3. William Maurer, Maurer Engineering

Maurer Engineering

Gas Hydrate Drilling Problems

Dr. William C. Maurer

Gulf of Mexico Hydrate R&D Planning Workshop

August 9-10, 2000

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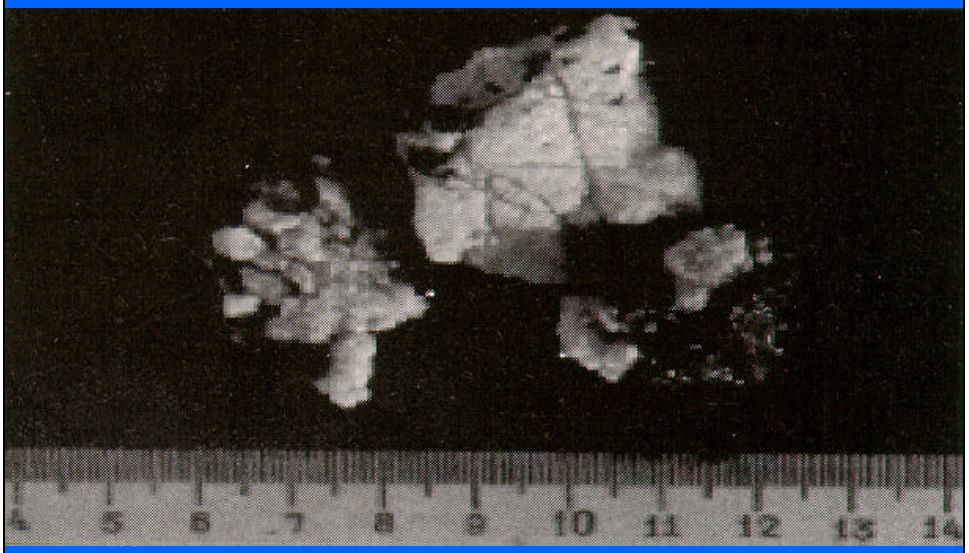
Maurer Engineering

Gas Hydrates

Solid Mixture of Gas and Water
(Petroleum Engineer, March 1998)



Burning Methane Hydrate
(Sloan, Jr., 1990)

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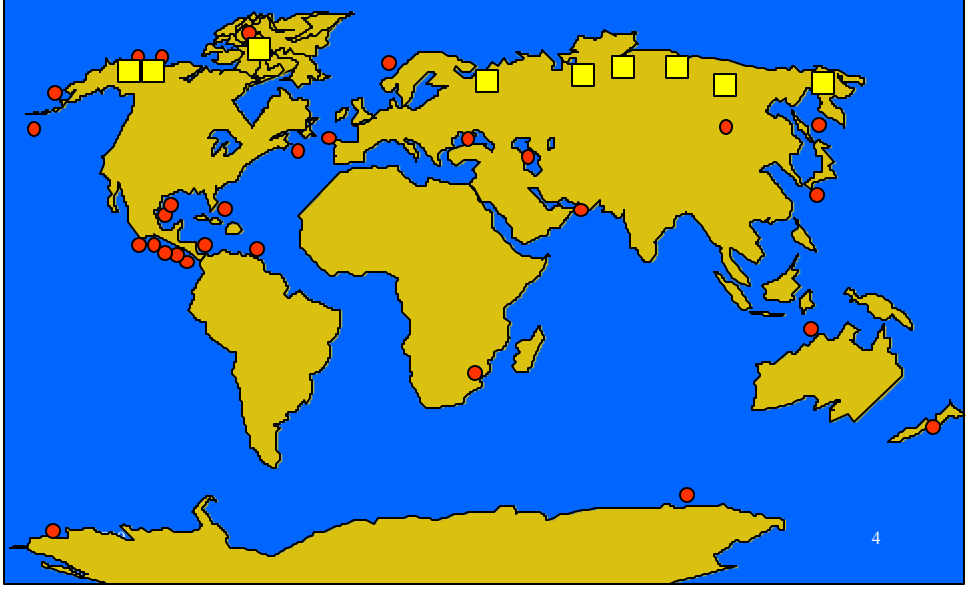
Global Gas Hydrate Locations
(Collett et al., 1998)



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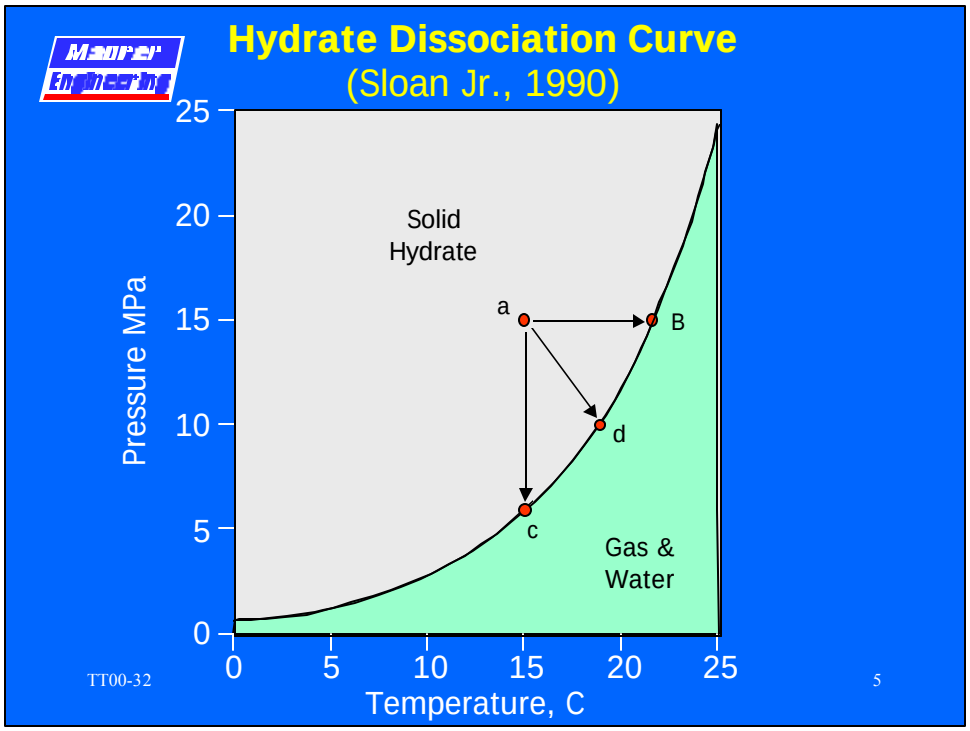
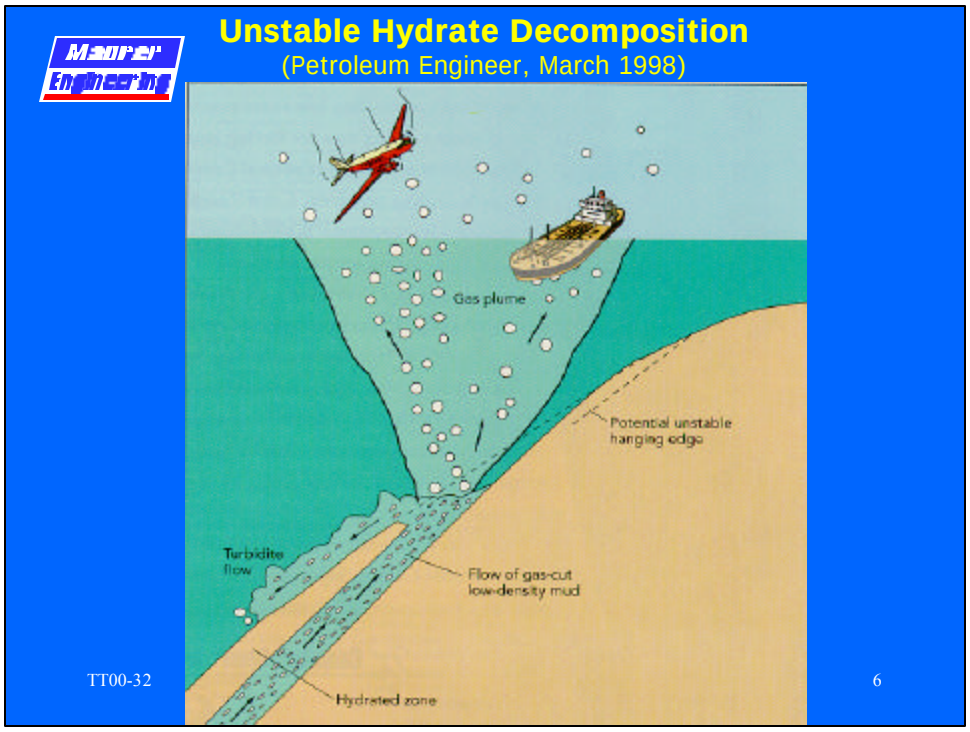
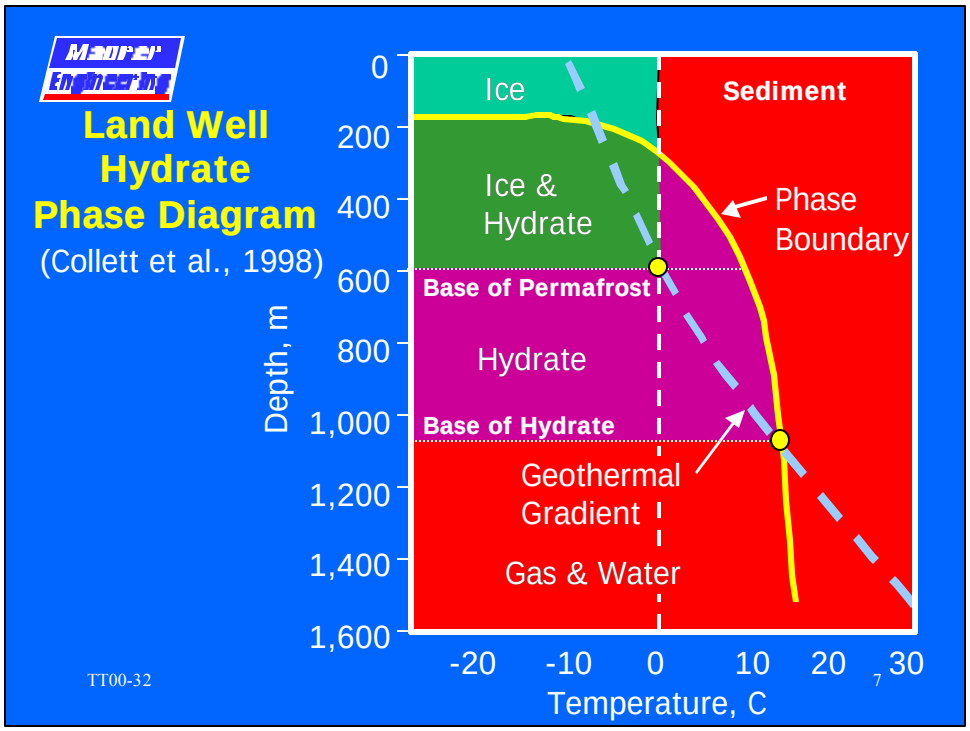
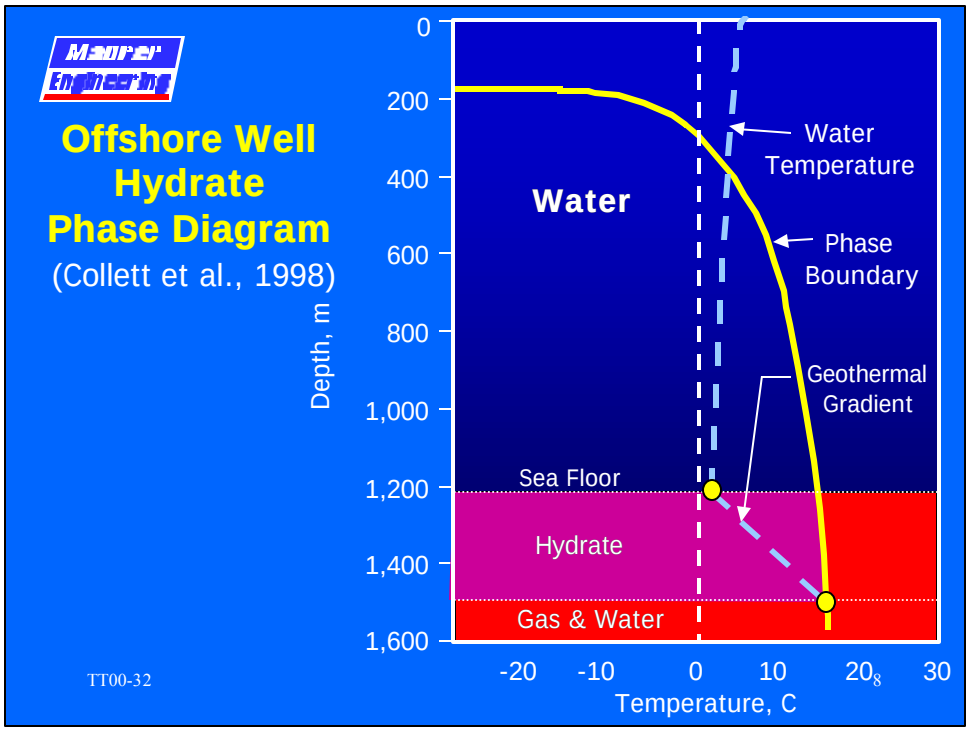
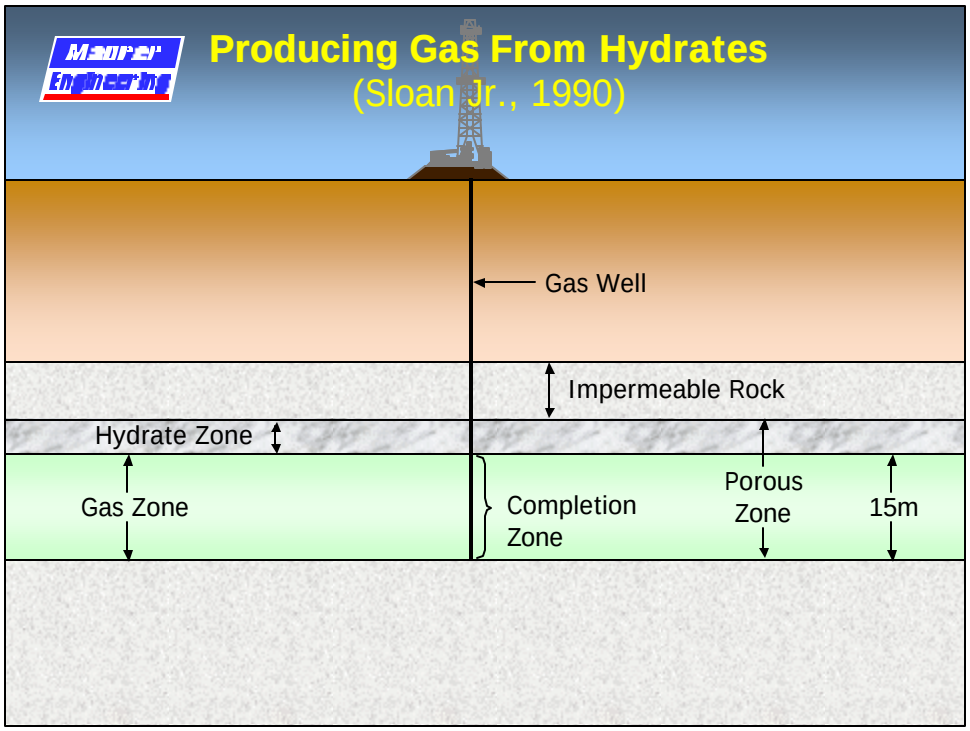
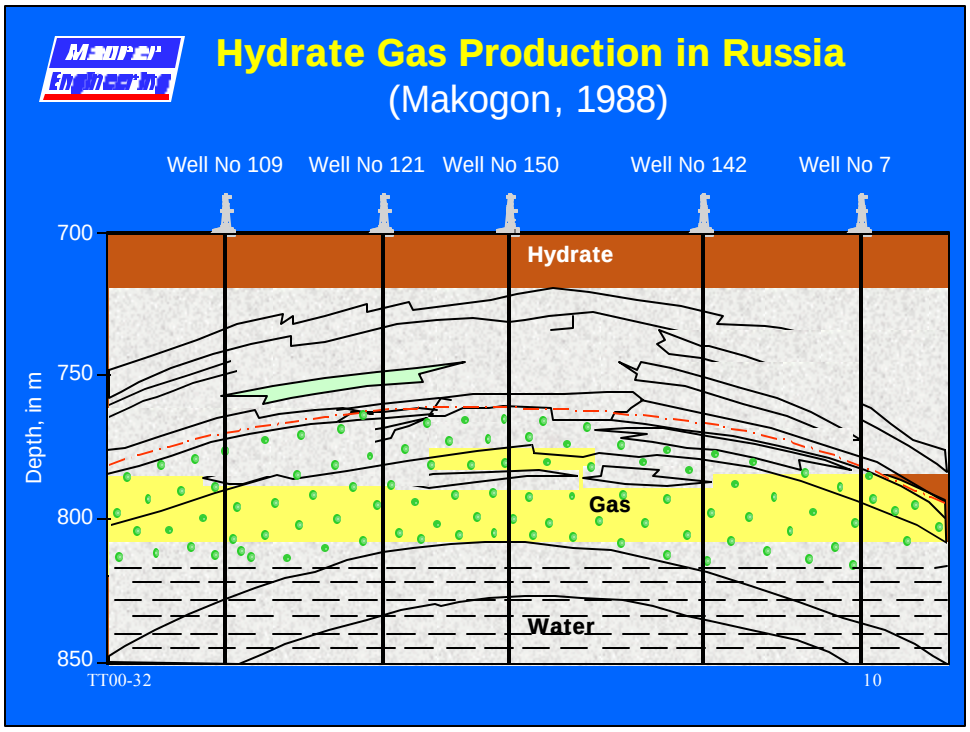

Hydrate Dissociation Curve
(Sloan Jr., 1990)
Solid
Hydrate
Gas &
Water
a
B
c
d
Pressure MPa
Temperature, C
0
5
10
15
20
25
TT00-32
5


Unstable Hydrate Decomposition
(Petroleum Engineer, March 1998)
Gas plume
Potential unstable
hanging edge
Turbidite
flow
Flow of gas-cut
low-density mud
Hydrated zone
TT00-32
6


Land Well Hydrate Phase Diagram
(Collett et al., 1998)
Ice
Sediment
Ice & Hydrate
Phase Boundary
Base of Permafrost
Hydrate
Base of Hydrate
Geothermal Gradient
Gas & Water
Depth, m
0
200
400
600
800
1,000
1,200
1,400
1,600
-20
-10
0
10
20
30
Temperature, C
TT00-32
7

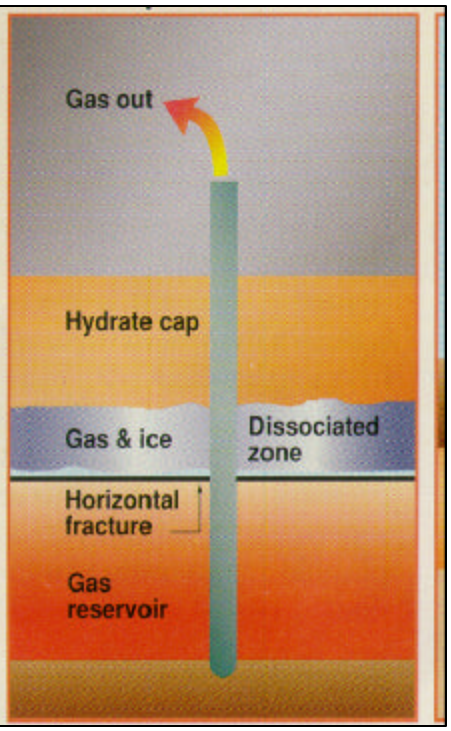

Offshore Well Hydrate Phase Diagram
(Collett et al., 1998)
Water
Water Temperature
Phase Boundary
Geothermal Gradient
Sea Floor
Hydrate
Gas & Water
Depth, m
0
200
400
600
800
1,000
1,200
1,400
1,600
-20
-10
0
10
20
30
Temperature, C
TT00-32
8


Producing Gas From Hydrates
(Sloan Jr., 1990)
Gas Well
Impermeable Rock
Hydrate Zone
Gas Zone
Completion Zone
Porous Zone
15m


Hydrate Gas Production in Russia
(Makogon, 1988)
Well No 109
Well No 121
Well No 150
Well No 142
Well No 7
Hydrate
Gas
Water
Depth, in m
700
750
800
850
TT00-32
10

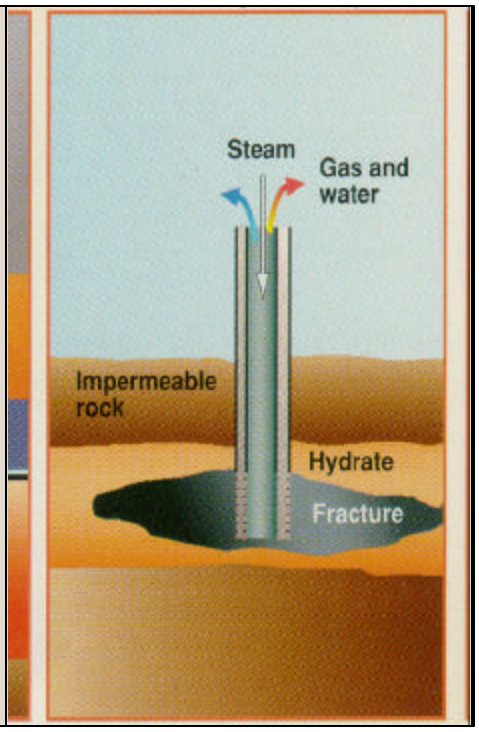
Depressurization Hydrate Production

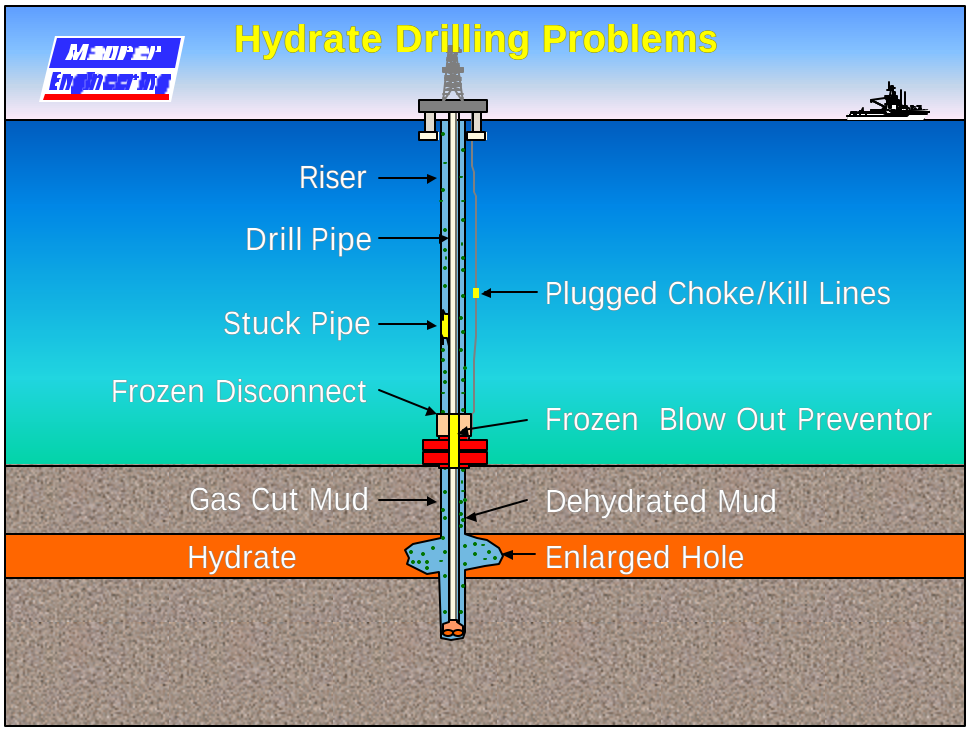
(Collett et al., 1998)

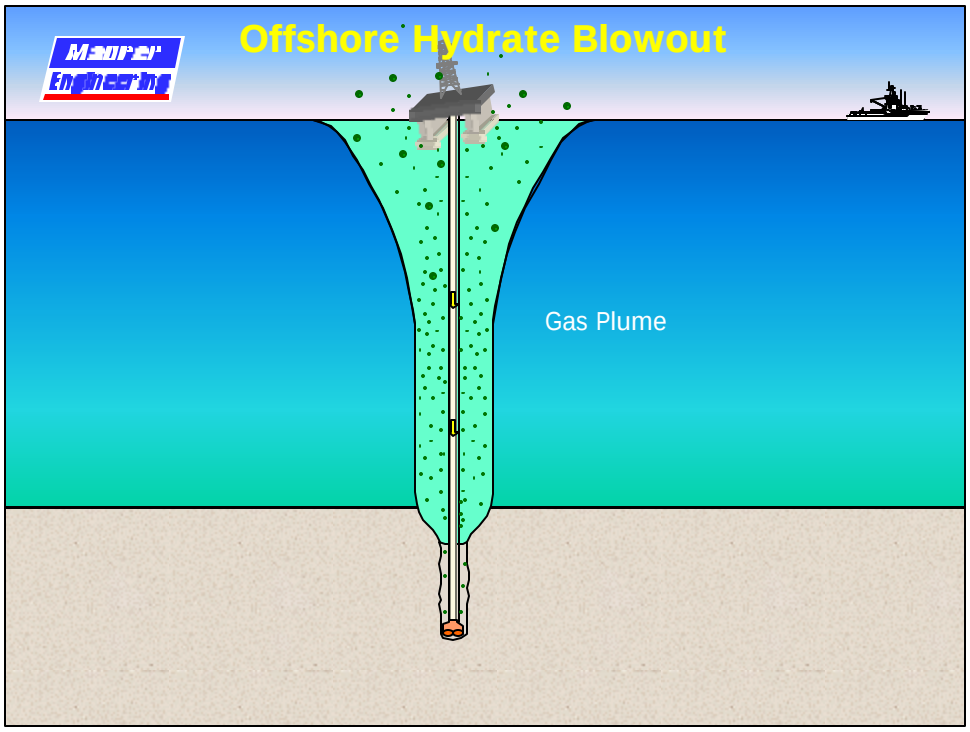


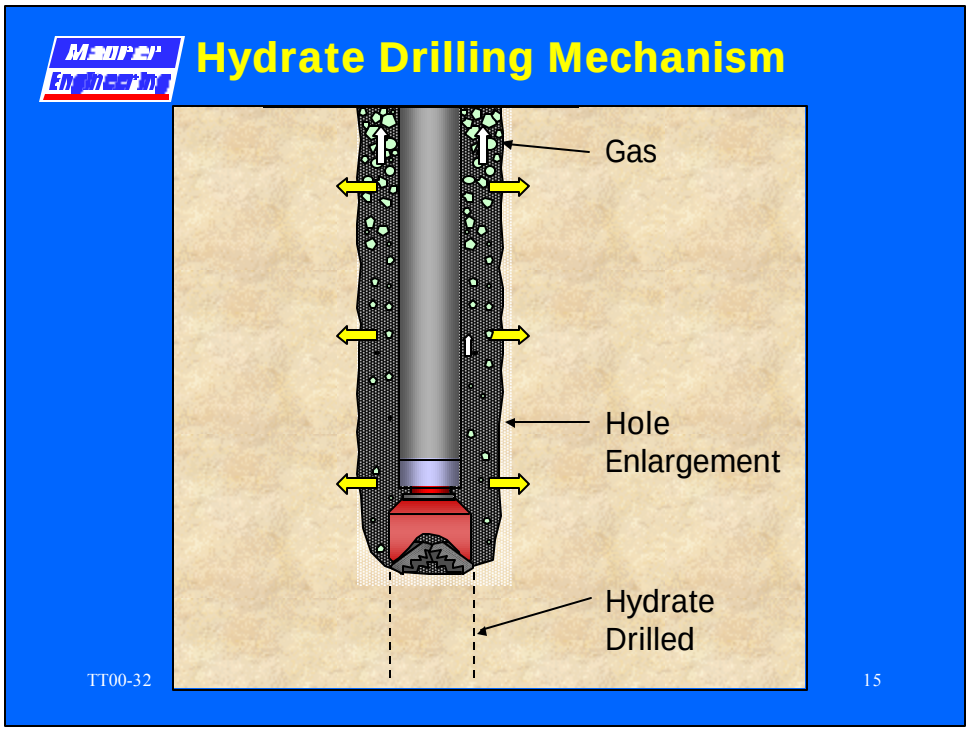
Thermal Injection-Cycle Hydrate Production

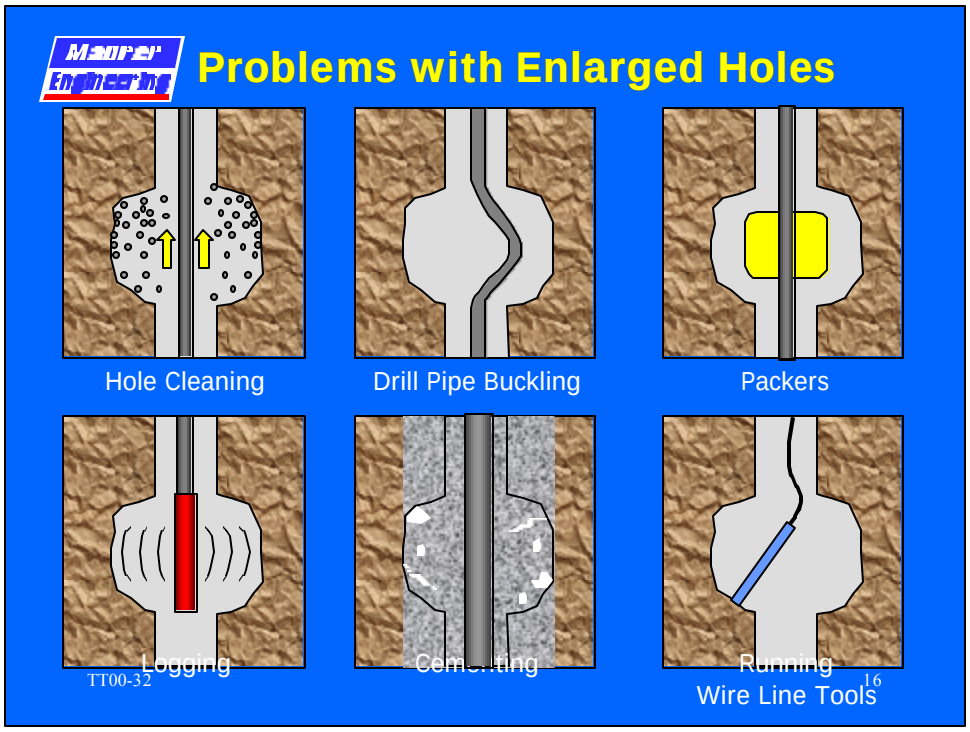
(Collett et al., 1998)




Hydrate Drilling Problems
Riser
Drill Pipe
Plugged Choke/Kill Lines
Stuck Pipe
Frozen Disconnect
Frozen Blow Out Preventor
Gas Cut Mud
Dehydrated Mud
Hydrate
Enlarged Hole

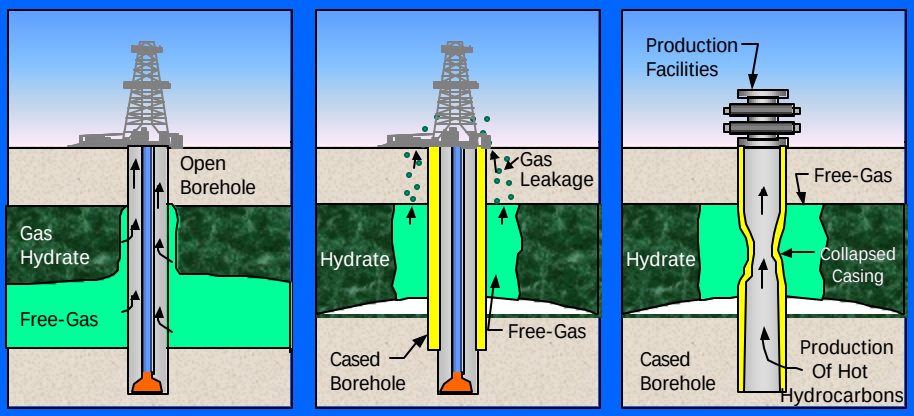

Offshore Hydrate Blowout
Gas Plume


Hydrate Drilling Mechanism
Gas
Hole
Enlargement
Hydrate
Drilled
TT00-32
15


Problems with Enlarged Holes
Hole Cleaning
Drill Pipe Buckling
Packers
Logging
Cementing
Running
Wire Line Tools
TT00-32
16

Gas Hydrate Drilling and Production Problems

(Collett, 2000)



Gas Release | Gas Leakage | Collapsed Casing

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"Gas hydrate is a significant hazard to drilling and production operations"

(Collett ,2000)

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"It is difficult to ensure sealing wells and consequently ecological safety in hydrate deposits using traditional oil field technology"

(Makogon, 1997)

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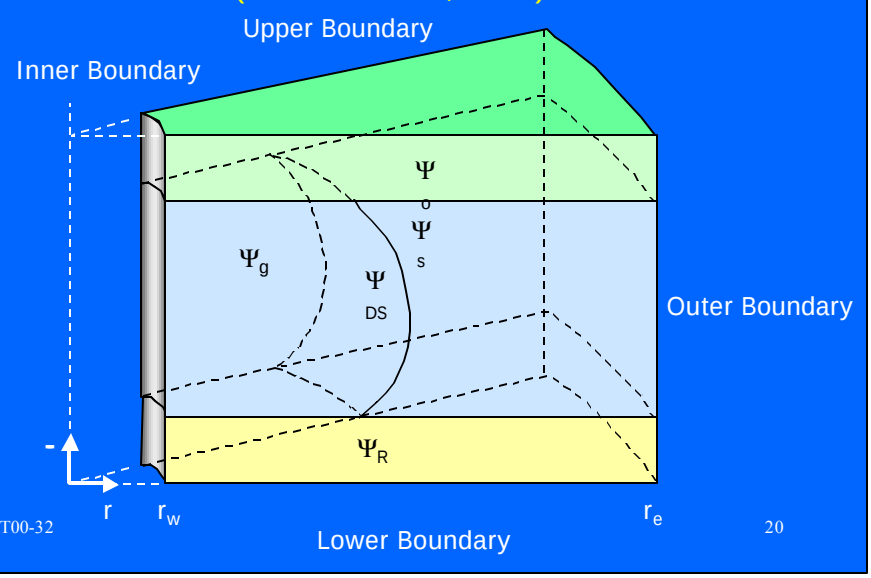
Moving Hydrate Boundary During Dissociation

(Roadifer et al., 1987)



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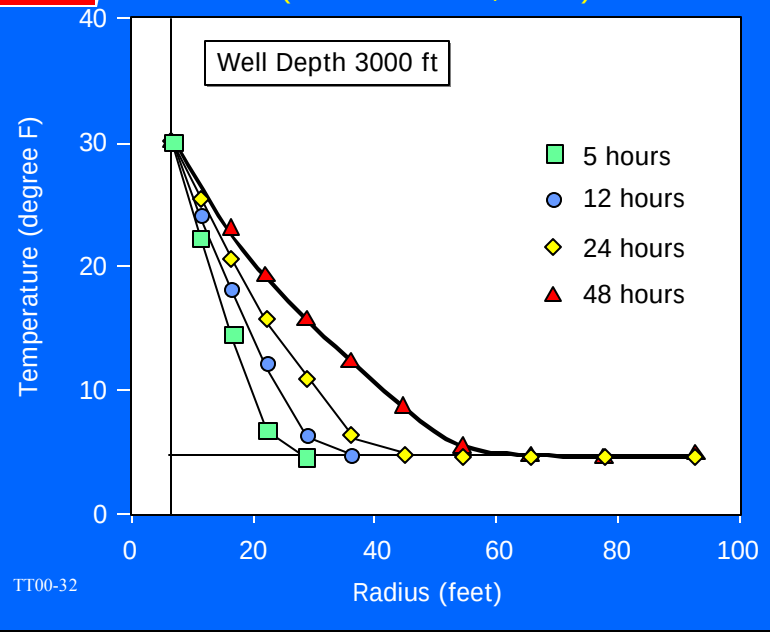
Temperature Profile in Dissociation Zone

(Roadifer et al., 1987)



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Factors Increasing Gas Flow Rate

(Roadifer et al., 1987)

- Increased mud temperature
- Reduced mud weight
- Increased wellbore diameter
- Increased hydrate thickness

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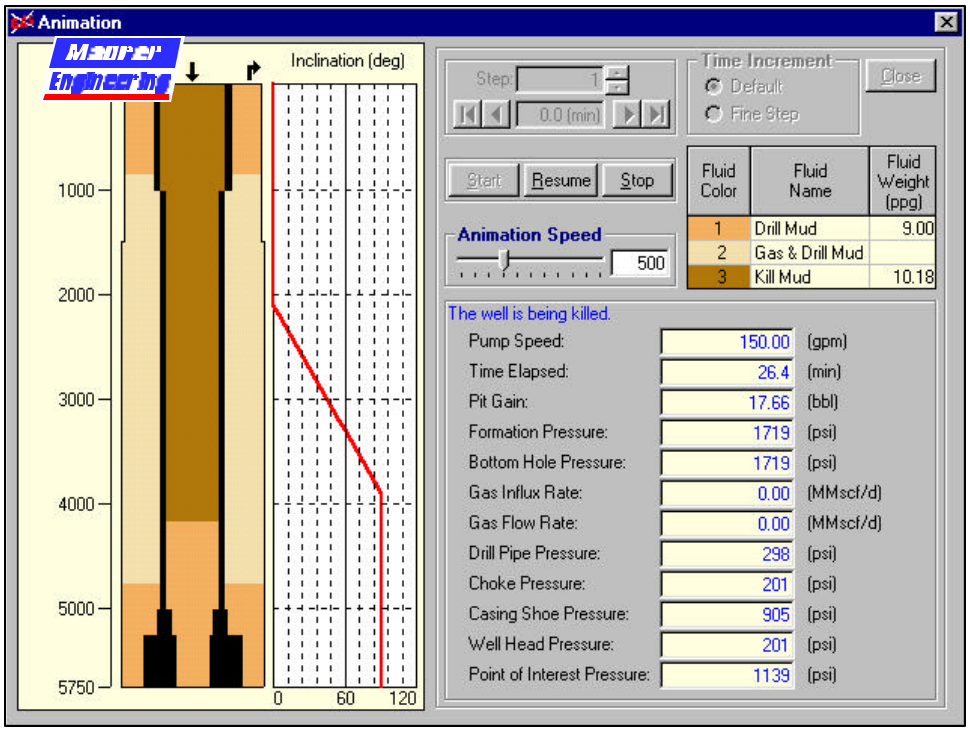
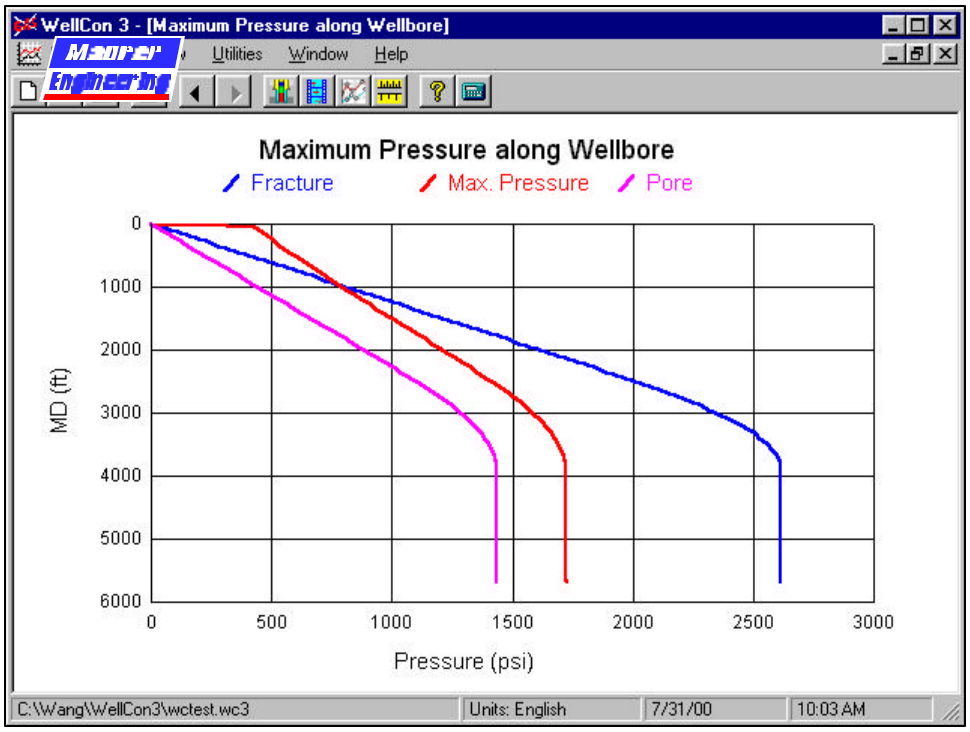
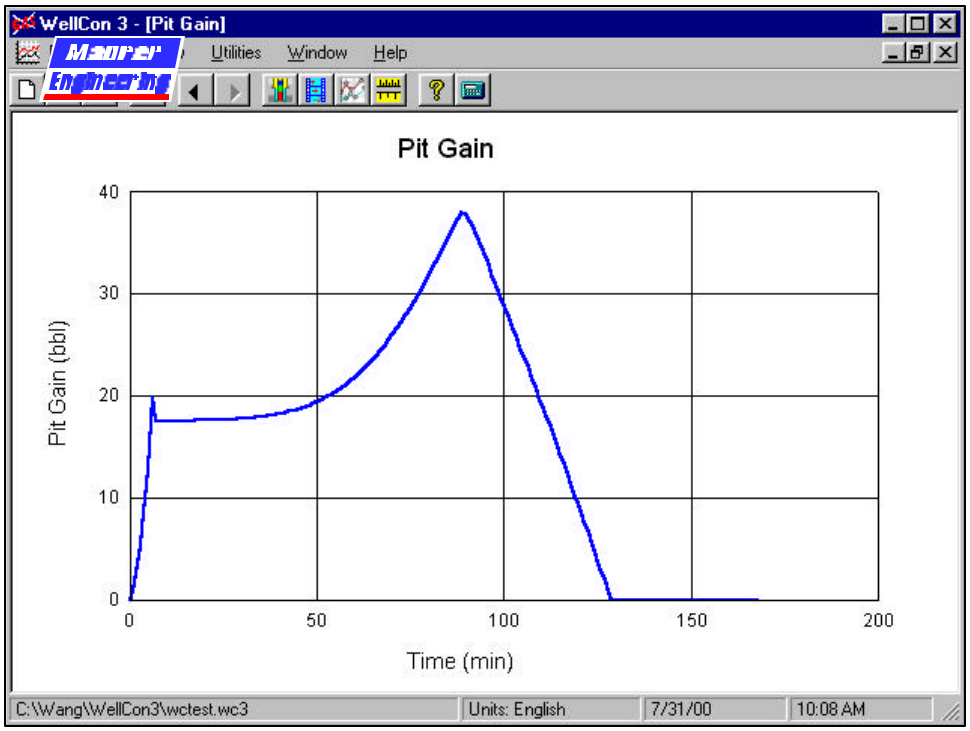
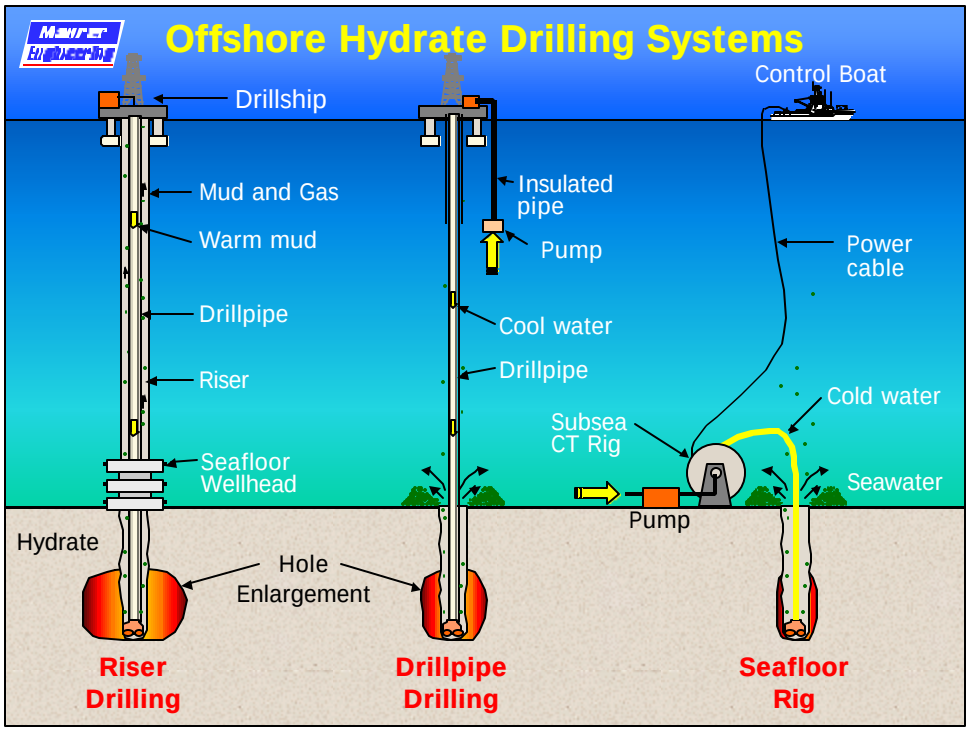
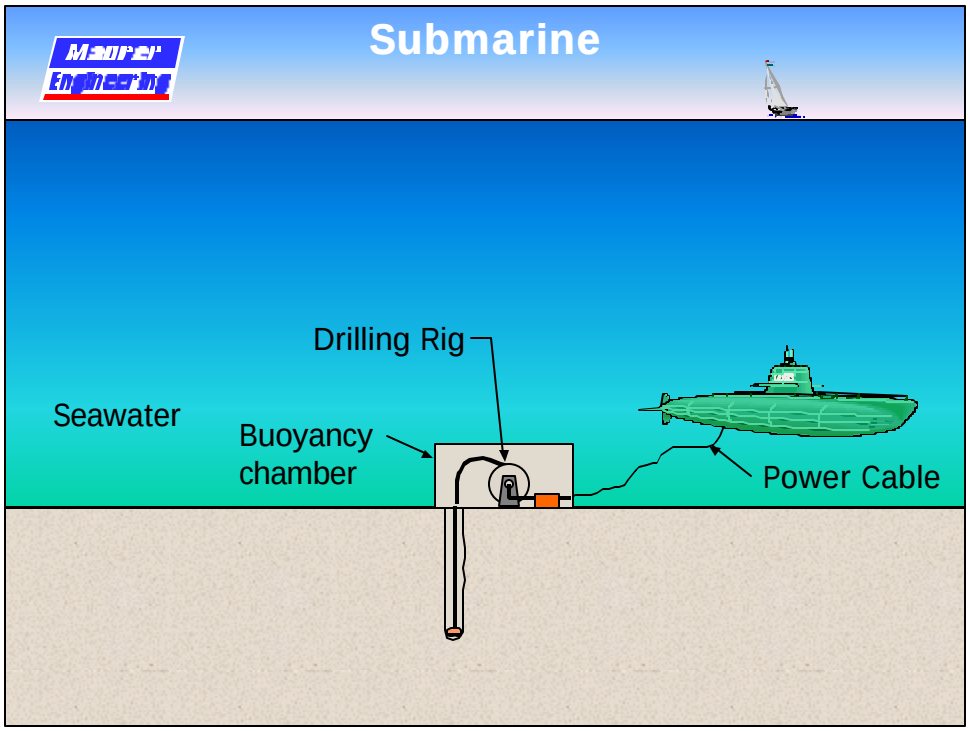
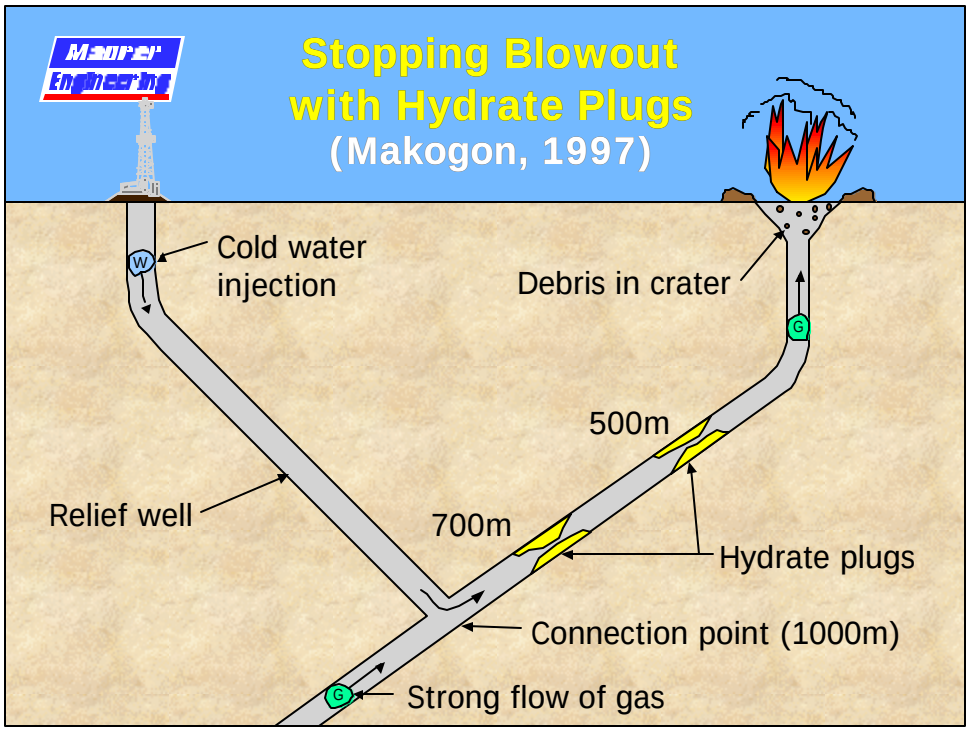

Animation
Maurer Engineering
Inclination (deg)
1000
2000
3000
4000
5000
5750
0
60
120
Step: 1
0.0 (min)
Time Increment
Default
Fine Step
Close
Start
Resume
Stop
Animation Speed
500
Fluid Color
Fluid Name
Fluid Weight (ppg)
1 Drill Mud 9.00
2 Gas & Drill Mud
3 Kill Mud 10.18
The well is being killed.
Pump Speed: 150.00 (gpm)
Time Elapsed: 26.4 (min)
Pit Gain: 17.66 (bbl)
Formation Pressure: 1719 (psi)
Bottom Hole Pressure: 1719 (psi)
Gas Influx Rate: 0.00 (MMscf/d)
Gas Flow Rate: 0.00 (MMscf/d)
Drill Pipe Pressure: 298 (psi)
Choke Pressure: 201 (psi)
Casing Shoe Pressure: 905 (psi)
Well Head Pressure: 201 (psi)
Point of Interest Pressure: 1139 (psi)


WellCon 3 - [Maximum Pressure along Wellbore]
Utilities
Window
Help
Maurer Engineering
Maximum Pressure along Wellbore
Fracture
Max. Pressure
Pore
MD (ft)
0
1000
2000
3000
4000
5000
6000
0
500
1000
1500
2000
2500
3000
Pressure (psi)
C:\Wang\WellCon3\wctest.wc3
Units: English
7/31/00
10:03 AM


WellCon 3 - [Pit Gain]
Utilities
Window
Help
Pit Gain
Pit Gain (bbl)
40
30
20
10
0
0
50
100
150
200
Time (min)
C:\Wang\WellCon3\wctest.wc3
Units: English
7/31/00
10:08 AM

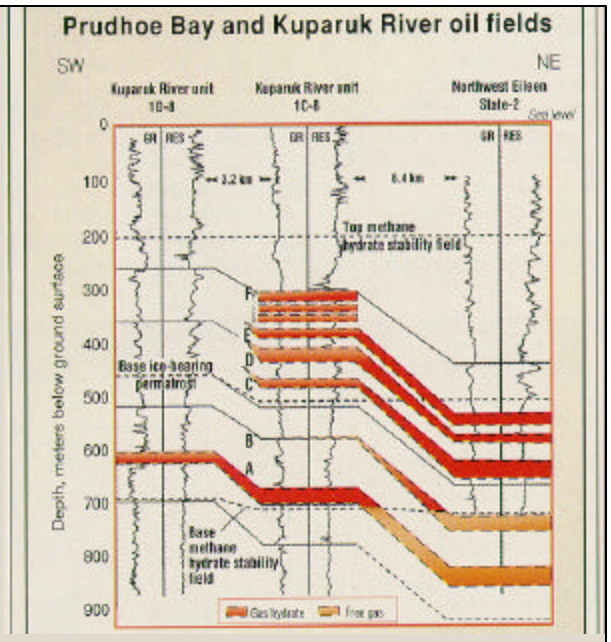

Offshore Hydrate Drilling Systems
Drillship
Control Boat
Mud and Gas
Warm mud
Drillpipe
Riser
Seafloor
Wellhead
Insulated
pipe
Pump
Cool water
Drillpipe
Power
cable
Cold water
Subsea
CT Rig
Seawater
Pump
Hydrate
Hole
Enlargement
Riser
Drilling
Drillpipe
Drilling
Seafloor
Rig


Submarine
Drilling Rig
Seawater
Buoyancy chamber
Power Cable


Stopping Blowout with Hydrate Plugs
(Makogon, 1997)
Cold water injection
Debris in crater
500m
Relief well
700m
Hydrate plugs
Connection point (1000m)
Strong flow of gas

Well Log Geologic Cross Section

(Collett et al., 1998)



Hydrate Drilling Recommendations

- Fund hydrate drilling R&D immediately
- Focus on safety and reducing costs
- Document Russian drilling technology
- Develop improved computer models
- Conduct experiments in oil and gas wells
- Develop inexpensive seafloor coring system

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The End
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