Society of Petroleum Engineers

Jackson, Mississippi - August 2010

Sand Control in Production Operations to Increase Production, Reliability, & Profits

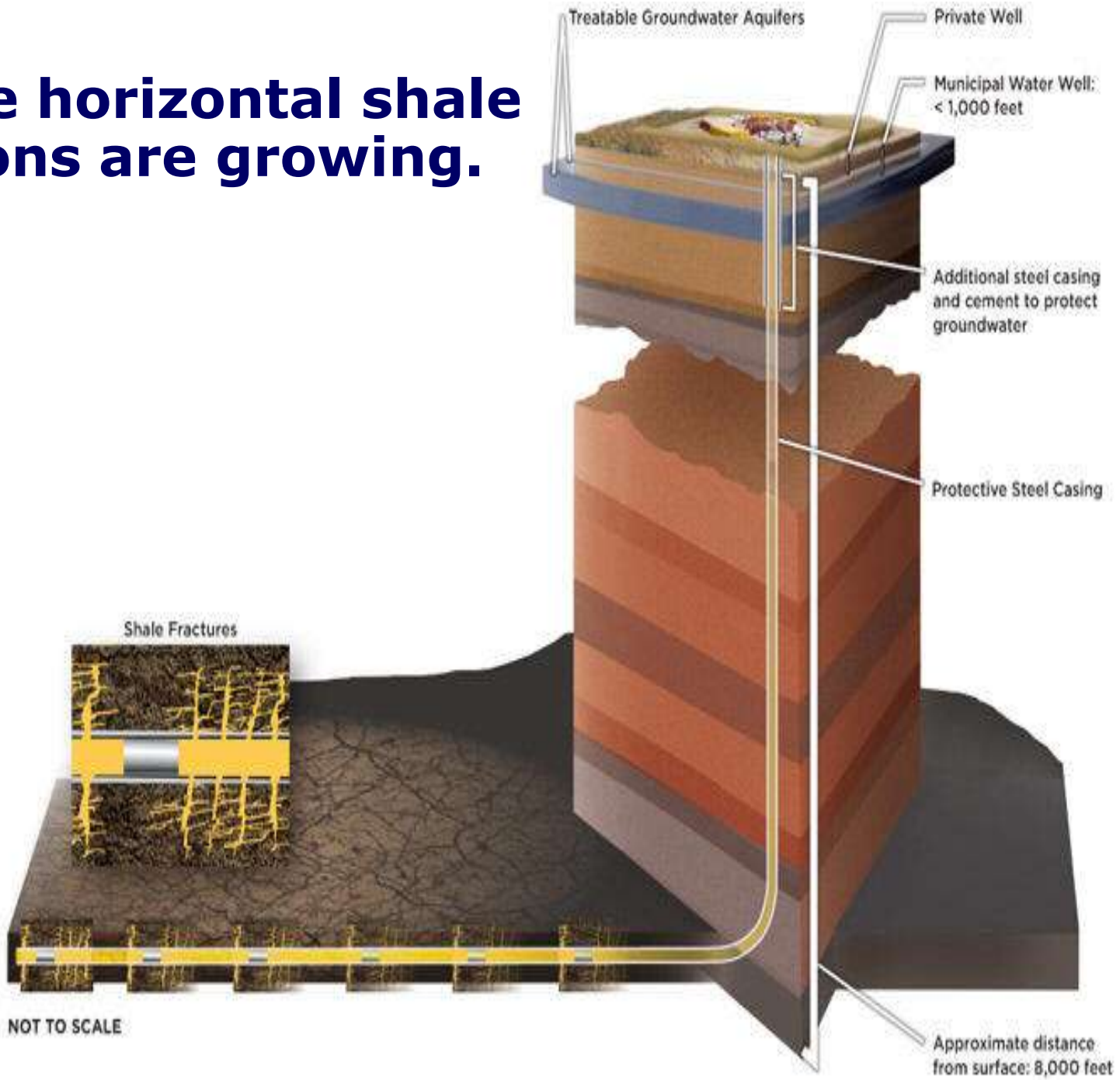
STREN

"A Leader in Producing Productivity"

Sand, commonly found in most wells, can be problematic.

The changing landscape is being accelerated by increasingly deeper shale development. As these new plays become an increasing percentage of onshore oil and gas production, new demands in rod pumping are being created.

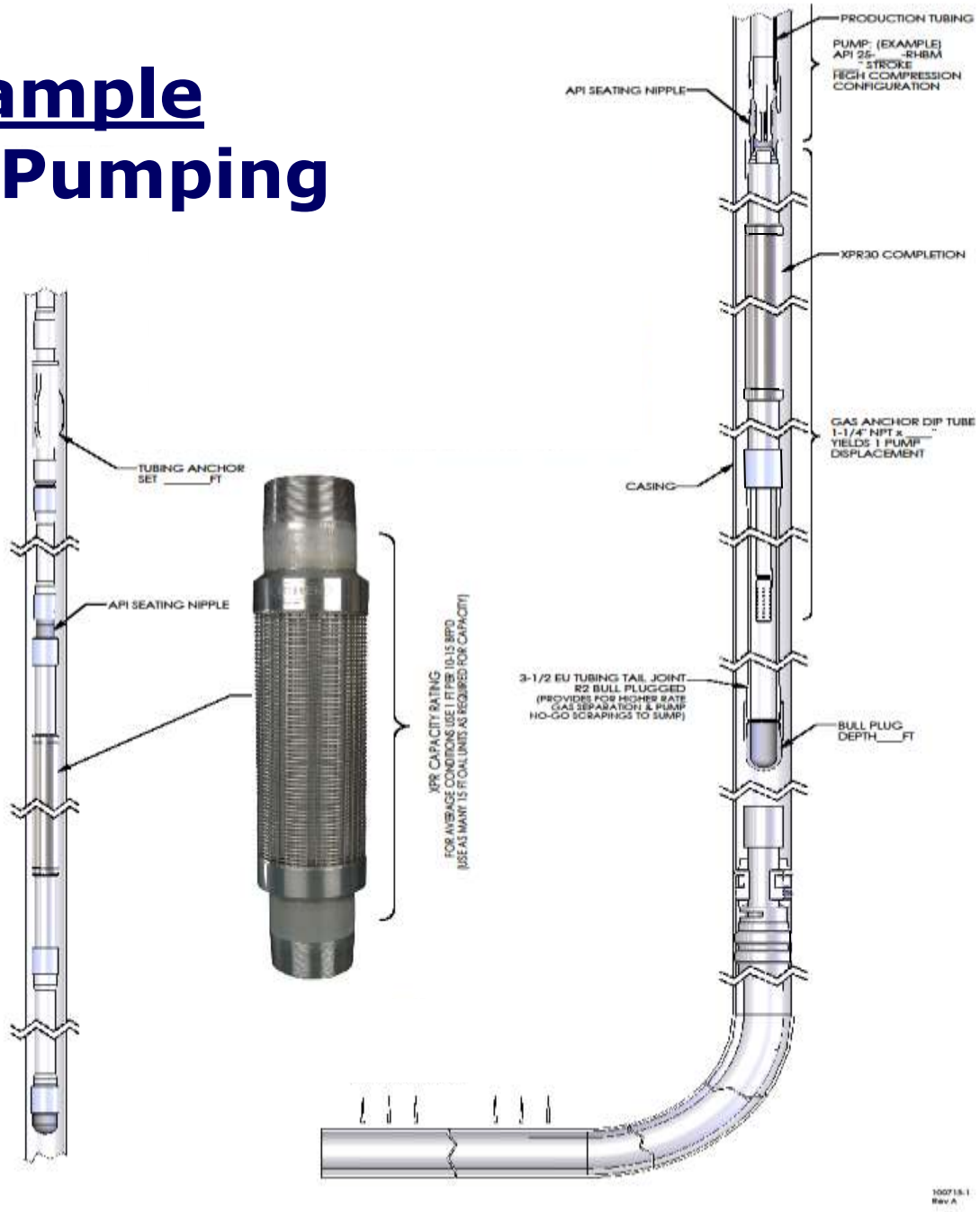
Multi-stage horizontal shale completions are growing.



Bakken Shale Example
Higher-Rate Rod Pumping

Configuration

SC2000 XPR Completion with API RHBM Bottom Holddown Pump Intake Protection, Gas Anchored.



General Principal

To protect the plunger and barrel of a rod pump, the sand and proppant fragments larger than the “fit "of the pump must be removed.

The most common and reliable API rod pump is a spray metal plunger in a nitrited, chrome, or nickel carbide plated barrel. The “fit” of the plunger barrel is typically .004 / .005” (100-125 microns)---approximately the width of a human hair.

Rod pumps are not designed or able to pump broken glass for long. Silica sand, proppant fragments, AND especially new, modern, high strength proppant fragments can rapidly cut into the precision ground, honed, and toleranced plunger and barrel surfaces leading to rapid pump failure.

For example, a nicarb-plated barrel only has plating .0015” thick. It is rapidly destroyed as the fragments of the high strength proppants (so valuable to deep shale development) carve through the plated surface into the softer base metal, leading to premature pump failure.

How are these proppant fragments (that look like broken glass under a microscope) generated?

- Pressure pumping (8000 PSI not uncommon)
- Proppant crushing by reservoir forces
- Velocity induced (impact) shattering forces
- A percentage of fines can be present from the manufacturing process.

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SAND ANALYSIS REPORT

HOW MUCH ARE YOU PAYING FOR SAND?

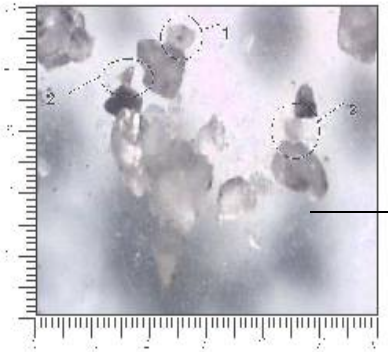
This is a practical analysis of particles from this well...
and how it may be affecting your pump.

It is not how much sand is in the fluid that causes damage to the pump,
it is the size of the abrasive particles that flow between the barrel and plunger.

Conversion Chart
Standard Screen to Inch to Micron

US & ASTM Std. Sieve No. (Meshes)	Equivalent Opening Inches	MM	Microns
20	0.0331	0.841	841
30	0.0234	0.595	595
40	0.0165	0.420	420
50	0.0117	0.297	297
60	0.0098	0.250	250
70	0.0083	0.210	210
80	0.0070	0.177	177
100	0.0059	0.149	149
120	0.0049	0.125	125
140	0.0041	0.105	105
170	0.0035	0.088	88
200	0.0029	0.074	74
240	0.0025	0.063	63
270	0.0021	0.053	53
400	0.0015	0.037	37
550	0.0010	0.025	25
800	0.0006	0.015	15
1250	0.0004	0.010	10
—	0.0002	0.005	5
—	0.00006	0.002	2

Typical Proppant (Frac. Sand)
Table Salt
Control Point: Typical Pump Plunger/Barrel Fit



PHOTOMICROGRAPH OF PARTICLES
30X ENLARGEMENT

READING THE PHOTOMICROGRAPH SCALE:
1 DIVISION REPRESENTS 50 MICRONS (OR)
1 DIVISION REPRESENTS 2 THOUSANDTHS OF AN INCH

TEST NUMBER: R00114-1 AREA: Calif. DATE: 14-Jan-2005

COMPANY: [redacted] LOCATION: STEVENS ZONE UNIT

WELL NAME AND NUMBER: [redacted] STREN REP: [redacted]

(1) SIZE OF PARTICLES: (#1) 220 (#2) 100 X 150 (#3) 175

(2) TYPE OF PARTICLES: (#1) SHARP FACE SILICA (#2) SHARP SILICA SAND FRAGMENT (#3) NODULAR SILICA

(3) BBLS/DAY: 502 (4) % WATER CUT: (5) API GRAVITY: 30 (6) DEPTH PERFS:

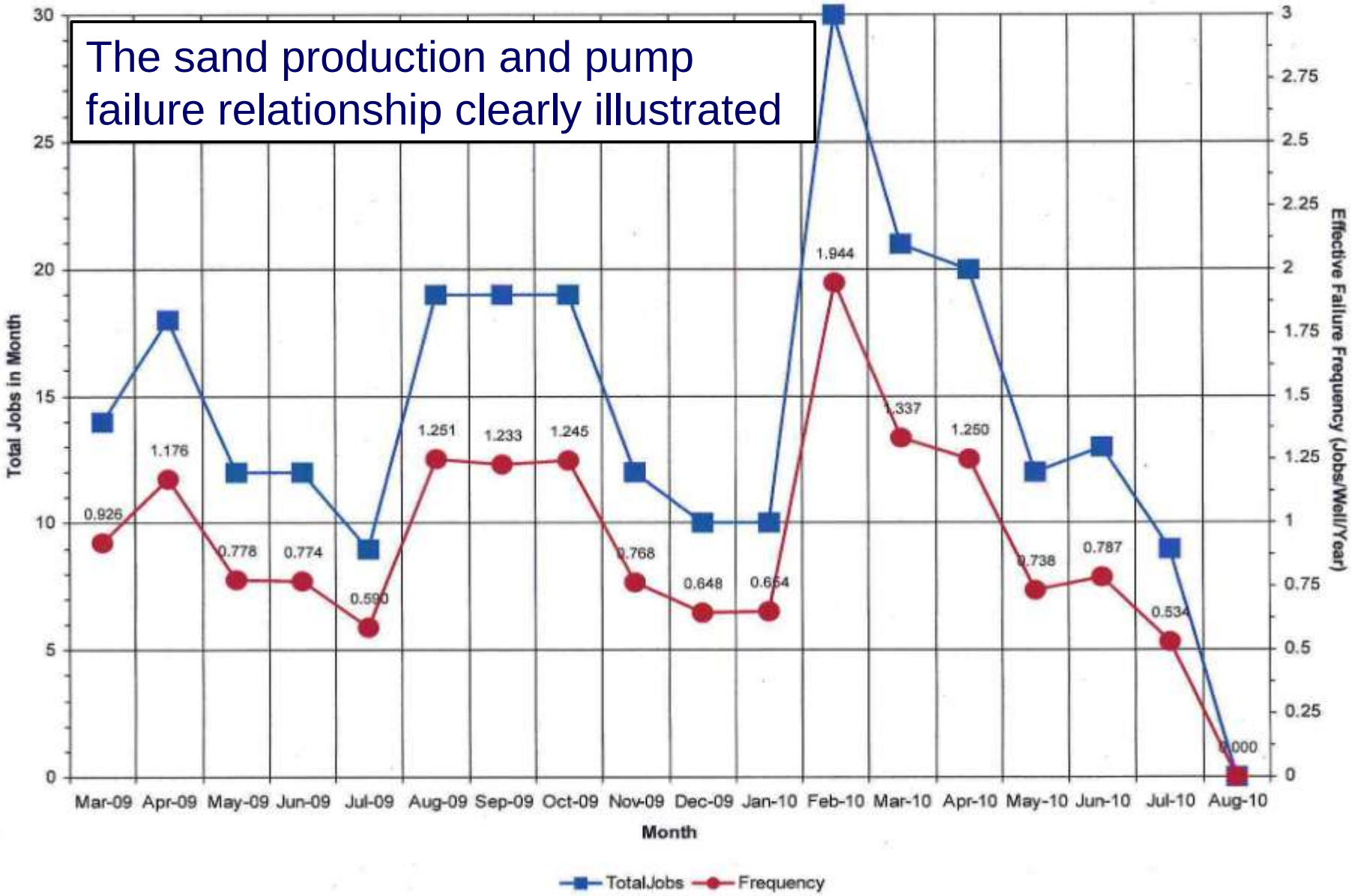
(7) ACTUAL DAYS PUMPED BETWEEN REPAIRS: (8) AVERAGE COST TO REPAIR PUMP:

(9) REMARKS: PREDOMINANT FRACTION IS SHARP FACE SILICA SAND AND SAND FRAGMENTS. THIS SAMPLE IS "FROM TUBING". BROAD PSD (Particle size distribution) EVIDENT. CLEAN SANDS WITH NO SIGNIFICANT MINERAL FINES OR SCALING POTENTIAL EVIDENT. SIG. FRACTION IN THE 100 TO 250 MICRON RATING MOST AGGRESSIVE TO PLUNGER-BARREL DAMAGE EVIDENT. RECOMMENDED CONTROL RATING= 100 MICRONS.

Sand and proppant fragments are problematic. They are being found in production fluids more than ever before due to fracturing stimulation.

Well Failure Frequency Analysis

The sand production and pump failure relationship clearly illustrated



Multi-stage shale fracing equates to higher production rates with subsequent increased risk of rod pumping failures. This results in greater downtime, loss of production, and higher pulling and pump repair costs.

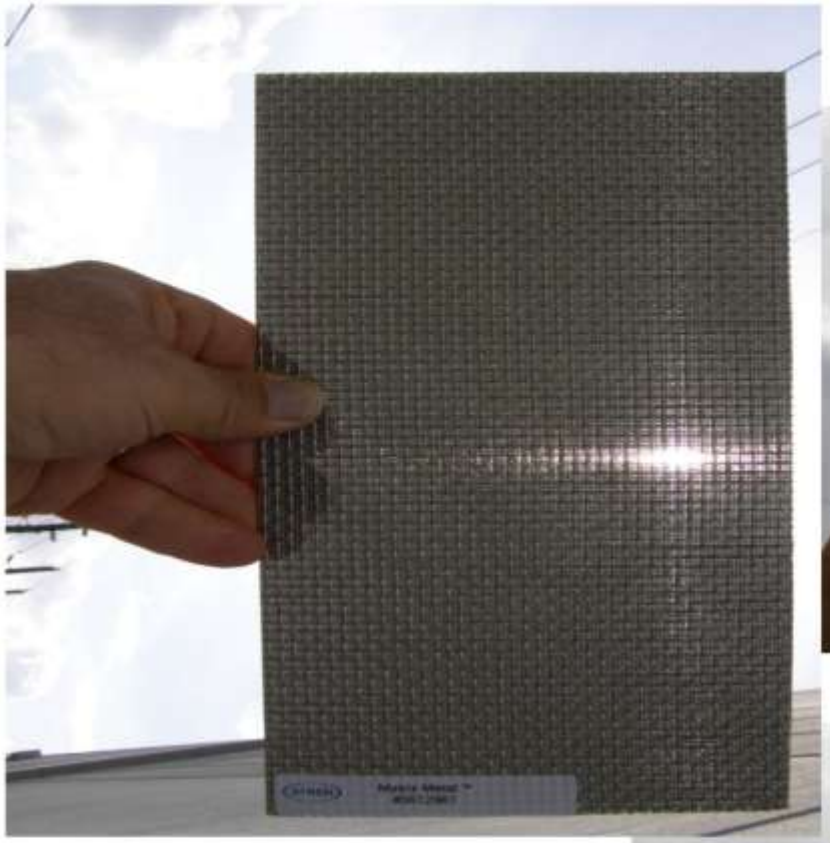
Properly planned completions achieve increased production and lower production cost.

- Properly sized tubulars aid in velocity reductions.
- Sieve analysis helps to select proper screen size.
- Pump clearance is an issue; specialty pumps?
- Rod/Beam system matched to inflow of well helps to eliminate excessive sand production from 'surging'.
- Automated drives (VFD's) can match motor speed to widely varying well production.

Advanced "clean wellbore" completions allow confident rod pumping

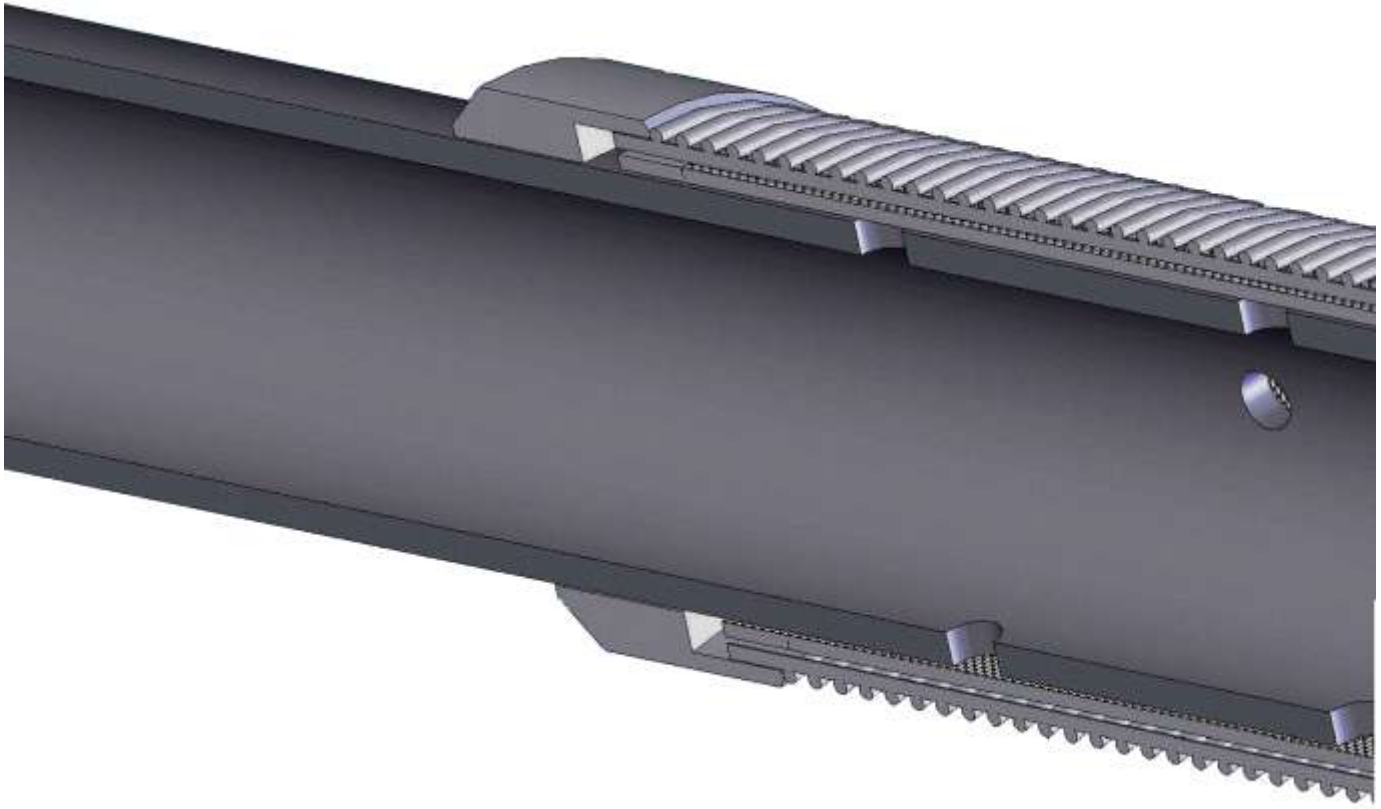
Screen selection is critical for success

Particles can easily pass through screens unless a determinate manufacturing process is employed.



Sometimes a practical photo is worth a thousand words; Stren 85 micron nominal, triangular wire wrap at 10 ga./(250 micron) 0.010 slot

Stren SC2000 Series XPR is engineered in 2⅜”, 2⅞”, 3½”, and all common API sizes for horizontal completions and rod pumping intake protection applications.



Stren SC2000 XPR Pump Intake Protection Screens

"If you let sand get into your pump you've got a fight on your hands."

SC2000™ Series XPR™
Pump Intake Protection Screens

The Series *XPR* screen design is unique with rugged, corrosion resistant, *matrix metal* stainless steel construction. The unit's standard 100 micron control point provides for lower pressure drops, higher production flow, and longer service life.

The *SC2000* Series *XPR* completion unit for oil and gas wells provides a clean, sand-free wellbore and the lowest reservoir backpressure for increased production flow and rod-pump longevity. Many operators are not achieving full-production potential because of backpressure on the reservoir caused by sand infill and liquid loading. The *XPR* completion unit provides a single answer to both problems.

Applications

- Rod lifted gas and oil production and well workovers, solids infill control, and gas well fluid-loading control
- Cased hole, perforated-interval-interface, or new drill completions

Features, Advantages and Benefits

- The *XPR* unit incorporates a high performance, matrix metal™ reservoir interface. This feature protects against sand infill and liquid loading to enhance production and extend pump life. It also prevents premature rod-pump failure caused by solids production, extending equipment life while preventing nonproductive time (NPT).
- Unique, rugged, corrosion resistant, matrix metal, stainless steel screen design with standard 100 micron control point results in lower pressure drops for longer service life and higher production flow.
- Heavy-duty CrossBar™ style shroud enhances flow vectoring attenuation of fluids, and flow distribution in perforated cased hole completions.
- The *XPR* unit provides cost-effective, easy installation and protects the rod pump from excessive wear – minimizing capital costs to replace failed rod pumps, as well as avoiding NPT.
- Integrated pumping sump increases rod-pump-productivity.
- System design can accommodate oil or gas wells of any size.

Options

- On/off tool/torque safety joint

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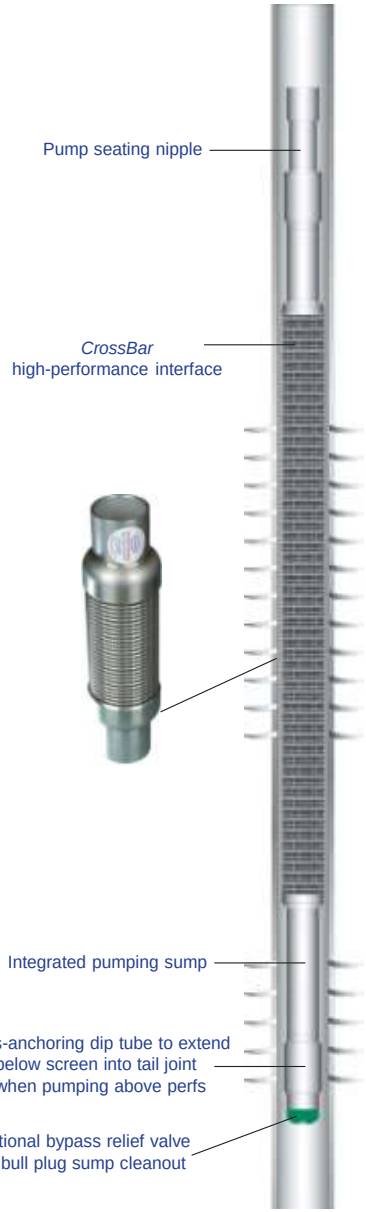

Stren SC2000 Series XPR Capacity Ratings

SC2000™ Series XPR™ Example Capacity Ratings for General Applications

Capacities to thousands of BPD and more by threading units end-to-end to reach capacity required.
Contact the Applications Engineering Dept. of Stren for well configuration and support assistance.

Product Description	Oil Well Production Completions	Gas Well De-watering Completions
Completion Series Stren XPR2012 CrossBar™: 2-3/8" 4.7# J55 base, 8rd EU connections, 100 micron control point and CrossBar™ high performance shroud. Max OD = 3.20" x 15 ft OAL with 1.5 ft bare pipe handling ends.	150 BPD, Based on average conditions, conventional +/- 30 API gravity	200 BFPD, Gas Well Post Frac Applications
Completion Series Stren XPR2512 CrossBar™: 2-7/8" 6.4# J55 base, 8rd EU box connections, 100 micron control point and CrossBar™ high performance shroud. Max. OD = 3.70" x 15 ft OAL with 1.5 ft bare pipe handling ends.	200 BPD, Based on average conditions, conventional +/- 30 API gravity	250 BFPD, Gas Well Post Frac Applications
Completion Series Stren XPR3012 CrossBar™: 3-1/2" 9.2# J55 base, 8rd EU box connections, 100 micron control point and CrossBar™ high performance shroud. Max. OD = 4.35" x 15 ft OAL with 1.5 ft bare pipe handling ends.	240 BPD, Based on average conditions, conventional +/- 30 API gravity	300 BFPD, Gas Well Post Frac Applications

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STREN SC2000 XPR Completion Unit

SC2000™ Series XPR™ Completion Unit

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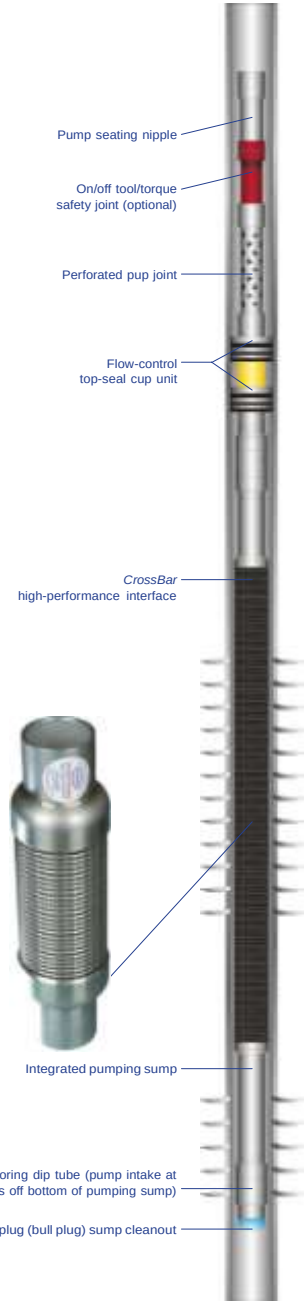

The Series *XPR* screen design is unique with rugged, corrosion resistant, *matrix metal* stainless steel construction. The unit's standard 100 micron control point provides for lower pressure drops, higher production flow, and longer service life.

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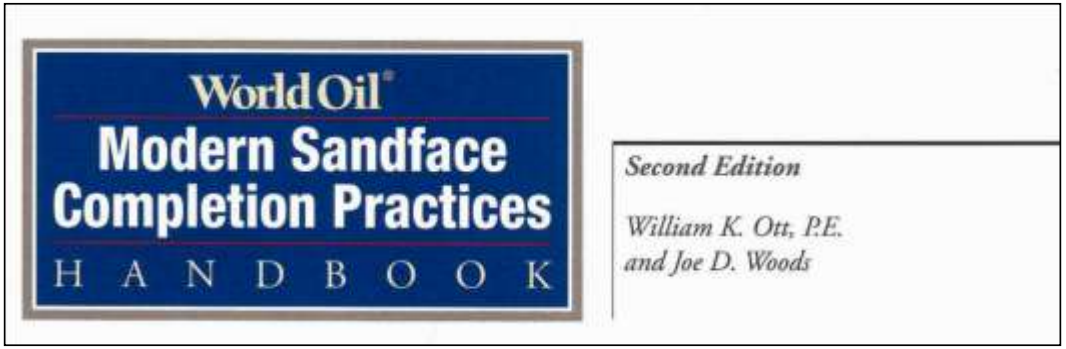
The above wedge wire type screen did not and cannot protect the pump. The slot opening at .010” (10 gauge) is too large. It let’s into the pump the very size range of sand and proppant fragments most damaging to the plunger and barrel. Narrowing the slot typically reduces the available open area to an unacceptable level.

As featured in the 2005 2nd Edition of World Oil Modern Sandface Completion Practices Handbook

Featured in *World Oil Completion Practices Handbook*



Stren SC2000 – This sand screen combines sintered metal mesh layers and metal fiber composite matrix for accurate pore sizing, yielding rugged, accurate sand particle control and flow erosion resistance. Robust and crush resistant, the SC2000 (Fig. 2.39) screens have body diameters typically only 0.25 in. (0.64 cm) larger than tubing upset diameter.

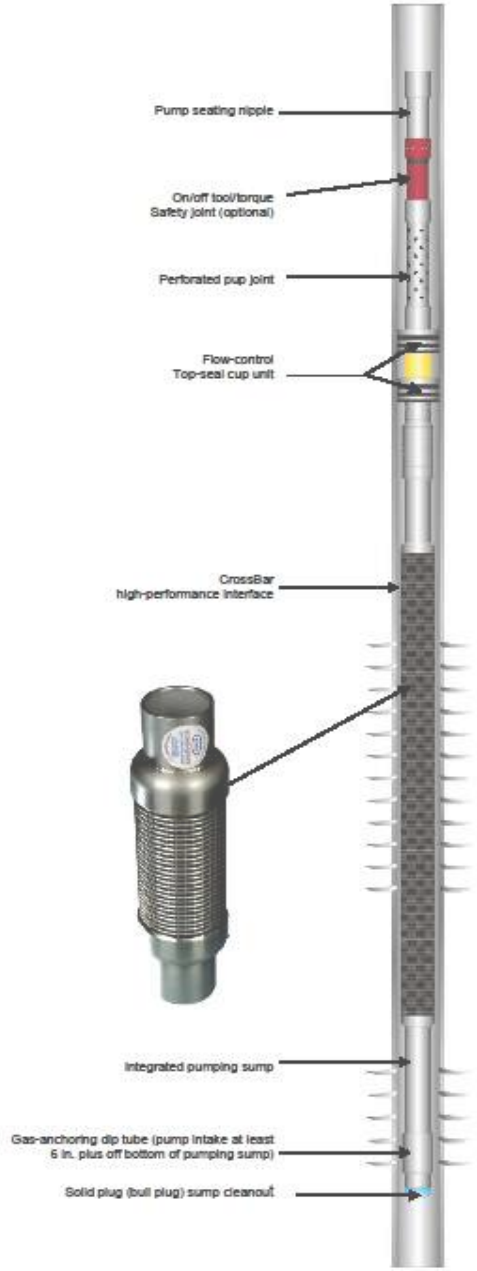
In addition, Stren's new SC2000 XPR CrossBar screen (Fig. 2.40) has particular utility in controlling solids infill into the wellbore. It is a component of the SC2000 Series XPR (see Chapter 5) completion unit that is designed to increase rod pumping productivity. Somewhat unique to this screen is its heavy-duty "cross bar" style shroud that, according to the manufacturer, enhances flow vectoring attenuation of fluids and flow distribution.

Fig.2.39. Stren SC2000 Screen

Fig.2.40. Stren SC2000 XPR CrossBar

Bakken higher capacity XPR3012-30-100M30, 3½” assembly configured for rod pumping intake protection and enhanced gas separation to increase pumping efficiency.

An alternative to TBG deployment is installation on a liner hanger or packer for ESP or long, horizontal completions. Special configurations assist in cost effective retrievals.



Stren CNC precision machining centers facilitate cost effective consistently accurate production components.

For insert pump retrievable configuration (sucker rod retrievable pump intake production)

Field Proven PumpGard™ Rod Pump Intake Protection Improves Pumping Productivity

An Example of Success

A major operator was experiencing repeated pump failure due to sand cut and gas lock. The existence of abrasive conditions from both sand and formation abrasives caused two problems: First, the need to set the pump 150 ft above the perforations in an attempt to reduce abrasive action and second, pump failure was occurring every 37 days. PumpGard was installed and 310 days later no service had been required. Additionally, the pump was lowered in closer proximity to the perforations resulting in increased production.

Bring it on line... keep it on line... *is* the bottom line.

PUMPGARD™

MODEL	PGXPR20	PGXPR25
Pump Type	Insert Rod Pump	Insert Rod Pump
API Pump Size	2-⅜" Insert (API 20)	2-⅞" Insert (API 25)
Rod string retrievable	Yes	Yes
Capacity:	Use 1 ft per 10-15 BFPD	Use 1 ft per 10-15 BFPD
Dimensions	Max. OD = 1.75" x 102" OAL	Max. OD = 2.06" x 103" OAL
Micron Ratings	100	100
Pressure:	To 3000 PSI	To 3000 PSI
Temperature	To 400° F	To 400° F
Pump End Connection	1.0" NPT	1-¼" NPT

For Higher Capacity Thread Multiple Units Together End-to-End

Typical Description:

PumpGard™ Model PGXPR for protecting API insert pumps;

PGXPR2(x)08-100M24; 1.0" (or 1.25") NPT API standardized pin up gas anchor dip tube base connection to 2-⅜" (or 2-⅞") insert pump, with 316 stainless steel matrix core #M24-125, 100 micron control point and CrossBar™ high productivity reservoir interface shroud.

Optional: Factory install PAB20-100 over-pressure control relief valve and 6" strainer nipple.

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Oil & Gas Producers Completion Configuration

For 4½" 11.6# CSG with 2⅜" EUE TBG

Stren SC2000 Series XPR2020 CrossBar™ Completion

Details matter: Customer preferred transport packaging can reduce labor and rig cost; especially in remote/international development. (This is for Caspian/Kazakhstan directionally drilled well set for example.)

STREN

"Technology Solutions"

We look forward to the opportunity to be of service in increasing production and productivity in your operations.