Bentonite supply and demand in drilling

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Summary

- Overview of global bentonite supply and demand
- Bentonite supply and demand in drilling mud
- The role of bentonite in drilling mud
- Trends in the oilfield drilling industry
- Trends in energy demand
- Future supply and demand of bentonite
Overview of global bentonite supply and demand
Bentonite supply in 2014

- Global bentonite production of 17.51Mt
- plus an additional 3.65Mt of fuller’s earth
- USA and China are the largest producers

World: Production of bentonite by country, 2014 (%)

Historical production of bentonite

- Increasing production in China and India
- Production in USA and Europe fairly steady in recent years

World: Production of bentonite by region, 2004 to 2014 (kt)

Historical demand for bentonite

- Demand growing at 2%py - strongest in Asia and South America at 4-5%py
- North American demand much lower but still the largest consuming region

**World: Demand for bentonite by region, 2004 to 2014 (kt)**

Global demand of around 20.43Mt plus an additional 5.30Mt for fuller’s earth

Drilling mud is the fourth largest market, behind foundries, pet litter and IOP

World: Demand for bentonite by application, 2014 (%)

- Foundry Sands 34%
- Iron Ore Pelletising 22%
- Civil engineering 10%
- Refining 4%
- Drilling Mud 11%
- Pet litter 11%
- Industrial Absorbents 2%
- Agriculture 1%
- Other 5%

Demand from drilling muds increased by 3-4%py over the last decade

One of the largest growing end-uses
Bentonite supply and demand in drilling mud
Bentonite demand by application and region, 2014

- Bentonite demand varies widely with region
- Demand from the drilling market is largest in North America

**World: Demand for bentonite and fuller’s earth by application and region, 2014**

Focus on North America

- Drilling consistently accounted for just over 20% of US bentonite consumption until recent increases lifted its share to over 30%; this is expected to fall in the future
- The USA represents around a third of the global supply of bentonite
- Supply assured
- Drilling activity fallen off in 2015

**USA: Demand for bentonite by end-use, 2004 to 2014 (kt)**

Source: USGS
Focus on North America – USA bentonite production and exports

- The USA is the second-largest exporter, accounting for 19% of global bentonite exports – it was overtaken by India for first time in 2013
- It accounts for 18% of world bentonite consumption
- The USA consumes the majority of what it produces – around 3.6Mt
- Rise in tight oil and gas production from late 2000s

Source: GTA, Roskill
The role of bentonite in drilling mud
Why is bentonite used in drilling?

- Cool and lubricate the drill-bit, tubing and rig
- Remove cuttings from the bottom of the well and transport them to the surface
- Hold cuttings in suspension if drilling is halted
- Control subsurface pressure
- Seal the borehole by depositing low-permeability filter cake on the walls of the well bore to prevent the loss of circulation fluids
- Stabilise the well bore without damaging the formation

Source: 3M
Specifications for drilling-grade bentonite

- Set by API, OCMA

### API specification 13A for bentonite and allied clays, 18th edition August 2010

<table>
<thead>
<tr>
<th></th>
<th>Bentonite</th>
<th>OCMA bentonite</th>
<th>Non-treated bentonite</th>
<th>Attapulgite and sepiolite</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Viscometer dial reading @ 600rpm</strong></td>
<td>30 minimum</td>
<td>30 minimum</td>
<td>1.5 maximum</td>
<td>30 minimum</td>
</tr>
<tr>
<td><strong>Yield point/plastic viscosity ratio</strong></td>
<td>3 maximum</td>
<td>6 maximum</td>
<td>1.5 maximum</td>
<td>30 minimum</td>
</tr>
<tr>
<td><strong>Filtrate volume</strong></td>
<td>15.0ml maximum</td>
<td>16.0 maximum</td>
<td>10 minimum</td>
<td>12.5 maximum</td>
</tr>
<tr>
<td><strong>Residue &gt;75µm</strong></td>
<td>4.0% maximum mass fraction</td>
<td></td>
<td>2.5% maximum mass fraction</td>
<td></td>
</tr>
<tr>
<td><strong>Dispersed plastic viscosity millipascal-seconds</strong></td>
<td>10 minimum</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Dispersed filtrate volume mm</strong></td>
<td>12.5 maximum</td>
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<tr>
<td><strong>Moisture</strong></td>
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</tr>
<tr>
<td><strong>Moisture</strong></td>
<td></td>
<td></td>
<td></td>
<td>16.0% maximum mass fraction</td>
</tr>
</tbody>
</table>

Source: Industrial Minerals
Where is bentonite used in drilling?

- Bentonite is mainly used in water-based drilling muds – easier to dispose of /more ‘natural’ – used in most traditional wells.
- Increasing use of oil-based muds in deeper wells - much smaller amounts of bentonite are used in the form of organophilic clays.

### Water-based muds

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water/brine</td>
<td>76%</td>
</tr>
<tr>
<td>Baryte</td>
<td>14%</td>
</tr>
<tr>
<td>Clay/polymer</td>
<td>6%</td>
</tr>
<tr>
<td>Other</td>
<td>4%</td>
</tr>
</tbody>
</table>

### Oil-based muds

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-aqueous fluid</td>
<td>46%</td>
</tr>
<tr>
<td>Baryte</td>
<td>33%</td>
</tr>
<tr>
<td>Brine</td>
<td>18%</td>
</tr>
<tr>
<td>Emulsifiers</td>
<td>2%</td>
</tr>
<tr>
<td>Gellants</td>
<td>1%</td>
</tr>
</tbody>
</table>

### Synthetic-based muds

<table>
<thead>
<tr>
<th>Component</th>
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<tbody>
<tr>
<td>Dry gas</td>
</tr>
<tr>
<td>Mist</td>
</tr>
<tr>
<td>Foam</td>
</tr>
<tr>
<td>Gasified mud</td>
</tr>
</tbody>
</table>

- Increasing drilling for unconventional oil and gas resources.
- These may require alternative drilling products to be developed – increasing use of artificial materials?
- Hectorite is an example of alternative natural product that may be used in harsher conditions, at higher depth and temperature – current market is very small.

Source: S&M Industrial Minerals
Trends in the oilfield drilling industry
Global distribution of oil and gas production

World: Oil and gas production, 2013
(7.2Bnt oil equivalent)

- Middle East: 26%
- Europe and Eurasia: 25%
- North America: 22%
- Asia Pacific: 12%
- Africa: 8%
- South and Central America: 7%

Source: BP Statistical Review of World Energy, June 2014
Global production of oil and gas – North America and ROW

North America and ROW: Production of oil and gas, 2003 to 2013 (Mt oil equivalent)

Source: BP Statistical Review of World Energy, June 2014
Global rig count

World: Average monthly oil and natural gas rig count by region, 2000 to 2015 ytd
(number of rigs)

Source: Baker Hughes
Notes: Mexico included in South and Central America; 2015 ytd Jan. to May
Focus on North America – oil and gas production

Year-on-year change in oil and gas production, 2004 to 2013 (%py)

Source: BP Statistical Review of World Energy, June 2014
Focus on North America - US crude oil production

USA: Field production of crude oil, 1981 to 2013 (thousand barrels)

Source: US Energy Information Administration
Focus on North America – trends in tight oil consumption

North American tight oil production (January 2005-February 2014)
million barrels per day

Sources: US Energy Information Administration tight oil and shale gas production estimates, Canadian National Energy Board
Focus on North America – increased horizontal drilling

USA: Average annual drilling rig activity by type, 2000 to 2015

- Directional
- Horizontal
- Vertical

Sources: Baker Hughes
Focus on North America – increased horizontal drilling

USA: Average monthly rig count and consumption of bentonite in drilling mud, 2000 to 2013

- Sources: Baker Hughes; USGS, Roskill estimates
Trends in energy demand
Global distribution of oil and gas consumption

World: Oil and gas consumption, 2013 (7.2Bnt oil equivalent)

- Asia Pacific: 28%
- North America: 26%
- Europe and Eurasia: 25%
- Middle East: 11%
- South and Central America: 6%
- Africa: 4%

Source: BP Statistical Review of World Energy, June 2014
Global consumption of primary energy

Global energy consumption has increased by 52% over the last 20 years and by 30% over the last 10 years.

World: Historical consumption of primary energy by type, 2003 to 2013 (Mt oil equivalent)

Source: BP Statistical Review of World Energy, June 2014
Focus on North America – trends in oil/gas consumption

Oil and gas as a proportion of primary energy consumption, 2003 to 2013 (%)

Source: BP Statistical Review of World Energy, June 2014
Future distribution of oil and gas consumption

- Global energy consumption to rise by 37% in total to 2035. Slower than in previous decades – increasing energy efficiency.
- 96% of consumption growth will come from emerging economies (more than half from China and India).
- Consumption in mature economies of North America and Europe forecast to grow slowly and decline in the long-term.
- Fossil fuels (oil, natural gas and coal) expected to account for 81% of demand by 2035.
- Natural gas - strongest growth in demand of the fossil fuels at 1.9%py to 2035.
- Coal - weakest growth in demand of the fossil fuels at 0.8%py to 2035.

Source: BP Energy Outlook 2035, January 2014
Significant energy production growth in India and China

- Overall global energy production is forecast to grow at 1.5%py.

- Growth concentrated in non-OECD countries, accounting for nearly 80% of the volume increases. Fastest growth in Asia-Pacific at 2.1% py

- Middle East and North America next largest growth areas. North American energy production will grow by 1%py to 2035, and it is on the path to achieve self-sufficiency by 2021.

- Growth in all regions except for Europe

Source: BP Energy Outlook 2035, January 2015
Future supply and demand of bentonite
Bentonite supply and demand in 2020

- Global production could rise at a rate of 4%py to reach 22.3Mt of bentonite and 4.2Mt of fuller’s earth by 2020.
- China is expected to become the largest producer of bentonite worldwide, overtaking the USA.
- Global demand for bentonite is forecast to reach 25.1Mt plus an additional 6.1Mt for fuller’s earth by 2020.
- Drilling mud could become the third-largest application.

Demand for bentonite by application and region, 2020

- Drilling will continue to be an important market for bentonite in North America
- Consumption of bentonite in drilling will increase in Asia and South America

**World: Demand for bentonite and fuller’s earth by application and region, 2020**

- Asia
- N. America
- Europe
- C and S. America

**Applications:**
- Pet litter
- Foundry Sands
- Iron Ore Pelletising
- Drilling Mud
- Civil engineering
- Industrial Absorbents
- Refining
- Agriculture
- Other

Summary

- Global energy demand increasing at 1.4%py

- Growth in natural gas and oil still be strong. New exploration and production rigs will increase demand for bentonite by ~3%py

- North America will continue to be the largest bentonite consuming region in drilling

- The jury is still out on the future of unconventional fields. This could drive changes in drilling product specifications to adapt to harsher environments – bentonite may lose some ground to alternative products

- Bentonite is still the best material for the job in most cases – relatively cheap, ‘natural’ and consistent.
Are you facing major decisions involving metals or minerals?


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