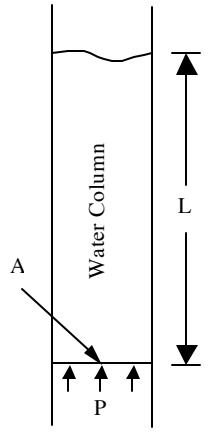
Energy Lost to Water Column Above GasGun Stimulation



P = Pressure
L = Length
A = Area
t = Time
F = Force
m = Mass
a = Acceleration

V = Volume
v = Velocity
W = Weight
g = Acceleration due to gravity
ρ = Density
s = Distance

Values:
P = 20,000 psi
t = 20 msec.
L = 1000 feet
$\rho = 62.4$ lb/ft^3 (density of water)
g = 32.2 ft/sec^2
A = 0.213 ft^2 (6 ¼" open hole)

Formulas:
F = ma or a = F/m
F = PA
m = W/g
W = Vρ
V = AL
s = ½at^2

Calculations:

a = F/m = PAg/W = PAg/ALρ = Pg/Lρ

$$a = \frac{20{,}000 \text{ lb/in}^2 * 144 \text{ in}^2/\text{ft}^2 * 32.2 \text{ ft/sec}^2}{1000 \text{ ft} * 62.4 \text{ lb/ft}^3} = 1{,}486 \text{ ft/sec}^2$$

Distance water column moves in 20 msec is:

$s = ½at^2 = ½(1486)(.02)^2 = 0.3 \text{ ft} = 3.6 \text{ in}$

Conclusion:

Energy produced by the GasGun is restricted to the pay zone.

Energy lost:

Formulas:
E(Energy) = KE(Kinetic energy) + PE(Potential energy)
$KE = \frac{1}{2}mv^2$
PE= Ws
v = at

Calculations:

$v = at = 1{,}486\ ft/sec^2 * .02\ sec = 29.7\ ft/sec$

$W = AL\rho = 0.213\ ft^2 * 1000\ ft * 62.4\ lb/ft^3 = 13{,}300\ lb$

$KE = \frac{1}{2}mv^2 = \frac{1}{2}(W/g)v^2 = \frac{1}{2}(13{,}300\ lb/32.2\ ft/sec^2)(29.7\ ft/sec)^2 = 182{,}000\ ft\text{-}lb$

$PE = Ws = 13{,}300\ lb * 0.3\ ft = 4{,}000\ ft\text{-}lb$

$E = KE + PE = 182{,}000\ ft\text{-}lb + 4{,}000\ ft\text{-}lb = 186{,}000\ ft\text{-}lb$

Energy in GasGun[a] = 40,000,000 ft-lb

% of energy lost = 186,000 ft-lb/40,000,000 ft-lb = 0.46 %

Conclusion:

99.54% of the energy in the GasGun goes to fracturing the formation.

[a] Total energy of GasGun is derived from the energy produced by a 3 ¼" x 10' GasGun tool.