Artificial Lift R&D Council

INCREASING PRODUCTION BY USING A TWO STAGE FILTRATION SYSTEM: CASE STUDIES IN SOUTH TEXAS

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OVERVIEW

UNDERSTANDING SAND & GAS PROBLEMS

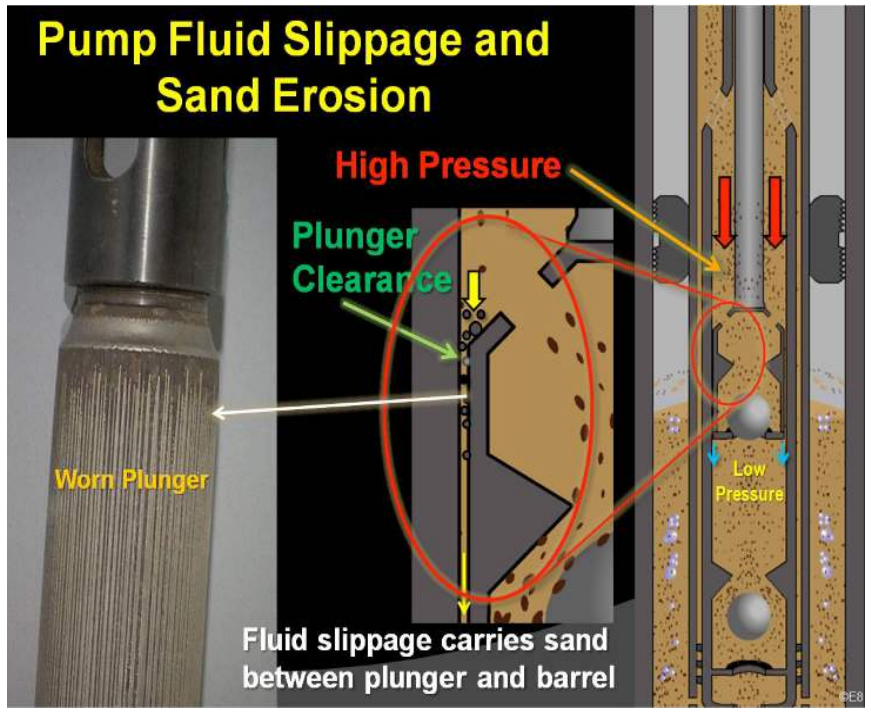
CRITERIA FOR SAND & GAS MANAGEMENT

SOLUTIONS

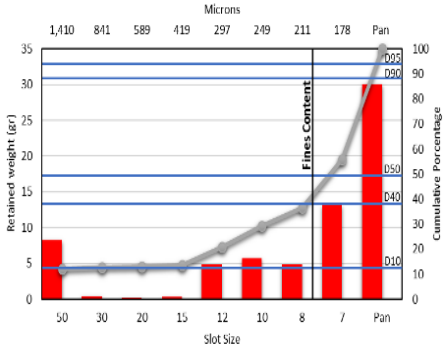
CASE STUDIES

CONCLUSIONS

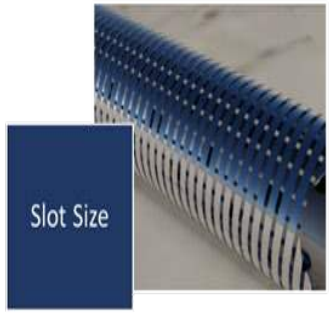
UNDERSTANDING GAS & SAND ISSUES

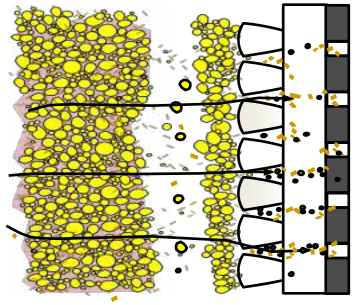


CRITERIA FOR SAND & GAS MANAGEMENT

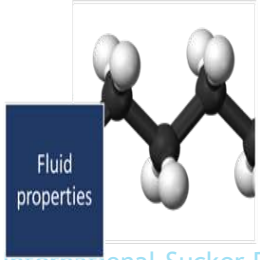


- Fluid Production
- WC
- Sand Production

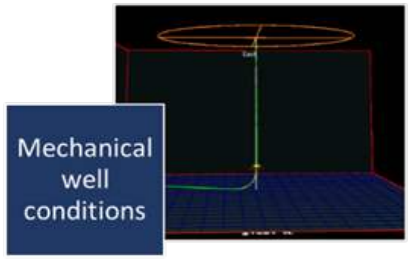




- Capacity for the First stage
- Calculation of Maximum speed
- Avoid Pressure drop
- Result of Simulation: Minimum length and size of the 1st stage



- Viscosity
- Inorganic depositions
- Organic Components
- Corrosive components



- Perforation Localization
- Inclination and DLS
- Option of centralizers

UNDERSTANDING TWO STAGE FILTRATION

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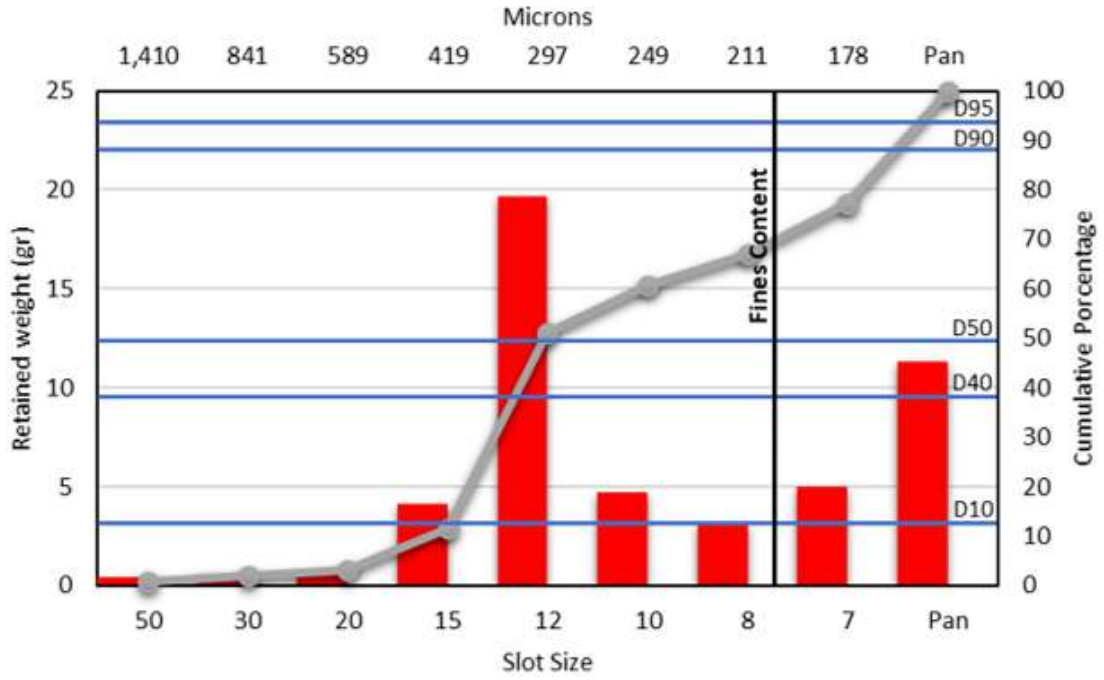
1ST Separation Stage- Tubing Screen

- Sand Sieve analysis (It describes the sand size particle distribution).



It is very important to identify the sand size distribution to know which slot size will be the most optimum, what % will be able to filtrate the 1st stage, so 2nd stage design should manage the rest.

UNDERSTANDING TWO STAGE FILTRATION

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1ST Separation Stage- Tubing Screen

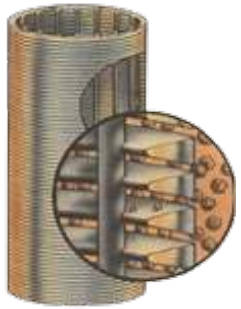
Pressure loss through the V-wire screen.

OSI

PRESSURE DROP THRU THE SCREEN	
INPUT DATA	
# Tubing Screen	5
Diameter (in)	2.441
Slot Size	15
Open Area	1814

Fluid Rate (BFPD)	5000
Water Rate (BWPD)	2500
Water cut (%)	50
API	40
Specific gravity W	1.05
Fluid Viscosity (cp)	1.5

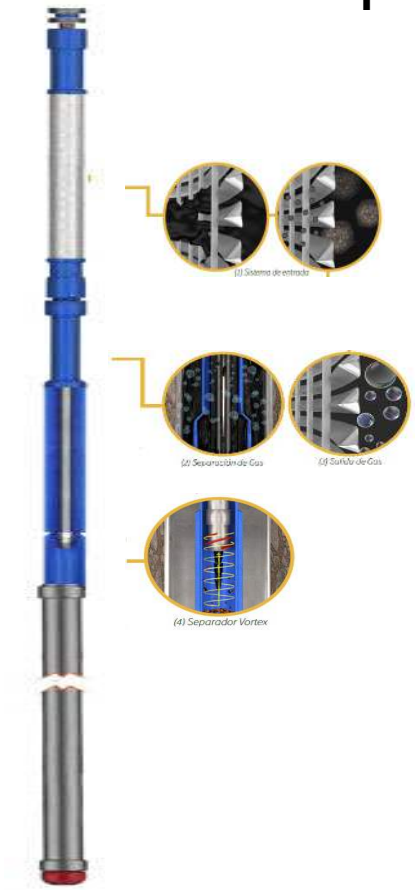
CALCULATED RESULTS	
Screen Aperture (ft)	0.001508
Fr. Free Area	0.20
Fluid Density (lb/ft3)	58.50
Fluid Velocity (ft/s)	0.00516
#Reynolds	2.291
Discharge Coeff. C	0.151362
Loss Press. Coeff. K	1079.639
Loss Pressure (Psi)	0.840512



0.84 PSI

- The **number of tubing screens** represent the **open area of the entire system**. High fluid rate flowing through a small open area crates a more turbulent flow regime which end up in higher pressure drops.
- Pressure drop is calculated to avoid losing kinetic energy that can affect the productivity of the well.

UNDERSTANDING TWO STAGE FILTRATION



1ST Separation Stage- Gas Separator

Gas and Sand tool is a concept used by OSI to maximize optimization of the artificial lift system through the combination of Tubing Screen and Gas Separator Bodies using an innovative dual flow connection

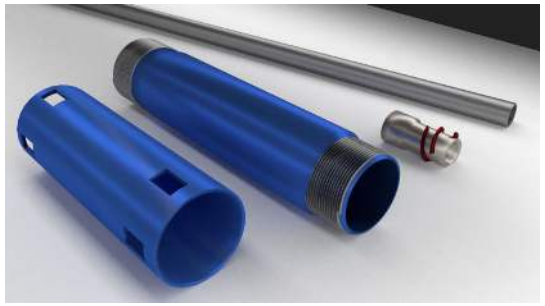
Principles used:

- Bernoulli's Principle
- Venturi Effect
- Coalescence effect
- Gravitational force

UNDERSTANDING TWO STAGE FILTRATION

2nd Separation Stage - Vortex Sand Shield

The second stage is a Desander: **the Vortex Sand Shield** which creates a centrifugal force which separates the less abrasive solids and deposits them in the tail joint
Second stage: Range: 10 - 250 Microns



Many wells completed with multiple frac stages use 100 mesh sand on the completion stage, filtrate this sand size is difficult, so The vortex Sand shield is the one in charge of separating the fine or smaller sand that can pass through the Tubing screen section.

Click to Video

UNDERSTANDING TWO STAGE FILTRATION

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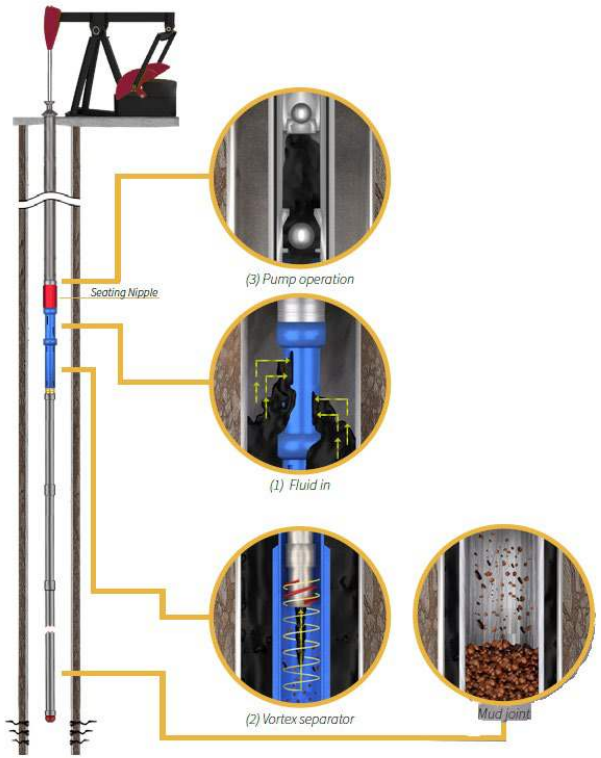
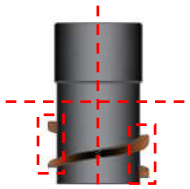
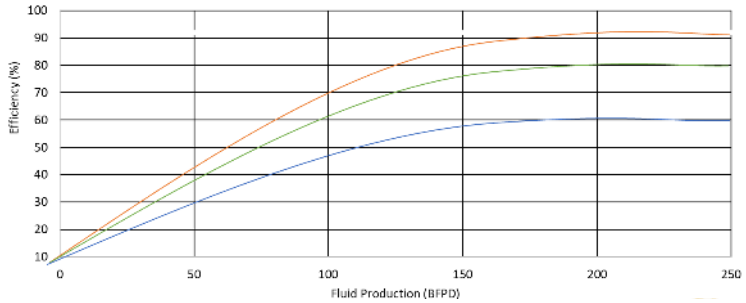
2nd Separation Stage - Vortex Sand Shield

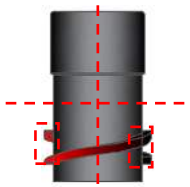
Design – Helix Size



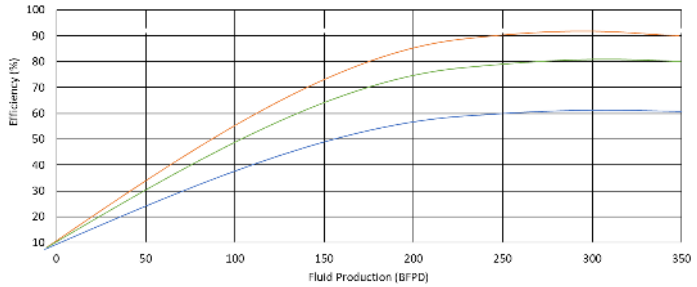


Helix 2.3

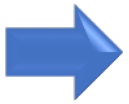


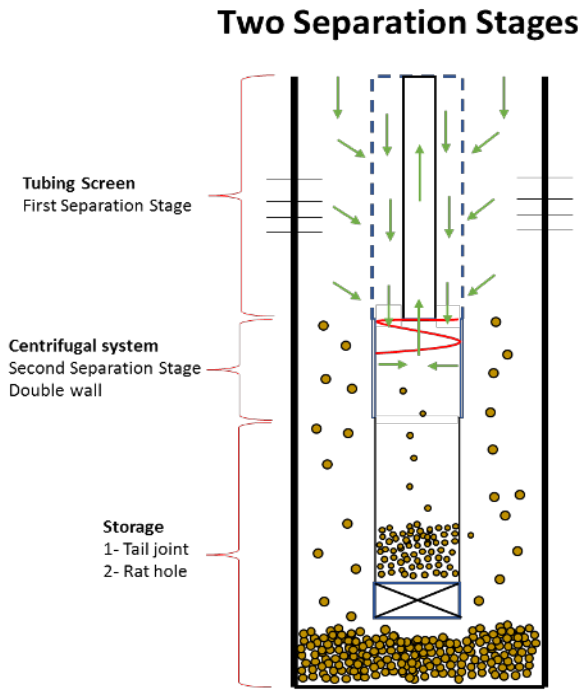


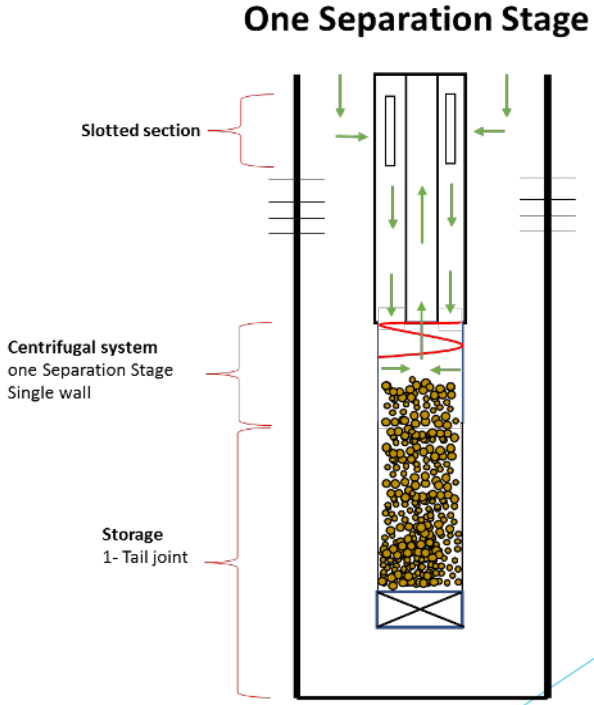
Helix 2.4



Two Separation Stages VS One Separation Stage







CASE STUDIES

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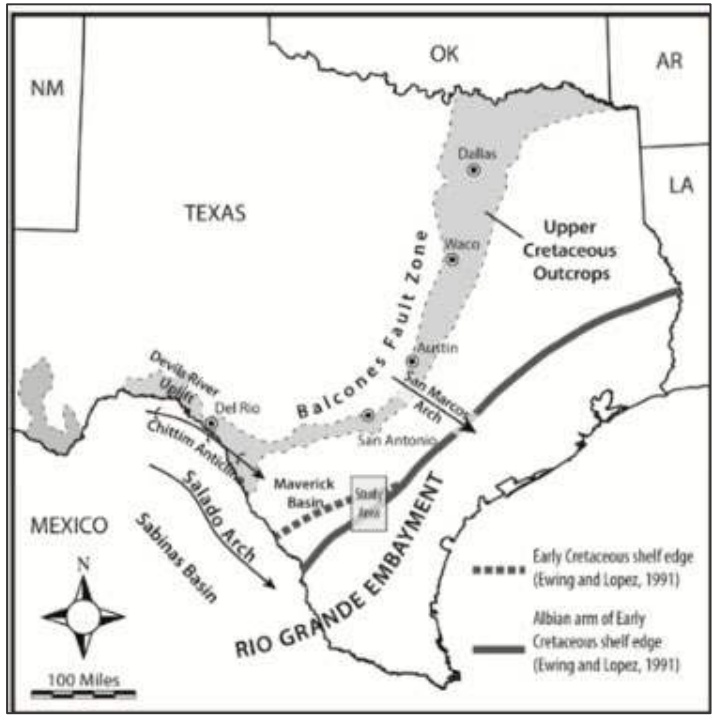
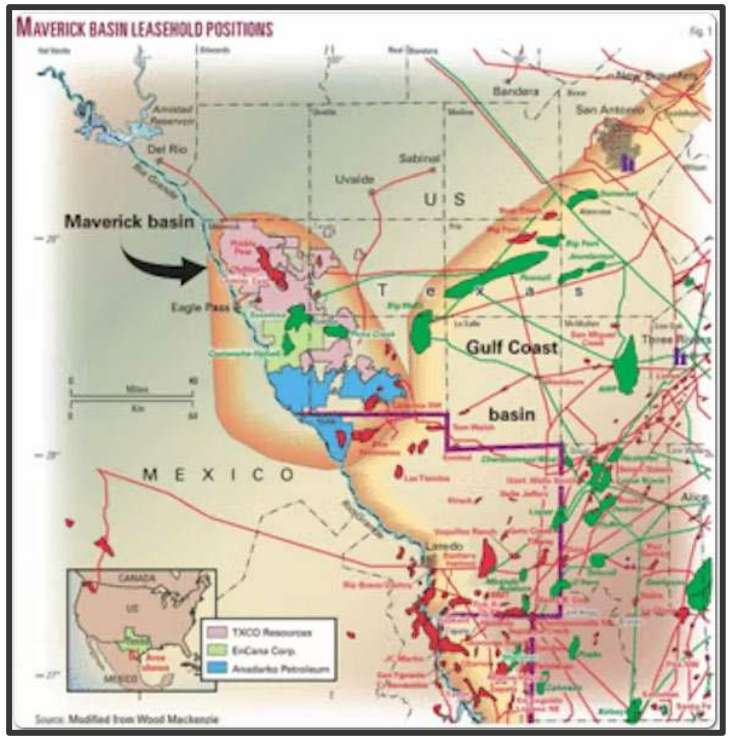
FIELD LOCATION





CASE STUDIES

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WELL A

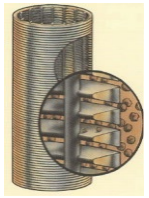
WELL CONDITIONS		
OPEN HOLE	6-1/8	IN
TUBING	2-7/8	IN
FLUID PRODUCTION	20	BFPD
WC	0	%
OIL PRODUCTION	20	BOPD
GAS FLOW	400	MCFD
PUMP DEPTH	5,150	MD FT

BHA DESCRIPTION	QTY
2-7/8” x 24’ x 12 Slot Tubing Screen w/Dual Flow™	2
2-7/8" x 2' Vortex Sand Shield W/ HE 2.1	1
2-7/8” x 4; Pup Joints w/Centralizers	2
2-7/8” x 32.5’ Mud Joint (Supplied by CML)	5
2-7/8” Bull Plug	1

CALCULATIONS & WELLBORE SURVEY

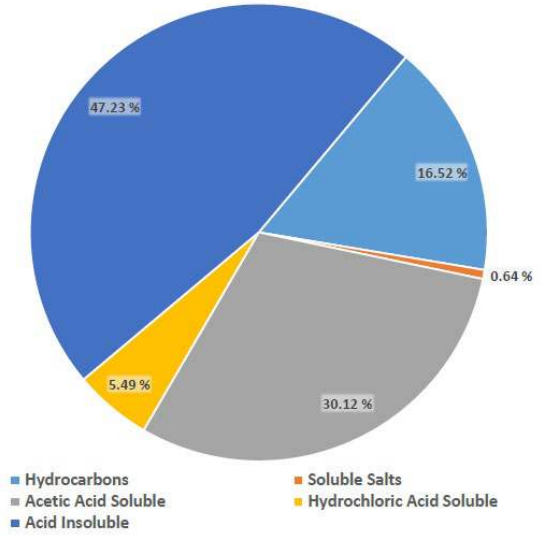
TUBING SCREEN CALCULATOR		
INPUT DATA		
Production of total liquid barrel per day	20	BFPD
Percent of run time	100%	%
Selected Tubing Screen:	*2-7/8" x 23.5'*	
Slot	*0.012*	
Well classification	*BAD*	
Open area of screen (in^2)	298.7	
# Tubing screen	2	

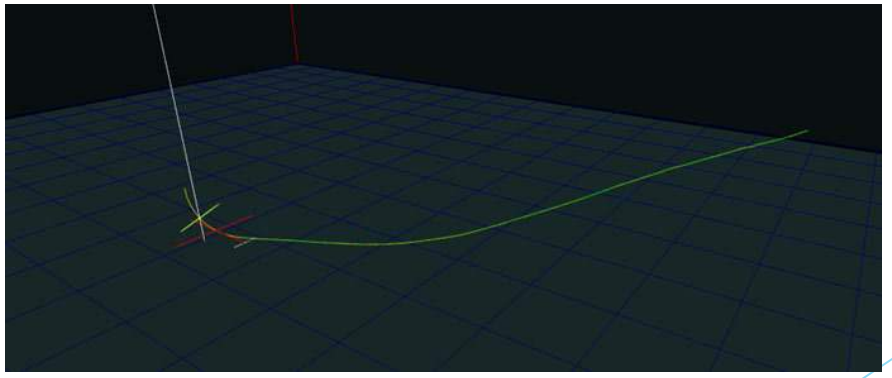
CALCULATED RESULTS		
Size of Sand	60/80	Mesh
Total Open area of screen	597.4	in^2
1440 minute per day *% of time	1440	min/day
production per minute of run	0.0139	bbl/min
production cubic inches	134.75	in^3/min
Production inch/ by screen opening	0.003759346	in/sec



0.003759346 in/sec Fluid velocity per second through Screen

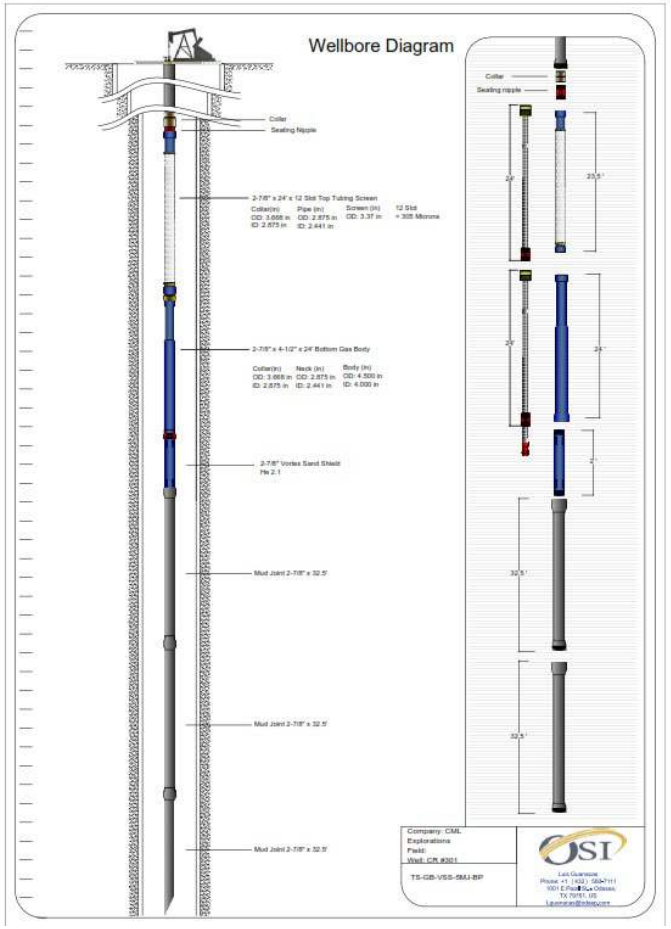
0.093577778 in/sec Max. by TS.

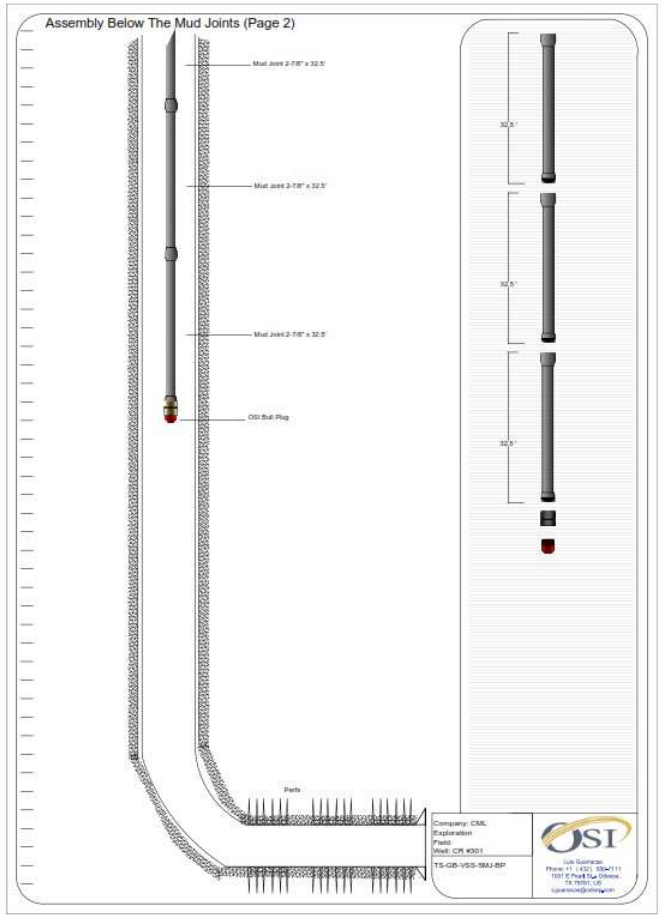




CASE STUDIES

BHA DESIGN



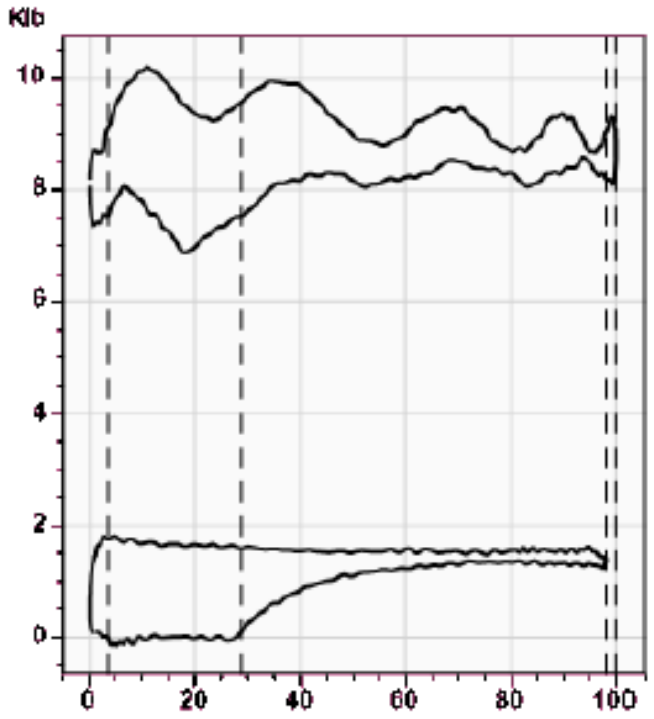


CASE STUDIES

DYNAMOMETER CARD

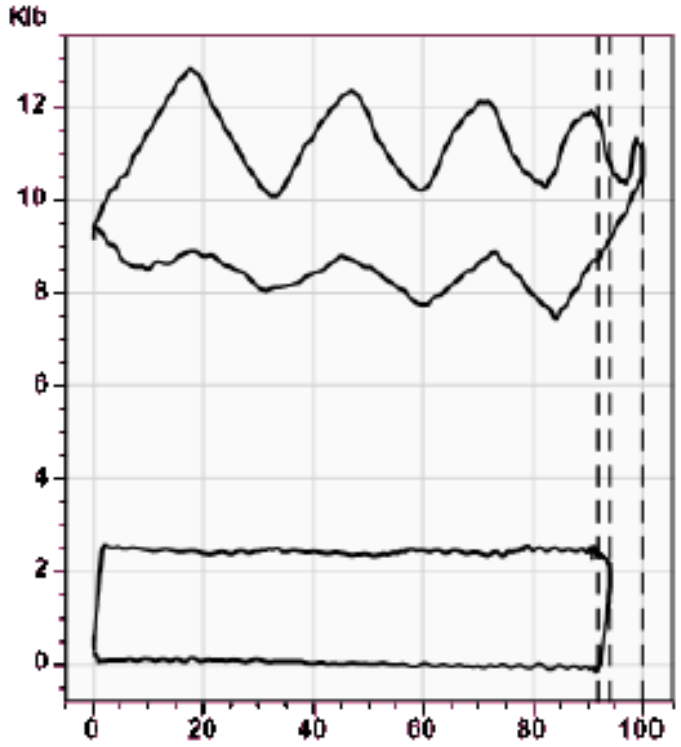
BEFORE INSTALLATION

03/24/2022



AFTER INSTALLATION

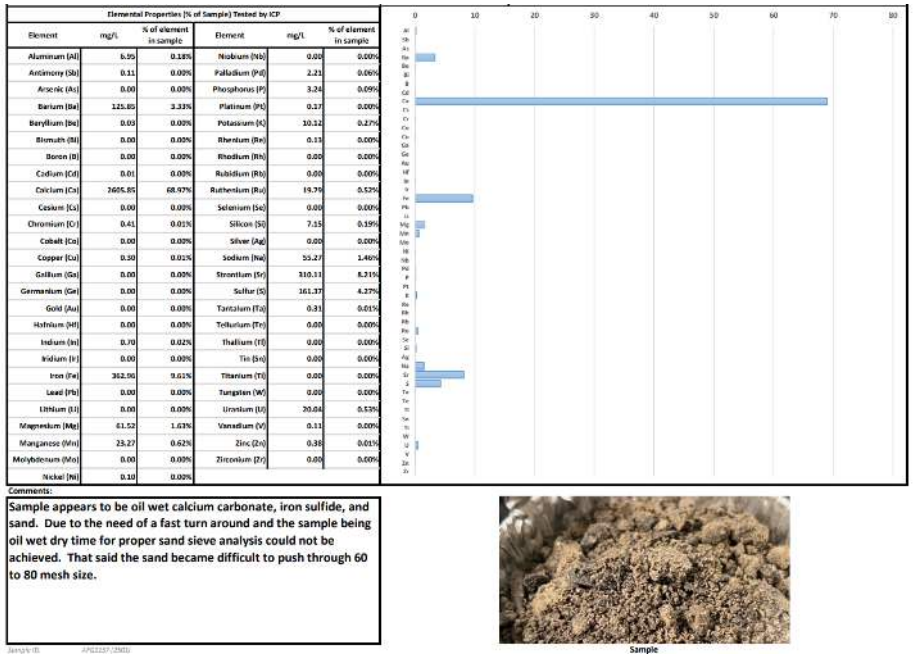
05/19/2022



CASE STUDIES

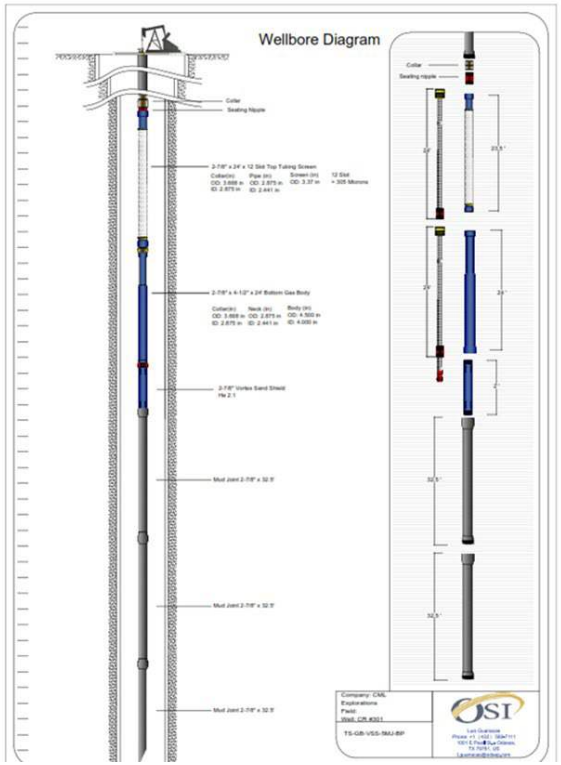
- **WELL B**

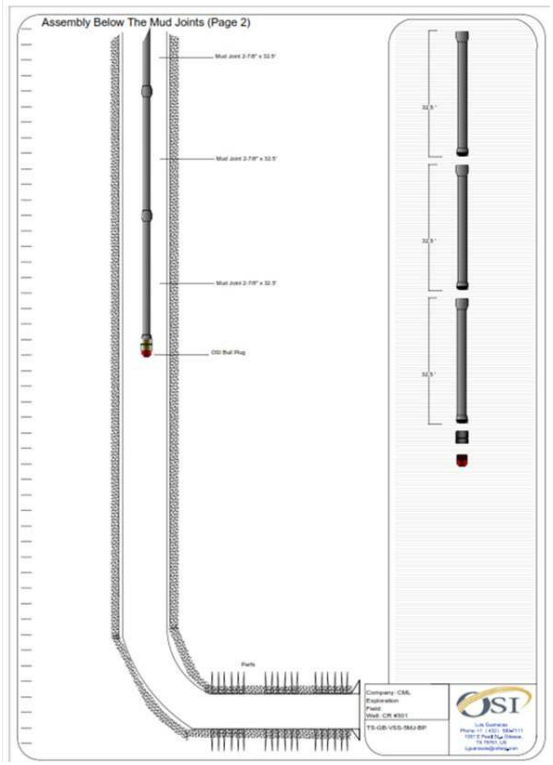
WELL CONDITIONS		
CASING 29#	7	IN
CASING DRIFT	6.059	IN
TUBING	2-7/8	IN
FLUID PRODUCTION	60	BFPD
WC	0	%
OIL PRODUCTION	60	BOPD
WATER PRODUCTION	0	BWPD
GAS FLOW	400	MCFD
GOR	6,666.67	SCF/STB
PUMP DEPTH	4,800	MD FT



CASE STUDIES

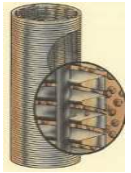
BHA DESIGN





TUBING SCREEN CALCULATOR		
INPUT DATA		
Production of total liquid barrel per day	60	BFPD
Percent of run time	100%	%
Selected Tubing Screen:	*2-7/8" x 23.5'*	
Slot	*0.012*	
Well classification	*BAD*	
Open area of screen (in^2)	298.7	
# Tubing screen	1	

CALCULATED RESULTS		
Size of Sand	60/80	Mesh
Total Open area of screen	298.7	in^2
1440 minute per day *% of time	1440	min/day
production per minute of run	0.0417	bbl/min
production cubic inches	404.25	in^3/min
Production inch/ by screen opening	0.022556076	in/sec



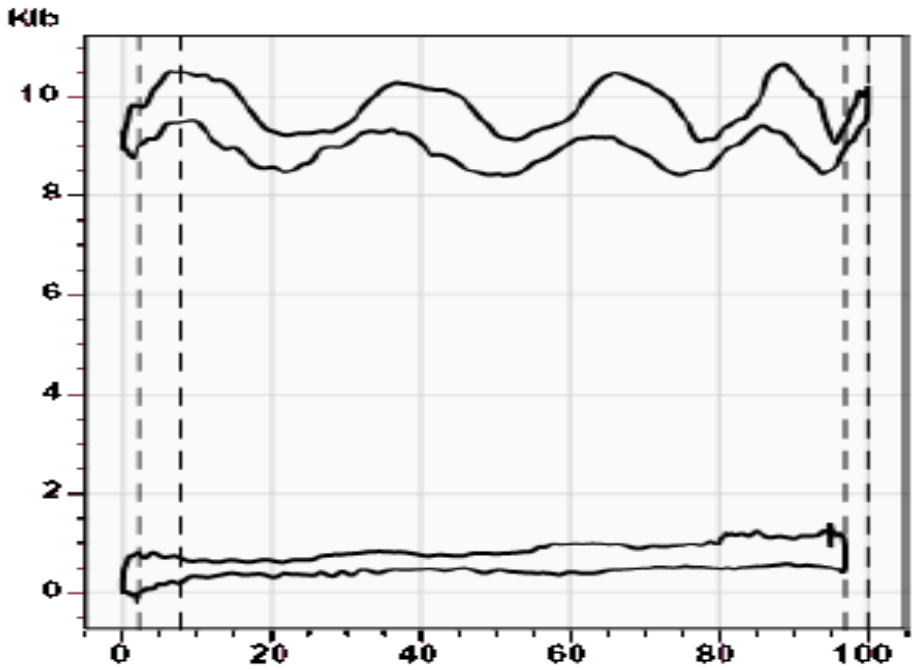
0.022556076 in/sec Fluid velocity per second through Screen

0.093577778 in/sec Max. by TS.

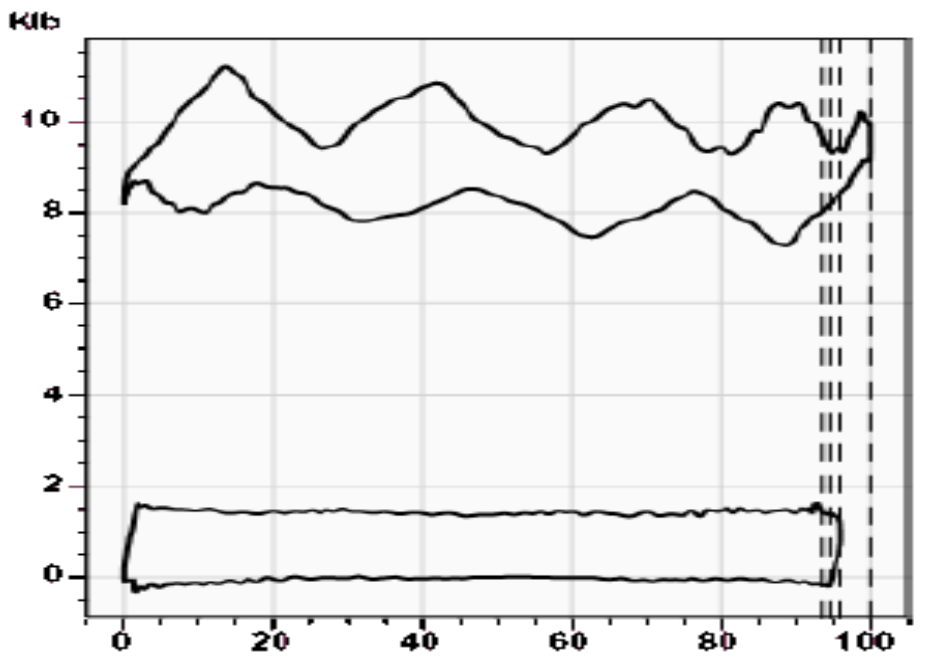
CASE STUDIES

DYNAMOMETER CARD

BEFORE INSTALLATION
01/17/2022



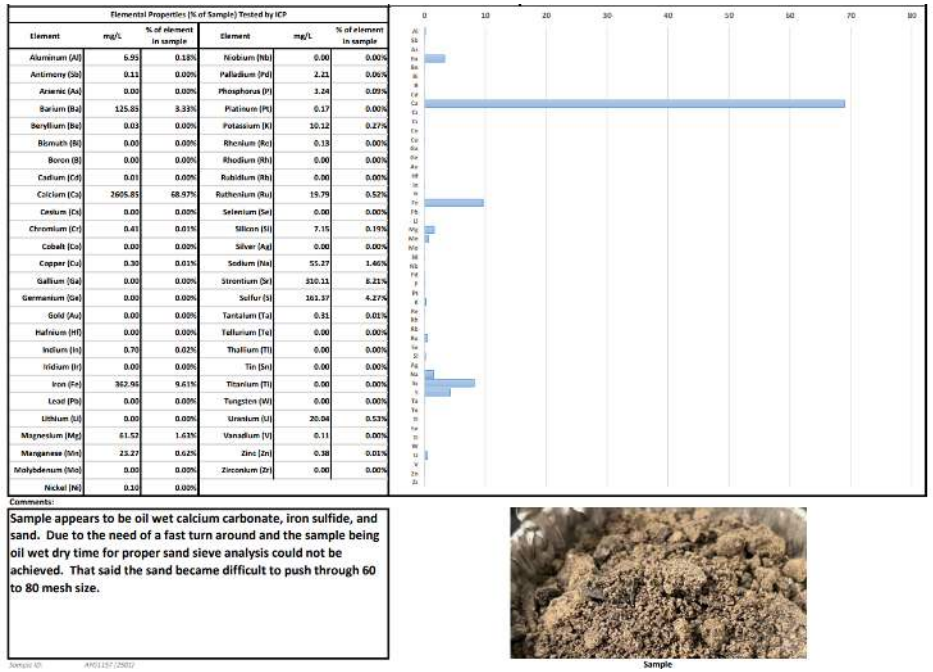
AFTER INSTALLATION
05/18/2022



CASE STUDIES

- **WELL C**

WELL CONDITIONS		
CASING 29#	7	IN
CASING DRIFT	6.059	IN
TUBING	2-7/8	IN
FLUID PRODUCTION	60	BFPD
WC	0	%
OIL PRODUCTION	60	BOPD
WATER PRODUCTION	0	BWPD
GAS FLOW	400	MCFD
GOR	6,666.67	SCF/STB
PUMP DEPTH	4,800	MD FT



Elemental Properties (% of Sample) Tested by ICP

Element	mg/L	% of element in sample	Element	mg/L	% of element in sample
Aluminum (Al)	6.95	0.18%	Niobium (Nb)	0.00	0.00%
Antimony (Sb)	0.11	0.00%	Palladium (Pd)	2.21	0.06%
Arsenic (As)	0.00	0.00%	Phosphorus (P)	3.24	0.09%
Barium (Ba)	125.85	3.33%	Platinum (Pt)	0.17	0.00%
Beryllium (Be)	0.03	0.00%	Potassium (K)	10.12	0.27%
Bismuth (Bi)	0.00	0.00%	Rhenium (Re)	0.13	0.00%
Boron (B)	0.00	0.00%	Rhodium (Rh)	0.00	0.00%
Cadium (Cd)	0.01	0.00%	Rubidium (Rb)	0.00	0.00%
Calcium (Ca)	2605.85	68.97%	Ruthenium (Ru)	19.79	0.52%
Cesium (Cs)	0.00	0.00%	Selenium (Se)	0.00	0.00%
Chromium (Cr)	0.41	0.01%	Silicon (Si)	7.15	0.19%
Cobalt (Co)	0.02	0.00%	Silver (Ag)	0.00	0.00%
Copper (Cu)	0.30	0.01%	Sodium (Na)	55.27	1.46%
Gallium (Ga)	0.00	0.00%	Strontium (Sr)	310.11	8.21%
Germanium (Ge)	0.00	0.00%	Sulfur (S)	161.37	4.27%
Gold (Au)	0.00	0.00%	Tantalum (Ta)	0.31	0.01%
Hafnium (Hf)	0.00	0.00%	Tellurium (Te)	0.00	0.00%
Indium (In)	0.70	0.02%	Thallium (Tl)	0.00	0.00%
Iridium (Ir)	0.00	0.00%	Tin (Sn)	0.00	0.00%
Iron (Fe)	362.91	9.61%	Titanium (Ti)	0.00	0.00%
Lead (Pb)	0.00	0.00%	Tungsten (W)	0.00	0.00%
Lithium (Li)	0.00	0.00%	Uranium (U)	20.04	0.53%
Magnesium (Mg)	61.57	1.63%	Vanadium (V)	0.11	0.00%
Manganese (Mn)	23.27	0.62%	Zinc (Zn)	0.38	0.01%
Molybdenum (Mo)	0.00	0.00%	Zirconium (Zr)	0.00	0.00%
Nickel (Ni)	0.10	0.00%			

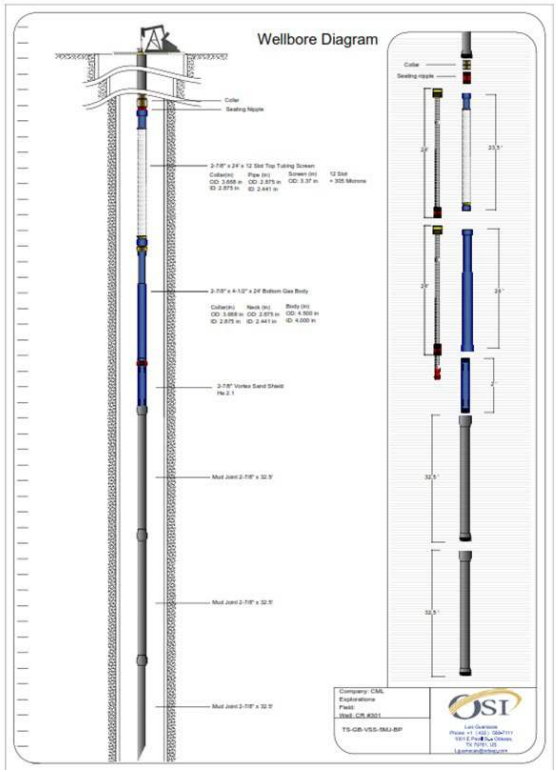
Comments:

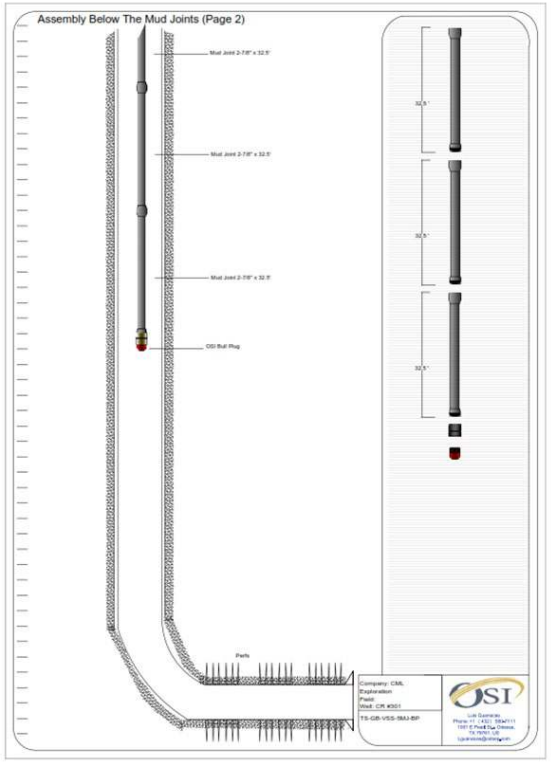
Sample appears to be oil wet calcium carbonate, iron sulfide, and sand. Due to the need of a fast turn around and the sample being oil wet dry time for proper sand sieve analysis could not be achieved. That said the sand became difficult to push through 60 to 80 mesh size.

Sample

CASE STUDIES

BHA DESIGN





OSI

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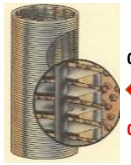

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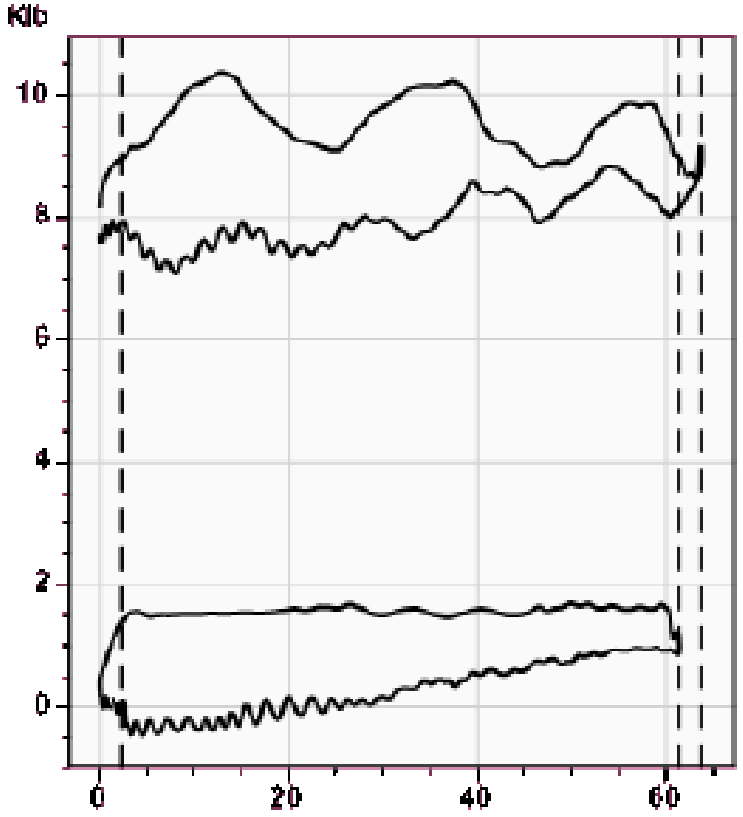
CASE STUDIES

DYNAMOMETER CARD

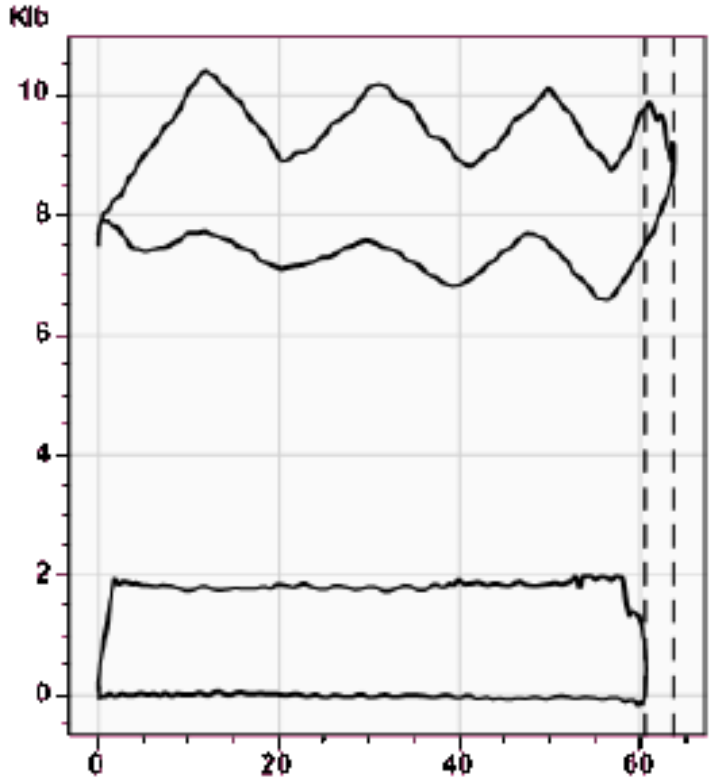
BEFORE INSTALLATION

01/17/2022

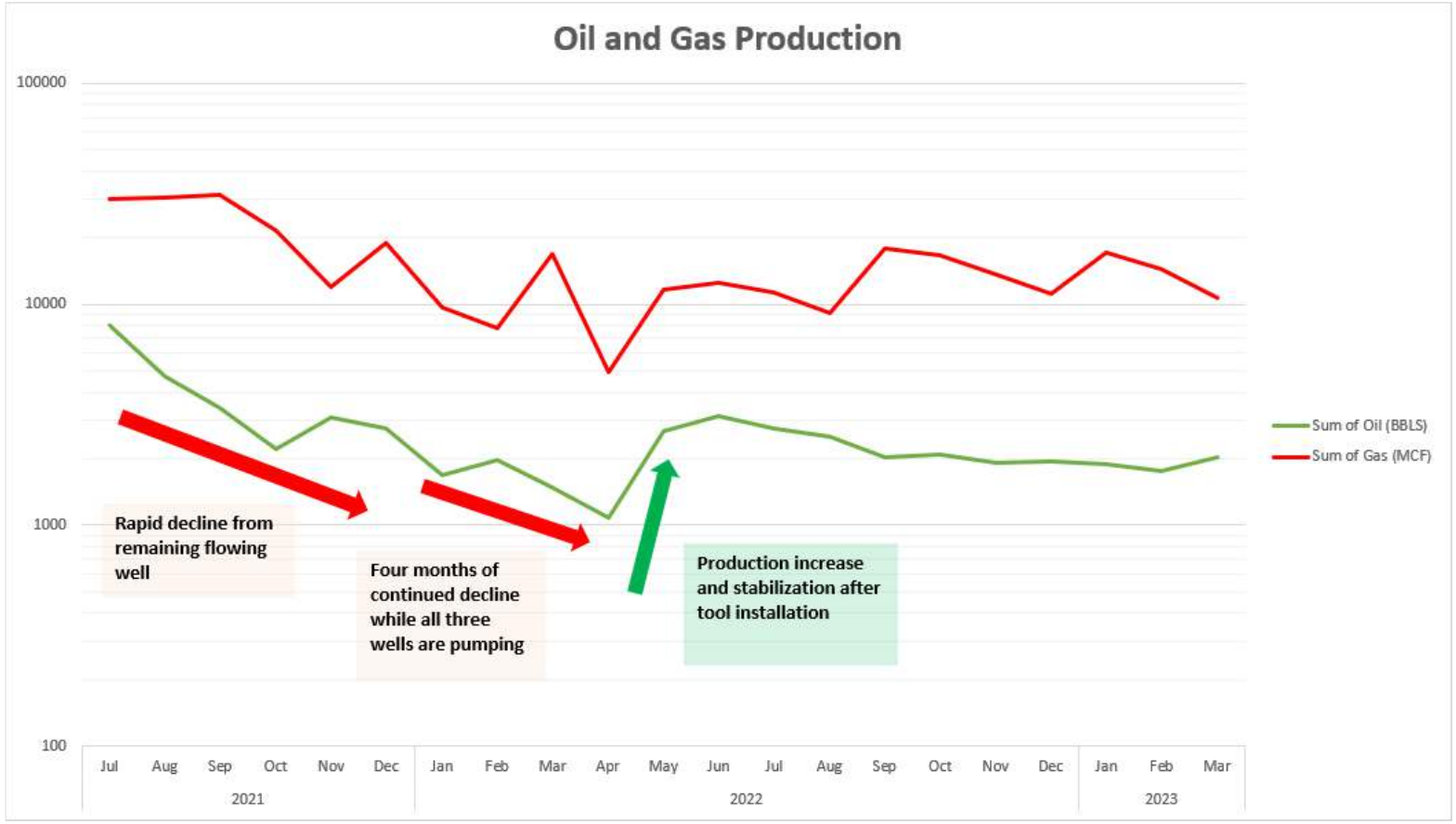


AFTER INSTALLATION

05/20/2022



TOTAL PRODUCTION



RUNTIME

BEFORE TWO STAGE FILTRATION

- **1 pump change every 4 months; total 3 pump changes for the year**
- **After OSI's two stage filtration – 10 months and still running. No pump change**

CONCLUSIONS

- The gas interference reduced the volumetric efficiency of the analyzed wells creating a more severe declination in the production profile. The rapid decline in production was stopped by installing a gas separator designed based on well conditions.

- The increase and stabilization in the production of the wells was due to the combined effect of the gas separator with the two-stage sand control system. This allowed for better pump performance while extending the run life of the equipment. To date the wells have been running for more than 9 months without any kind of failure.

- For the design of the gas separator, the correct analysis of the downhole conditions is important to determine the best method for gas separation. In general, for a more realistic modeling of gas separation, it is necessary to know the total fluid production, downhole pressure and temperature, fluid properties, casing size, and gas separator geometry. The type of intake of the separator also influences the modeling.

- The 2-stages filtration system is designed based on the particle size distribution, the sand production rate, and the fluid production rate. The chemical conditions in the well are important to size the slot size and the number of joints installed below the vortex desander.

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