KAIZEN intelligent drilling optimizer saves days of drilling and increases ROP

M/D Totco™ completed a five month run the KAIZEN™ intelligent drilling optimizer in a United States basin to evaluate the effectiveness of the system in Advisory and Closed Loop Modes on the same rig.

The KAIZEN drilling optimization application has continuous learning capabilities that enable it to provide proactive drilling dysfunction mitigation, maximize rate of penetration (ROP), and optimize mechanical specific energy (MSE). Employing artificial intelligence, it continuously evaluates drilling performance based on current wellbore conditions, compares it to offset well data, and recognizes environmental changes. This approach enables the KAIZEN system to instantly respond to changing conditions and provide optimal weight on bit (WOB) and revolutions per minute (RPM) setpoints.

In Advisory Mode, the KAIZEN system supplies recommended set points via the RigSense™ electronic drilling recorder (EDR) interface which includes drilling dysfunction identification and a heat map for easy analysis of the recommended set points for WOB and RPM. In Closed Loop Mode, KAIZEN'S calculated RPM and WOB setpoints are instantly applied to the autodriller as shown in the evaluation table below.

Optimization Mode	Wells	Runs
No KAIZEN	3	8
KAIZEN - Advisory	9	14
KAIZEN - Closed Loop	9	14

The assessment was derived from data collected by the EDR and bit records for each well. On wells where the KAIZEN system was enabled, the channels were available in the primary EDR data feed and used for analysis of when the KAIZEN application was on, in what mode (advisory or closed loop), its recommendations, and their impact (ROP improvement).

While the KAIZEN system was installed, the rig crew switched between Advisory and Closed Loop Mode as indicated in the chart on page two. The % KAIZEN On column indicates the % of time during that run where KAIZEN was enabled. The % KAIZEN Closed Loop and % KAIZEN Advisory columns further breakdown in what capacity the application was used and the adjacent columns provide the performance results while in that mode. KAIZEN was not used during slide drilling and those data sets were excluded.

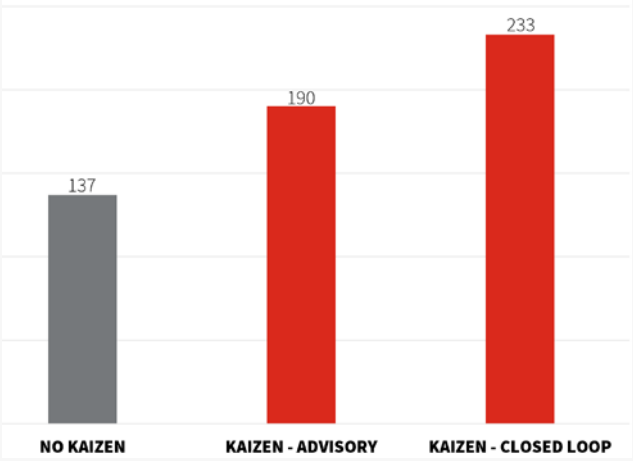
To learn more about the KAIZEN intelligent drilling optimizer, contact your sales representative.

Results Delivered

- Total footage drilled with KAIZEN: 66,781
- Drilling days without KAIZEN at 137 ft/hr: 20
- Drilling days with KAIZEN advisory at 190 ft/hr: 15
- Drilling days with KAIZEN closed loop at 233 ft/hr: 12

Total of 5-8 drilling days saved

Average ROP Comparison



Case Study

On Bottom Rotary Drilling Only

Data From - To	Well Run	On Btm Rotary Feet	On Btm Rotary Hours	On Btm Rotary ROP	% KAIZEN On	Closed Loop Mode				Advisory Mode			
						% KAIZEN - CLOSED LOOP	% KAIZEN Ft Drld	KAIZEN Hours	KAIZEN ROP	% KAIZEN Advisory	KAIZEN Ft Drld	KAIZEN Hours	KAIZEN ROP
Nov 11 - 18	f YYYYY 001H R3 m	6,461.58	31.43	205.59	100.00	74.33	4,893.60	23.36	209.49	25.67	1,567.98	8.07	194.30
Nov 19 - 23	Xg YYYYY 008H R1j m	2,380.58	10.98	216.81	100.00	54.27	1,266.55	5.96	212.51	45.73	1,114.03	5.02	221.92
Nov 19 - 23	g YYYYY 008H R2 m	6,778.86	21.83	310.53	99.98	73.38	5,390.66	16.01	336.71	26.62	1,388.20	5.82	238.52
Nov 25 - Dec 3	h YYYYY 010H R1 m	2,608.61	13.77	189.44	99.89	78.82	2,050.10	10.84	189.12	21.18	558.51	2.93	190.62
Nov 25 - Dec 3	h YYYYY 010H R2 m	7,092.09	26.14	271.31	99.98	66.09	5,156.77	17.27	298.60	33.91	1,935.32	8.87	218.19
Dec 11 - 18	i ZZZZZ 002H R1 m	1,392.02	6.16	225.98	99.92	68.12	965.28	4.20	229.83	31.88	426.74	1.96	217.72
Dec 11 - 18	i ZZZZZ 002H R2 m	2,879.57	10.98	262.26	99.77	75.49	2,212.06	8.27	267.48	24.51	667.51	2.71	246.31
Dec 11 - 18	i ZZZZZ 002H R4 rss	11,863.52	53.66	221.09	89.17	18.50	2,664.22	8.86	300.70	81.50	9,199.30	44.80	205.34
Dec 22 - 28	j ZZZZZ 007 R3 m	4,971.65	23.31	213.28	88.35	20.55	905.67	4.23	214.11	79.45	4,065.98	19.08	213.10
Jan 20 - 27	k ZAZAZA R 008H R1 m	3,777.37	18.02	209.62	100.00	66.81	2,416.06	12.04	200.67	33.19	1,361.31	5.98	227.64
Jan 20 - 27	k ZAZAZA R 008H R3 rss	7,988.58	49.48	161.45	99.74	36.88	3,326.99	18.20	177.86	63.12	4,751.59	31.28	151.91
Jan 29 - Feb 1	l ZAZAZA 005H R1 m	2,201.00	15.10	145.76	36.04	31.01	198.47	1.69	117.44	68.99	2,002.53	13.41	149.33
Feb 2 - 7	m ZAZAZA 006H R1 m	3,357.87	19.86	169.08	100.00	18.30	636.11	3.63	175.24	81.70	2,721.76	16.23	167.70
Mar 7 - 8	p ZBZBZB J 008H R1 m	3,028.15	16.95	178.65	100.00	38.15	2,548.99	13.76	185.25	61.85	479.16	3.19	150.21
TOTALS		**66,781**	**318**	**210**			**34,542**	**148**	**233**		**322.40**	**169**	**190**

For the evaluation of runs not using Kaizen, Kaizen was not installed and no user interface or recommendations were visible to the rig crew.

Date From - To	Well Run	On Bottom Rotary Feet Drilled	On Bottom Rotary Hours	On Bottom Rotary RPM
	r ZBZBZB 011H R3 m	1,354.77	9.46	143.21
Mar 22 - Mar 25 XXXX	s ZBZBZB 001H R1 m	3,542.54	20.48	172.98
	s ZBZBZB 001H R2 m	202.29	0.09	2,247.67
Mar 26 - Mar 31 XXXX	t ZBZBZB 010H R1 m	518.53	2.67	194.21
	t ZBZBZB 010H R4 m	519.12	7.47	69.49
	t ZBZBZB 010H R5 rss	3,191.78	33.07	96.52
Apr 1 - Apr 9 XXXX	u ZBZBZB 010H ST R1 m	2,032.49	12.34	164.71
	u ZBZBZB 010H ST R2 rss	9,328.00	65.30	142.85
TOTALS		**20,690**	**151**	**137**