SPE WA

Sand Control in Challenging Reservoirs

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Perth

Advanced Ceramic Technology

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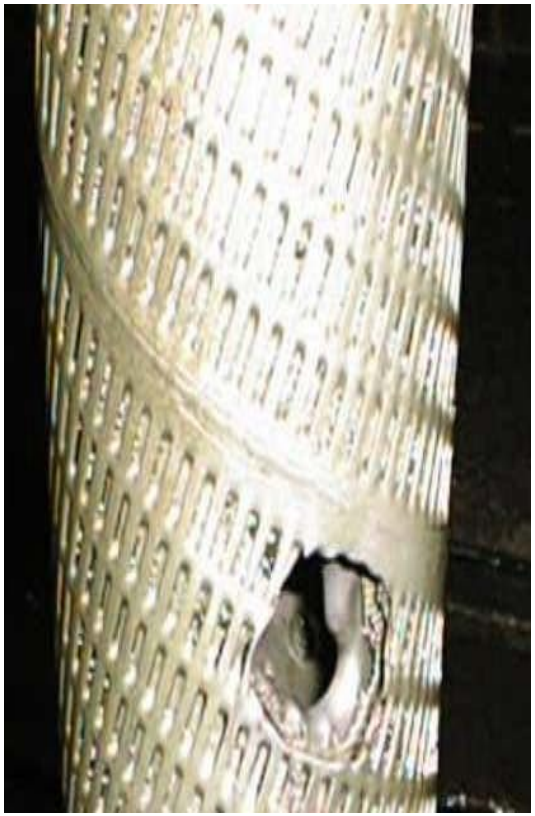
Global Industry Challenge: 'Screen Erosion Costs Millions'



The petroleum Industry spends millions of dollars each year to prevent and repair down-hole sand control failures which reduce hydrocarbon production rates

– Source, Halliburton

"With a good quality completion in place, the analysis of screen failures indicated that screen erosion was by far the most common screen failure mechanism. Fluid that flowed through the screen with a small amount of fine sand particles greatly accelerated the screen erosion." Sand control completions using flux analysis

– Oil and Gas Journal based on *SPE 84495* -M.H. Stein, *BP America*; A.A. Chitale, *Quiline Software Inc.*; G. Asher, APA; and H. Vaziri, Y. Sun, J.R. Colbert, and F.A. Gonzalez, *BP America -2005*

Industry challanges & expectations

Oil/gas production challenges:

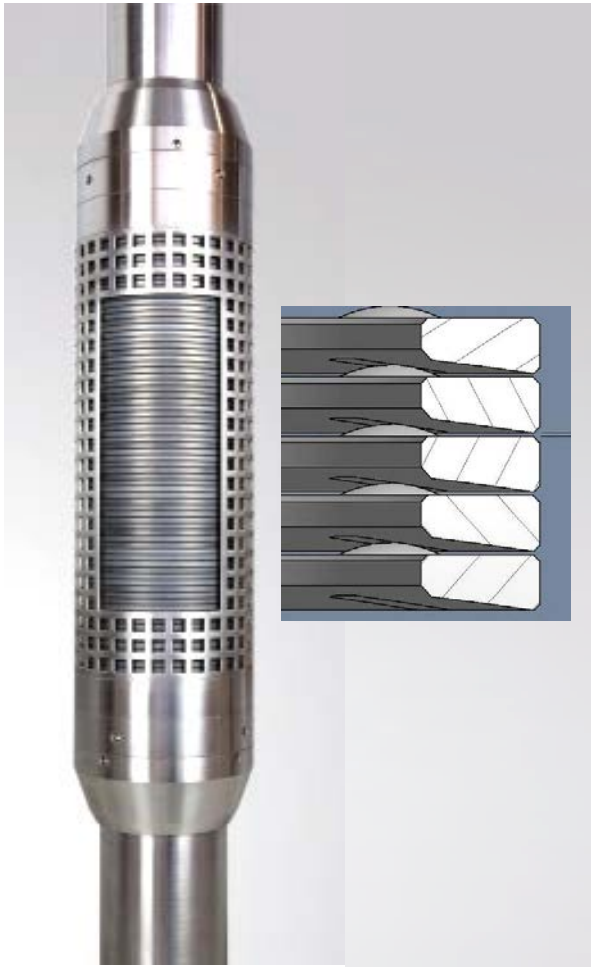
Ultradeep wells
HP/HT wells
Sand erosion, corrosion

Why requirement for new solutions

Long life time
Increased MTBF

3M / Maersk development:

Patented Ceramic sand screen solution
Stack of ceramic rings
Defined gap width for sand retention and laminar flow



Why Ceramic Sand Screens

- A proven track record of 18 installations attribute to the success of this innovation
- SPE papers document Installation performance
- Ceramic Screen earned the „CEO innovation award“ from BG Group in 2013 for deploying ceramic sand screens in a gas well in Bolivia

Material Characteristics

EXTREME HARDNESS

- Diamond
- Cubic Boron Nitride
- Boron Carbide
- **Silicon Carbide**

EXCEPTIONAL RESISTANCE TO WEAR

- The higher the hardness, the lower the erosion

CORROSION STABILITY

- Corrosion resistant against chlorides, hydrogen sulfide or hot sulfuric acid

EXTREME TEMPERATURE RANGE

- Temperature range: -196°C (

-320.8°F) to 1800°C (3270°F)

Low ceramic thermal expansion

extreme thermal cycling

SAND SCREEN SELECTION

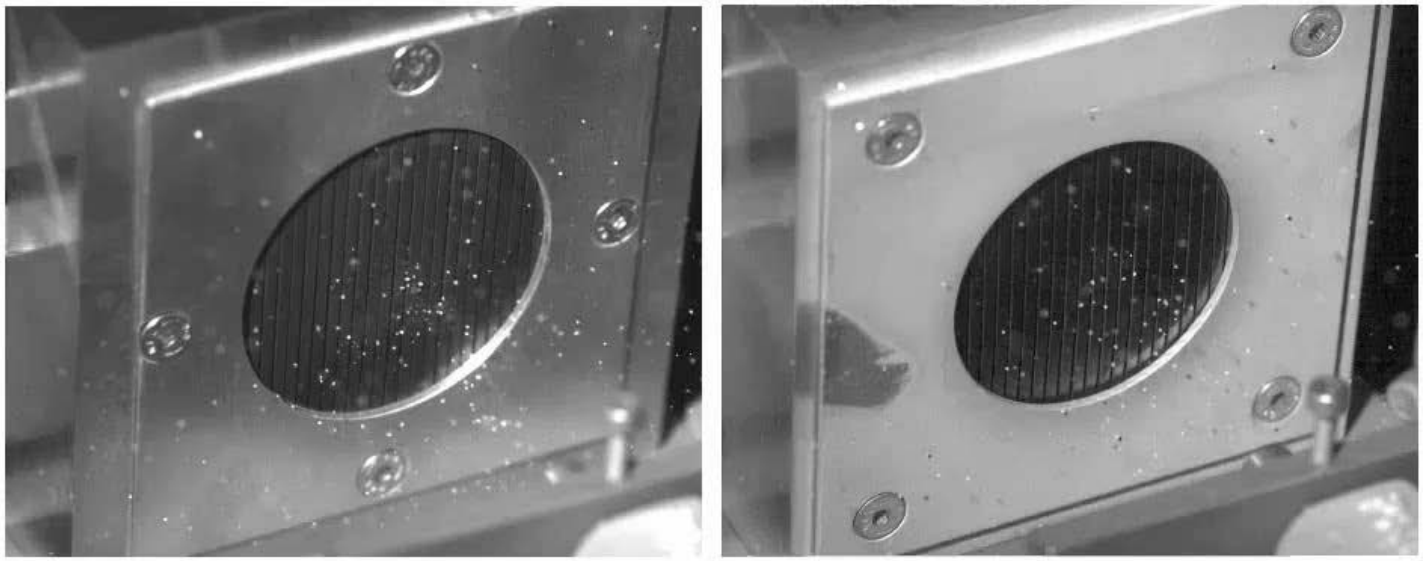
90 years experience of particle analysis and its facilities to perform state of the art sand analysis

- Particle Size Distribution (PSD) Analysis
  - Dry sieve analysis
  - Laser particle size analysis (LPSA)
- Sand retention testing
- Erosion testing
- Corrosion testing
- Scanning Electron Microscope (SEM)

SCREEN QUALIFICATION - EROSION

Test conditions: 20/40 mesh sand, high loaded in air, blasting with 30 – 50 m/s (90 – 150 ft/s)

Ceramic Longevity Test Duration: 4 hours with no erosion (no change in mass)



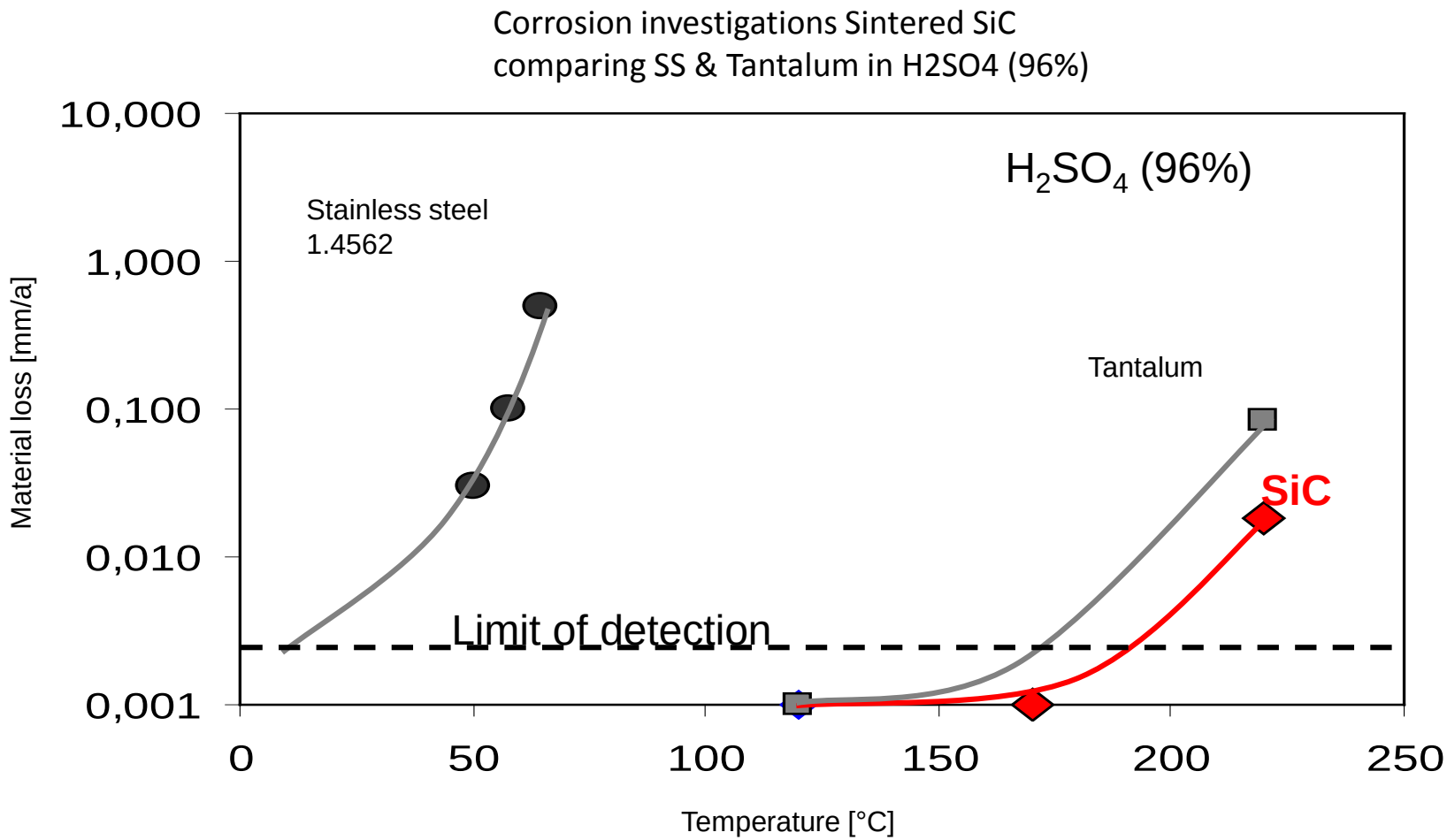
Ceramic 1 min Steel

Extreme hardness

Sand erosion test 2011-03-25
High speed documentation film

SCREEN QUALIFICATION - CORROSION

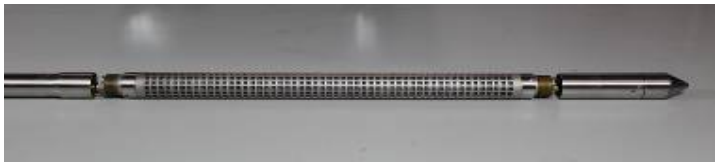
Testing comparison with metals



PROVEN TECHNOLOGY - TRACK RECORD

DATE OF INSTALLATION	LOCATION	APPLICATION TYPE	NUMBER OF JOINTS/MODULES	PRODUCTION DATA (after installation)	WHY 3M™ Ceramic Sand Screen Technology?	POSITION/ PERFORATIONS
MAY 2010	North Sea	SSD PROTECTOR	3 Joints/ 9ft	2,000 BBL/D (30% WATER CUT)	New oil well. Precaution to avoid erosion of Sliding sleeve due to proppant flow back.	Across
FEBRUARY 2011	North Sea	CTT	1 Joint/ 16ft	6MMSCF/D (LEVELED AT 2MMSCF/D)	Remedial screen for gas well. Production was stopped for over 2 years because of sand production prior to ceramic install.	Above
JUNE 2011	North Sea	SSD PROTECTOR	15 Joints/ 45ft	6,000 BBL/D	New oil well. Precaution to avoid erosion of Sliding sleeve due to proppant flow back.	Across
DATE UNKNOWN	North Sea	SSD PROTECTOR	13 Joints/ 39ft	n/a	New oil well. Precaution to avoid erosion of Sliding sleeve due to proppant flow back.	Across
SEPTEMBER 2011	North Sea	CTT	1 Joint/ 36ft	n/a	Remedial screen for gas well. Successful deployment. 4"BP with 5 ½" OD, 250 micron	Across
DECEMBER 2011	Austria	SAS	1 Joint/ 21ft	CASE STUDIES	Remedial screen for a oil well, that replaced Gravel-Pack successfully.	Across
DATE UNKNOWN	North Sea	SSD PROTECTOR	11 Joints/ 33ft	n/a	New oil well. Precaution to avoid erosion of Sliding sleeve due to proppant flow back.	Across
JANUARY 2012	North Sea	SSD PROTECTOR	14 Joints / 42ft	n/a	New oil well. Precaution to avoid erosion of Sliding sleeve due to proppant flow back.	Across
TBC	North Sea	SAS	1 Joint/ 55 ft	Installation to be scheduled	Trial well for ceramic sand screen	Across
SEPTEMBER 2012	Bolivia	SAS & SSD PROTECTOR	2 Joints/ 110ft 2 Joints/ 22ft	8MMSCFD	Workover for gas well, previous stand alone screens failed just after 2 months. 3M Ceramic Sand Screen was an alternative to GP.	Across
NOVEMBER 2012	AUSTRIA	SAS	1 Joint/ 27ft	Screen deployed.	Workover for gas storage, application to test the screens.	Across
TBC	North Sea	CTT	2 Joints/ 36 ft	Installation to be scheduled	Unexpected sand production with potential erosion	Accross
DECEMBER 2013	South America	SAS	1 Joint/ 20 ft	Screen deployed	Replacement of a Gravel pack	Across
MAI 2014	Indonesia	SAS	1 Joint/ 5 ft	3 MM SCFD	Erosion/ Hotspotting issue, Production rates below expectations with conventional screen, Improve MTBF	Above
MAI 2014	Indonesia	SAS	1 Joint/ 5 ft	2 MMSCFD	DST, Ceramic Sand screen performance test, Improve MTBF	Above
JUNE 2014	North Sea	SAS	3 Joints/ 54 ft	27 MMSCFD	Proppant flowback causing erosion	Across
SEPTEMBER 2014	North Sea	SAS	3 Joints/ 54 ft	35 MMSCFD	Proppant flowback causing erosion	Across
SEPTEMBER 2014	Indonesia	SAS	1 Joint/ 19 ft	2.4 MMSCFD	Cased holeTest well. Replacement of IGP. Pilot well for sand screens	Across
NOVEMBER 2014	Indonesia	SAS	2 Joints/ 38 ft	2 MMSCFD	Cased holeTest well. Replacement of IGP. Pilot well for sand screens	Across
JANUARY 2015	Indonesia	SAS	1 Joint/ 19 ft	Well clean-up	Cased holeTest well. Replacement of IGP. Pilot well for sand screens	Across
TBC	South America	CTT	20 Joints/ 400 ft	Installation Scheduled in March 15	Failed Gravel pack system offsore well	Across
TBC	North Sea	CTT	1 Joint/ 20 ft	Installation to be scheduled	Failed sand control system	TBD
TBC	North Sea	CTT	4 Joints/ 108 ft	Installation to be scheduled	Oil well with unexpected sand production	

Retrofit screen – Low CAPEX, Fast ROI, Longer well life cycle



Well on production since 2011
Intervention payback: 1 week

Source: ATCE Presentation 2011

Challenge:

Gas Producer in the North Sea (Maersk Oil):

- Old gas well, started in 1983
- Several well treatments and work-overs
- 2009: well was shut in. Unmanageable at 1,250 psi flowing pressure

Enabling Technology:

3M Ceramic Thru Tubing Sand Screen

Success:

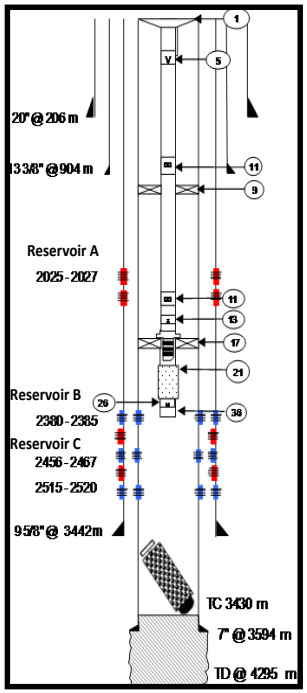
Re-gain sand free production with new tubing head pressure of 650psi

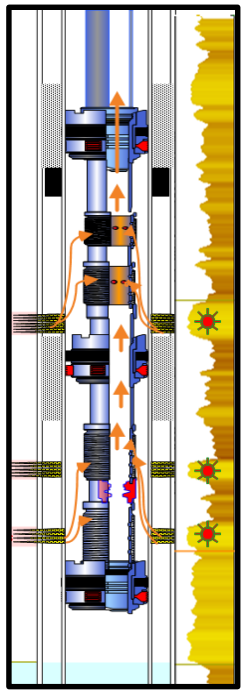
Production rate leveled in at 2 MMscf/d

No further Intervention required

* Based on US avg gas import price (Sept 14) $3.95 per 1000 cubic feet

SAS Installation Success – Lower CAPEX / OPEX & Higher Production Rate





Challenge:

Gas producer in Bolivia (onshore):

Metallic screens failed after 2 months

Remote location

Complex work over

Enabling Technology:

3M Ceramic Sand Screen without IGP

SAS Installation Success – Lower CAPEX / OPEX & Higher Production Rate

Success: "Approval of Ceramic Sand Screens as the recommended standard sand control method within the whole BG group"

Reduced work over complexity

Lower CAPEX

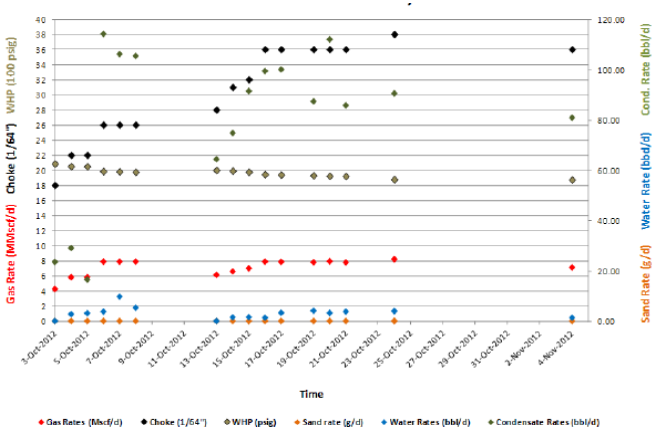
Lower OPEX

25% Higher Production Rate

- **from expected 6MMscf/d to 8MMscf/d – 52MMscf/Month extra to present**
- **($xxxK EXTRA per Month*)**

Continuous Production from November 2012 to present

* Based on US avg gas import price (Sept 14) $3.95 per 1000 cubic feet



X17 Longevity increase to date compared to conventional premium metallic screen life

".....All operational costs including re-completion have been recouped (17 days for the ceramic screens and 100 days for the entire work over)."

Source: Extracts of BG abstract for the ATCE, (SPE 166092)

3M Ceramic Sand Screens- delivering successful erosion resistance against proppant flowback

Customer Challenge:

- Client wants to fracture the new drilled wells in order to reach better production rates
- Issue with proppant flow back. Erosion of the well Jewelry.
- Frac pack was unfavourable in this well as this could damage the PI of the Well
- Erosion risk not totally mitigated via Frack pack
- No Sand management facilities on this platform
- 3M ceramic sand screen can be considered because of high erosion resistance properties

3M Ceramic Sand Screens- delivering successful erosion resistance against proppant flowback

Results:

Well 1

- on line since 13th of August 2014
- 35 MMSCFD during ‚Bean Up‘
- Now 27 MMSCFD @ 2044 psi PDHG; THP 107 bar
- Proppant flow back before the installation of the screen: 1Kg/MMSCFD
- Proppant flow after the installation of the screens: none

Well 2

- Completed on 25th of September 2014
- Bean-up 46 MMSCFD
- Now 35 MMSCFD @ 2354 psi PDHG ; THP 120 Bar since 31 October
- No proppant flow back topside
- SPE paper to follow

SPE References

OTC-25106-MS: An Innovative Approach of Revival for Damaged Wells in High Erosive Environment Using Ceramic Sand Screens – BG Group

SPE 146721: An innovative milestone in Sand Control – Maersk Oil & Gas

SPE 160327: Ceramic sand Screens for Sand Control in unconsolidated Resevoirs (with fines content) – RAG

SPE 166092-MS: Ceramic Sand Screen : Ceramic Sand Screen – An innovative Downhole Sand Control Solutions for Old & Challenging Cased Holes – BG Group