ALPINE ENERGY SERVICES

Case Study

Under Balanced Drilling Procedures to Reduces Drilling Fluid Losses and Rig Time in Fractured Formation

Challenge

- Drilling in Lower Malm formation has historically been challenging due the formation composition of vugular limestone and its fractured nature. This results in a below-normal fracture gradient (±0.75 SG).

- High drilling fluid losses and associated rig time attempting to heal the losses increased total well costs.

Solution

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- If the fracture gradient was below 0.35 SG, a contingency plan was established to drill with Foam system

Results

- The operator was able to drill to TD ahead of drilling curve and below AFE cost.

- The downhole pressure was maintained below the fracture gradient minimizing fluid losses.

Successfully Minimized Fluid Losses to the Malm Formation

When drilling into the vugular Lower Malm formation, UBD drastically mitigated loss rates and reduce non drilling time required to re-establish circulation. The use of UBD lowered the ECD to 0.70 SG, by injecting 45 m^3/min Nitrogen and 1040 L/min light polymer water-based fluid. Fluid losses while drilling the 8½" interval were substantially lower compared to offset wells; 450 m^3 with UBD compared to 5050 m^3 with conventional methods - a reduction of 91%.

See Table 1: Comparing Losses of conventionally drilled offset well to UBD well.

Quickly Resolved Fluid Losses Allowing Operator to Drill Ahead with Minimal Delays

The ability to quickly convert from a conventional WBM system to an Underbalanced system drastically reduced the total number of operating days on the well. The UBD well was drilled conventionally until losses were encountered. At this point it was approximately 3 hours to fill the large vugular void and continue drilling with a two-phase system. Time spent to circulating to cure losses was reduced by 27.7 days compared to the offset well.

See Figure-2: Days vs Depth Drilling Curve.

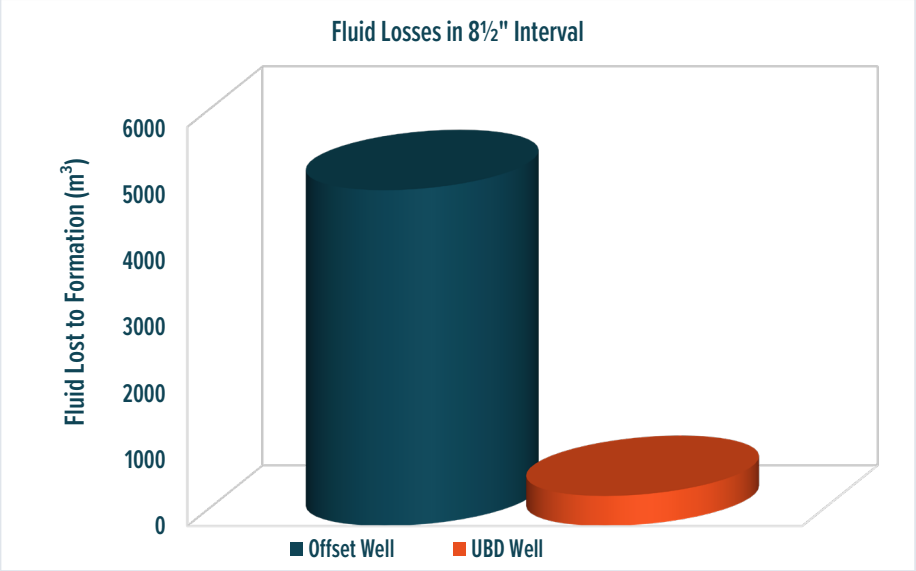

Figure 1: Comparing Fluid Losses in 8 ½" Intervals

Section	Unit Inch	Offset Well 8½"	 6"	 Total	UBD Well 8½"
Interval	m	**2285-3014**	3014-3698	2285-3698	**2100-2978**
Length	m	**729**	684	1413	**878**
Mud Type		**KCl Polymer**	KCl Polymer	KCl Polymer	**Two-phase (N2 & water)**
MW / ECD	S.G.	**1.05 - 1.10 / +**	1.05 / +	1.05 - 1.10 / +	**1.00 / 0.7**
Losses in Formation	m^3	**5050**	2811	7861	**450**
Losses	$m^3/100m$	**693**	411	556	**51**
Percent Fluid Loss Increase	Compared to UBD Well	**91%**	84%	94%	-

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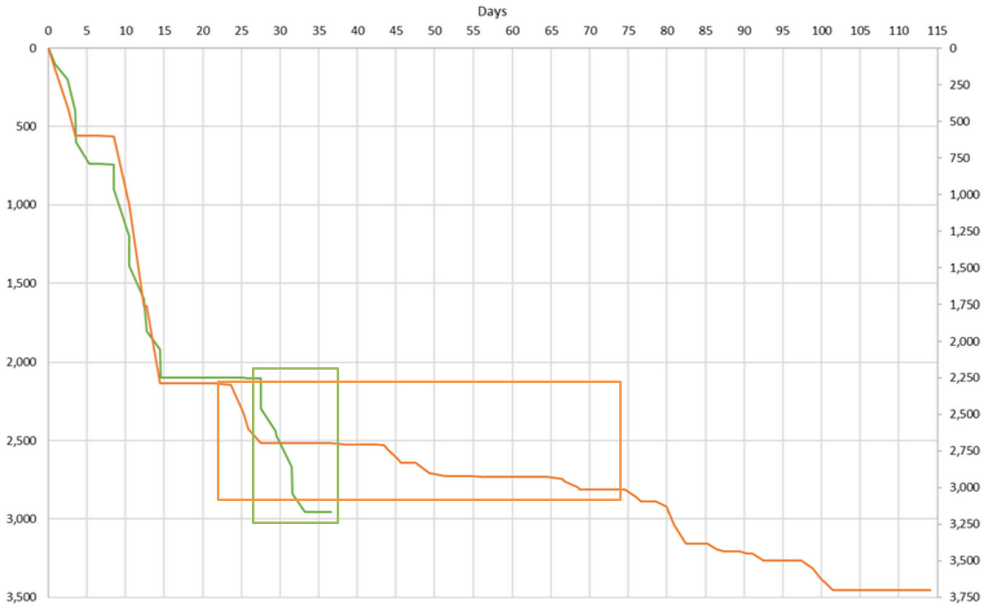

Figure-2: Days vs Depth Drilling Curve. (graph provided by HUNT International)

- Green: UBD well (left axis depth)
- Orange: Conventional well (right axis depth)
- Box: 8 ½“ Interval’s