GEOTHERMAL GROUT™

ENHANCED THERMALLY CONDUCTIVE GROUT

Certified to NSF/ANSI 60

DESCRIPTION

GEOTHERMAL GROUT is a specially blended high solids bentonite that can be mixed with sand in a two-part thermally conductive grouting material to improve the performance of ground source heat loop applications. GEOTHERMAL GROUT is an easy pumping grout that has been carefully developed to efficiently suspend solids (silica sand) for enhanced thermal conductivity. GEOTHERMAL GROUT can be mixed to meet a range of thermal conductivity (TC) from 0.40 to 1.00 Btu/hr/ft/F (0.68 to 1.69 W/mK). GEOTHERMAL GROUT is certified to NSF/ANSI Standard 60, Drinking Water Treatment Chemicals - Health Effects.

ADVANTAGES

GEOTHERMAL GROUT improves the efficiency and performance of ground source heat loop systems by matching the thermal conductivity of the surrounding soil and creating a permanent flexible seal to prevent aquifer contamination. Depending on site soil conditions, GEOTHERMAL GROUT can be mixed and adjusted to meet individual thermal conductivity requirements, improving the transfer of heat between the fluids circulated in the loop and the surrounding soil for optimum system performance.

TYPICAL PROPERTIES	
Batch Yield	16.4 - 31.3 gal/batch (62.2 – 119.6 liters/batch)
Grout Weight	10.2 - 14.1 lb/gal (1.22 – 1.69 kg/l)
Max Particle	<300 µm
Percent Solids	30.0 - 68.0%
Permeability	$<5.2x10^{-9}$ cm/s
Specific Gravity	2.62 g/cm^3
Thermal Conductivity	0.40 - 1.00 Btu/hr/ft/F (0.68 - 1.69 W/mK) *(TC values will vary depending on testing method and the quality of sand used)*

MIXING AND APPLICATION

Place freshwater in a paddle-mixing tank of a commercial grout mixer. Start the grout mixer paddle, and add one 50 lb (22.7 kg) bag of GEOTHERMAL GROUT to the water. Mix for about 1 minute. Add silica sand at a steady rate (1 to 2 minutes), and continue mixing for about 2 minutes to obtain a consistent mixture. Pump with a positive displacement piston pump through a tremie pipe at a rate of 5 to 15 gallons (19 to 57 liters) per minute.

Thermal conductivity values are based on ASTM D-5334 procedures. Testing performed by the CETCO Laboratory uses the D-5334 method. (see page 3)

PACKAGING

50 lb (22.7 kg) bag, 48 per pallet. All pallets are plastic-wrapped.

Btu/hr/ft/F (D-5334)	Silica lb/batch	Water gal/batch	Yield gal/batch	Weight lb/gal	Total Solids
0.40	0	14	16.4	10.2	30.0%
0.80	150	15	24.6	13.2	61.5%
0.90	200	16	28.0	13.7	65.2%
1.00	250	17	31.3	14.1	68.0%

W/mK (D-5334)	Silica kg/batch	Water l/batch	Yield l/batch	Weight kg/l	Total Solids
0.68	0	53	62	1.22	30.0%
1.36	67.5	57	93	1.58	61.5%
1.52	90	61	106	1.64	65.2%
1.69	113	64	130	1.69	68.0%

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GEOTHERMAL GROUT Grout Volume Requirement Table					
Nominal Borehole Size (in)	U-Bend Pipe Size		Gallons of Grout/ Linear Foot with Single U-Bend (2 Pipes)	Batches/100 ft of Bore (@ 65-68% Solids)	
	Nominal O.D. (in)	Actual O.D. (in)		200 lb	250 lb
4.50	3/4	1.050	0.7362	2.78	2.49
	1	1.315	0.6851	2.71	2.43
	1 1/4	1.660	0.6013	2.54	2.26
4.75	3/4	1.050	0.8306	3.14	2.82
	1	1.315	0.7794	3.04	2.71
	1 1/4	1.660	0.6957	2.86	2.55
5.00	3/4	1.050	0.9300	3.50	3.13
	1	1.315	0.8789	3.36	3.00
	1 1/4	1.660	0.7951	3.21	2.88
	1 1/2	1.900	0.7254	3.10	2.78
5.50	3/4	1.050	1.1442	4.25	3.76
	1	1.315	1.0931	4.16	3.70
	1 1/4	1.660	1.0093	4.01	3.57
	1 1/2	1.900	0.9396	3.88	3.47
6.00	3/4	1.050	1.3788	5.07	4.53
	1	1.315	1.3277	4.92	4.40
	1 1/4	1.660	1.2439	4.85	4.34
	1 1/2	1.900	1.1742	4.76	4.21
6.50	1	1.315	1.5827	5.84	5.27
	1 1/4	1.660	1.4989	5.75	5.14
	1 1/2	1.900	1.4292	5.64	5.04

Note: U-Bend Pipe Sizes based on ASTM D-3035 and ASTM D-2447 (Polyethylene, IPS-OD)

GEOTHERMAL GROUT Grout Volume Requirement Table					
Nominal Borehole Size (cm)	U-Bend Pipe Size		Liters of Grout/ Linear Meter with Single U-Bend (2 Pipes)	Batches/30 m of Bore (@ 65-68% Solids)	
	Nominal O.D. (cm)	Actual O.D. (cm)		90 kg	113 kg
11.4	1.91	2.67	9.43	2.78	2.49
	2.54	3.34	8.50	2.71	2.43
	3.18	4.22	7.47	2.54	2.26
12.1	1.91	2.67	10.31	3.14	2.82
	2.54	3.34	9.68	3.04	2.71
	3.18	4.22	8.64	2.86	2.55
12.8	1.91	2.67	11.55	3.50	3.13
	2.54	3.34	10.92	3.36	3.00
	3.18	4.22	9.87	3.21	2.88
	3.81	4.83	9.01	3.10	2.78
14	1.91	2.67	14.16	4.25	3.76
	2.54	3.34	13.58	4.16	3.70
	3.18	4.22	12.53	4.01	3.57
	3.81	4.83	11.67	3.88	3.47
15.2	1.91	2.67	17.11	5.07	4.53
	2.54	3.34	16.49	4.92	4.40
	3.18	4.22	15.45	4.85	4.34
	3.81	4.83	14.58	4.76	4.21
16.5	2.54	3.34	22.73	5.84	5.27
	3.18	4.22	18.62	5.75	5.14
	3.81	4.83	17.75	5.64	5.04

Note: U-Bend Pipe Sizes based on ASTM D-3035 and ASTM D-2447 (Polyethylene, IPS-OD)

How to use this table when using 200 lbs of sand:

Example: 100 bores, each 250 feet deep with a 5 in diameter and a 1 in U-bend assembly installed.

1. Find the bore diameter on the left side of the table (5.00 in).
2. Next, find the U-bend Pipe Size, Nominal O.D. in the next column (1 in).
3. Looking across this row, notice these bores will require 0.8789 gallons of grout per linear foot.
4. Calculate total batches of GEOTHERMAL GROUT required for each bore.
   3.21 (from the far right column) x 2.50 (250 ft deep/100) = 8.03 batches per bore
5. Calculate the total batches of GEOTHERMAL GROUT required for the entire project.
   8.03 (from step 4 above) x 100 (total number of bores) = 803 total batches required

How to use this table when using 90 kg of sand:

Example: 100 bores, each 75 m deep with a 12.8 cm diameter and a 2.54 cm U-bend assembly installed.

1. Find the bore diameter on the left side of the table (12.8 cm).
2. Next, find the U-bend Pipe Size, Nominal O.D. in the next column (2.54 cm).
3. Looking across this row, notice these bores will require 0.8789 gallons of grout per linear meter.
4. Calculate total batches of GEOTHERMAL GROUT required for each bore. 3.21 (from the far right column) x 2.50 (75 m deep/30 m) = 8.03 batches per bore
5. Calculate the total batches of GEOTHERMAL GROUT required for the entire project.
   8.03 (from step 4 above) x 100 (total number of bores) = 803 total batches required

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SAND REQUIREMENTS

In order to comply with GEOTHERMAL GROUT specifications, the silica sand used must meet the following criteria. To minimize freight cost it is recommended that the sand portion be obtained locally for most projects, following the sand specifications above for grain mesh size. GEOTHERMAL GROUT can be used with a wide variety of sand sizes. Some suggested specifications are listed below.

Silicon Dioxide: 99%	Grain Shape: Rounded		Moisture: <0.1%
Sieve Mesh Size	Retained %	Cumulative %	Passing %
#40	1.0% maximum	1.0% or less	99.0%
#50	23.0%	23.0%	77.0%
#70	57.0%	80.0%	20.0%
#100	15.0%	95.0%	5.0%
#140	3.0%	98.0%	2.0%
<#140	2.0%	100.0%	0.0%

OUR SUGGESTION:

EQUIPEMENT ENVIRONNEMENTAL TERRA INC

ATLANTIC SILICA INC.

HIGH PERFORMANCE SILICA SAND 00

FOR

GEOTHERMAL GROUT MIX

SUB ANGULAR NATURAL GRAIN FOR EASIER PUMPING

LESS ABRASIVE ON YOUR PUMPING EQUIPMENTS

HIGH PURITY SILICA FOR HIGHER THERMAL TRANSFER

GRAIN SIZE CONTROLED FOR HIGHER SUSPENSION IN GROUT MIX

PRODUCED TO MEET BENTONITE MANUFACTURER' S REQUIREMENTS

AVAILABLE IN VARIOUS FORMAT TO ACCOMODATE YOUR NEEDS

Typical Chemical Analysis		
Element Compound	Not Magnetically Seperated	Magnetically Seperated
SiO_2	99.6	99.75
Al_2O_3	0.2	0.1
Fe_2O_3	0.06	0.02
TiO_2	0.02	ND-Trace
CaO	<0.01	<0.01
MgO	<0.01	<0.01
K_2O	<0.01	<0.01
Na_2O	<0.01	<0.01
LOI	0.1 Max	0.1 Max
Acid Demand	<1	<1
Specific Gravity	2.64	2.64

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GEOTHERMAL GROUT TEST POLICIES

THERMAL CONDUCTIVITY (TC)

TC testing as required can be performed in the CETCO Laboratory free of charge for the distributor or contractor purchasing GEOTHERMAL GROUT.

a) CETCO will perform the testing using ASTM D-5334 - *Determination of Thermal Conductivity of Soil and Soft Rock by Thermal Needle Probe Procedure*. Testing using ASTM C-518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus, can be performed at an outside test facility for an additional charge.

b) The sample container(s) shall be a minimum of four inches in diameter by at least five inches deep.

c) The container should be completely filled to the top and covered to prevent moisture loss.

d) The container should be rigid to semi-rigid and packaged appropriately so no disturbance takes place when shipped for analysis.

e) CETCO can provide the contractor with a list of laboratories qualified to conduct the TC testing according to acceptable ASTM standards.

f) Test results will be reported as they become available to the supervising engineer, the installation contractor, and CETCO.

g) CETCO will not be financially responsible for charges billed by independent laboratories and charges will be billed directly to the supervising engineering firm, CETCO distributor, or installation contractor.

SAND

Sand quality has a direct effect on the TC achieved by enhanced bentonite grouts. Sand quantity needed may vary depending on characteristics. CETCO suggests that sand being considered for enhancing the thermal conductivity of GEOTHERMAL GROUT be submitted to CETCO for laboratory analysis prior to commencement of the project. This service is free of charge for the distributor or contractor purchasing the GEOTHERMAL GROUT. TC testing as required can be performed in the CETCO laboratory free of charge for the distributor or contractor purchasing the GEOTHERMAL GROUT. The following procedures and policies should be adhered to in order to achieve desired results.

a) Sand samples should be sent directly to the CETCO laboratory by the manufacturer.

b) Sand should be accompanied by a description and sieve analysis from the manufacturer.

c) Quality of the sand will be analyzed to confirm silica content, roundness, and size.

d) CETCO will mix the sand into a lab batch with GEOTHERMAL GROUT using the same proportions of sand typically required to achieve the thermal conductivity (TC) desired.

e) TC testing results will determine the quantity of sand required for the job specification.

f) Results and recommended mix proportions will then be reported to the responsible party.

PERMEABILITY TESTING

Permeability testing as required can be performed in the CETCO Laboratory for a fee per sample for the distributor or contractor purchasing the GEOTHERMAL GROUT.

a) CETCO will perform the testing using ASTM D-5084 - *Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*.

b) The sample(s) shall be a minimum of five inches in diameter and two inches deep and covered prior to shipment.

c) Sample container should be rigid to semi-rigid in construction.

d) If independent testing is required, CETCO can provide the contractor with a list of qualified laboratories.

e) Test results will be reported as they become available to the supervising engineer, the installation contractor, and CETCO.

f) CETCO will not be financially responsible for charges billed by independent labs and charges will be billed directly to the supervising engineering firm, CETCO distributor, or installation contractor.

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