(((ECHOMETER)))

Echometer TechNote: Acoustic Survey Analysis

This TechNote covers the following topics.

Analysis of data collected from Acoustic Surveys should answer the following questions:

- Does liquid exist above the pump?
- At what depth is the top of the liquid column?
- Does the liquid in the casing annulus restrict production from the well?
- What is the maximum production rate available from the well?
- What is the casing-head pressure?
- Does it restrict production?
- What is the percentage of liquid in the annular fluid column?
- Is gas flowing up the annulus?
- At what rate?
- What is the gas gravity?
- Are there any restrictions or anomalies in the annulus above the liquid level?

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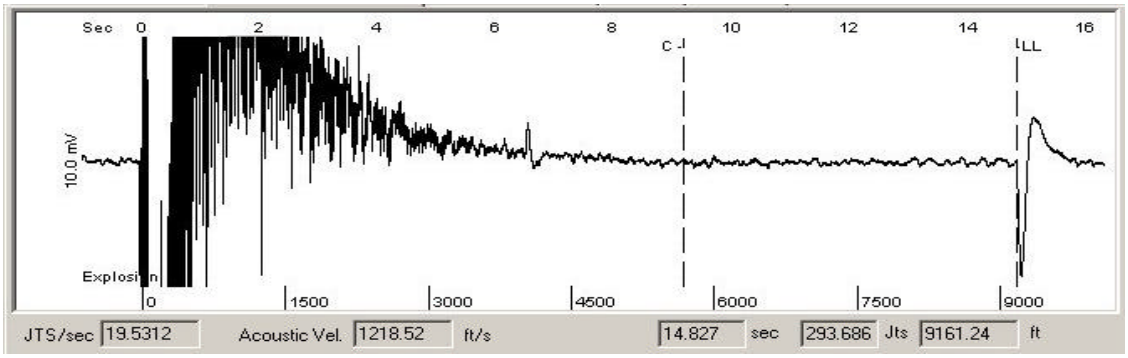
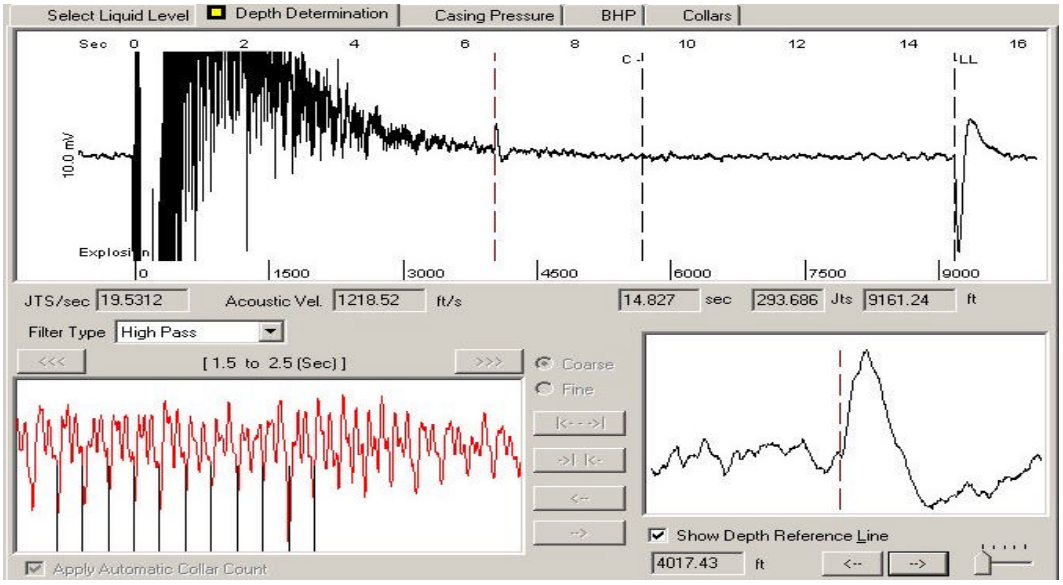
From Acoustic Survey collected on a well on 12/07/00 10:58:02:

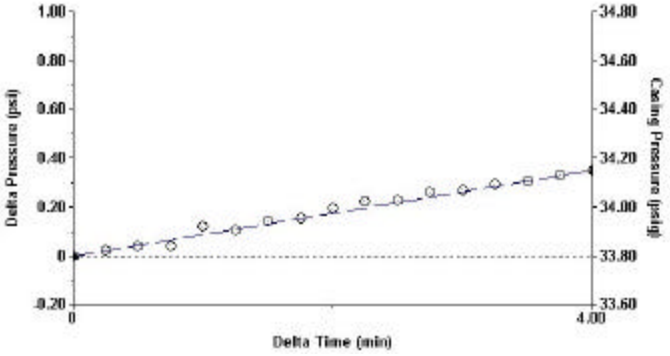


At the surface an acoustic pulse was generated by suddenly releasing high-pressure gas into the casing annulus from the volume chamber of the remote fire gas gun. As the acoustic pulse traveled down the casing annulus, changes in annular volume reflected acoustic signals back to the microphone in the gas gun. A strong reflected compression (down kick) acoustic pulse recorded at 14.827 seconds indicates the depth to the top of the liquid level is 9161 feet from the surface. The measured casing pressure of 33.8 psig is low in comparison to the calculated 486 psig pump intake pressure and the casing pressure does not restrict production from the well.



An anomaly in the annulus above the liquid level was detected at a depth of 4017 feet, as indicated by a strong reflected rarefraction (up kick) acoustic pulse recorded at 6.507 seconds. The anomaly was displayed at the same depth in both acoustic traces collected while testing the well. The depth to the anomaly corresponds very well to the increase in the casing volume at the depth of 4015.92 at the crossover from the 2 3/8 inch Hydril to the 1.90 inch Hydril collar-less tubing.

The closed-in casing pressure built up 0.3 psi in 4 minutes, indicating gas is flowing up the annulus at a 7 Mscf/D rate. The gas flowing up the casing annulus is aerating the liquid column above the pump so that 76% of the annular fluid column is liquid. An equivalent gas free liquid height of 1353 feet was found to exist above the pump intake. Analyzing the acoustic reflection from the tubing collars spaced on average of 31.19 feet apart, determined that the acoustic velocity of the gas in the casing annulus to be 1236 ft/sec. Knowing that the acoustic velocity of a gas is directly related to a gas's density, pressure and temperature, then the hydrocarbon gas specific gravity of the gas in the casing annulus equals 0.79.



Group: Utah Well: (acquired on: 12/07/00 10:58:02)

Production

Current	Potential		
Oil 27	39.1	STB/D	
Water 210	304.1	STB/D	
Gas 80	115.8	Mscf/D	

IPR Method Vogel
PBHP/SBHP 0.51
Production Efficiency 69.1

Oil 40 deg.API
Water 1.02 Sp.Gr.H2O
Gas 0.79 Sp.Gr.AIR

Acoustic Velocity 1235.75 ft/s

Casing Pressure
33.8 psi (g)

Casing Pressure Buildup
0.3 psi
4.00 min

Gas/Liquid Interface Pressure
46.5 psi (g)

Liquid Level
9161.24 ft

Formation Depth
12120 ft

Pump Intake Depth (MD) 10947 ft
Total Gaseous Liquid Column HT (TVD) 1786 ft
Equivalent Gas Free Liquid HT (TVD) 1353 ft

Producing

Annular Gas Flow
7 Mscf/D

% Liquid
76 %

Liquid Stream Below Pump
Oil 0 %
Water 100 %

Liquid Below Pump
- * - %

Pump Intake Pressure
485.9 psi (g)

Producing BHP
1003.9 psi (g)

Static BHP
2000 psi (g)

Well productivity calculations are based on the Vogel's IPR method. Assuming that the producing bottom hole pressure (which is 1004 psi) could be drawn down to 0 psig at the formation depth of 12120 feet and the static reservoir pressure equals 2000 psig, then the maximum production rate available from the well is 39.1 STB/D oil, 304.1 STB/D water, and 115.8 Mscf/D gas. Production is some-what restricted from the well as indicated by the producing efficiency of 69.1%. The height the liquid in the casing annulus above the pump intake/bottom of the producing interval restricts production from the well. In general the PBHP should be less than 10% of the SBHP to insure 95% of the maximum rate is produced from the well.

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