Alchemy Geopolymer Solutions

AGS is a Technology Licensing Company specializing in the design and development of fly ash based geopolymer products solving problems for multiple industries including oil/gas well solutions.

Coal-fired power plant

Source Material

AGS line of products include:

- Castable and pre-cast refractory concrete
- Castable and pre-cast corrosion resistant concrete
- Well cementing
- Proppants

Value Proposition

Well cementing

- Higher sulfate resistance compared with traditional cementations grouts.
- Lower shrinkage reducing potential cracking
- Enhanced bond to steel casing
- Setting time can be chemically “programmed” using proprietary additives developed using an advanced nanotechnology process.
- Water works as a carrier and not part of the chemical formulation

Proppants

- Lower cost compared with ceramics
- Increased conductivity compared with to sand and resin coated sand
- Increased acid resistant to sulfates
- AGS Spherical-shaped proponents cause lower wear on expensive well equipment compared to sand or resin coated sand

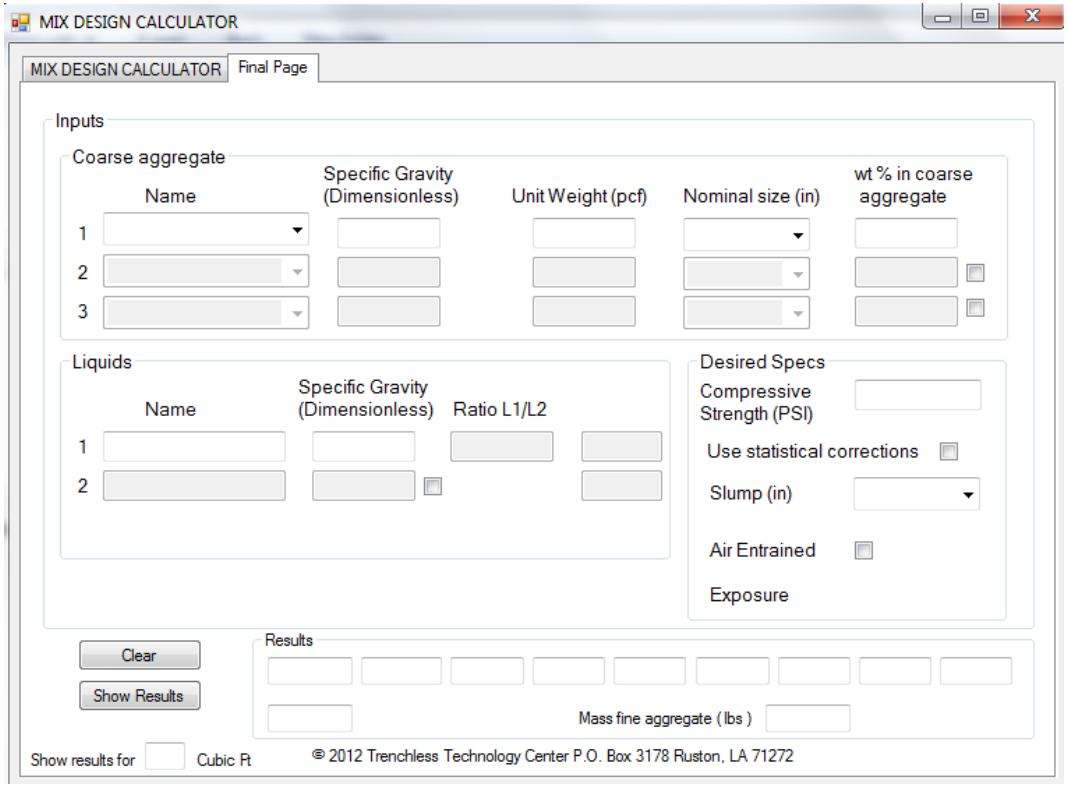
Green Appeal - Environmentally and Economically Attractive

Typical characteristics of AGS Geopolymer Concrete

Test	ASTM Standard	Typical Values/ Properties
Mechanical Properties		
Compressive Strength*	C-39	80 MPa (11,600 psi)
Flexural Strength	C-78	7.4 MPa (1,073 psi)
Elastic Modulus	C-469	43 GPa (6,236 ksi)
Poisson's Ratio	C-469	0.11-0.2
Bond Strength	D-4541	9.6 MPa (1,400 psi)
Setting Time	C-403	25 - 600 minutes
Water Absorption	C-642	2%-8%
Density	C-642	1800 - 2350 kg/m^3 (110 - 146 lb/ft^3)
Durability of Geopolymer Concrete		
Corrosion Rate when subjected to one year of saltwater exposure	G-02	0.09 µA/cm^2
Chloride Diffusion Coefficient	C-1556	$1.45x10^{-12}$ m^2/s
% Expansion due to Alkali Silica Reaction (ASR)	C-1260	Min: 0.04 % Max: 0.1%
Sulfate attack		Stable in 5 % solution of $NaSO_4$ & $MgSO_4$
Corrosion Resistance	C-267	High level of resistance to a range of acids and salt solutions (Na2SO4, MgSO4, NaCl, Sulphuric Acid, Hydrochloric Acid)
Temperature		Thermal Stability up to 2500°F
Thermal Conductivity		~0.2-0.3 W/m/K

AGS Geopolymer Software

• AGS has developed a proprietary software to overcome the variability of the raw material chemical compositions and produce a material with constant quality.

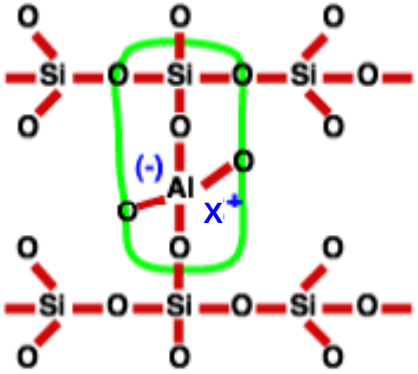


• With the use of AGS's geopolymer software, geopolymer concrete can be designed for a wide range of compressive strengths and slumps as well as for different exposure conditions including freeze-thaw, corrosive environments and elevated temperature/fire by making use of our extensive fly ash database.

Geopolymerization Reaction

Na or K Hydroxide Sodium Silicate

Coal-fired power plant

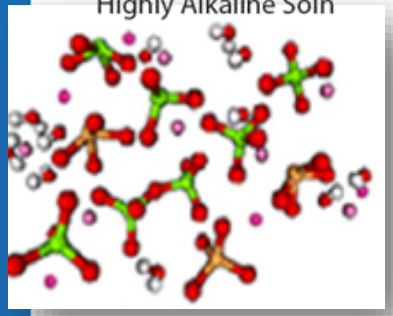


X = Na or K

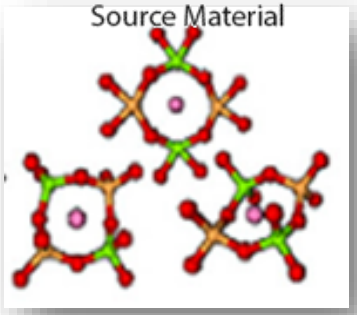
GPC
(N-A-S-H) or (K-A-S-H)

Highly Alkaline Soln

Source Material

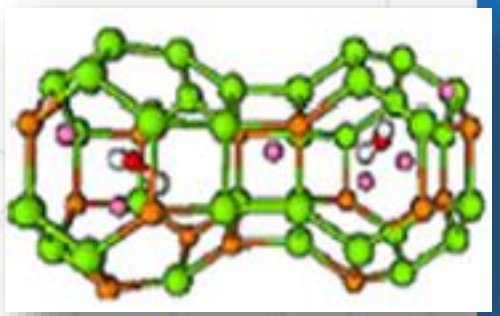


Dissolution
of all components



Precipitation
of aluminosilicate species

Polymerization
polymeric Si–O–Al–O bonds

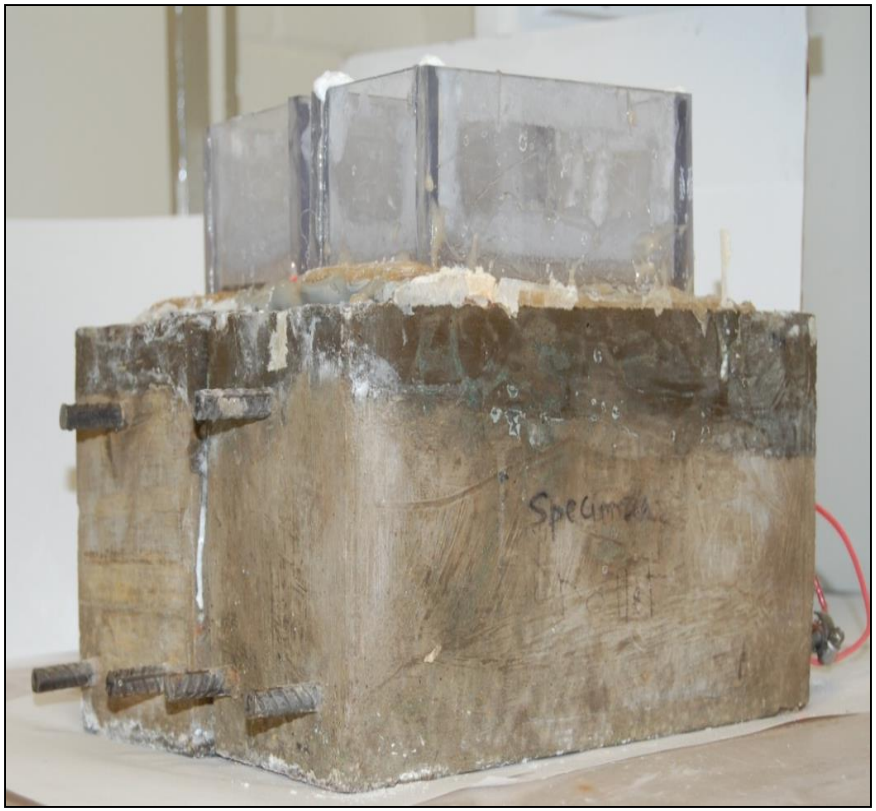


Growth
3D polymer chain from Si-O-Al-O bonds

High Temperature Resistance

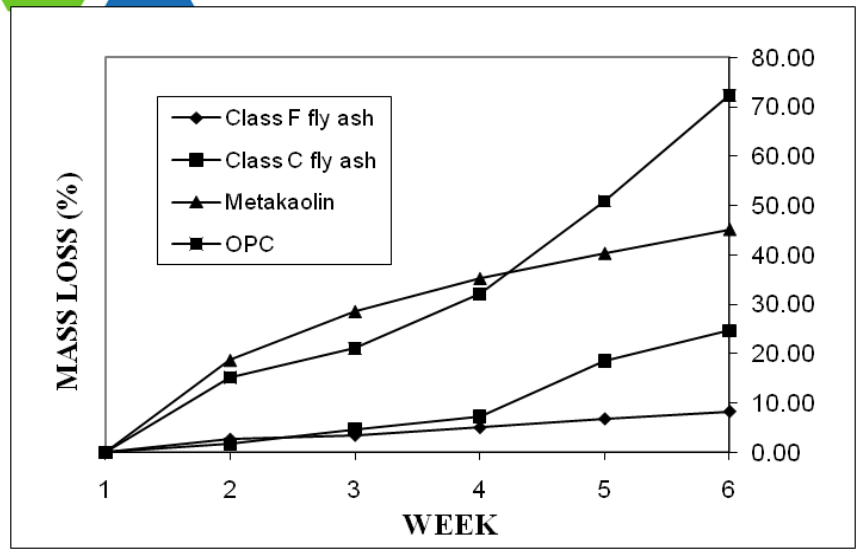
- Resists shock effect of temperatures up to 4000°F, and continuous temperatures to 2800°F
- Outperforms products currently used on NASA launch pads, American Electric Power coal furnace, and Georgia Pacific acid tanks

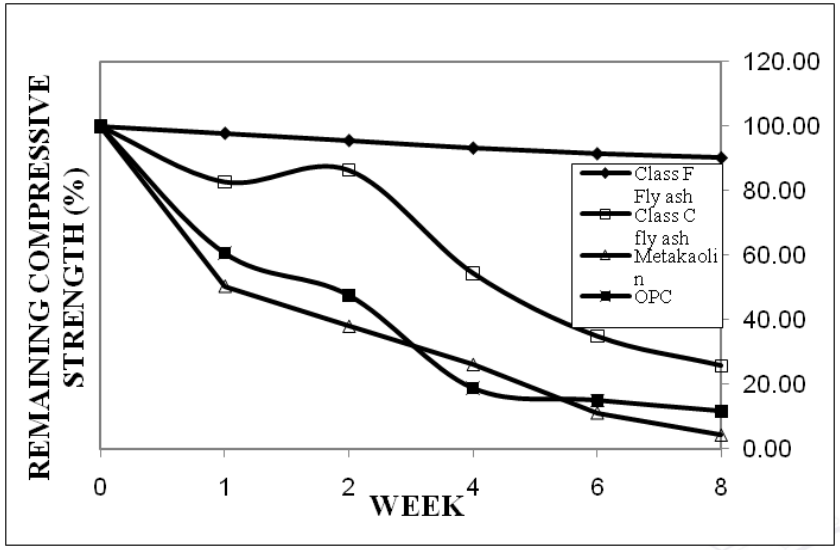
High Corrosion Resistance



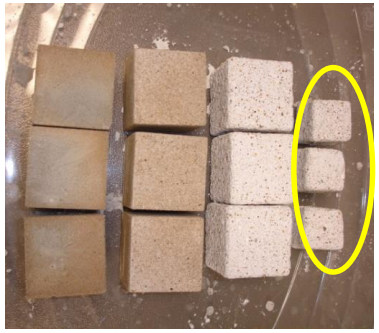
- Resists the action of most common industrial acids, such as sulfuric, nitric, etc.
- Cost-effective alternative to organic polymers

High Corrosion Resistance



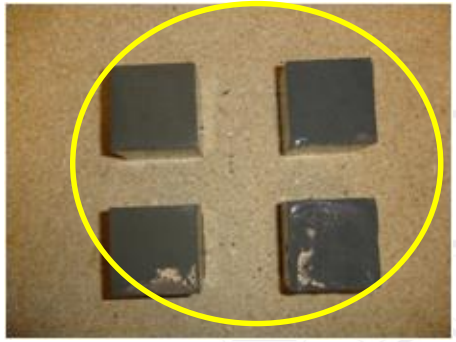


Ordinary Portland Cement



Class C fly ash Geopolymer

Class F fly ash Geopolymer



The geopolymer and Portland cements in the yellow circle were tested according to ASTM C-267. They were exposed to a 6% sulfuric acid solution for 8 weeks.

Waste to Energy Solutions

- Recycling of municipal waste ash into geopolymer products.
- Controlled low strength flowable fill manufactured from municipal waste ash to be used in beddings, encasements, closures for tanks and pipes, road crossings and general backfill for trenches and abutments.
- Recycling of landfilled fly and bottom ash.

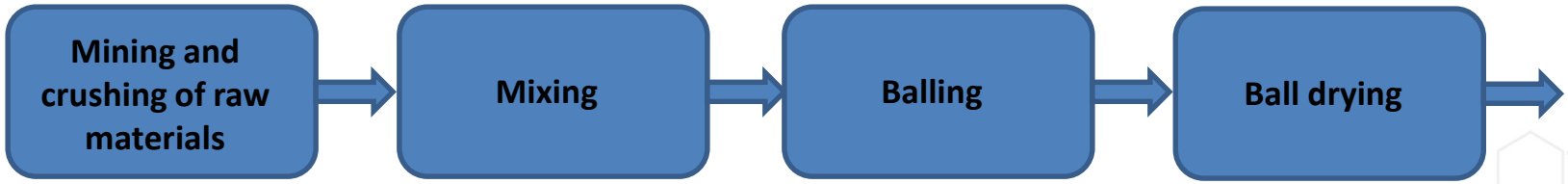
Proppants

AGS geopolymer proppants offers the following advantages:

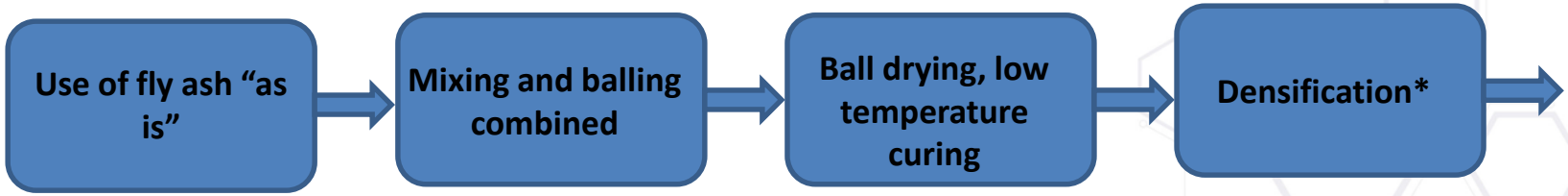
- A cost effective alternative to ceramic proppants
- Low energy production process
- Manufactured 85% from fly ash, offering a green appeal
- Can be manufactured near shale plays, dramatically reducing transportation costs
- Offers greater performance than resin coated sand due to higher sphericity
- Lightweight

Comparison of manufacturing process with ceramic proppants

CERAMIC PROPPANT



GEOPOLYMER PROPPANT



* **Densification** is a low energy proprietary process to enhance the quality of geopolymer proppants.

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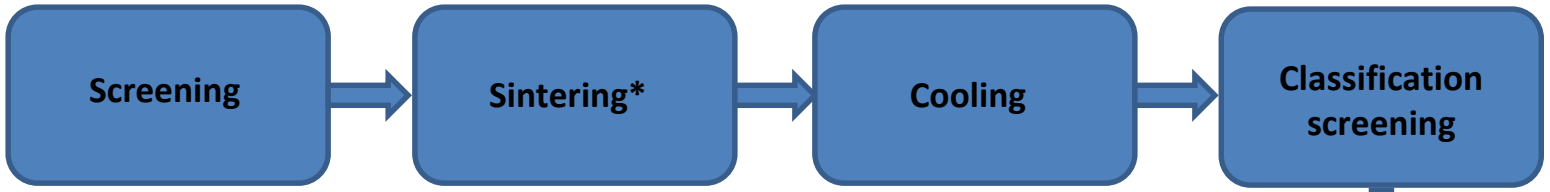
CERAMIC PROPPANT



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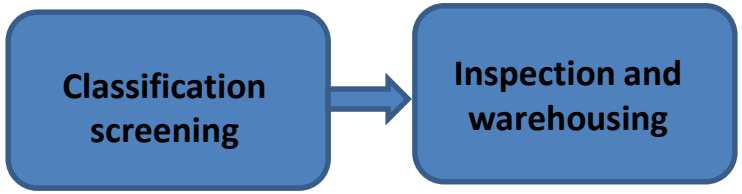
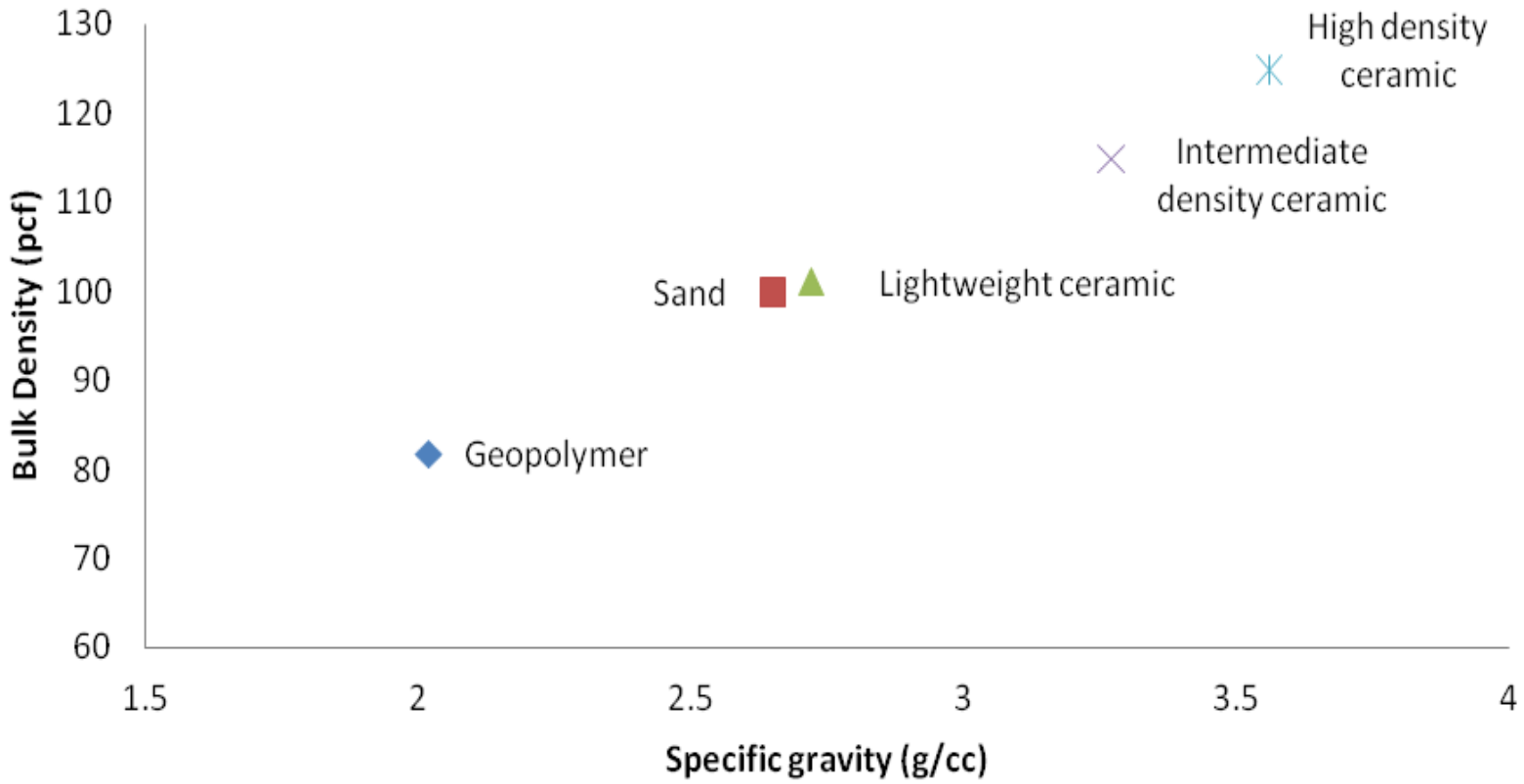


* The high energy sintering process is not required for fly ash geopolymer proppants.

TYPICAL PROPPANT SPECIFIC GRAVITIES AND BULK DENSITIES



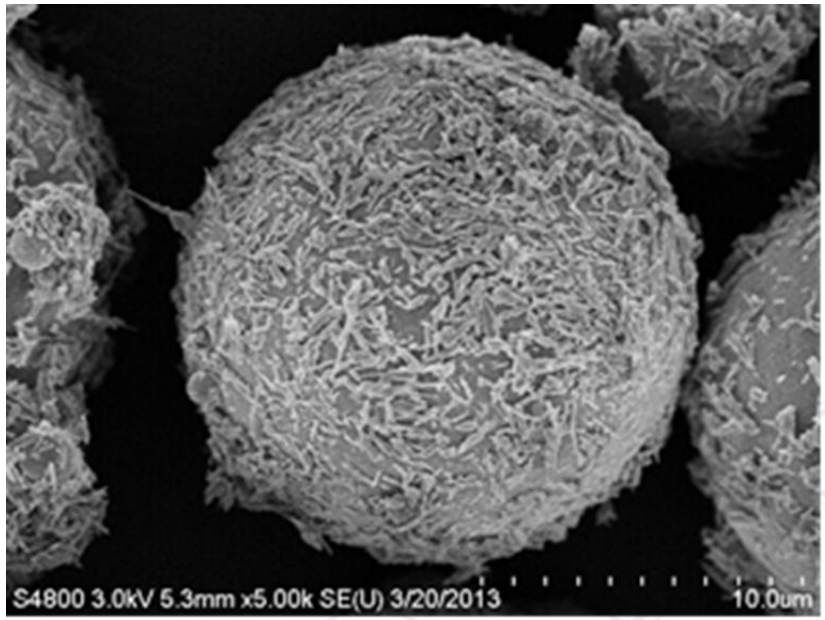
Property	API recommended	Typical/Competitor	Results
Particle size distribution	Mesh 8/12, 10/20, 20/40, 70/140.	Mesh 20/40 or 40/70.	Mesh 20/40 or 40/70.
Sphericity and roundness	0.6 for both	0.9, 0.8	0.9, 0.8
Crush resistance	Size / Max fines by weight at compressive stress between 4000-6000 psi. 6-12 mesh / 20% 16-30 mesh / 14% 20-40 mesh / 14% 30-50 mesh / 10% 40-70 mesh / 6%	Max fines by wt. @5000psi 0.5% @7500 psi 2.0%	Max fines by wt. @5000psi 25%
Acid solubility	<7% solubility in a solution of 12 parts HCl-4 parts HF	4.8% solubility in 12/3 HCl/HF	6.4% solubility in 12/4 HCl/HF
Turbidity	N/A	< 250 NTU	30 NTU
Bulk Density	Not specified	87-125 pcf	84 pcf
Apparent Specific Gravity	Not specified	2.5-3.5	1.34
Conductivity	Not specified	Depending on closure stress.	Not conducted yet

Geopolymer Well Cementing for 'Tight' Oil & Gas Wells

- The main problem associated with geopolymer underground applications is the control of their setting under high temperature and pressure

- AGS well cement is the result of combining geopolymer technology and nano-technology

- Capable of highly controlled rheological behavior across multiple pressure and temperature zones as a function of time



Binder granular coated with 'delay-action' nano-particles

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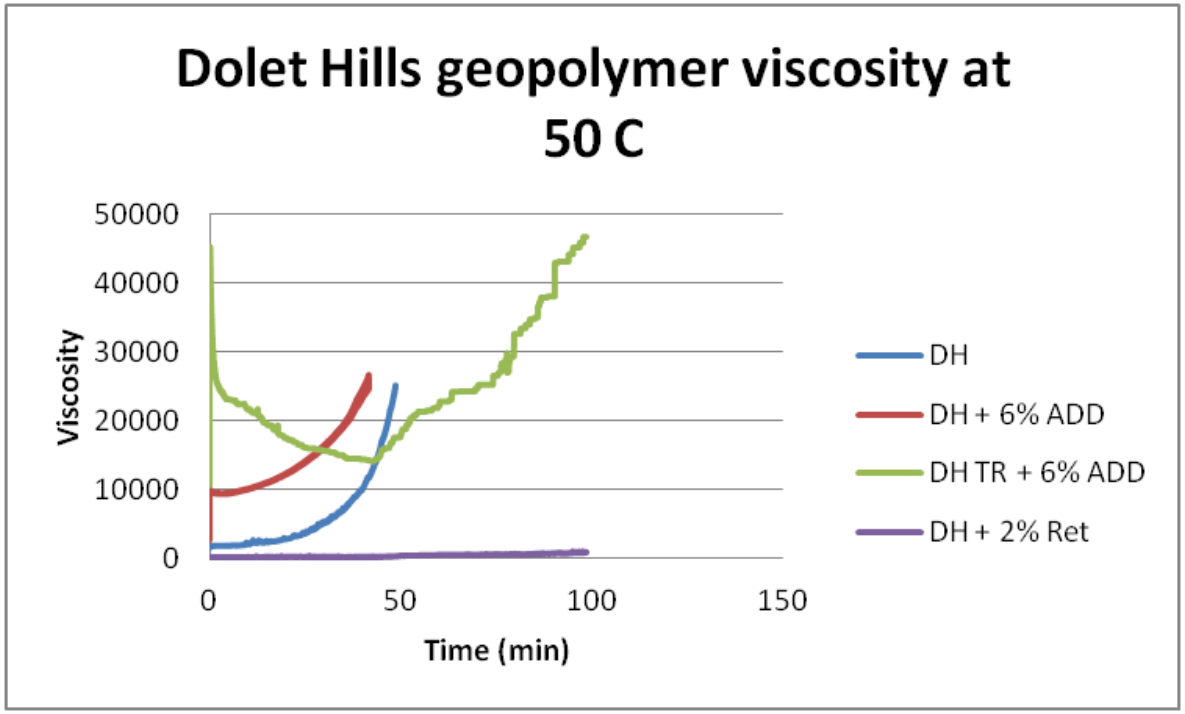

- AGS nanoparticle treated geopolymer (DH TR + 6% ADD) has a thixotropic behavior even at 50 C (122 F), compared to traditional geopolymer formulations (DH and DH + 6% ADD), which start setting immediately.
- AGS geopolymer starts setting approximately 50 minutes after exposed to temperature, and finishes setting at approximately 2 hours, giving time for adequate placing.
- DH + 2% Ret shows that commonly used retarders prevent the setting of geopolymer under this conditions.

Value Proposition

Well cementing

- Higher sulfate resistance compared with traditional cementations grouts.
- Lower shrinkage reducing potential cracking
- Enhanced bond to steel casing
- Setting time can be chemically “programmed” using proprietary additives developed using an advanced nanotechnology process.
- Water works as a carrier and not part of the chemical formulation

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Green Appeal - Environmentally and Economically Attractive

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