School of Civil Engineering

High Performance Computing Laboratory

"XFEM Analysis of Gas-Driven Crack Propagation Around a Blast Hole"

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One dimensional equations of gas flow

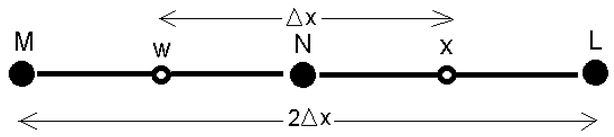
$$\frac{\partial(\rho h)}{\partial t}+\frac{\partial(\rho v h)}{\partial x}=0$$

$$\frac{\partial(\rho v h)}{\partial t}+\frac{\partial(\rho v^2 h)}{\partial x}=-\rho h\left(\frac{1}{\rho}\frac{\partial P}{\partial x}+\psi\right)$$

$$\psi=\begin{cases}\dfrac{12\,\mu v}{\rho h^2}\\ a\left(\dfrac{\varepsilon}{h}\right)^b\dfrac{v^2}{h}\end{cases}$$

Equation of state

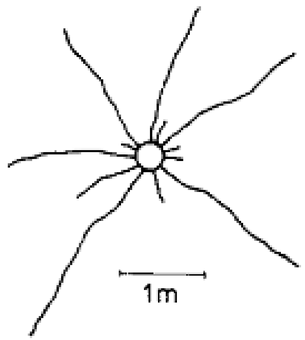
$$P=P_0\left(\frac{\rho}{\rho_0}\right)^{\gamma}$$



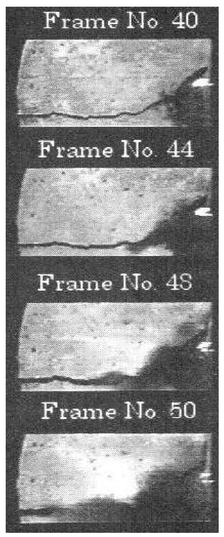
One dimensional mesh for gas flow through cracks

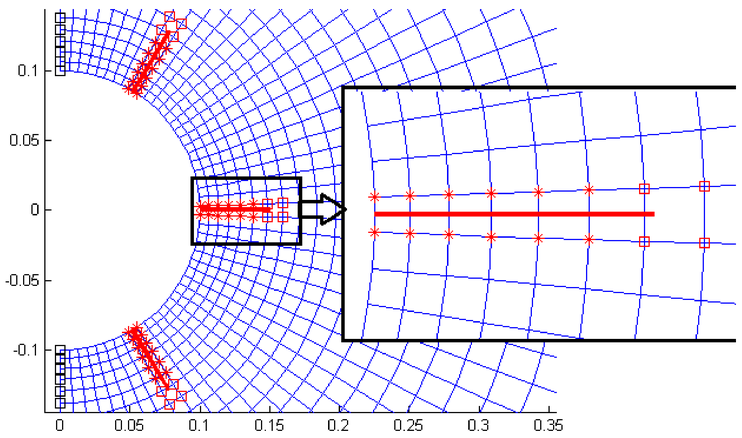
Sandia Lab Experiment

P_0 = 90 Mpa
Confining stress = 10 MPa
Bore hole diameter: 0.2 m
Charge diameter: 0.2 m
Charge density: 0.5 gr/cm^3
Toughness=0.5 Mpa/m$^{0.5}$
γ= 1.29
Number of cracks: 7
Average Length: 1.7 m



Observed pattern of cracks

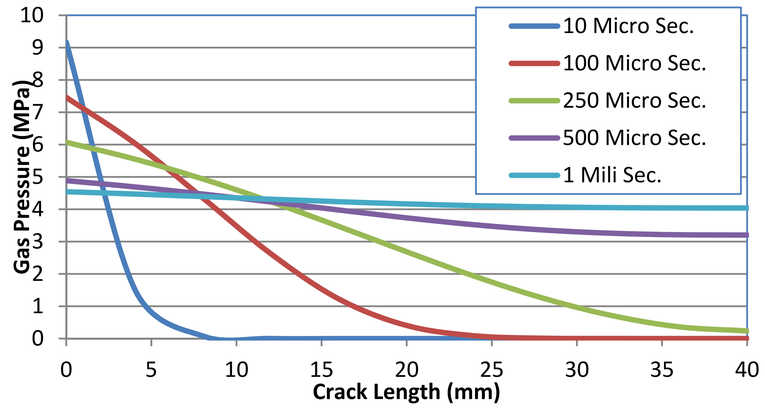


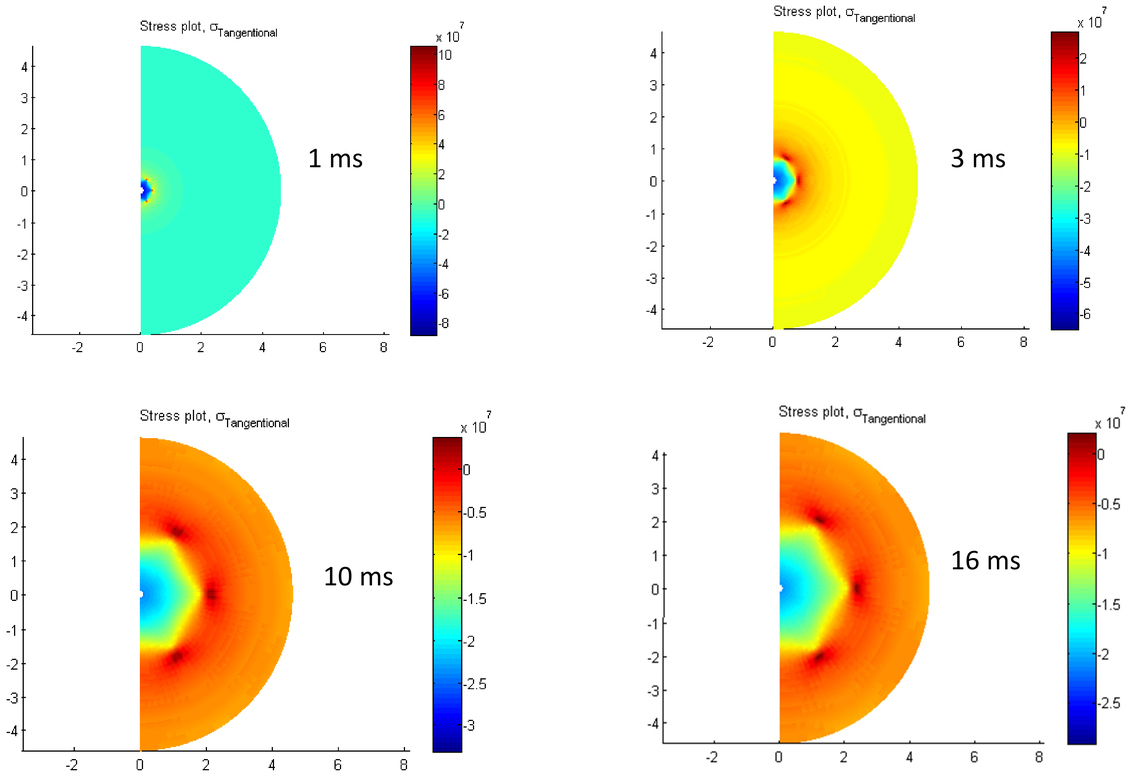


XFEM model

Gas pressure development through a crack, which is connected to a source of gas

P_0=10 MPa
ρ_0 = 0.39 Kg/m^3
Crack length= 40 cm
h= 2 mm
ε/h=1
γ= 1.29





Crack propagation and stress contours