Pilot Project of Frac Pack Technology Implementation on Stružec and Privlaka Fields Shallow Reservoirs

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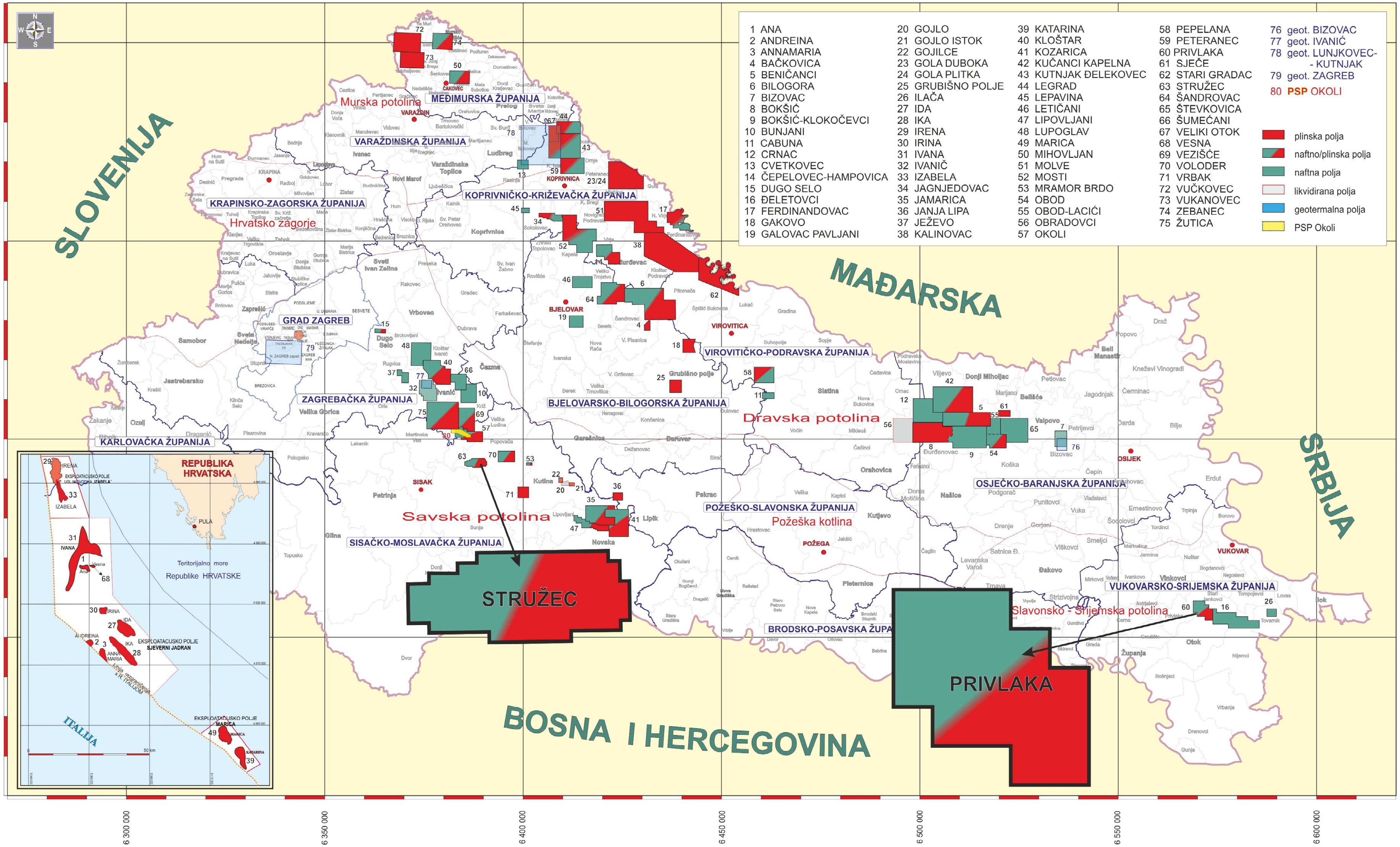
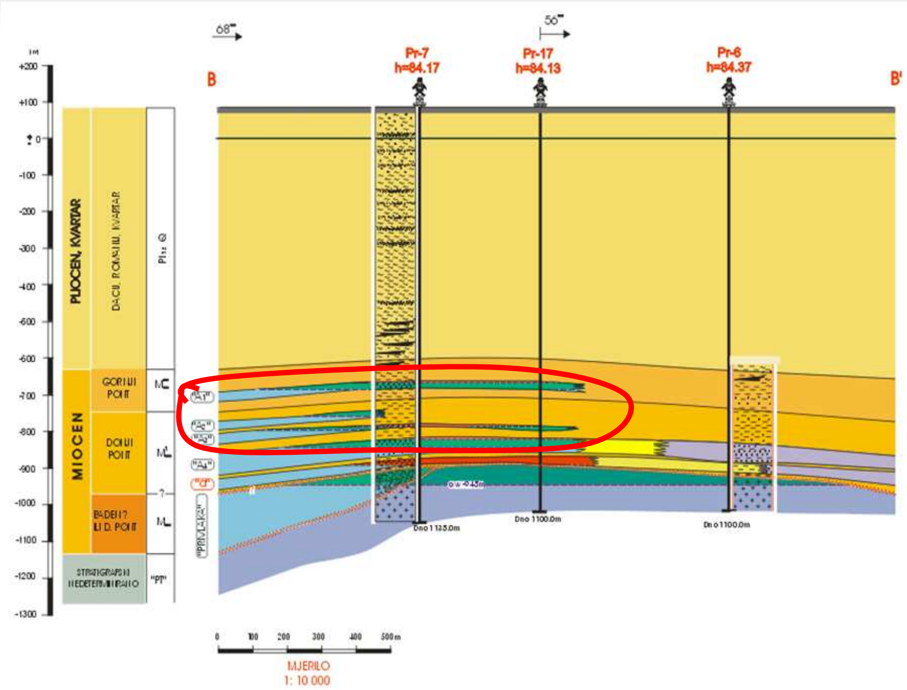
Stružec & Privlaka Field's Shalow Reservoirs

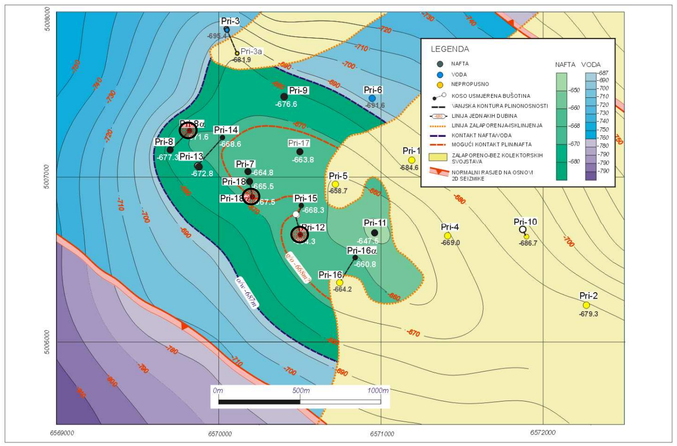


Privlaka Field Shalow Reservoirs - A1,A2,A3

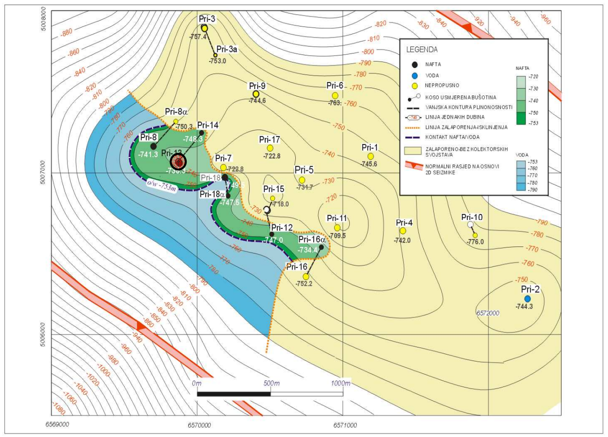


- fine-grained, highly unconsolidated sandstones
- oil saturated
- h_{ef} = 3 - 8 m (750 - 900 mTVD)
- K_{oil} = 244 - 270 mD
- conventional GP unsuccessful

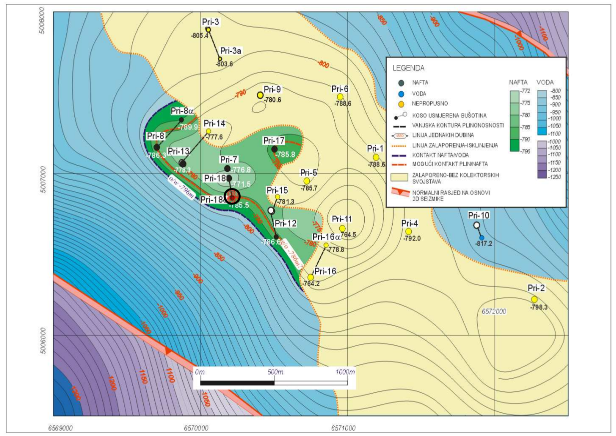
A1 Reservoir



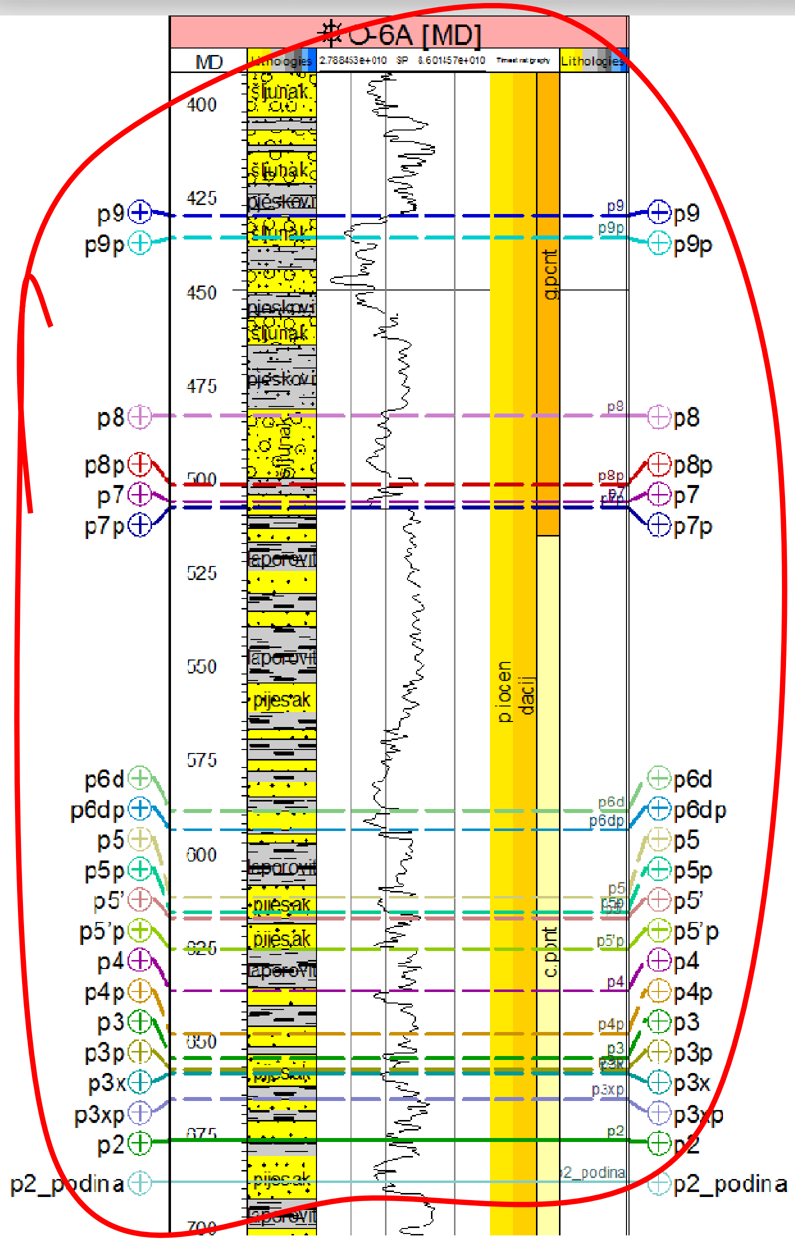
A2 Reservoir



A3 Reservoir



Stružec Field Shalow Reservoirs p2 -p9



- 19 o&g uncons. sandstone reserv.
- h_{ef} = 1 - 3 m (400 - 700 mTVD)
- K_o = up to100 mD; K_g = cca 20 mD
- ineffective sand control (8 oil wells producing with high skin and water conning problem)
- 7 gas wells stopped due to sand control problem (since 70's)
- additional potential of 9 gas and 10 oil wells currently inactive wells to complete shallow reservoirs

GOALS - SUMMARY

GOALS

- testing the feasibility, effectiveness and reliability of Frac Pack technology in existing 5 ½" cased hole wells as:
  - sand control reservoir completion technique;
  - stimulation reservoir completion technique;
- reservoirs (wells) productivity index (PI) evaluation, quantification and future PI estimation;
- testing the feasibility effectiveness and reliability:
  - of multizonal sand control completion in commingled production from several reservoirs at naturally flowing or artificial lift environment;
  - of Sucker Rod Pumping Automating System and impact to production optimization on sand control completion environment;

GOALS - SUMMARY

GOALS

- matching Privlaka Field Shallow Reservoirs Integrated Production Model (IPM) to tested wells performance with the aim to reevaluate production potential for chosen development scenario;

- matching Stružec Field Shallow Reservoirs Integrated Production Models (IPM) to tested wells performance with the aim to accurately estimate production potential for various fields' development scenarios in Stružec Field Shallow Reservoirs Development Feasibility Study which will be done in parallel;

RISKS

RISKS

- certain probability of production casing integrity failures due to time - corrosion induced wall loss;

- due to non-representative formation sand-silt sample availability, there is a certain probability of sand control induced productivity impairment caused by no optimal proppant selection, i.e. probability of productivity index overestimation which can have impact on production profile and overall recovery factor;

- certain probability of productivity index overestimation is possible also due to deviation of actual achieved fracture geometry to those optimal mathematically modeled;

TARGETS - KEY ISSUES TO BE SOLVED

- RESERVOIR COMPLETION SELECTION IN 5-1/2” CASING
  - effective sand control
  - maximize productivity index
  - multiple stacked selective completion
  - to provide fluid loss control during job execution - well completion
- UPPER COMPLETION OPTIMIZATION
  - to optimize vertical lift performance
- UTILIZE EXISTING WELL - SURFACE INFRASTRUCTURE
- INTEGRATED PRODUCTION MODELING APPROACH

EFFECTIVE SAND CONTROL

- KEY ISSUE FOR SAND CONTROL (ON BOTH FIELDS)
  - no available representative formation sand sample
- WHAT WE KNOW?
  - with 4 spf dp spiral overbalanced perf's
  - with 20-40 us mesh gravel for sand control
  - with 8 gauge 2-7/8" screens for gravel control
  - have good sand control w/ very high inflow restriction (enormous skin)

EFFECTIVE SAND CONTROL

- CONSEQUENCES
  - no production from Privlaka field unconsolidated shallow reservoirs at all
  - very restricted oil production w/ water conning problem and no gas production at all from unconsolidated shallow reservoirs on Stružec field
- WHAT WE CAN DO IN „MATURE” CASED HOLE WELLS ??
  - Frac Pack
  - High Rate Water Pack
  - Gravel Pack

EFFECTIVE SAND CONTROL

- VOLUMETRIC FLUX

$$v_{SF} = \frac{B_o \, q_o}{A_{GP,FP,...}}$$

- BASIC CONCEPT

$$v_{SF} < v_{SF,critical}$$

- TARGET
  - sand face volumetric flux as less as possible
  - target is to maximize effective filtration area

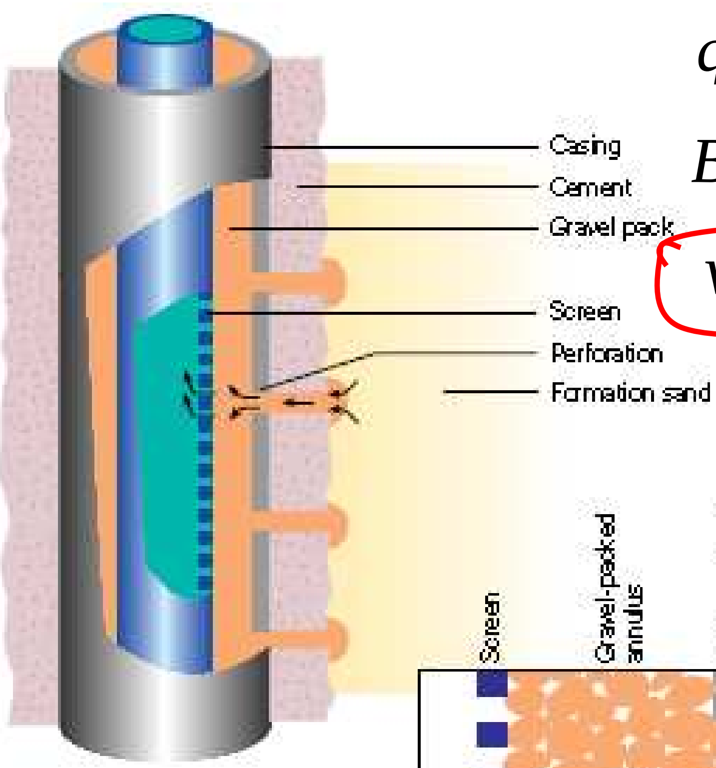
$$A_{GP} = 2 r_p \pi L_p h_{ef} SPF$$

$$A_{GP} = 1{,}668\, m^2$$

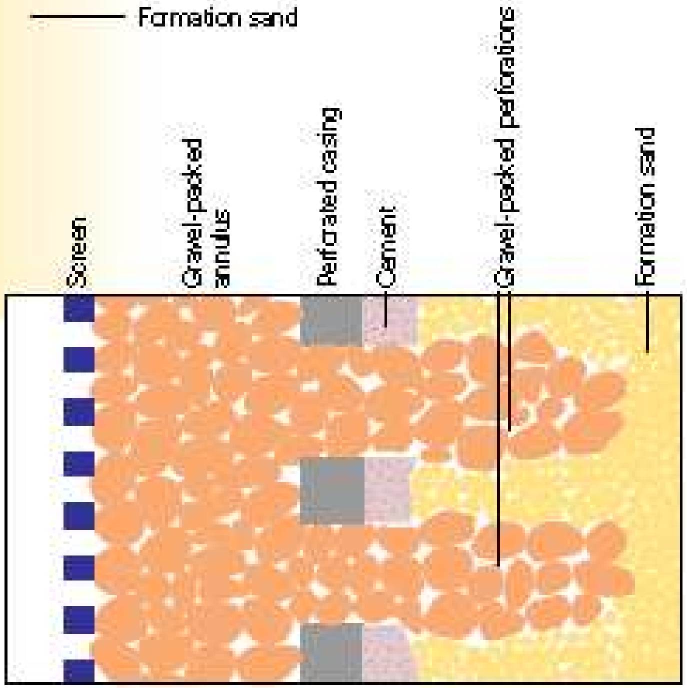
$$q_o = 15\, m^3 / day$$

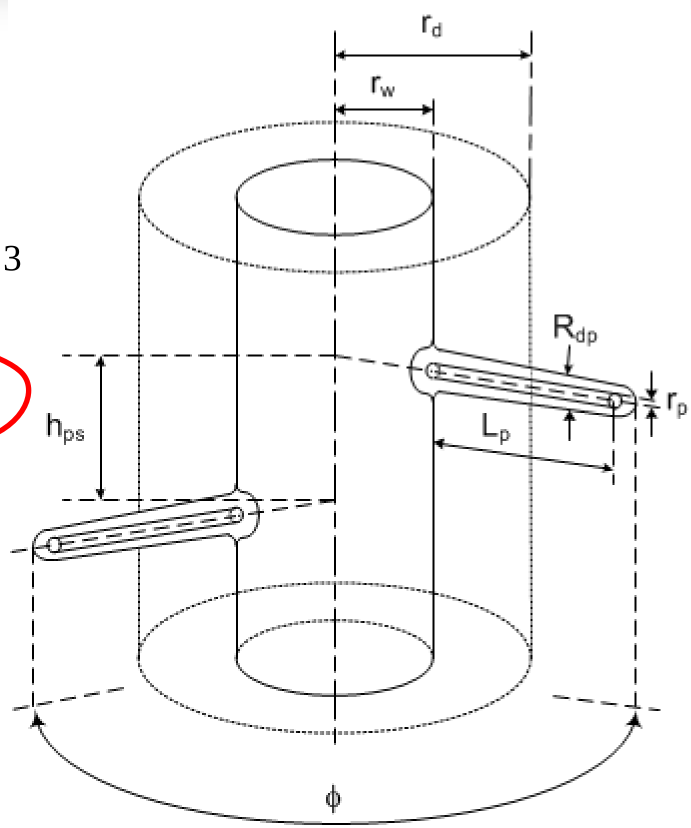
$$B_o = 1{,}092\, m^3 / Sm^3$$

$$v_{SF} = 9{,}82\, m / s$$



Anatomy of a cased-hole gravel pack.





$$SPF = 39\ perf / m$$

$$r_p = 0{,}008\, m$$

$$L_p = 0{,}127\, m$$

$$h_{ef} = 6{,}7\, m$$

SAND CONTROL - UFD METHOD

$$N_{prop} = \frac{2k_f}{k_R}\frac{V_{prop-2wings}}{V_{drenge}} = 2\frac{220000\,mD}{244\,mD}\frac{3,545\,m^3}{841950\,m^3} = 0,007593\ \ for\ 1000\ {}^{kg}\!/_{m}$$

$$for\ N_{prop} \leq 0,1 \Rightarrow C_{fD,opt}\left(N_{prop}\right) = 1,6$$

$$J_{fD,\max}\left(N_{prop} \leq 0,1\right) = \frac{1}{0,990 - 0,5\ln\left(N_{prop}\right)} = \frac{1}{0,990 - 0,5\ln\left(0,007593\right)} = 0,29152$$

$$w_{opt} = \left(\frac{C_{fD,opt}\left(V_{prop-2wings}/2\right)k_R}{h_{ef,f}k_f}\right)^{1/2} = \left(\frac{1,6\times\left(3,545/2\right)\times 244}{6,7\times 220000}\right)^{1/2} = 0,021667\,m$$

$$x_{f,opt} = \left(\frac{\left(V_{prop-2wings}/2\right)k_f}{C_{fD,opt}h_{ef}k_R}\right)^{1/2} = \left(\frac{\left(3,545/2\right)\times 220000}{1,6\times 6,7\times 244}\right)^{1/2} = 12,21m$$

SAND CONTROL - UFD METHOD

$$N_{prop} = \frac{2k_f}{k_R}\frac{V_{prop-2wings}}{V_{drenge}} = 2\frac{47700\,mD}{244\,mD}\frac{3,545\,m^3}{841950\,m^3} = 0,001646 \;\; for\, 1000\, {}^{kg}\!/_{m}$$

$$for\; N_{prop} \le 0,1 \Rightarrow C_{fD,opt}\left(N_{prop}\right) = 1,6$$

$$J_{fD,\max}\left(N_{prop} \le 0,1\right) = \frac{1}{0,990 - 0,5\ln\left(N_{prop}\right)} = \frac{1}{0,990 - 0,5\ln\left(0,001646\right)} = 0,2384$$

$$w_{opt} = \left(\frac{C_{fD,opt}\left({}^{V_{prop-2wings}}\!/_{2}\right)k_R}{h_{ef,f}\,k_f}\right)^{1/2} = \left(\frac{1,6\times\left({}^{3,545}\!/_{2}\right)\times 244}{6,7\times 47700}\right)^{1/2} = 0,04653\,m$$

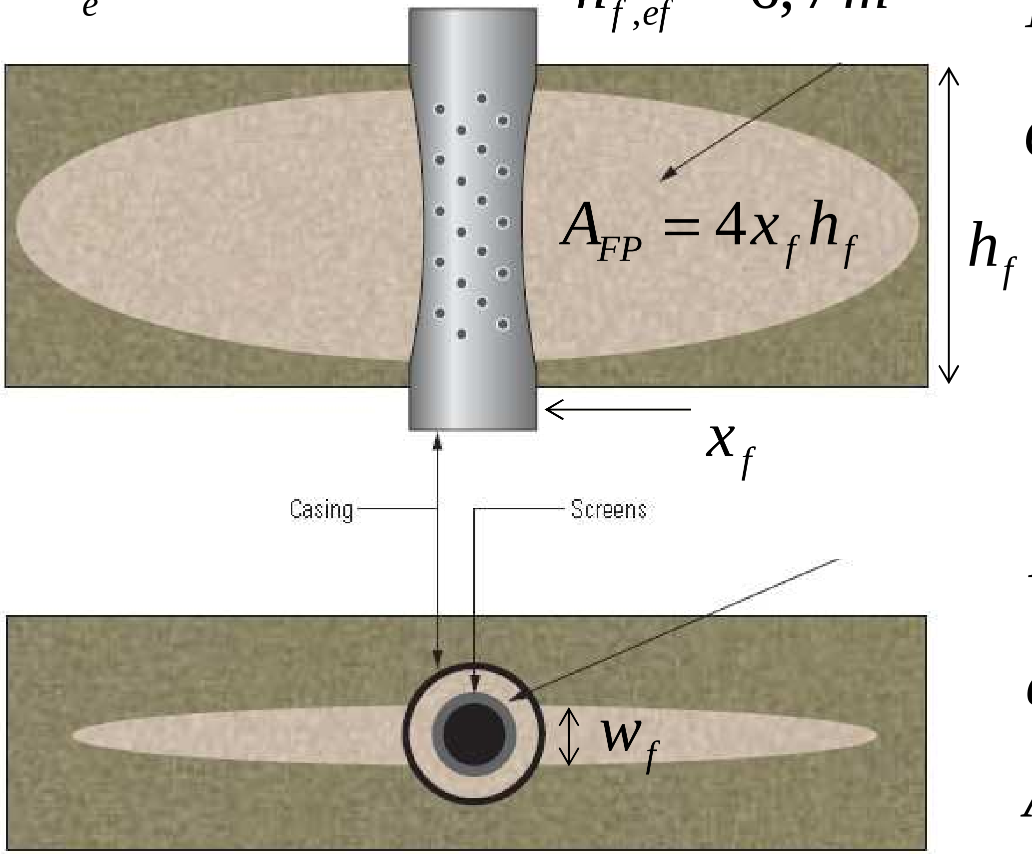
$$x_{f,opt} = \left(\frac{\left({}^{V_{prop-2wings}}\!/_{2}\right)k_f}{C_{fD,opt}\,h_{ef}\,k_R}\right)^{1/2} = \left(\frac{\left({}^{3,545}\!/_{2}\right)\times 47700}{1,6\times 6,7\times 244}\right)^{1/2} = 5,685\,m$$

SAND CONTROL - CHFP Pri-12 CASE

UNIFIED FRACTURE DESIGN METHOD (Valco & Economides)

$r_e = 200\,m$

$h_{f,ef} = 6,7\,m$



$N_{prop} = 0,007593 \; for\, 1000\, kg/m$

$C_{fD,opt} = 1,6; \qquad J_{fD,\max} = 0,29152$

$x_{f,opt} = 12,21\,m$

$w_{f,opt} = 2,17\,cm$

$B_o = 1,092 \; m^3 / Sm^3$

$q_o = 15 \; m^3 / day$

$A_{FP} = 326,96\,m^2 (196,0 \times A_{GP})$

$$FOI = \frac{\ln\left(\frac{r_e}{r_w}\right) - \frac{3}{4} + (s_t = 0)}{\ln\left(\frac{r_e}{x_f}\right) + \left(s_f + \ln\frac{x_f}{r_w}\right) - \frac{3}{4} + s_G} = 4,169$$

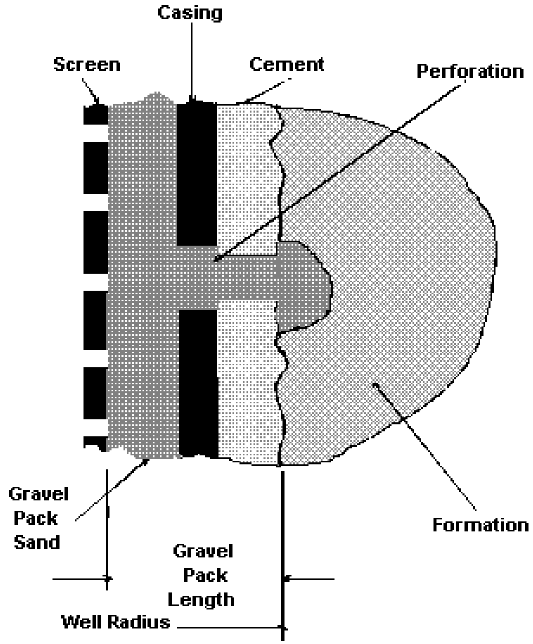
$v_{SF,FP} = 0,05\,m/s\,(196,0 \times v_{SF,GP})$

DIMENSIONLESS PRODUCTIVITY INDEX

- DIMENSIONLESS PRODUCTIVITY INDEX - GRAVEL PACK

$$J_{fD} = \frac{1}{\ln\left(\frac{r_e}{r_w}\right) + s_G - \frac{3}{4}}$$

$$s_G = 8,0\frac{\left(k_R / k_G\right) h_p L_p}{d_p^2 n_p}$$



- DIMENSIONLESS PRODUCTIVITY INDEX - FRAC PACK

$$J_{fD} = \frac{1}{\ln\left(\frac{r_e}{r_w}\right) + s_f + s_G - \frac{3}{4}} = \frac{1}{\ln\left(\frac{r_e}{x_f}\right) + \left(s_f + \ln\frac{x_f}{r_w}\right) + s_G - \frac{3}{4}}$$

DIMENSIONLESS PRODUCTIVITY INDEX

- EQUIVALENT SKIN DUE TO FRACTURE EFFECT

$$s_f = \frac{1}{J_{fD,\max}} - \ln\left(\frac{r_e}{r_w}\right) + \frac{3}{4}$$

FROM UFD

- FOLDS OF INCREASE

$$FOI = \frac{J_{fD}}{J_{sD}} = \frac{\ln\left(\frac{r_e}{r_w}\right) - \frac{3}{4} + s_{total}}{\ln\left(\frac{r_e}{x_f}\right) + \left(s_f + \ln\frac{x_f}{r_w}\right) - \frac{3}{4} + s_G}$$

DIMENSIONLESS PRODUCTIVITY INDEX

$$J = \frac{q}{\overline{p} - p_{wf}} = \frac{2\pi kh}{\alpha B\mu} J_D$$

Pri-12 EXAMPLE

$$J_{fD,\max}\left(N_{prop} \le 0,1\right) = \frac{1}{0,990 - 0,5\ln\left(N_{prop}\right)} = \frac{1}{0,990 - 0,5\ln\left(0,007593\right)} = 0,29152$$

$$s_f = \frac{1}{J_{fD,\max}} - \ln\left(\frac{r_e}{r_w}\right) + \frac{3}{4} = \frac{1}{0,29152} - \ln\left(\frac{200}{0,108}\right) + \frac{3}{4} = -3,34365$$

$$s_G = 8,0\frac{\left(k_R / k_G\right) h_p L_p}{d_p^2 \, n_p} = 8,0\frac{\left(244/200000\right)\times 6,7\times 0,127}{0,008^2 \times 261} = 0,497$$

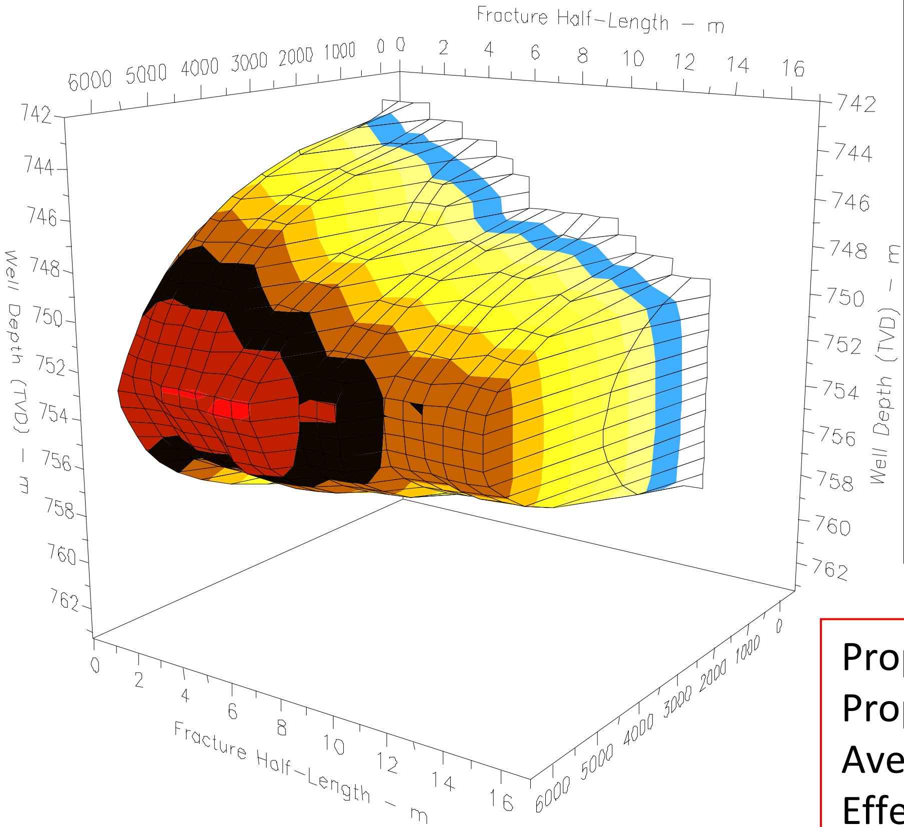
$$FOI = \frac{\ln\left(\frac{r_e}{r_w}\right) - \frac{3}{4} + s_G}{\ln\left(\frac{r_e}{x_f}\right) + \left(s_f + \ln\frac{x_f}{r_w}\right) - \frac{3}{4} + s_G} = \frac{\ln\left(\frac{200}{0,108}\right) - \frac{3}{4} + 0}{\ln\left(\frac{200}{12,21}\right) + \left(-3,34365 + \ln\frac{12,21}{0,108}\right) - \frac{3}{4} + 0,497} = 4,169$$

FRACTURE DESIGN (Pri - 12 EXAMPLE)

Dist. from Well	Prop Width	Prop Height	Prop Conc.	Conduc-tivity
m	mm	m	lb/ft^2	mD m
3,5	21,3	16,1	7,67	4375
6,9	21,4	12,9	7,69	4449
10,4	18,3	11,5	6,56	3858
13,8	12,1	7,3	4,33	2433

Target reservoir „A1” 770,0 - 781,0 mTVD (11 m)
Target proppant conc. 1000 kg/(mTVD of fracture)
$x_{f,opt} = 12,21\,m\,;\; w_{f,opt} = 2,17\,cm$
Target geometry

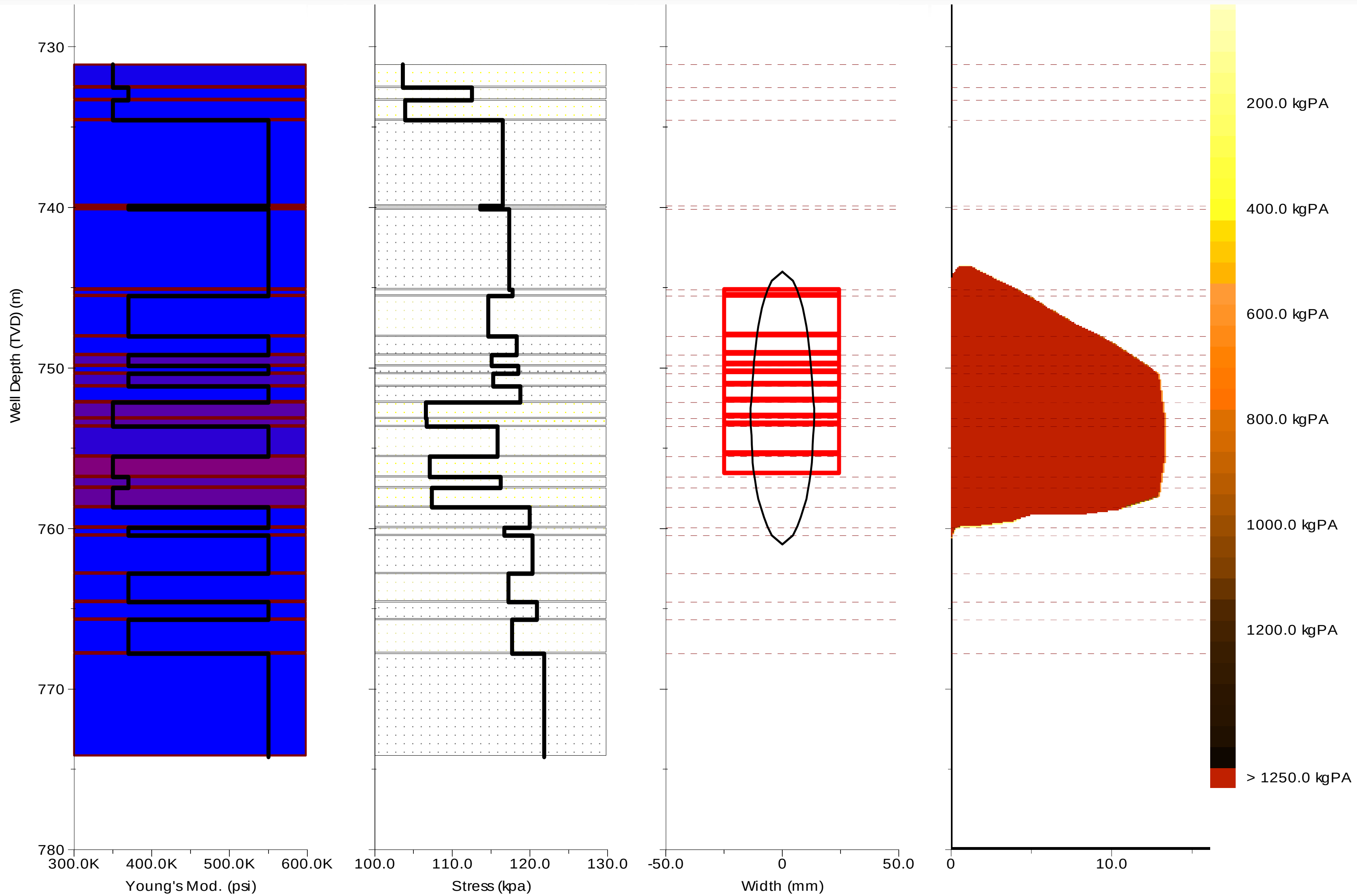
Proppant „Econoprop” 30 - 50; 220 000 mD in situ
VES fluid 92 cP @ 170 1/s; c_t = 1,5E-3 ft/min(0.5)
n'= 0,75; K'= 8,531E-03 lbf.s^n/ft2



Stage Nbr	Pump Rate	Fluid Name	Clean Fluid	Proppant Nbr.	Prop. Conc.	Prop. Mass	Slurry Volume	Inj. Time
	bbl/min		m3		PPA	kg	m3	min
1	3	PAD	2,50	0	0	0	2,50	5,2
2	3	VES	0,50	30/50 Econoprop	0,5	30,0	0,50	1,1
3	3	VES	0,75	30/50 Econoprop	1,0	89,9	0,80	1,6
4	3	VES	1,00	30/50 Econoprop	2,0	239,7	1,10	2,3
5	3	VES	1,25	30/50 Econoprop	3,0	449,3	1,40	3,0
6	3	VES	1,50	30/50 Econoprop	4,0	719,0	1,80	3,7
7	3	VES	1,75	30/50 Econoprop	5,0	1048,5	2,10	4,5
8	3	VES	2,00	30/50 Econoprop	6,0	1437,9	2,50	5,3
9	3	VES	2,25	30/50 Econoprop	7,0	1887,3	2,90	6,2
10	3	VES	2,50	30/50 Econoprop	8,0	2396,5	3,40	7,1
11	3	VES	2,85	30/50 Econoprop	9,0	3073,5	4,00	8,4
		Total:	21,10			11371,5	25,30	53,1

Propped Fracture Half-Length 13,8 m
Propped Width at Well 2,11 cm (0,833 in)
Average Propped Width 1,82 cm (0,718 in)
Effective Conductivity 3635 mD m

FRACTURE DESIGN (Pri - 12 EXAMPLE)



FRACTURE DESIGN (Pri - 12 EXAMPLE)

Top TVD	Top MD	Rock Type	Leakoff Height	Fracture Gradient	In-situ Stress	Young's Modilus	Poisson's Ratio	Fracture Toughness	Reservoir Pressure	Permeab.
m	m	psi	m	psi/ft	bar	psi		psi*in^{0,5}	bar	mD
731,10	751,40	CLEAN-SANDSTONE	1,40	0,63	103,63	3,50E+05	0,25	2500	77,47	200
732,50	752,90	DIRTY-SANDSTONE	0,80	0,68	112,52	3,70E+05	0,29	2300	77,59	50
733,30	753,80	CLEAN-SANDSTONE	1,30	0,63	103,93	3,50E+05	0,25	2500	77,70	200
734,60	755,10	SHALE	5,30	0,70	116,49	5,50E+05	0,35	1000	78,05	0
739,90	760,70	DIRTY-SANDSTONE	0,20	0,68	113,61	3,70E+05	0,29	2300	78,34	5
740,10	761,00	SHALE	5,00	0,70	117,34	5,50E+05	0,35	1000	78,62	0
745,10	766,30	SHALE	0,40	0,70	117,76	5,50E+05	0,35	1000	78,90	0
745,50	766,70	DIRTY-SANDSTONE	2,50	0,68	114,65	3,70E+05	0,29	2300	79,06	20
748,00	769,40	SHALE	1,20	0,70	118,28	5,50E+05	0,35	1000	79,25	0
749,20	770,70	DIRTY-SANDSTONE	0,70	0,68	115,07	3,70E+05	0,29	2300	79,35	50
749,90	771,40	SHALE	0,50	0,70	118,52	5,50E+05	0,35	1000	79,41	0
750,40	771,90	DIRTY-SANDSTONE	0,80	0,68	115,26	3,70E+05	0,29	2300	79,48	50
751,20	772,80	SHALE	1,00	0,70	118,76	5,50E+05	0,35	1000	79,57	0
752,20	773,80	CLEAN-SANDSTONE	1,00	0,63	106,58	3,50E+05	0,25	2500	79,68	250
753,20	774,90	CLEAN-SANDSTONE	0,50	0,63	106,69	3,50E+05	0,25	2500	79,76	250
753,70	775,40	DIRTY-SANDSTONE	1,90	0,68	115,84	5,50E+05	0,29	2300	79,94	50
755,50	777,50	CLEAN-SANDSTONE	1,30	0,63	107,08	3,50E+05	0,20	2500	80,05	250
756,80	778,80	DIRTY-SANDSTONE	0,70	0,68	116,23	3,70E+05	0,29	2300	80,15	50
757,50	779,60	CLEAN-SANDSTONE	1,20	0,63	107,35	3,50E+05	0,25	2500	80,25	250
758,70	780,90	SHALE	1,30	0,70	119,97	5,50E+05	0,35	1000	80,39	0
760,00	782,30	DIRTY-SANDSTONE	0,50	0,68	116,71	3,70E+05	0,29	2300	80,48	10
760,40	782,80	SHALE	2,40	0,70	120,34	5,50E+05	0,35	1000	80,63	0
762,80	785,40	DIRTY-SANDSTONE	1,80	0,68	117,24	3,70E+05	0,29	2300	80,85	20
764,60	787,30	SHALE	1,10	0,70	120,89	5,50E+05	0,35	1000	81,00	0
765,70	788,50	DIRTY-SANDSTONE	2,10	0,68	117,71	3,70E+05	0,29	2300	81,17	50
767,80	790,80	SHALE	6,40	0,70	121,82	5,50E+05	0,35	1000	81,62	0

RESERVOIR COMPLETION

- 30-50 US Mesh Lightweight (Econoprop or equivalent) proppant in combination with 3-1/4” gauge 8 prepacked screens as a filtering media
- VES (viscoelastic system) preferably or other viscous polymers will be used as a proppant carrier
- It is anticipated that up to 10 bpm may be required to treat the longer intervals
- Step rate tests, circulation tests and a mini-frac will be conducted prior to the main treatment
- A tip screen out fracture treatment will be designed and executed with a goal of achieving high net pressure

WELLS PREPARATION

- 5 1/2”, J-55, 14 # and 15,5 # csg sizes in vertical or slightly deviated wells till to 23°
- Properly cleaned well – rig – tools i.e., total system is mandatory for successful completion operations.
- Casing will be scraped & brushed, pickled and sand blasted to remove impurities, rust and deposited hydrocarbons from casing wall, at the end displacement of well volume will be performed to KCl 1,20 sg filtered completion brine.
- Circulation and filtration of returned brine will be continued until a minimum value of 20 NTU is obtained at surface while circulating.

WELLS PREPARATION

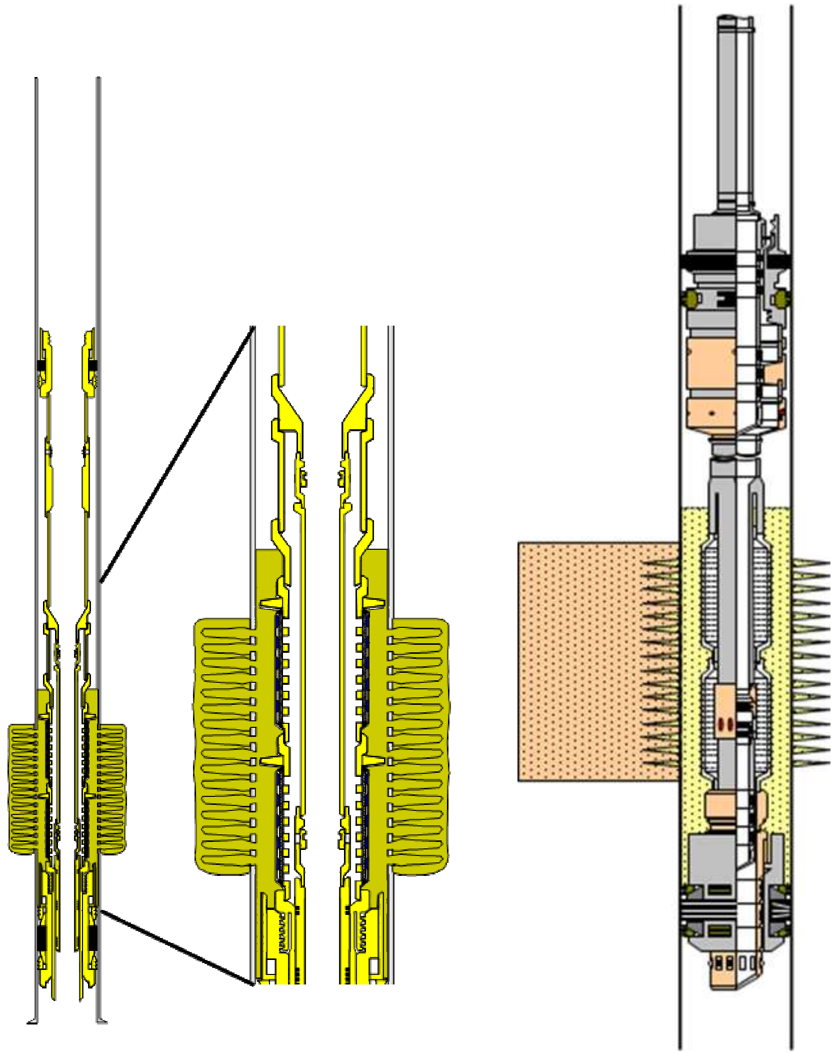
- Killing the well, pooling out of hole existing well completion and already perforated not targeted reservoirs isolation;
- Mechanically removing (scraping and brushing) impurities, rust and deposited hydrocarbons from casing wall with special attention to area of FP hardware installation. Work string will consist of Taper Mill, Scraper Rotovert, Casing Brushes carried on 2-7/8” tubing work string;
- Casing pickling activities utilizing standard INA PT-15 pickling pills formulation, consisting of prescribed ratios of HCl, NH4Cl, Citric Acid and Corrosion Inhibitors mixed in fresh water to dissolve and remove mechanically non removable impurities. Pickling will be performed by separate 2-7/8” tubing work string;
- Casing sand blasting activities to finally remove finest impurities from production casing wall performed in continuity to casing pickling by the same 2-7/8” tubing work string. At the end of the job, displacement of well volume will be performed to KCl 1,20 sg filtered completion brine.
- Circulation and filtration of returned brine will be continued until a minimum value of 20 NTU is obtained at surface while circulating. At the end production casing pressure testing and pooling out of hole of 2-7/8” tubing work string will be performed.

WELLS PREPARATION

- In casing logging
  - Gama Ray Neutron (GRN) / Casing Collar Locator (CCL);
  - Cement Bond Log (CBL) / Casing Collar Locator (CCL);
  - Temperature/ diff. temperature(T/dT) / Casing Collar Locator (CCL);
  - Multifinger Caliper (MFC)
- intervals will be perforated with casing guns 12spf, 135° /45° phasing big hole charges in overbalanced conditions (zones of interest from 400 ÷ 900 mTVD and 3 ÷ 15 mMD in length)
- wellbore cleaning after perforating by running in hole Taper Mill or Washover Shoe, Ventury Junk Basket, Standard Junk Basket Tandem, Magnets Tandem and Jar Assembly

RESERVOIR COMP. - FLUID LOSS CONT.

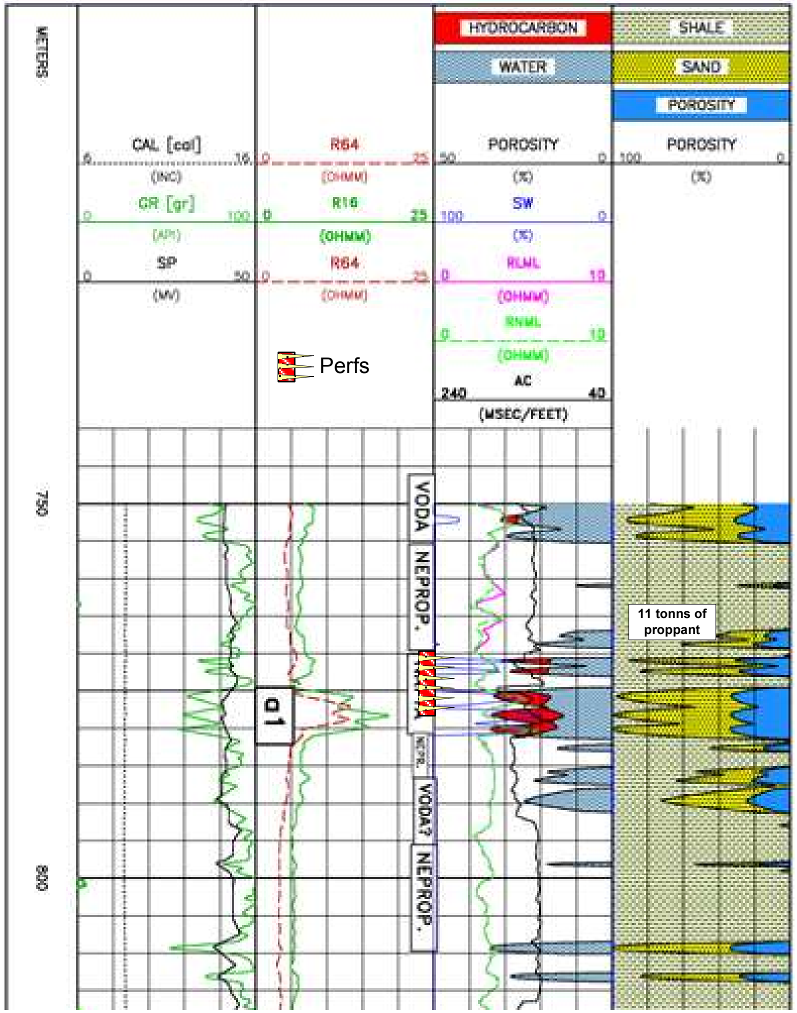
- Fluid loss will be controlled mechanically utilizing three way sub (double pin sub) – Sliding Sleave Door (SSD) inner string assembly upon completion of the job.
- Production selectivity of the completion

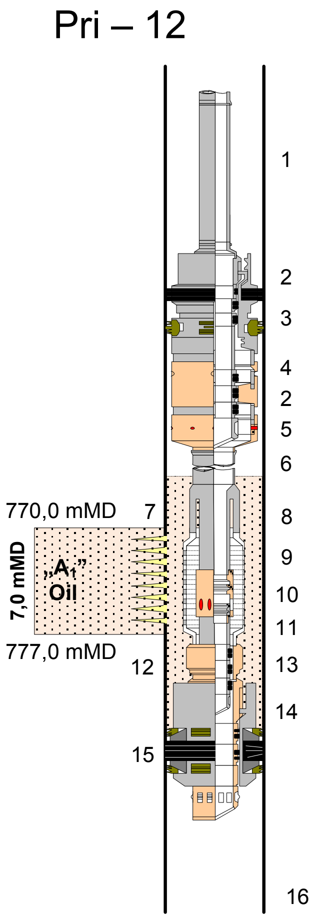


RESERVOIR COMPL. (Pri - 12 EXAMPLE)

	Oil form. vol. factor	Permeab.	Viscosity	Initial pressure	Reservoir temperature	Fracturing gradient
	B_{oi}	K	μ_{gi}	p_i	T_r	p_f
	m^3/Sm^3	$10^{-3}\ \mu m^2$	mPa·s	bar	°C	bar/10m
A_1	1.062	244	5.08	75.1	48.5	1.58

1.	TUBING EU 2-7/8"; 6,5#; N-80 - INA
2.	SNAP LATCH SEAL ASSY
3.	GRAVEL PACK PACKER
4.	GP EXTENSION (CIRC. HOUSING) W/ SLID. SLEEVE
5.	SHEAR OUT SAFETY JOINT
6.	BLANK PIPE
7.	TREE WAY SUB (DOUBLE PIN SUB)
8.	TUBING 2-3/8"; 4.7#; ST-L (OR EQUIVALENT)
9.	PREPACKED 3-1/4" 8 GAUGE SCREEN
10.	SSD 2-3/8" x 1,875" X PROFILE - CLOSE UP
11.	TUBING EU 2-3/8"; 4,6#; N-80 - INA
12.	SEAL BORE RECEPTACLE
13.	INNER STRING SEAL ASSY
14.	SUMP PACKER SEAL ASSY
15.	SUMP PACKER
16.	PRODUCTION CSG. 5-½"; 15,5#; J-55



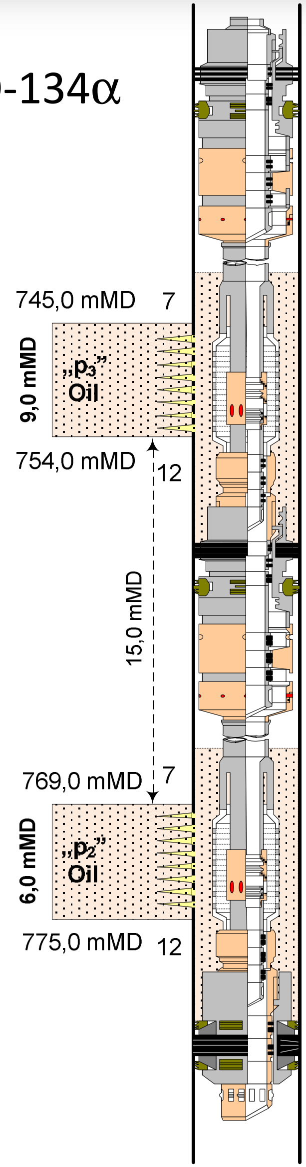


MD (m)	TVD (m)	Displ. (m)	Angle (deg.)
0	0	0.0	0.0
303	303	0.0	0.0
345	344	9.1	12.5
407	405	20.2	10.3
435	432	27.6	15.4
463	459	35.0	15.4
510	504	48.6	16.8
548	540	60.8	18.7
576	567	68.2	15.4
605	594	78.8	21.4
642	629	90.8	18.9
680	664	105.6	22.9
727	708	122.1	20.6
765	744	134.3	18.7
802	778	148.8	23.2

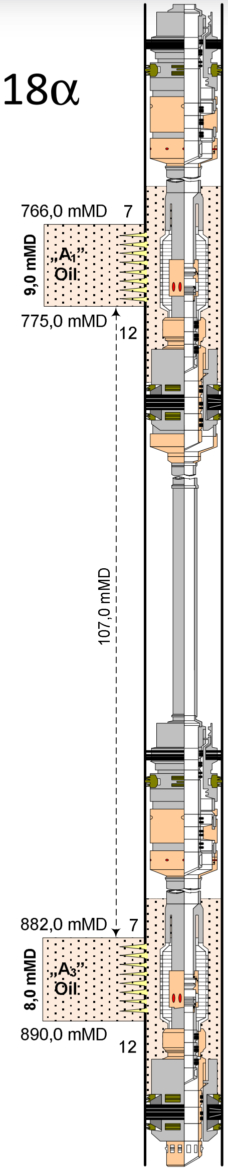
RESERVOIR COMPLETION

- Multiple Stacked Cased Hole Frac Pack Selective Sand Control Completions

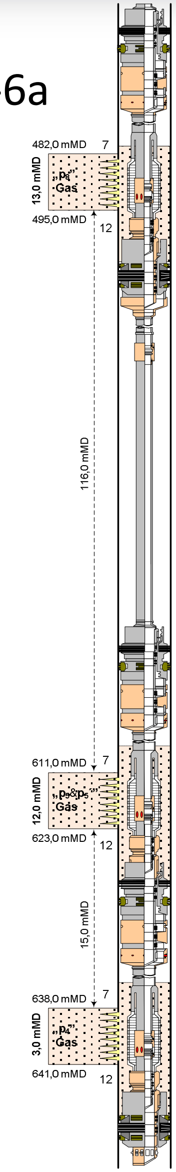
O-134α



O-18α



O-6a



UPPER COMPLETION & AL METHODS

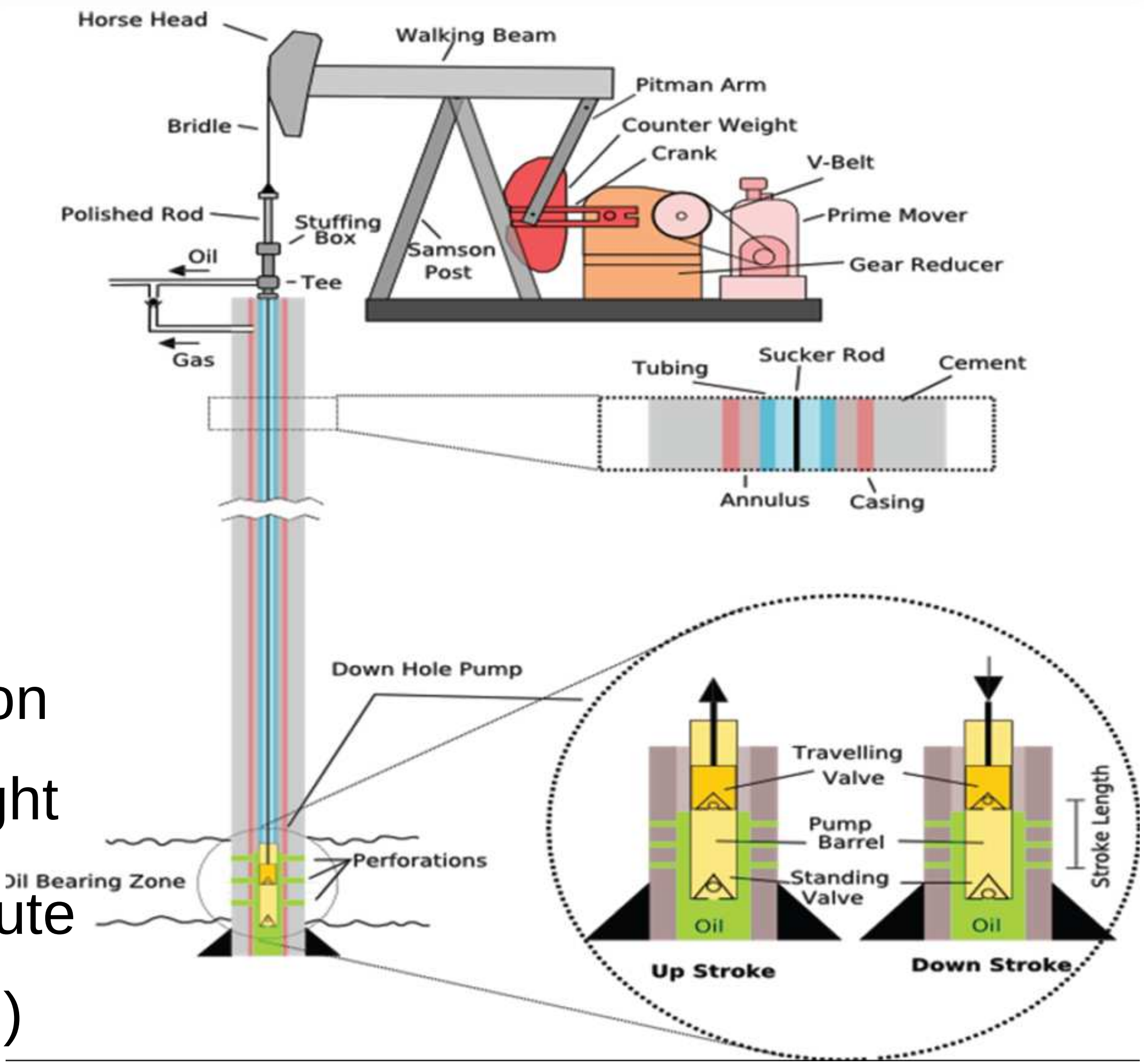
- Basic idea in regard to artificial lifting (AL) methods selection is to use existing completion – gathering system infrastructure if satisfying given production targets.
- Beam pumping unit method is AL method that have been using on Privlaka field. Both Pri – 12 and Pri – 18α wells are currently lifted with this method.
- Gas lift is AL method that have been using on Stružec field. O – 134α well is currently producing oil from deeper reservoir utilizing continuous gas lift as well.
- O – 6a gas well will be completed with naturaly flowing standard upper completion 2-7/8” production string.

UPPER COMPLETION & WELLS TESTING

- Upon finalizing reservoir completion activities 2-7/8” upper production strings will be installed in each well
- Configuration depends on Artificial Lift Method app.
- Typical well testing procedure will include:
  - – reservoir clean up period;
  - – vertical lift dynamic pressure and temperature gradient profile recording;
  - – pressure build up testing utilizing surface read out hardware and static pressure and temperature gradient profile recording

PRIVLAKA FIELD AL METHODS

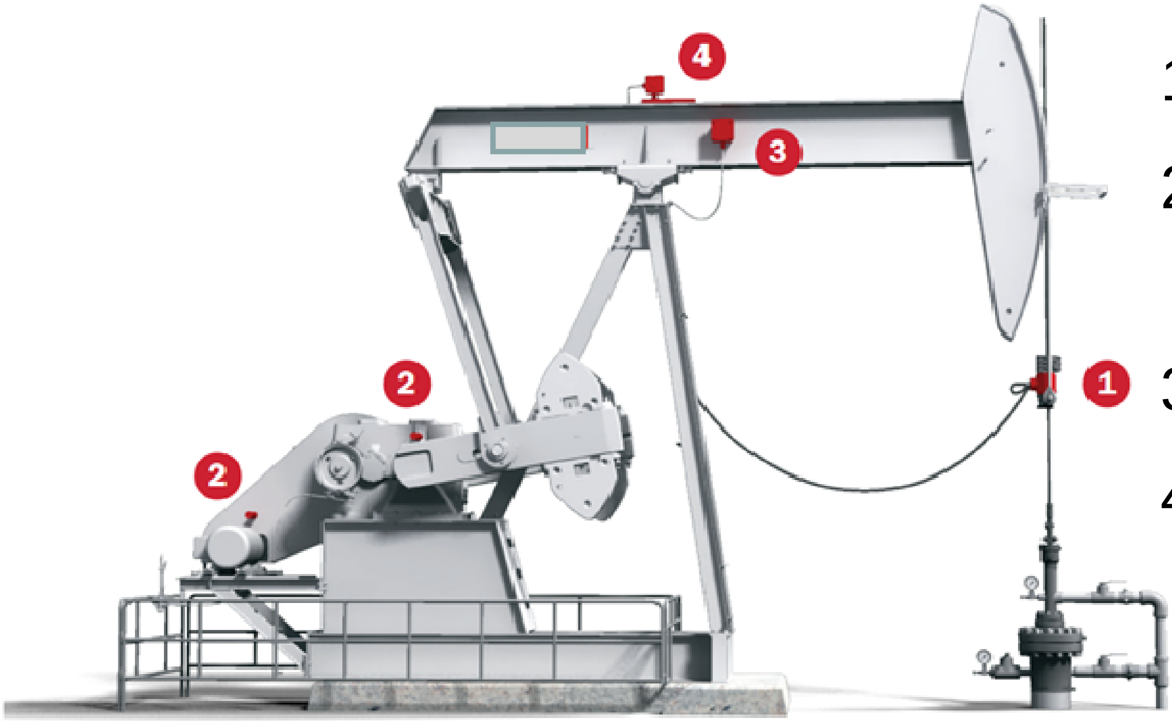
- Surface Unit's existing 160-143-74
- Tubing pump's max 2-1/2" available
- Request to meet the drawdown range
- Subject of optimization with max. stroke lenght
  - Strokes per minute (pumping speed)



PRIVLAKA FIELD AL METHODS

- to meet the drawdown range the pumping parameters (pumping speed, torque and load) will be controlled with Rod Pump Controller (RPC)
- surface stroke length will be as long as it could be

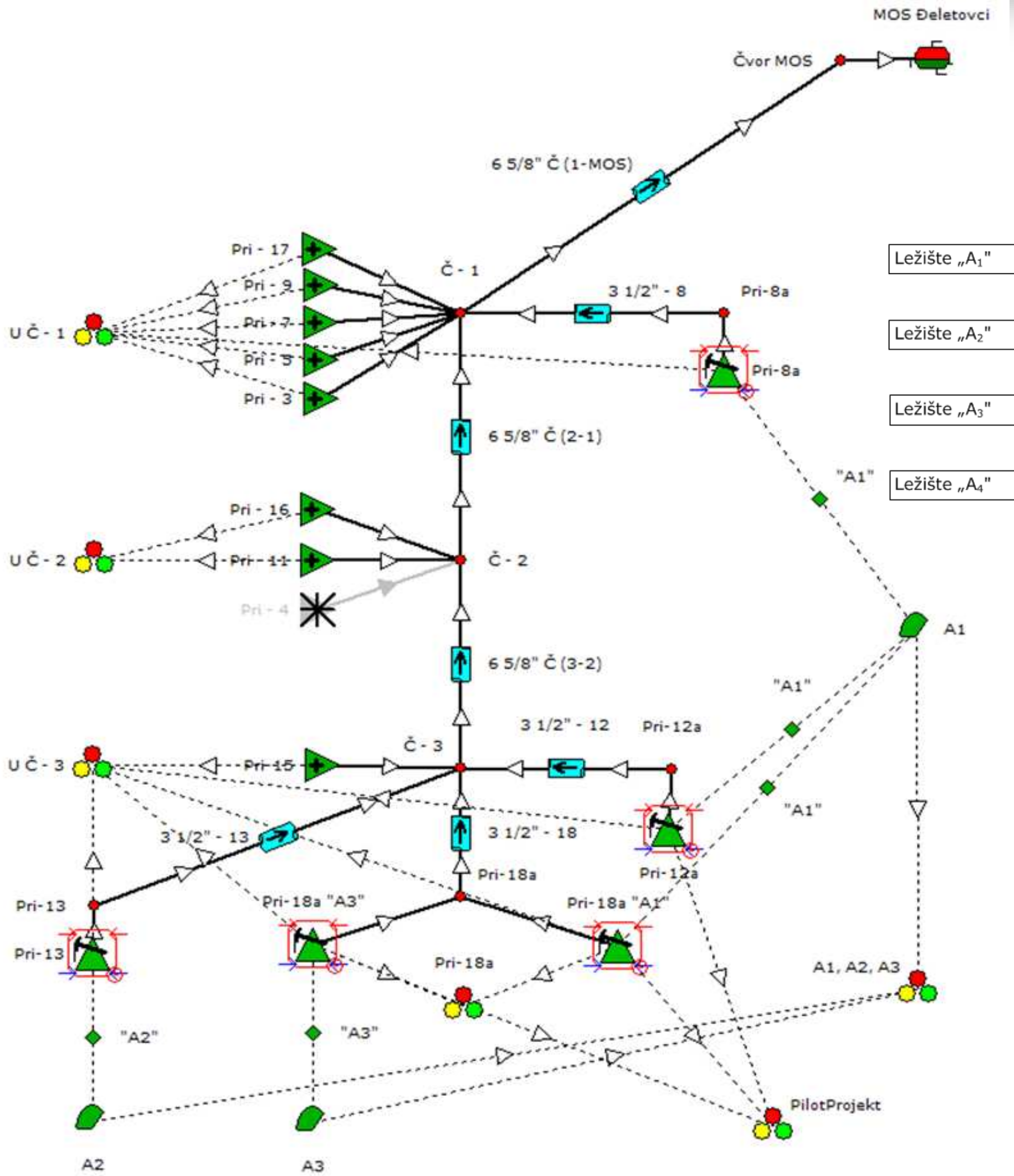
PRIVLAKA FIELD AL METHODS

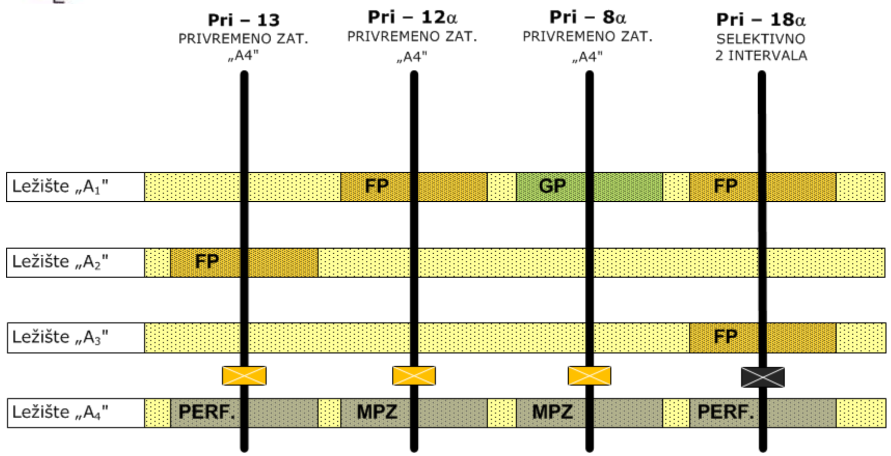


1. Polished Rod Load Cell
2. Motor and Crank Hall Effect Transducers
3. Inclinometer
4. Beam Transducers

- Transducers which are mounted on the pumping unit measure, monitor and send the data to controller.
- Central computer system analyzes data from transducers and controls the VFD.
- Variable Speed Drive (VSD) makes an optimal pumping unit speed.

PRIVLAKA FIELD IPM (A_1, A_2 I A_3)



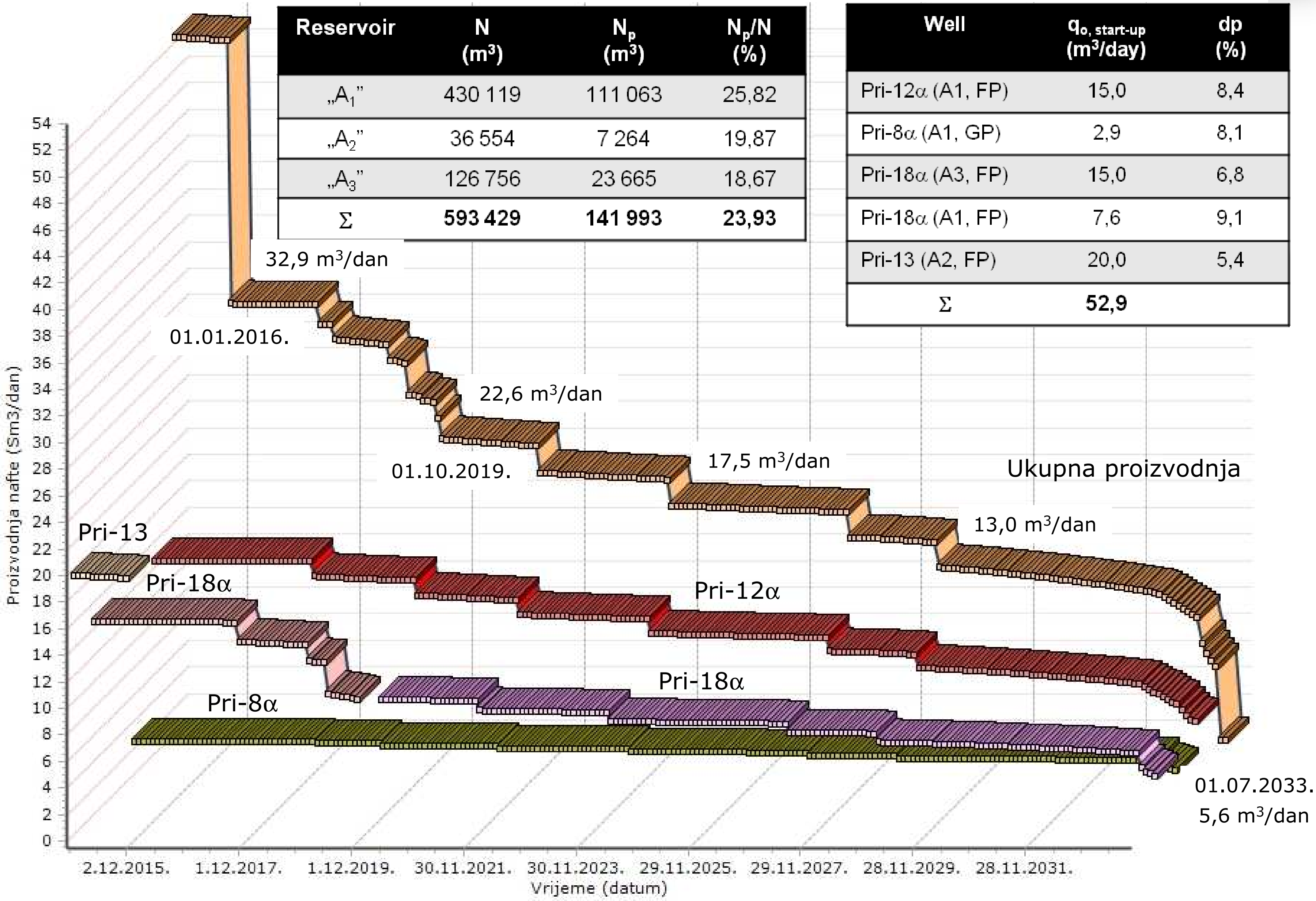


- P_{sep} = 3 bar
- P_R(abandoning) = 15 bar
- Max drawdown = 10% regulated by VFD's

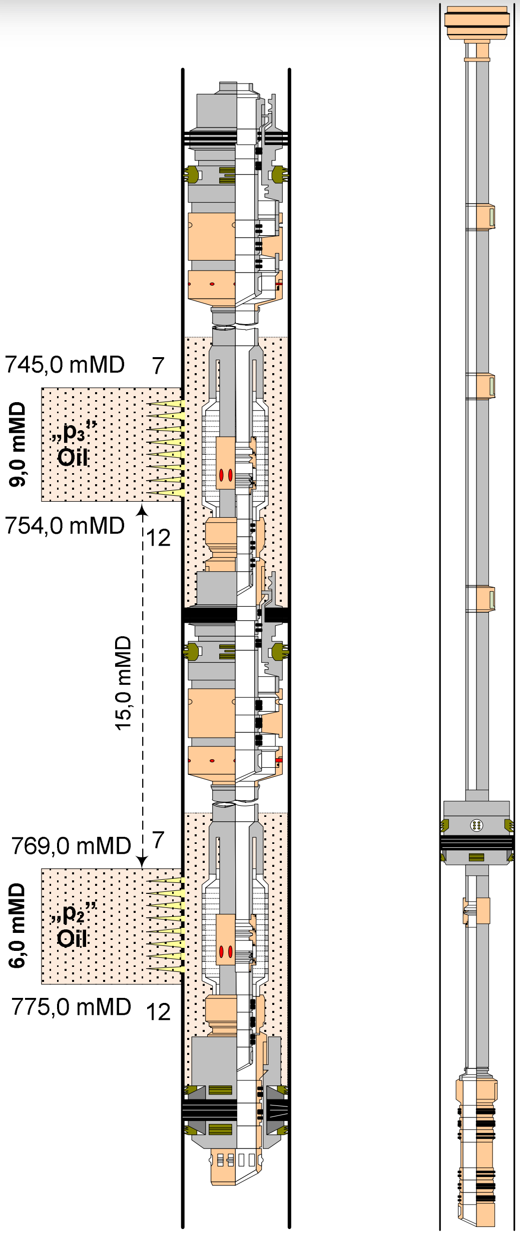
PRIVLAKA IPM RUN RESULTS EXAMPLE

Reservoir	N (m^3)	N_p (m^3)	N_p/N (%)
„A_1"	430 119	111 063	25,82
„A_2"	36 554	7 264	19,87
„A_3"	126 756	23 665	18,67
Σ	**593 429**	**141 993**	**23,93**

Well	$q_{o,\ start\text{-}up}$ (m^3/day)	dp (%)
Pri-12α (A1, FP)	15,0	8,4
Pri-8α (A1, GP)	2,9	8,1
Pri-18α (A3, FP)	15,0	6,8
Pri-18α (A1, FP)	7,6	9,1
Pri-13 (A2, FP)	20,0	5,4
Σ	**52,9**	

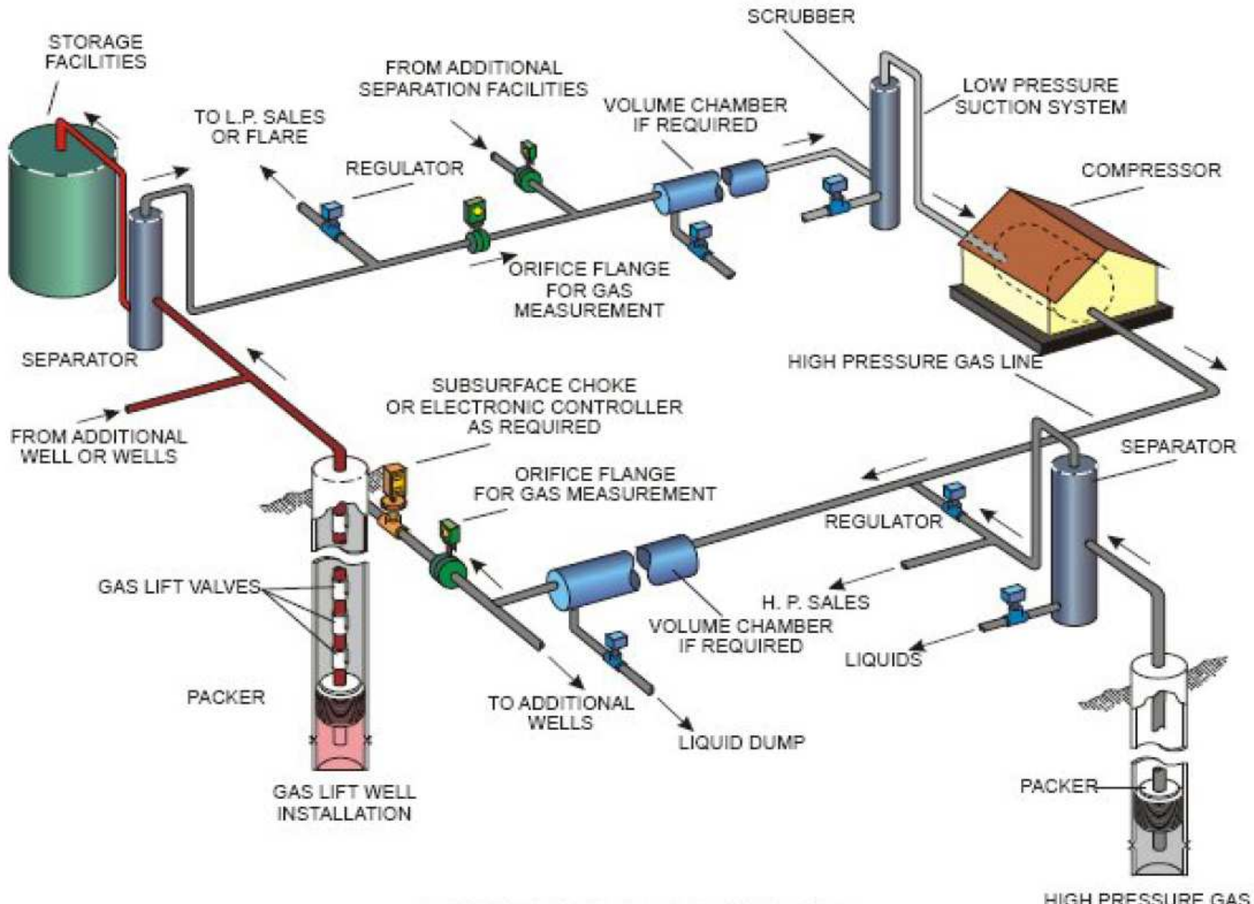


STRUŽEC FIELD AL METHODS



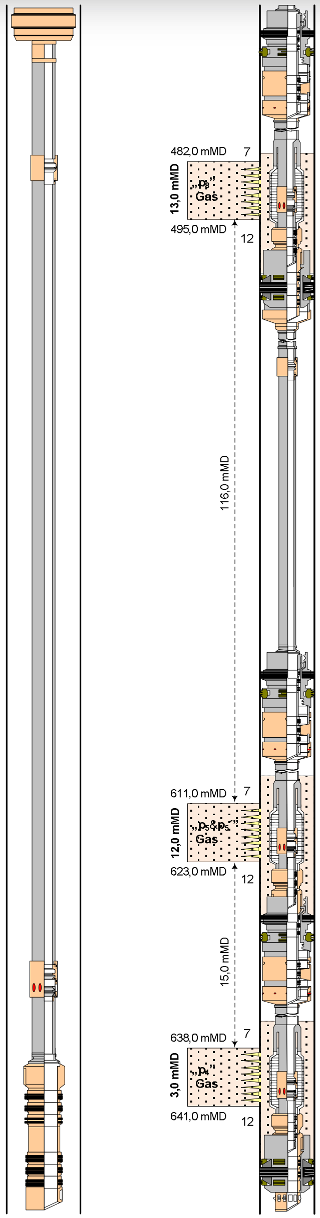
O - 134α Continous Gas Lift (Stružec Field)

•utilizing existing infrastructure - gathering system



Basic Components for a Gas Lift System

STRUŽEC FIELD GAS WELL COMPLETION



O - 6a Gas Well

- well will be completed with standard upper completion 2-7/8” production string
- 200 m of pipeline needs to be built to connect to gas gathering system.

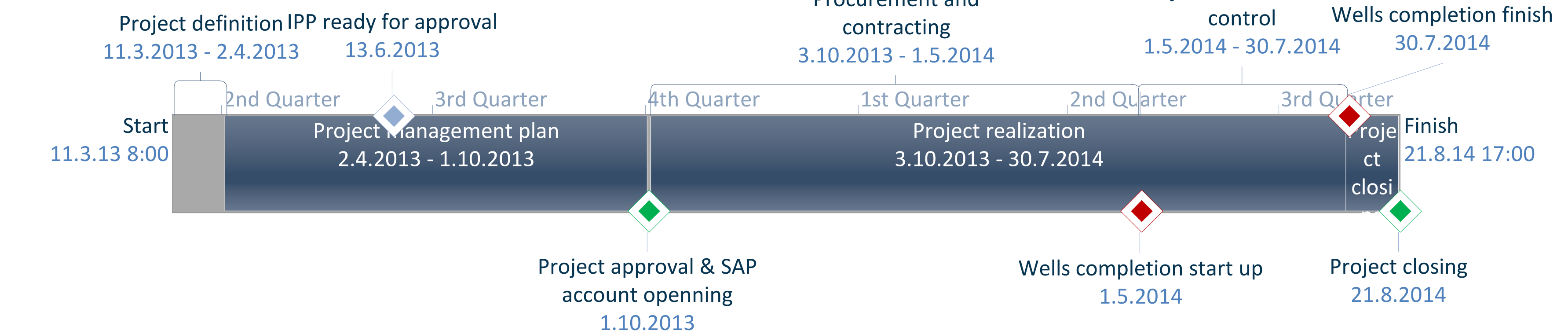
SUMMARY W/ PROJECT TIMELINE

Privlaka field wells Pri – 12, Pri – 18α and O-164α to production immediately upon completion (due to the availability of surface gathering system).

O – 6a requires 200 m of pipeline to connect it to the gas gathering system.

Compl.	Well	Reserv.	Start up (m^3/day)/date	Total (m^3)	Lifting system
1 zone Frac Pack	Pri - 12	A_1 Oil	15.0 m^3/day 1.6.2014.	69 017	Sucker Rod Pump
In stacked 2 zone selective Frac Pack	Pri - 18α	A_3 Oil	15.0 m^3/day 1.6.2014.	23 528	Sucker Rod Pump
		A_1 OIl	7.7 m^3/day 1.02.2019.	27 422	Sucker Rod Pump
In stacked 2 zone selective Frac Pack	O - 134α	p_{3a} Oil	20.0 m^3/day 1.6.2014.	46 117	Gas Lift
		p_2 OIl			
In stacked 3 zone selective Frac Pack	O - 6a	p_8 Gas	45 000 Sm^3/day 1.10.2018.	11 724 300	Naturally Flowing
		$p_{5\ 5'}$ Gas	40 000 Sm^3/day 1.6.2016.	14 352 400	Naturally flowing
		p_4 Gas			

Gantt chart :



THANK YOU SLIDE

Thank You!