# Macondo MC_252-1-A Losses Analysis

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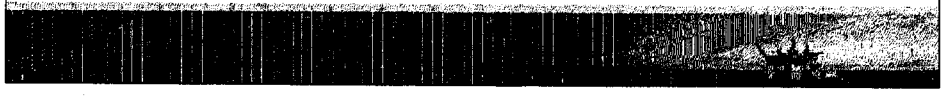


## Losses Data

- Losses location:
  - Mostly in M-90 below the 18" casing shoe from LCM pill behavior
- Loss Volume: 6300 bbls

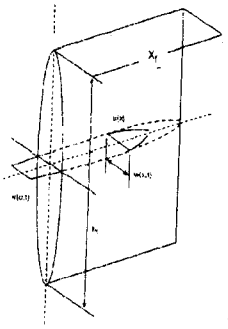
## Input data for analysis

- Input Data for most likely case
  - Depth: 9050 ft
  - FG in sand :11.24 ppg
  - ECD: 11.7 ppg
  - OB: 12.38 ppg
  - Pp: 10.1pg
  - Hole size: 20"
  - Young' s modulus: 483000 psi (from correlation between effective overburden stress and Young' s modulus)

# modeling ("Penny-shape" model)

"Penny-shape" model is assumed: $h_f = 2 \cdot x_f$

Maximum and average fracture width: $\overline{w} = w_{max}\left(\frac{\pi}{4}\gamma\right)$



Where:

$x_f$ = half fracture length

$h_f$ = fracture height

$W_{max}$ = maximum fracture width, in.;

w = average fracture width, in.;

$\frac{x}{f}$

$\gamma$ = fracture geometry factor (0.75 for "Penny-shape "model).

Losses volume: $V_{loss} \cdot (1 - f_s) = 2x_f \cdot h_f \cdot \overline{w}$

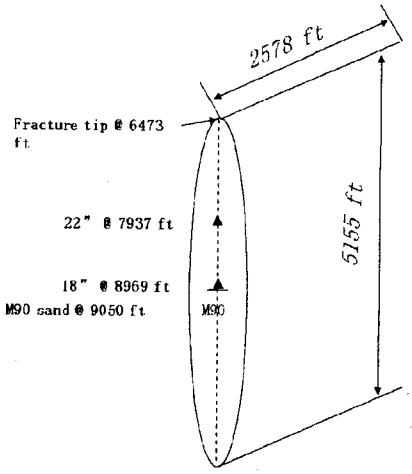
Where:

$f_s$ = fraction of seepage loss (0.2 is assumed in this analysis)

# Results

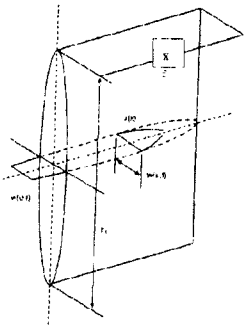
Fracture length: $x_f$ = 2578 ft

Fracture height: $h_f$ = 5155 ft




**Based on the calculation, losses already reached the zone behind the 22" casing.**

# Hydraulic fracturing modeling (PKN Model)



PKN model geometry ($x_f \geq h_f$)

Shear modulus:

$$G = \frac{E}{2(1+\nu)}$$

Maximum fracture width:

$$w_{max} = 0.3 \times \left[ \frac{q_i \mu (1-\nu) \cdot x_f}{G} \right]^{1/4}$$

Average fracture width:

$$\overline{W} = W_{max} \left( \frac{\pi}{4} \gamma \right)$$

*Where:*

E = Young's modulus; G = shear modulus, psi;

$\nu$ = Poisson's ratio, dimensionless;

$q_i$ = loss rate, bpm; $\mu$ = apparent viscosity, cp;

$x_f$ = fracture half length, ft;

$W_{max}$ = maximum fracture width, in.;

$\overline{w}$ = average fracture width, in.;

$\gamma$ = fracture geometry factor (0.75 for PKN model).

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# modeling (PKN Model)

bp

Input Data

| Depth from (ft) | Depth to (ft) | Losses (1) (bbls) | Losses Rate (2) (BPM) | Fracture Height (ft) | Fraction of seepage | Young's (3) Modulus (psi) | Poisson's ratio | Apparent (4) Viscosity (cp) |
|---|---|---|---|---|---|---|---|---|
| 9050 | 9230 | 2300 | 6 | 180 | 0.2 | 930000 | 0.2 | 27 |

Note

(1) Losses into this zone is 2300 bbls (confirmed with Mark Hafle).
(2) Pump at 6 bpm to keep hole full (Feb. 18 daily operation)
(3) From Mark's StressCage work.
(4) From Feb. 18 daily mud report.

Result

| Fracture Length (ft) | MaximumFracture Width (in ) | Average Fracture Width (in.) |
|---|---|---|
| 2,130 | 0.276 | 0.162 |

Note

(1) Half fracture length is predicted to be 2130 ft. It may propagate with more losses
(2) Average fracture width is 0.162 in (4122 microns)

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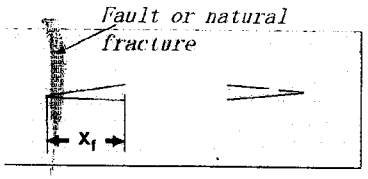
# Possible causal analysis

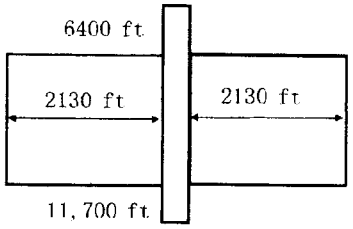
Observation:

- Big losses (over 6000 bbls), little flow back.
- Different types of LCM pills did not work very well, even EZ-Squeeze with size up to 3000 micron.




**Possible explanation:**

Induced fractures are generated at early stage (lower loss rate). Then the induced fractures are connected to the natural fractures, which caused high rate of losses.




**Further analysis may help:**

- Check to see if fault/natural fracture exist from 6400 ft to 11,700 ft TVD at 2000 ft-3000 ft around wellbore
- Analyze flow in & out data to check slope change in the losses volume against time curve