Distinguished Lecturer Program

Primary funding is provided by

The SPE Foundation through member donations and a contribution from Offshore Europe

The Society is grateful to those companies that allow their professionals to serve as lecturers

Additional support provided by AIME

ارامكو السعودية
Saudi Aramco

Managed Pressure Drilling – Experiences and Way Forward

Muhammad A. Muqeem, Ph.D., P. Eng.

Saudi Aramco

SPE Distinguished Lecturer Program

Outline

- Definition
- The Big Challenge
- Impact of the Technology
- Benefits & Case Histories
- What’s Next
- Conclusions

Challenging Wells

Expensive Wells

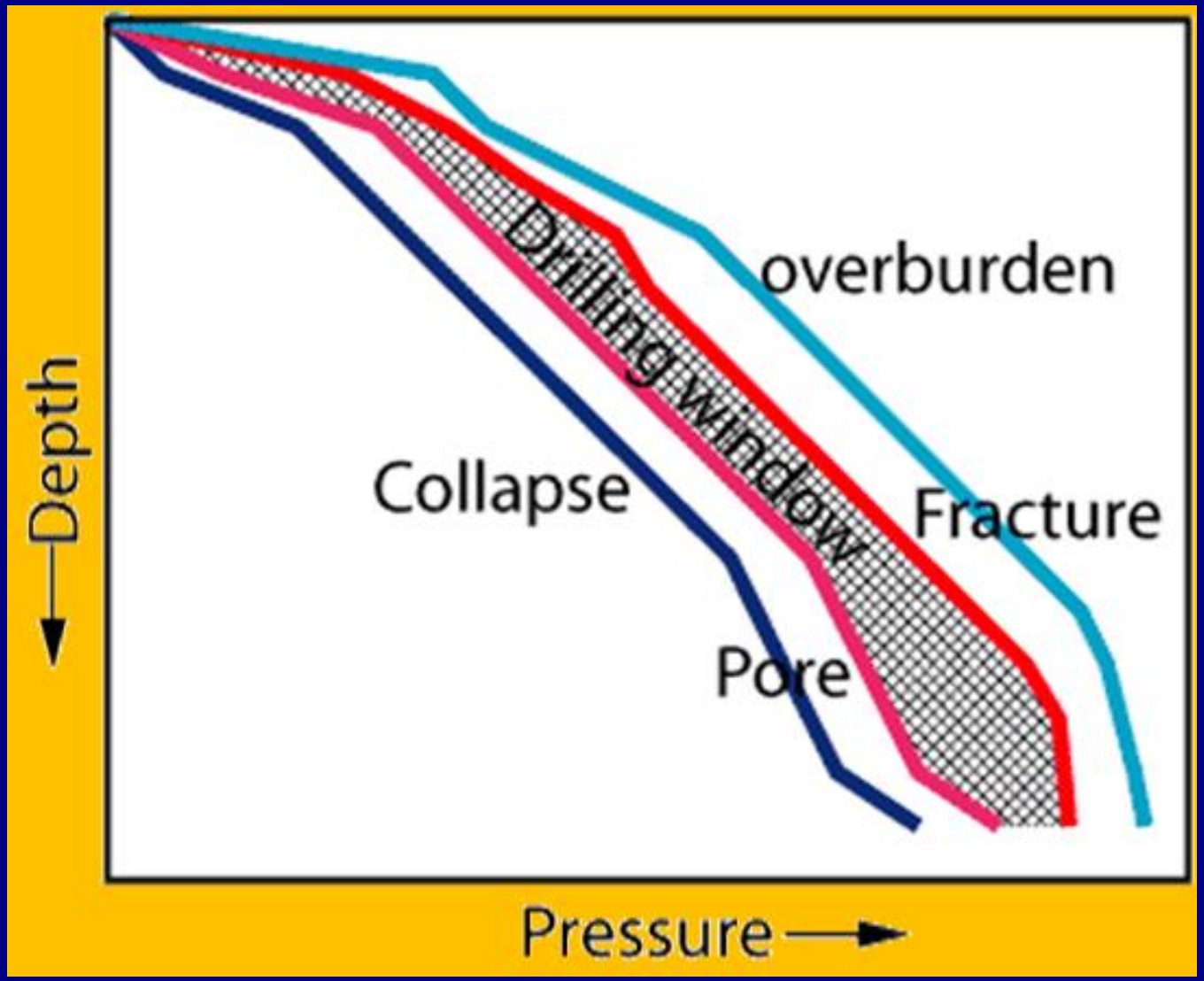
“The world is running out of conventional prospects…. but don’t worry. Managed Pressure Drilling (MPD) is one enabler for tackling “undrillable” wells.”

*Signa Engineering Corp. website

IADC Definition – Managed Pressure Drilling

"an adaptive drilling process used to precisely control the annular pressure profile throughout the wellbore. The objectives are to ascertain the downhole pressure environment limits and to manage the annular hydraulic pressure profile accordingly."

The Big Challenge



*IADC/SPE 122281

Conventional Drilling

Bottomhole circulating pressure (BHCP) is manipulated by only two variables:

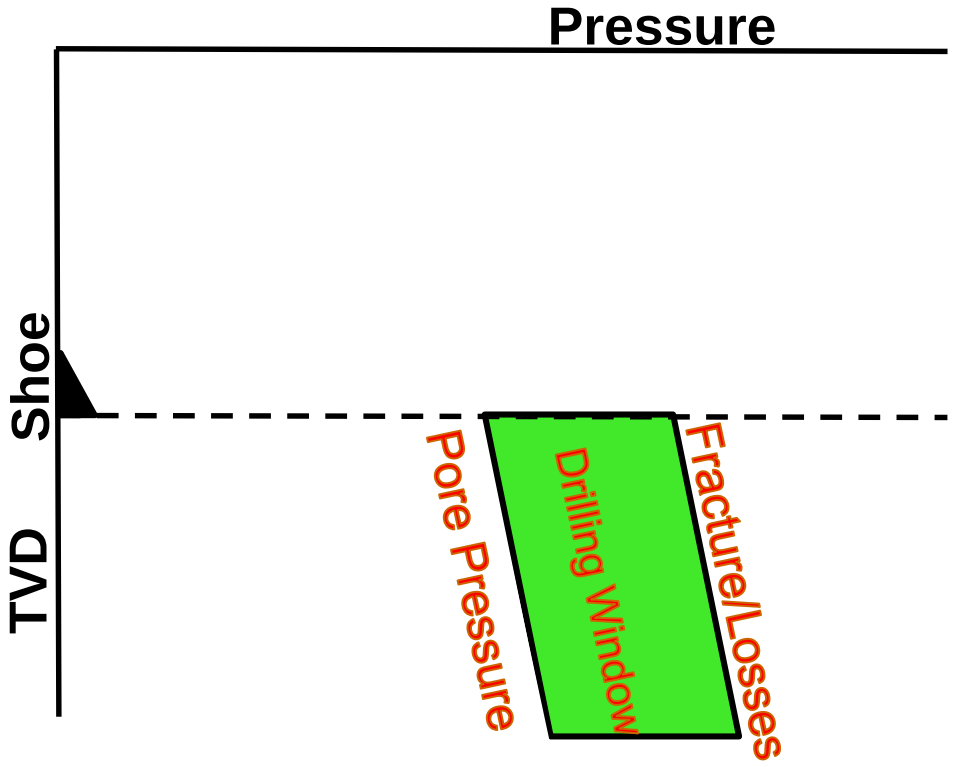
BHCP = Hydrostatic Pressure + Friction Pressure

Managed Pressure Drilling

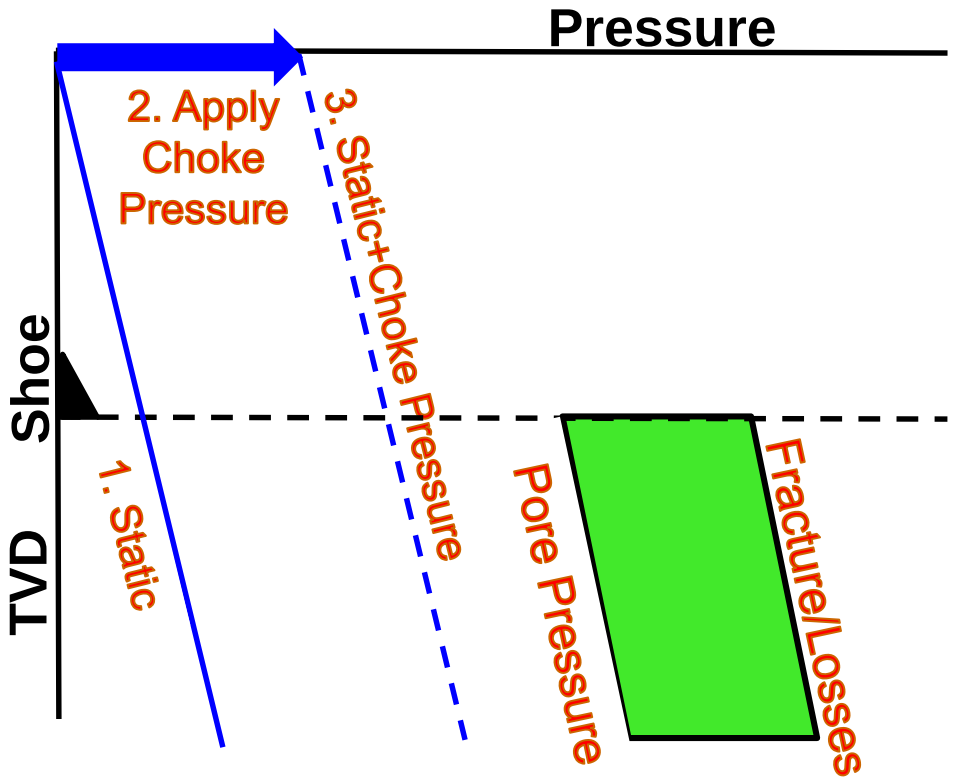
Bottomhole circulating pressure is manipulated by three variables:

BHCP = Hydrostatic Pressure + Friction Pressure
+ Surface Back Pressure

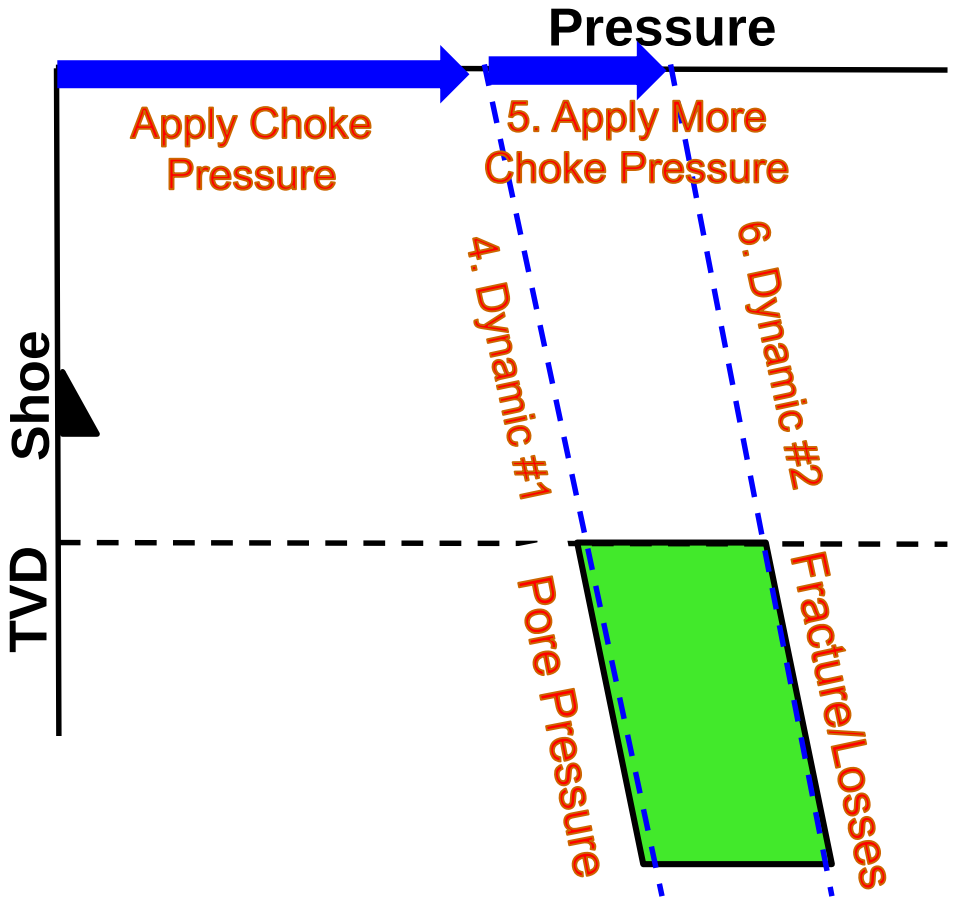
MPD – Fundamental Principles



MPD – Fundamental Principles (cont.)



MPD – Fundamental Principles (cont.)



Variations of MPD

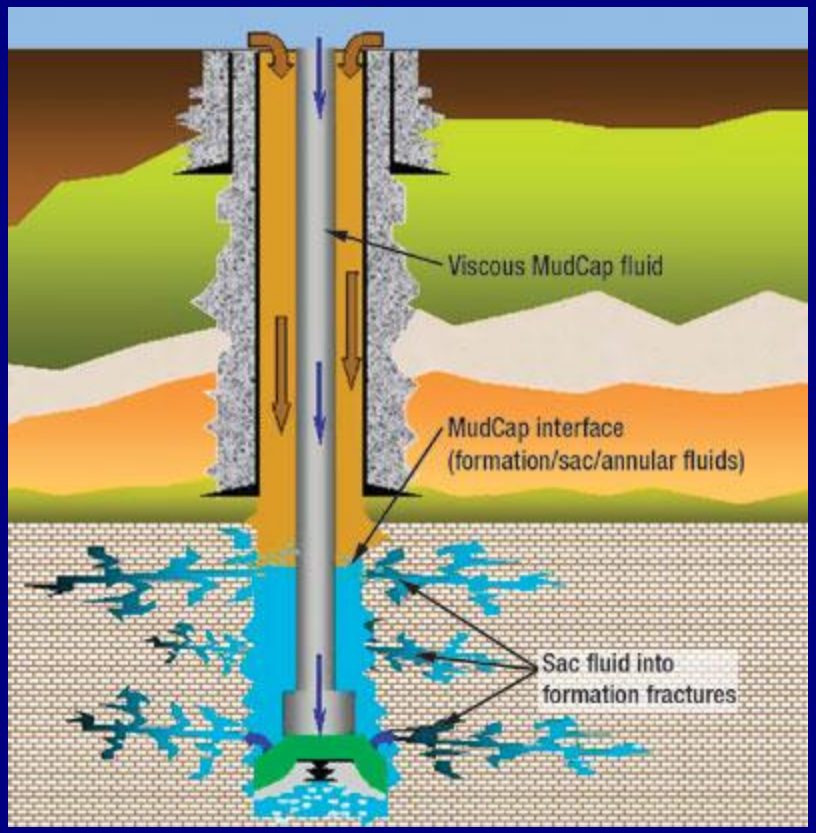
- Constant Bottomhole Pressure (CBHP)
- Pressurized Mudcap Drilling (PMCD)
- Dual Gradient Drilling (DGD)

Constant Bottomhole Pressure (CBHP)

- “ECD Management”
- Narrow drilling window
- Slightly lighter fluids than conventional
- Influx is prevented by backpressure
- Intent to keep BHCP as constant as possible.

Pressurized Mudcap Drilling (PMCD)

- Total loss circulation
- Well control challenges
- Failure to reach TD

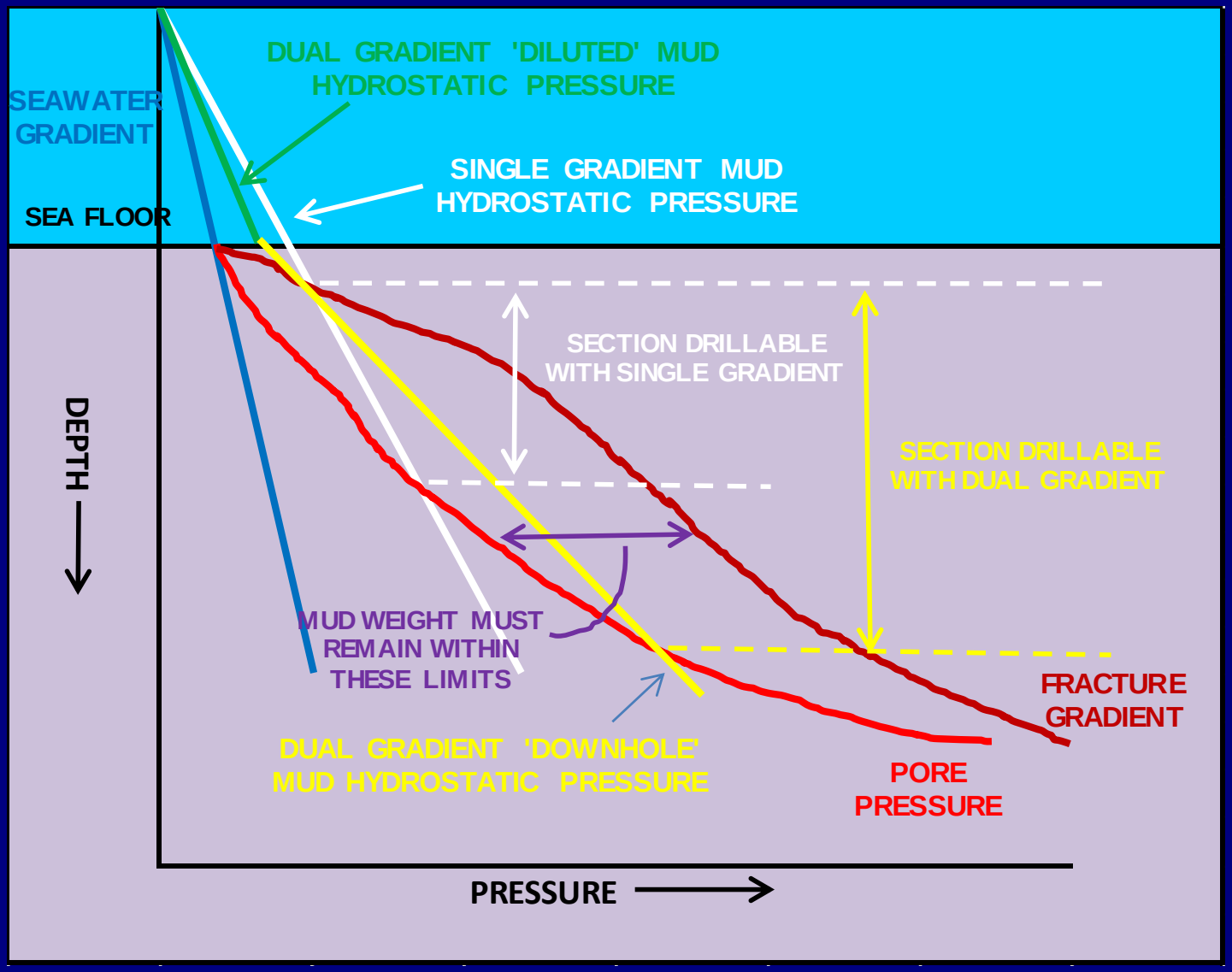


*World Oil, March 2006

Dual Gradient Drilling (DGD)

- High equivalent circulating density
  - Ultra deepwater
  - Extended reach
  - Narrow sidetrack drilling
- Subsea RCD
- Subsea pumps

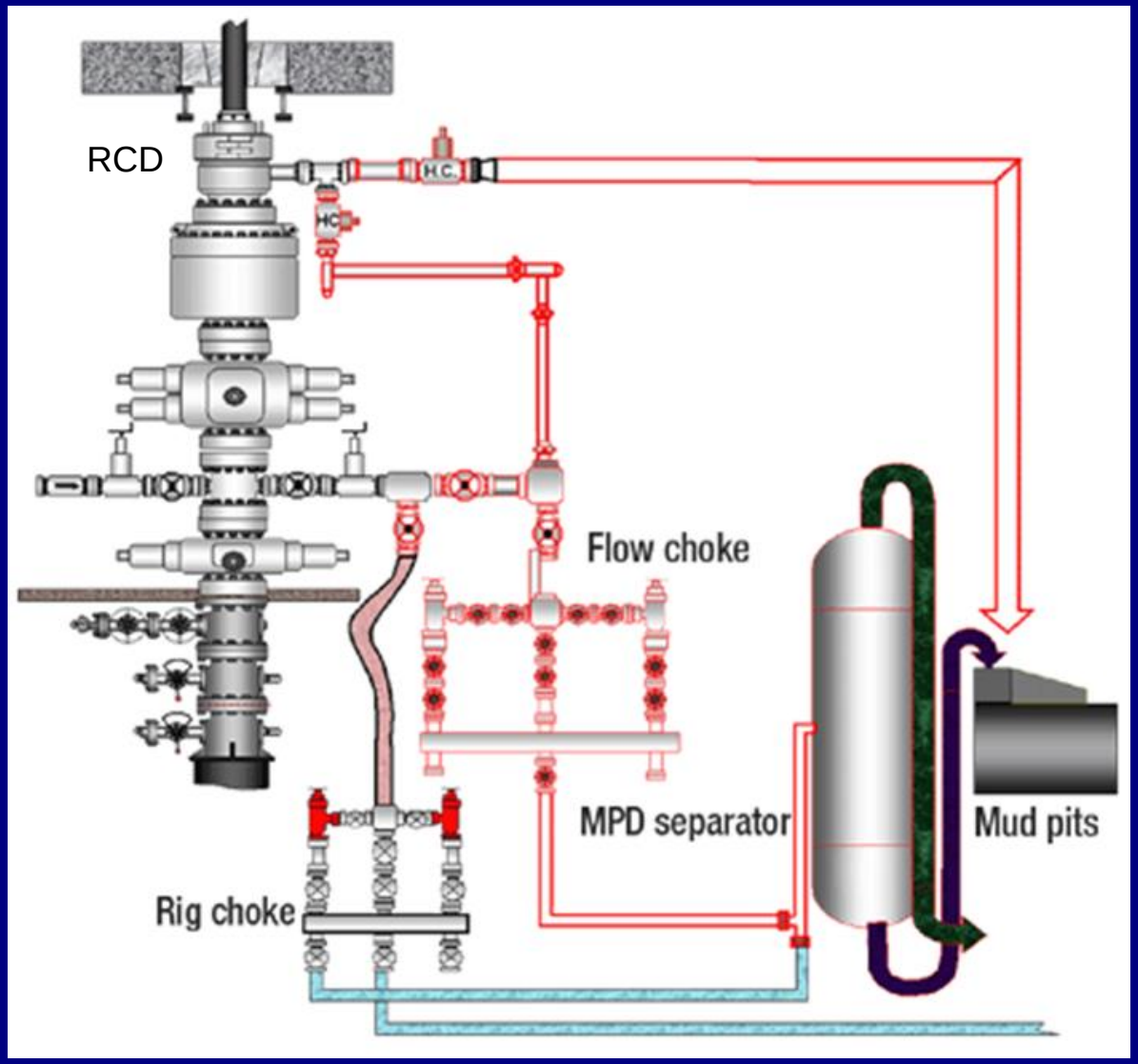
Dual Gradient Drilling Schematic



MPD enabling tools

- Rotating Control Diverter (RCD)
- Dedicated choke
- Mass flow meter
- Drill string floats
- Continuous circulating device
- Separation package
- Training

MPD Equipment Layout (Closed)



*Medley & Reynolds, "Distinct variations of MPD exhibit application potential"

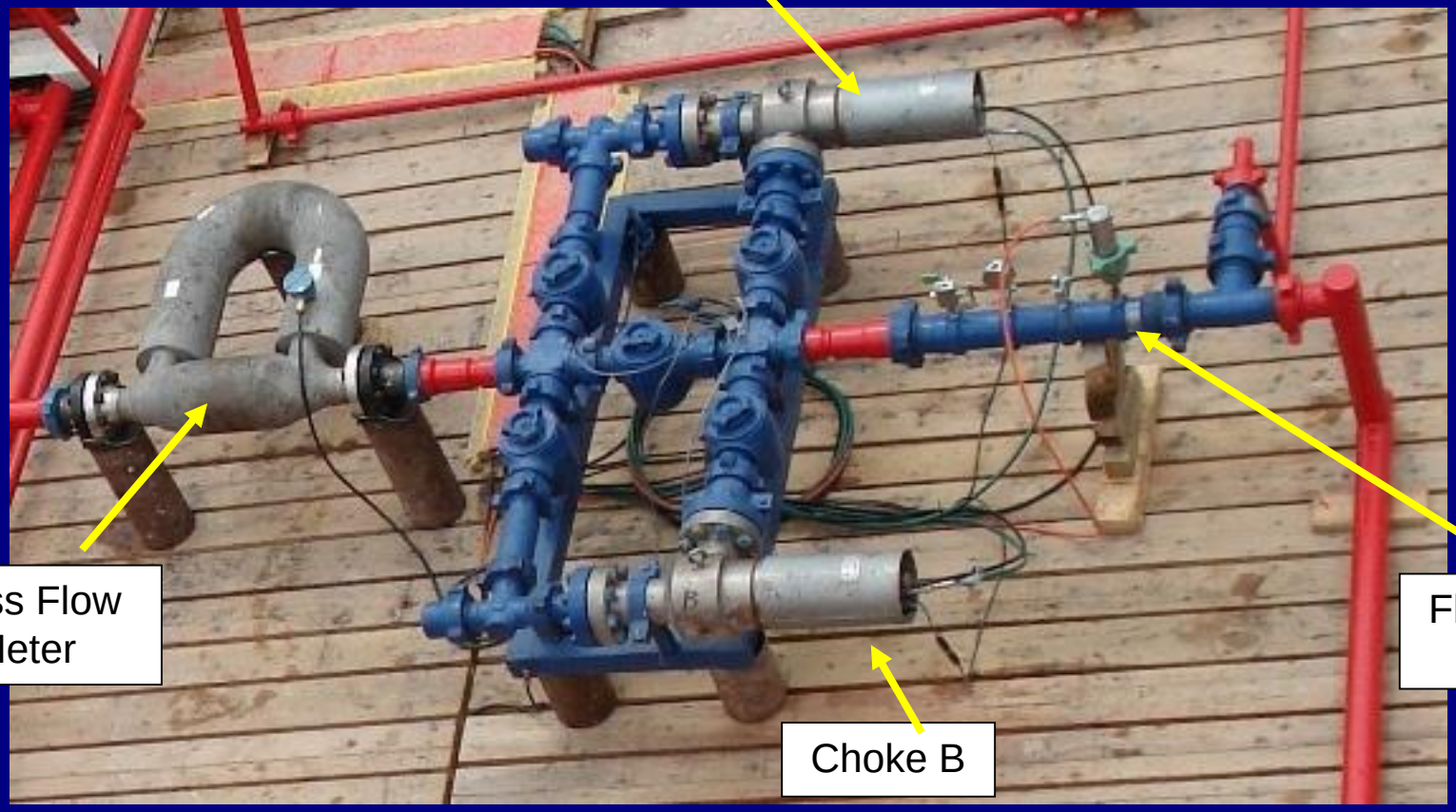
Rotating Control Diverter

RCD

RCD Control Console

*Weatherford

MPD Choke Manifold



*Schlumberger

Separation Package

- Multi-phase separator
- Separates gas from drilling mud
- Sends mud to active system for further processing

*Schlumberger

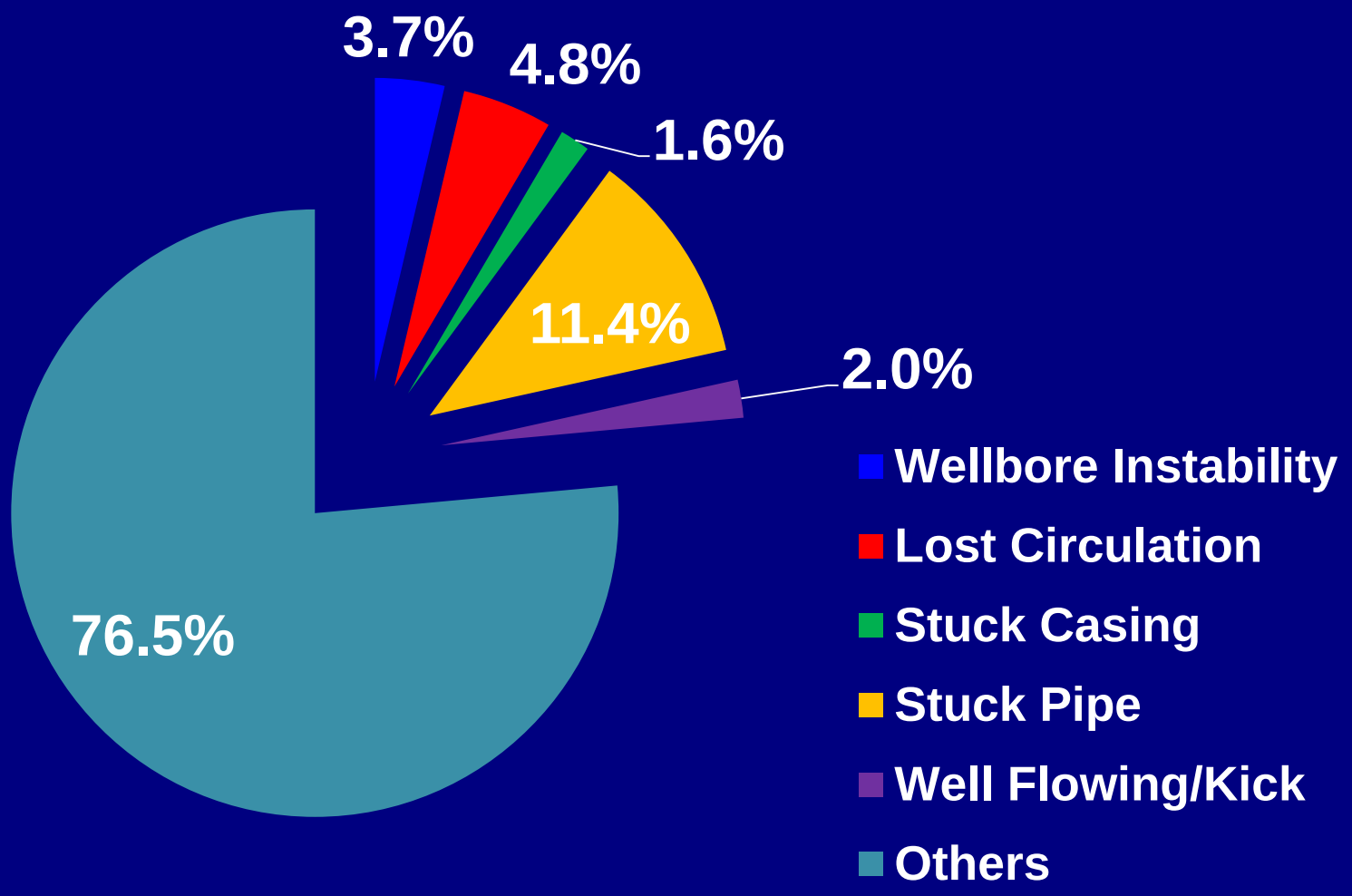
Benefits

- Reduces non productive time
- Enables the use of a lighter weight mud
- Reduces solids invasion to improve productivity
- Avoids fluid losses, minimizes mud costs

Benefits (continued)

- Significant increase in safety and efficiency
- Mitigates potential stuck pipe and well control incidences
- Allows drilling in environmentally sensitive and hazardous (H_2S) areas
- Detects gas kicks quickly using the intelligent control system

2012 MPD Preventable NPT (MENA Region)



Impact of MPD (MENA Region)

- MPD preventable NPT ~ 23.5%
- Average onshore rig spread
  - Oil well drilling cost/foot ~ 642 USD
  - NPT cost per foot ~ 151 USD
- Average cost avoidance for a 15,000 ft well ~ 2.3 MM USD

1st MPD Well - Kingdom of Saudi Arabia

8-3/8" Section	Offset Well	MPD Well
Total Drilling Days	65	40
Days spent on Well Control	7.6	1.1
Days spent on Reaming	2.8	0.8

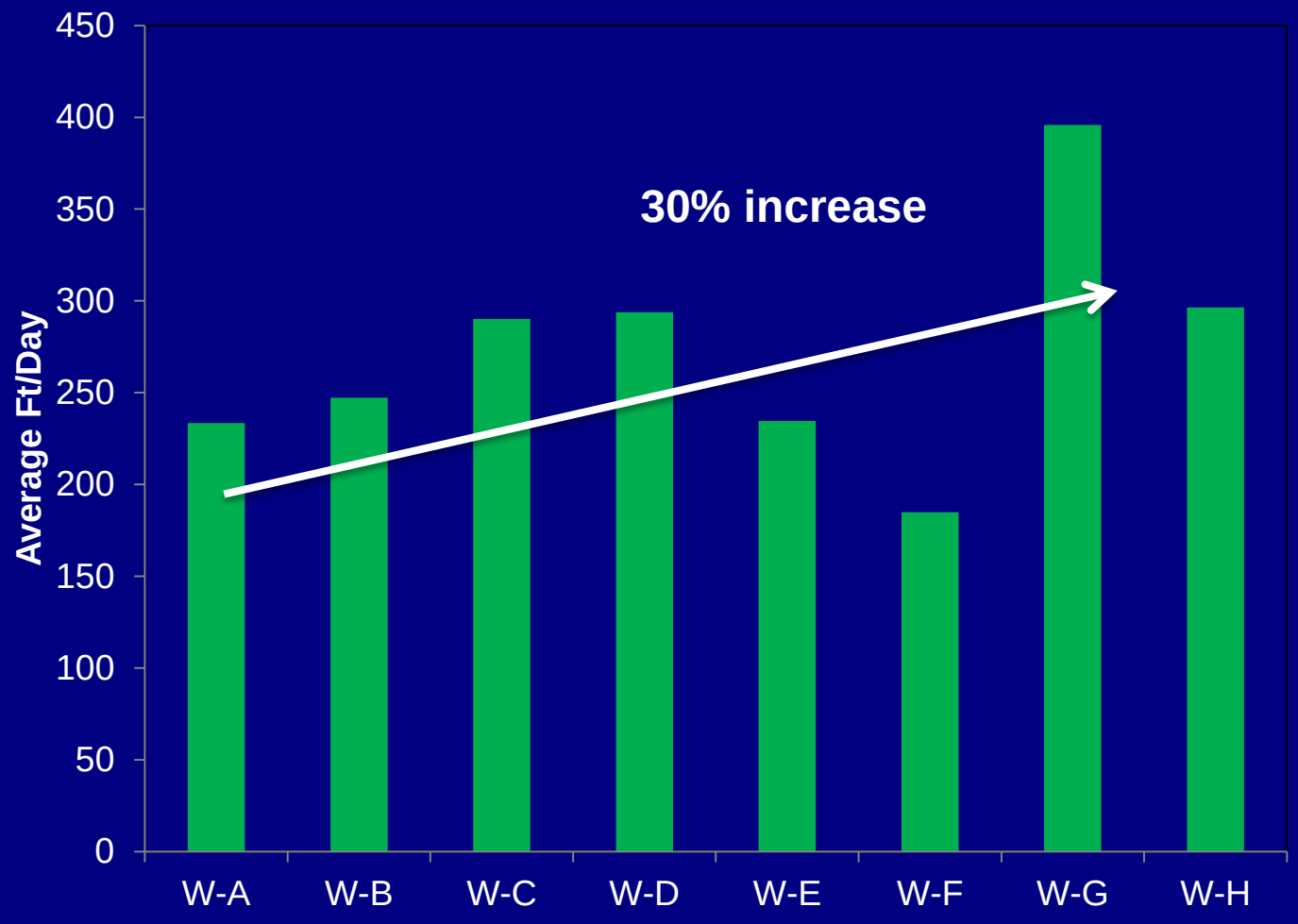
*SPE/IADC 113679

Case History – MENA Region

Objectives:

- Enable use of a lighter mud system to avoid unnecessary and excessive overbalance
- Keep drilling fluids out of the formation
- Reduce/Eliminate the potential NPT related to pipe stuck scenarios and well control events

Case History – MENA Region (contd.)



Case History – MENA Region (contd.)

- Reduced stuck pipe & fishing NPT by 95%
- Allowed reducing the drilling mud weight from 14 ppg to 10.5 ppg improving drilling efficiency
- Reduced solids invasion and improved water injectivity in the lateral
- Average number of bit/motor runs increased three-folds

Case History – Shale Plays (North America)

Average values	6 Offset Wells	4 MPD Wells
Mud weights at TD, ppg	16.5	15.0
Days for lower hole section	33.0	16.5
Total days to TD	62	40

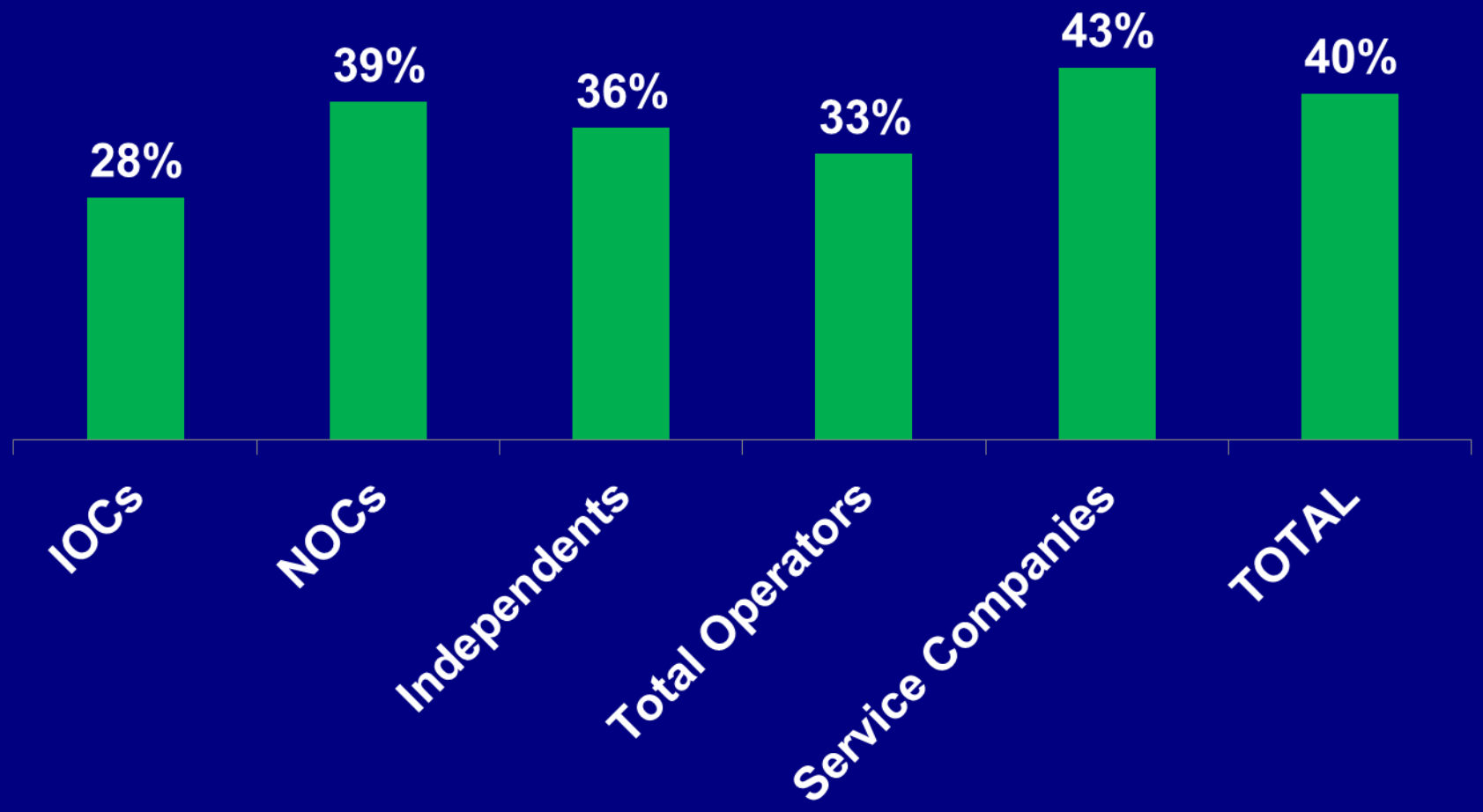
*AADE-11-NTCE-55

Steps for MPD Technology Acceptance

- Better communication of benefits
- To include cost/benefit analysis
- Reduce cost of MPD
- More successful applications
- Extensive training

*Journal of Petroleum Technology: February 2011

Offshore wells using MPD in 5 years



*Journal of Petroleum Technology: February 2011

What's Next

- Deepwater MPD
- Improved modeling of subsurface conditions (multiphase annular flow)
- Greater automation (choke)
- Data availability in certain environments (compressible fluid) using wired drillpipe
- Barrier Monitoring

What's Next (continued)

- Mainstream technology in the near future
- "Un-drillable" wells are becoming "drillable"
- Unconventional wells are being drilled using MPD
- Managed Pressure Cementing
- Methane Hydrates

Methane Hydrates – The Next Frontier

- Major Challenges:
  - Narrow margin between pore pressure and fracture gradient in ocean sediments
  - Surface hole instability
  - Subsidence caused by hydrate production
  - Manage temperatures & pressures to limit hydrate dissociation in wellbore

Methane Hydrates – The Next Frontier

- MPD Toolbox:
  - Rotating control diverter
  - Drilling choke system
  - Non-return valves
  - Multiphase circulation pumps
  - Multiphase separation system

Conclusions

- Wells are becoming more expensive and difficult to drill
- MPD is evolving into a key enabling technology to tackle those challenging wells
- Numerous case histories in all types of well indicate that MPD is here to stay

Conclusions (continued)

- MPD is a complex, multidisciplinary activity which requires proper engineering, HSE and project management skills
- Enhances formation evaluation
- Fit for purpose training is a prerequisite for successful implementation

Thank You

Distinguished Lecturer Program

Your Feedback is Important

Enter your section in the DL Evaluation Contest by completing the evaluation form for this presentation :

http://www.spe.org/dl/

Society of Petroleum Engineers
Distinguished Lecturer Program
www.spe.org/dl