Predicting Gun Jump Possibility by Gun Blow-up Model

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APPS-13-002

Introduction

Background:

Completion type : Slimhole Monobore

Perforation strategy : Thru Tubing Underbalanced Perforation by E-line

2007

- Chevron has implemented **"Underbalanced Perforation "**
  - **Better Productivity Index**
  - **Higher chance of gun jump >> Fish >> Lost Production**

2009

- The percentage blown-up fish was continuously increased **(1.12% or 61 fish)**
- Consequently,…
  - *Lost production opportunity*
  - *Spent time for fishing (**14,652 hrs or 610 days**)*

Opportunity Statement :

To reduce the blown-up fish with continuity of underbalanced perforation

Introduction

How to minimize the of blow-up fish?

Shut-in the well

Pressure up

Anchoring tool

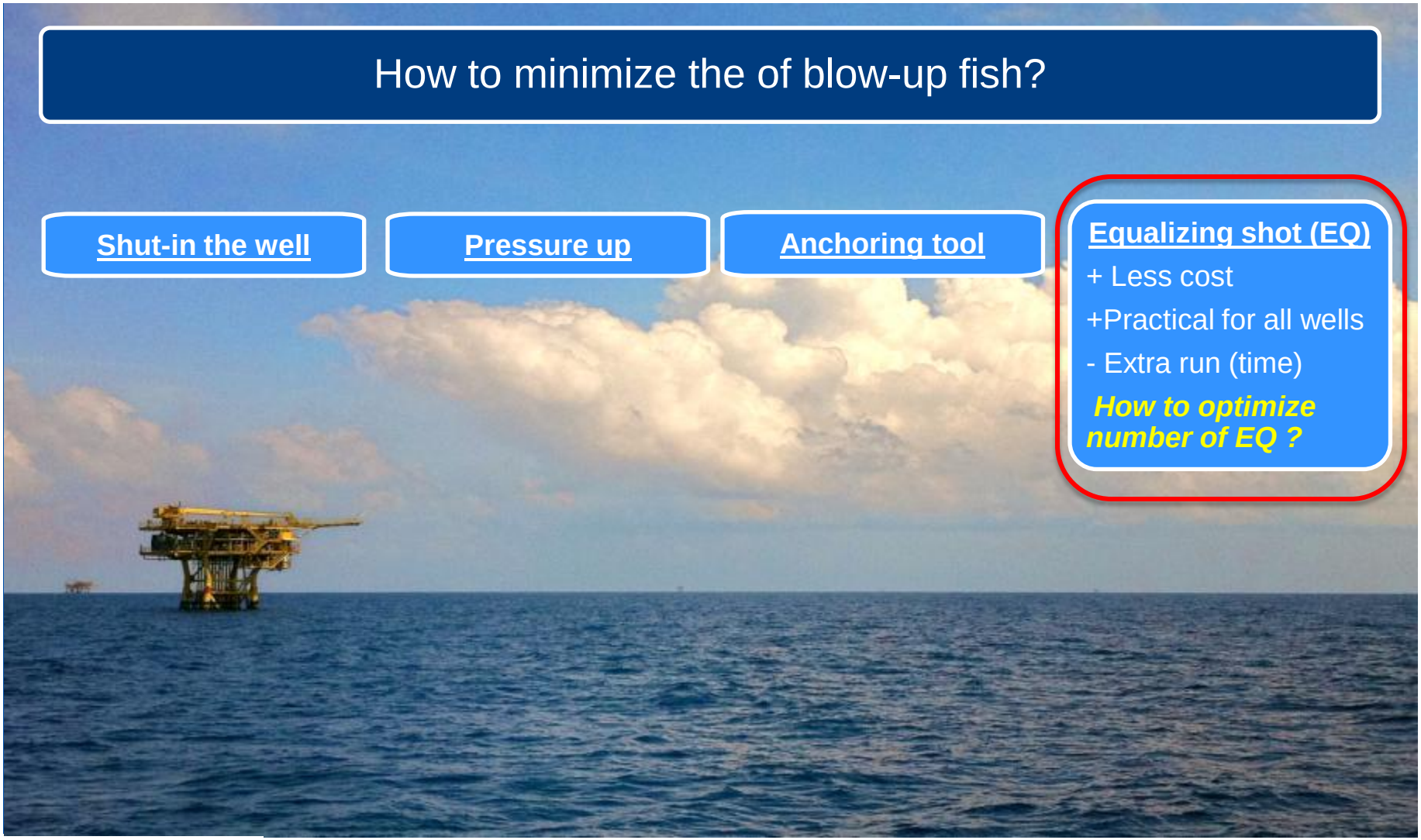
Equalizing shot (EQ)

+ Less cost

+Practical for all wells

- Extra run (time)

How to optimize number of EQ ?

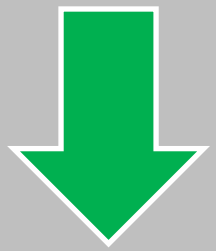


Methodology

Principle

What makes the gun jump ?

Downward Force



Cable weight

Tool string weight

Downward force<Upward force

Upward Force

Buoyancy force

-Function of Fluid Density, Well deviation, Tool string dimension

Lifting force

- Function of Formation Pressure, Porosity, Perforation interval etc.
- “Darcy Law”

Upward force – Downward force > 0	Blow up
Upward force – Downward force < 0	Not Blow up

Methodology

Step1: Determine the ***flow rate (Q)*** by Darcy Law

$$Q_g = \frac{703 \times 10^{-6} kh(P_r^2 - P_{wf}^2)}{\mu_g ZT \ln(\frac{0.472 r_e}{r_w})}$$

$$Q_o = \frac{0.00708 kh(P_r - P_{wf})}{\mu_o B_o \ln(\frac{r_e}{r_w})}$$

Step2: Convert flow rate(Q) to ***Lifting force***

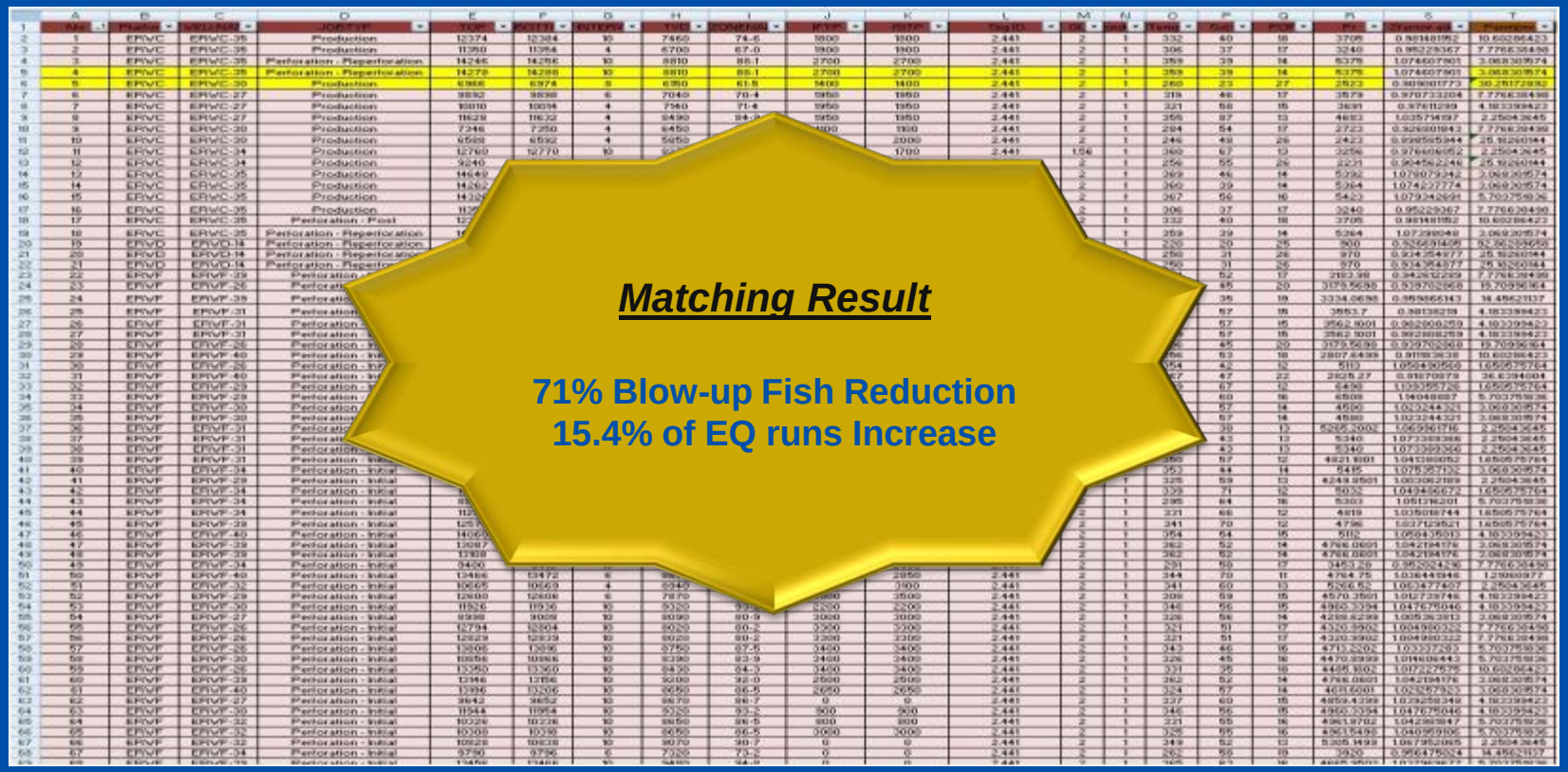
Step3: Combine Lifting force with Buoyancy force to get Upward force

Step4: Determine the ***Net force*** by subtracting Downward force from Upward force

Methodology

History Match

Data Point during 1-Jan-08 to 1-Oct-09 (Total 5131 points)

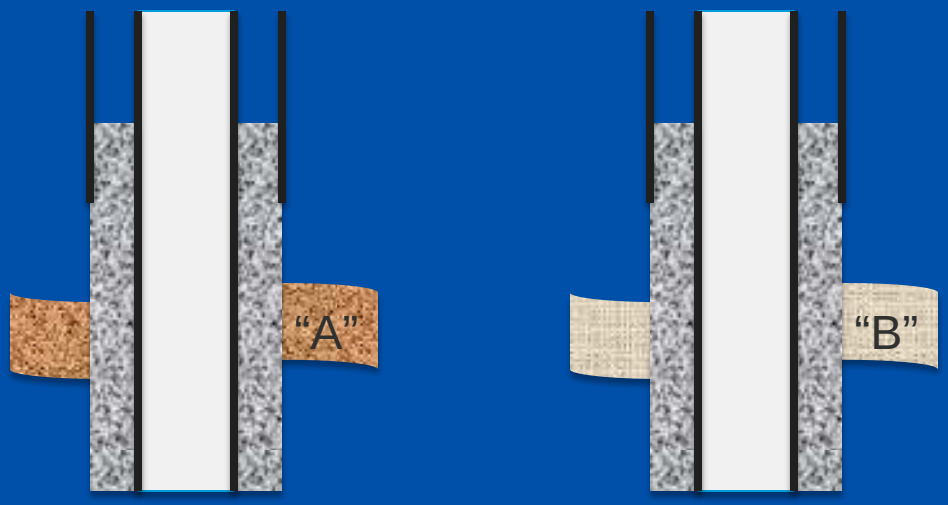


Matching Result

71% Blow-up Fish Reduction
15.4% of EQ runs Increase

Methodology

Which sand requires the EQ shots?



Sand	Top	Bottom	Interval	Formation Pressure	Porosity	Oil/Gas	Temp	Current SITP
"A"	9000'	9006'	6 ft	2500 psi	25%	Gas	310 F	1200 psi
"B"	8900'	8910'	10 ft	3000 psi	20%	Gas	300 F	1300 psi

Methodology

Sand	Top	Bottom	Interval	Formation Pressure	Porosity	Oil/Gas	Temp	Current SITP
"A"	9000'	9006'	6 ft	2500 psi	25%	Gas	310 F	**1200 psi**
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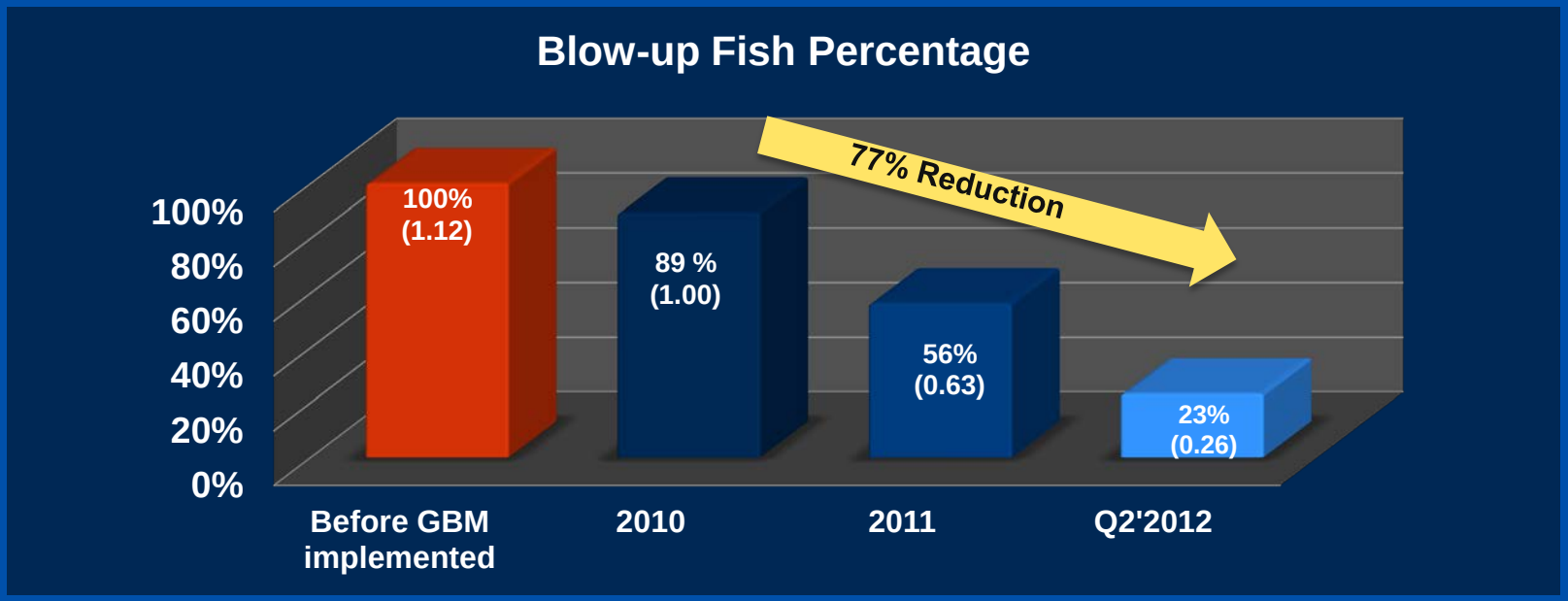
Gun Blow-up Model		
Field	"Red"	
Tubing ID	2.441	inch
TVD	-8900	TVDSS
Top interval	9000	ftRKB
Bottom interval	9006	ftRKB
Gun size	2	inch
Porosity	25	%
Temperture	310	deg F
Formation Pressure	2500	psi
Result	EQ is required if SITP<=1324 psi ("A")	

Gun Blow-up Model		
Field	"Green"	
Tubing ID	2.441	inch
TVD	-8800	TVDSS
Top interval	8900	ftRKB
Bottom interval	8910	ftRKB
Gun size	2	inch
Porosity	20	%
Temperture	300	deg F
Formation Pressure	3000	psi
Result	EQ is required if SITP<=1200 psi ("B")	

Result

Project Deliverability

- Since Gun Blow-up Model has been implemented in 2009, percentage of blown-up fish was **reduced significantly**



- LPO due to fish was decreased by ***42.7% (Gas), 79% (Oil)***
- Percentage of EQ runs was increased to **14%**

Conclusions

- ✓ Gun Blow-up Model was developed to determine whether the gun will be blown up after perforating at given condition. As a result, the blow-up fish was drastically reduced *(77% reduction).*
- ✓ *User friendly*. Only few input is required.
- ✓ The Gun Blow-up Model could successfully improve the *Production Deliverability, Efficiency and Safety Performance.*
- ✓ *The Gun Blow Up Model Concept could be applied to other operating area to improve the Underbalanced Perforation Efficiency*

Question & Answer