil before the grout fully hydrates or "sets up".

SOLUTION

The only method to reduce (but not completely eliminate) such losses is to allow the grout to thicken before placement. This can be accomplished by either extending mixing time in the tank or by reducing the amount of mix water in each batch (by 1-2 gallons per 50 lb bag of BH20, TG Lite or TG Select).

HIGHLY FRACTURED OR CAVERNOUS CONSOLIDATED ROCK FORMATIONS

PROBLEM

When highly-fractured or cavernous rock formations are encountered, large amounts of grout can flow into or be washed through the fractured zones.

SOLUTION

One way to stop such losses is to place a granular material such as our 3/8" Bentonite Plug through the problem area. In this situation, the best method of placement is to start by pumping grout from the bottom of the bore up to the problem area. Next, plug the fractured zone by removing the tremie line from the hole and simultaneously pouring 3/8" Bentonite Plug and pea rock from the surface to build a bridge through the fracture.

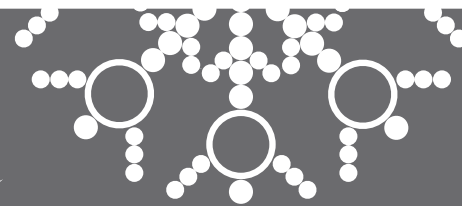
The bridge will serve as a platform to resume grouting from just above the fracture up to the top of the hole. Typically, this small amount of material (with a considerably lower thermal conductivity value) will not significantly affect the average thermal performance of the bore.



CONTACT
877.580.9348

Contact our technical support department for help determining the best course of action when similar problems arise.

SEASONAL ISSUES



Time of year can greatly affect incoming mix water temperature. Through the winter and into early spring, mix water temperatures will be their coldest. Conversely, through the summer months and into early fall, water temperatures will be their warmest.

50°F IDEAL MIX WATER TEMPERATURE RANGE 70°F

COLD MIX WATER (< 50°F)

A natural property of bentonite is that it reacts with water more slowly with decreasing water temperature. When thermal grout is exposed to cold mix water, its slow hydration rate may cause sand settling in the mixing tank. While nothing can be done to the bentonite itself to overcome this issue, several precautions can be made to minimize issues in the field.

Extend mixing time for each batch. Increasing the mix time by 2-4 minutes on each batch before adding the silica sand component will give the thermal grout more time to hydrate and in doing so, give it more gel strength so it can adequately suspend the sand in the slurry.

Decrease water content in each batch. Removing mix water (1-2 gallons of water per 50 lb bag of BH20, TG Lite or TG Select) will thicken the mixture, increasing its overall gel strength and ability to suspend the sand in the slurry.

Use finer sand. Fine sand particles are easier to suspend than coarse particles. Switching to a finer grade of silica sand may alleviate issues related to cold mix water and sand settling.

HOT MIX WATER (> 70°F)

Hot mix water has the opposite effect of cold mix water. Bentonite reacts more rapidly with increasing water temperature. When exposed to hot mix water, the rapid hydration rate may cause thermal grout to become difficult to handle. If the mix water is hot enough, it can plug the mixing tank, pump assembly or tremie line. As before, while nothing can be done to the bentonite to overcome this issue, several precautions can be made to minimize issues in the field.

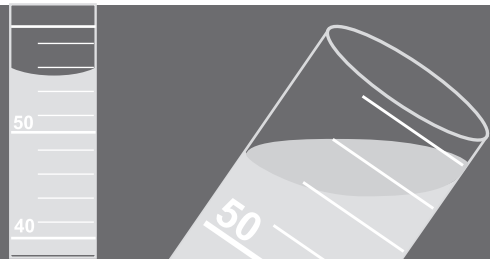
Draw directly from the public water supply. The most effective way to prevent mix water from becoming too warm is to draw it directly from the public water system into the mixing tank. This will ensure that the mix water is not given time to absorb excessive amounts of solar energy before being mixed with the grout.

Keep storage tanks in shaded areas. If drawing directly from the public water supply is not an option, make sure that the on-site storage tank is not placed in direct sunlight. If possible, place it in a shaded area to minimize solar heat absorption by the water.

Drain water lines. Ensure that the water line from the storage tank to the mixing tank is not extremely long. If the water line holds a large volume of water and is allowed to sit in direct sunlight, drain the line completely to prevent the hot water from being introduced into the mixing tank.

Use coarser sand. Coarse sand particles absorb less water than fine particles. Switching to a coarser grade of silica sand will yield a thinner grout slurry and may alleviate issues related to hot mix water.

SAMPLING ISSUES



GeoPro offers grout sample thermal conductivity testing (performed in our lab according to ASTM D-5334, line source method) as a free service to any customer who chooses to take advantage of the service. In fact, we strongly suggest using the sample containers that we provide to ensure an adequate sample size.

All of the thermal conductivity (TC) tests performed by GeoPro are blind. We report the tested TC value of a sample without any knowledge of your targeted value. If the reported value meets or exceeds the target value, no action will be required. If the reported value falls below target, we will work to help determine possible causes and solutions for the discrepancy.

SAMPLING GUIDELINES

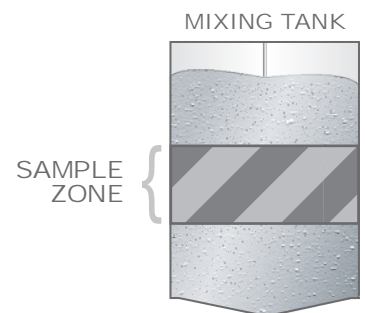
If our mixing specifications are followed with a reasonable degree of accuracy in the field, drilling contractors should meet or exceed thermal conductivity specifications every time. Occasionally, we are contacted when the contractor is making every effort to follow our mixing specifications, are using a pre-approved silica sand source and the tested values of the grout samples they submit still fall below their target value. In these cases, the discrepancies can usually be attributed to sampling error.

When obtaining a sample fill the sample container completely. Samples that are too small will not be tested and a new sample will need to be submitted.

SAMPLING FROM THE PADDLE MIXING TANK

Take the sample from the middle (vertically) of the batch. When sampling from the tank, make sure the mixer is at a COMPLETE STOP before doing so.

Taking the sample by skimming grout off of the top of the tank will probably result in a thermal conductivity test value that falls below target. GeoPro makes a grout sample collector available for purchase that has been specifically designed to take an appropriately-sized sample from the center of the mixing tank without requiring the sample-taker to get their hands dirty. Contact us for more information.



SAMPLING FROM THE TREMIE OR CLEANOUT LINE

When obtaining a grout sample directly from the end of the tremie or from the cleanout bypass (side discharge), take the sample in the middle or near the end of pumping the batch. It will be easiest to take the sample when the tremie line is at the top of the bore and there is material left in the line.

Taking the sample at the beginning of the pumping process will likely result in a tested thermal conductivity value which falls below target.

SAMPLING FROM THE COMPLETED BORE

NEVER attempt to take a grout sample intended for thermal conductivity analysis from the completed bore.

To initiate sample thermal conductivity testing, simply contact our Technical Support department and we will send the requested number of grout sample containers with instructions and a Thermal Conductivity Analysis Sheet to fill out with each sample.

CONTACT

877.580.9348



PRIMARY OFFICE LOCATIONS

CORPORATE OFFICES

GeoPro, Inc.
302 E. Warehouse St.
Elkton, SD 57026

Phone: (877) 580-9348
Fax: (877) 580-9371

SALES OFFICES

GeoPro, Inc.
P.O. Box 150
Bowie, TX 76230

Phone: (877) 580-9348
Fax: (877) 580-9371

DIRECT CONTACTS

TECHNICAL SUPPORT

Chuck Remund

President / Director of Technical Support
Phone: (877) 580-9348 ext. 101
Fax: (877) 580-9371
Email: CRemund@GeoProInc.com

Ryan Carda

Lead Product Support Engineer
Phone: (877) 580-9348 ext. 102
Fax: (877) 580-9371
Email: RCarda@GeoProInc.com

Jared Horn

Product Support Engineer
Phone: (877) 580-9348 ext. 104
Fax: (877) 580-9371
Email: JHorn@GeoProInc.com

Tyler Harbeck

Technical Support Engineer
Phone: (877) 580-9348 ext. 106
Fax: (877) 580-9371
Email: THarbeck@GeoProInc.com

SALES

Allan Skouby

Vice President / Director of Sales & Marketing
Toll Free: (877) 580-9348 option 3 then 1
Phone: (940) 872-8097
Fax: (940) 872-3678
Email: ASkouby@GeoProInc.com

Treg Yowell

Sales & Marketing
Toll Free: (877) 580-9348 option 3 then 4
Phone: (512) 551-9459
Fax: (512) 551-9468
Email: TYowell@GeoProInc.com

ORDERS / CUSTOMER SERVICE

Steve Wetrosky

Customer Service
Toll Free: (877) 580-9348 option 1
Phone: (605) 582-8861
Fax: (877) 580-9371
Email: SWetrosky@GeoProInc.com

LaRee Farnham

Office Manager
Phone: (877) 580-9348 ext. 100
Fax: (877) 580-9371
Email: LFarnham@GeoProInc.com