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What the future holds for US proppants

Hydraulic fracturing – colloquially know as fracking – produces fractures in rock formations that stimulate the flow of natural gas or oil, increasing the volumes that can be recovered. Wells may be drilled vertically hundreds to thousands of feet below the land surface, may extend 1-6,000ft (304-1,828 metres) away from the well and may include horizontal or directional sections extending thousands of feet.

Fractures are created by pumping large quantities of fluids at high pressure down a wellbore and into the target rock formation. Fracking fluid commonly consists of water, proppants and chemical additives that open and enlarge fractures within the rock formation. The proppants – sand, ceramic pellets or other small incompressible particles – hold open the newly created fractures.

Proppants play an integral role in the fracking process. As the name suggests, proppants serve to prop open the fractures created in the process of pumping pressurised fluid into the well bore. Without them, the closure stress from the weight of the rock above would quickly close the cracks and prevent the extraction of petroleum fluid.

Evidently, proppants must be able to withstand considerable pressure and must be durable. If the external pressure of the crack is too great, it crushes the proppant into small grains called "fines", which clog up the cracks and impede fluid extraction.

Other important characteristics of proppants are shape and size, which also play a factor in conductivity.

The three basic types of proppant are ceramic (sintered bauxite, alumina, kaolin), sand (sorted silica sand, known as frac sand) and resin-coated (ceramic or sand).

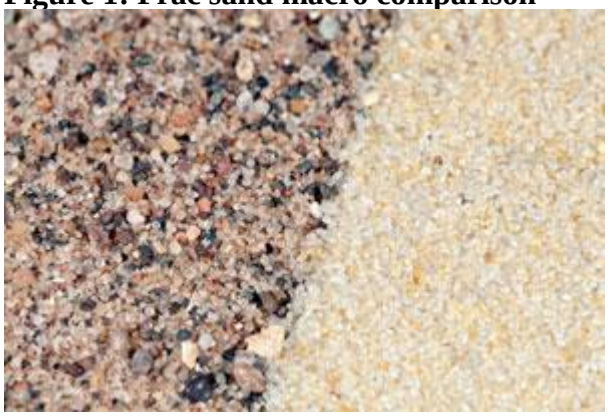
Ceramic proppants comprise three groups: lightweight, intermediate density and high density. The performance of ceramic proppants varies greatly both by composition and manufacturer; however, numerous ceramic proppants have been used in the Bakken Formation that are advertised to withstand closure stresses of 6,000-14,000 psi.

Frac sand is typically divided into two types: white sand and brown sand. White sand, the stronger of the two, is typically sourced from the St Peter's Sandstone in Ottawa, Illinois, while brown sand is sourced from the Hickory Sandstone near Brady, Texas. Frac sand is typically used in environments below 6,000 psi.

Resin coating of sand does not increase strength properties; however, resin-coated sand (RCS) is a popular proppant choice because of better consolidation, which reduces flowback and provides for better stress distribution across the proppant pack. Resin coating ceramic proppant provides similar performance enhancements.

In shale gas wells, a multi-stage frac would commonly involve between 10 and 20 stages, multiplying the volumes of water and solids by 10 or 20, and hence the total values for water use might reach from a few thousand to up to 20,000 cubic metres per well and volumes of proppant of the order of 1,000 to 4,000 tonnes per well.

Figure 1: Frac sand macro comparison



Close-up view of frac sand (on the right) and a typical sand of similar grain size (on the left). Source: iStock

Global proppants market

While most of the proppant spending will take place in the Americas, and in the US in particular, annual growth rates for other nations and regions are more aggressive. The unconventional oil and gas boom is expected to spread across the globe over the next 10 years.

Of particular note are the proppants markets in Argentina, throughout the Americas and in China. These nations and regions have extensive unconventional oil and gas reserves and the global trend toward natural gas as the dominant feedstock will ensure significant political and fiscal capital is spent developing them. Strong global oil prices and, in the case of markets outside North America, gas prices, further justify such development and spending.

London, UK-based research firm Visiongain calculated that the global market for proppants reached $8.85bn in 2014. Evidently, as well as altering the energy source mix in North America, the shale gas boom has completely changed the breadth and depth of the US proppants industry.

It was expected that total US land proppant consumption for well stimulation would increase from 51bn lbs (23.1m tonnes) in 2011 to 83bn lbs (37.6m tonnes) in 2015, equal to a 12.9% CAGR.

At the **IM** Oilfield Minerals Outlook conference held in Houston, US, in 2014, Stan Kaplan of the US Energy Information Administration (EIA) predicted that North American-produced natural gas will contribute 30% of the continent's total energy consumption by 2040.

Outside the North American market, which is set to continue its growth for some years, the future potential hotspots for proppant demand look to be Australia, China, the Middle East/North Africa, Mexico and South America, depending on investor confidence, political willpower and a lowering of cost risk.

Figure 2. Shale rock

Source: Geology.com

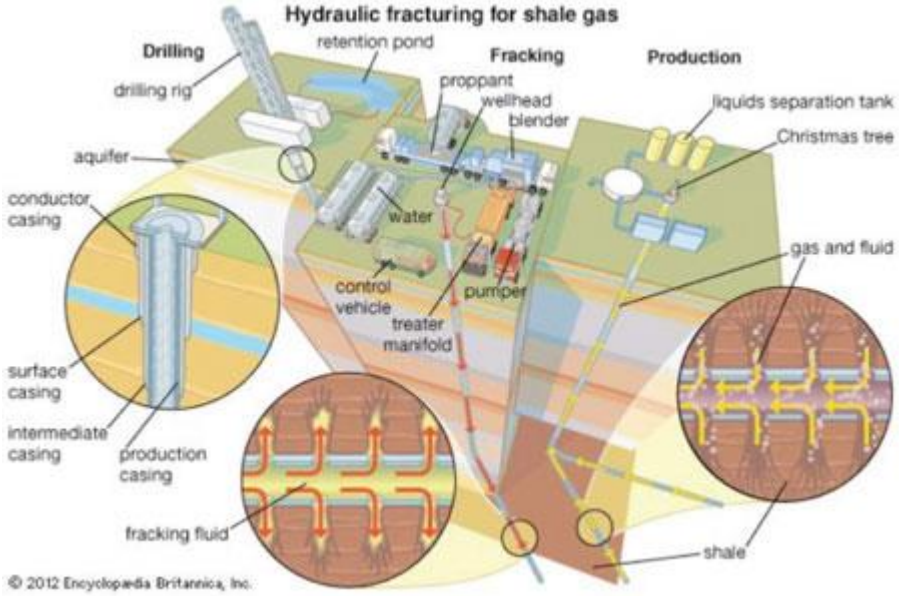
Proppant production in the rest of the world accounts for about 20% of global production. However, production in this region is expected to grow at a higher CAGR for two main reasons. First, players in low cost manufacturing destinations such as India and China are expected to multiply due to the export

opportunities to North America. In addition, fracking is poised to take off in some countries such as Poland and China.

Production is also expected to commence to cater for this new demand. The fracking market in the rest of the world is in its nascent stage and, as the technology finds wider use, the production of proppants is also expected to take off.

Proppant production in the rest of the world is expected to grow from 5.2m tonnes in 2012 to 10.9m tonnes by 2017.

Figure 3. Hydraulic fracturing process



Source: Britannica

The US and Canada

The "shale revolution," Americans are told, will fundamentally change the US energy picture for decades to come – leading to energy independence, a rebirth of US manufacturing and a surplus supply of both oil and natural gas that can be exported to allies around the world.

This promise of oil and natural gas abundance is influencing climate policy, foreign policy and investments in alternative energy sources. The primary source for these expectations of future production is the US Department of Energy (DoE). Each year the DoE's Energy EIA releases its Annual Energy Outlook (AEO), which provides a range of forecasts for energy production, consumption and prices.

The 2014 AEO reference case projects US crude oil production to increase to 9.6m barrels of oil per day (bbls/d) in 2019 and slowly decline to 7.5m bbls/d by 2040, while natural gas production is projected to grow for at least the next 25 years and hit 37.5 trillion cubic feet (tcf) per year in 2040.

Tight oil (shale oil) and shale gas serve as the foundation for these optimistic forecasts. However, the price of oil and gas is a determining factor.

North America, which consumes the vast majority of proppants worldwide, experienced robust activity during the first two quarters of 2014. Despite significant

weather-related issues during Q1 2014, demand was trending at over 25% of annualised 2013 demand and well over 50% in select regions.

Increases of 30% or more in base proppant demand were expected throughout the remainder of 2014 in North America (as compared to 2013 annualised demand).

The most notable driver impacting demand is increased proppant loadings, specifically, larger volumes of proppant placed per frac stage. The trend of using larger volumes of finer mesh materials, such as 100 mesh sand and 40/70 sand and ceramics, either on their own or in conjunction with coarser and more conductive proppant tail-ins, continues.

Proppant supply also continues to expand. It is estimated that at least 16bn lbs (8m tonnes) of new annualised Tier 1 sand capacity alone will enter the market before the end of 2015. Logistical abilities to handle current demand, most notably rail, railcar, terminal and truck accessibility, are constrained. Regional utilisation of Tier 2 and Tier 3 sands are increasing as a result.

Morgan Stanley has said that exploration and production (E&P) companies have discovered that if they use more sand when they frac unconventional shale plays, they are able to increase the amount of reserves they can extract from the ground.

Simmons & Company International estimates that US proppant demand in 2014 is running at an annualised demand rate of 100-110bn lbs/annum (45.4-45.9m tpa). This is based on the rig count and anecdotal market commentary on current service intensity based on Simmons & Company International's assumptions for rig activity and service intensity. The company believes that annualised demand will increase to a run
rate of 140-150bn lbs (63.5-68m tonnes) during the first half of 2015 and if oil prices stay in the mid-$90s, then demand would further increase as more rigs likely get added in the second half of 2015.

Continual expansion of unconventional oil and gas development seen over the next decade – most notably in the US, but also around the globe – will necessitate steadily increasing proppant sales throughout the next 10 years.

In the US, proppant sales are primarily driven by the shale (tight) oil industry, since the natural gas price has decoupled from the crude oil price, making it more economical to develop shale oil. However, elsewhere in the world, proppant sales are underpinned by shale gas development as nations seek to exploit unconventional gas resources for export purposes or for the sake of domestic energy security.

Table 1. Canada's marketable unconventional gas resources

	(trillion cubic feet)	(trillion cubic feet)
Natural gas from coal/coalbed methane		
British Columbia	4	8
Alberta	27	117

Saskatchewan	<1	<1
Maritimes	3	4
Total	34	129
Tight gas		
Jean Marie (BC)	11	23
Montney (BC portion)	77	166
Other BC	59	132
Cretaceous Deep Basin (Alberta)	69	155
Total	*215*	*476*
Shale gas		
Horn River	75	170
Cordova Embayment	30	68
Colorado Shale	4	14
Utica	7	42
Maritimes Basin	11	49
Total	*128*	*343*
Total unconventional marketable gas resources	376	947
Total marketable resources, including conventional	733	1,304

Source: Fraser Institute

Canada

According to the Canadian Society for Unconventional Gas (CSUG), "Marketable resources for shale gas in Canada are estimated to range from 700-1,300 tcf of natural gas". For context, the National Energy board estimates that marketable natural gas for all of Canada in 2013 was approximately 0.17 tcf.

At around $3.57/1,000 cubic feet (an average mid-range estimate of gas prices in North America), Canada's unconventional gas resources would have a market value of about $2.5 trillion at the low end, and about $4.6 trillion at the high end.

Canada controls large discovered unconventional natural gas formations and reserves, the development of which carries significant economic promise.

Table 1, which is taken from the CSUG report, summarises the estimate of Canada's potentially marketable natural gas resources by type, province and geologic formation. A more recent study by the EIA in 2013 examines areas not addressed in the CSUG report and places Canada's technically recoverable shale gas resources at 573 tcf, or 1.7 times CSUG's upper range estimate for shale gas. The EIA also estimates that Canada has 8.8bn bbls of technically recoverable shale oil.

Shale gas potential is highest in Alberta and British Columbia, where the Montney Formation holds the most massive shale gas potential.

Fracking in an environment of low energy prices

The development of unconventional fuels has benefited from US technological and entrepreneurial savvy, a favourable institutional environment – especially regarding land ownership and mining rights – and the existance of specialised service companies and favourable logistics.

Less attention has been paid to the equally important fact that shale oil and gas have thrived in a period of oil prices around $100/bbl. When this price falls to $50-60/bbl, a number of fracking operations and projects become uneconomical and the same happens to proppant manufacturing.

Addressing this issue, an entire chapter of the *US Proppants Report* is devoted to studing how low energy prices affect (directly or through financing impediments) the entire value chain of shale oil and gas developments (*pp.50-53*).

**This feature serves as an executive summary of IM's US Proppants report, written by Vasili Nicoletopoulos, Business Consultant, Natural Resources GP. The report is available to purchase from January 2015. To order your copy or to receive a report brochure please contact Emma Hughes, Special Projects Editor, on ehughes@indmin.com or +44 (0) 207 827 6449.*

http://www.indmin.com/Article/3457641/Issue/94129/What-the-future-holds-for-US-proppants.html