Batch Foaming Gas-lifted Oil and Liquid Loaded Gas wells in BSP

Olumuyiwa Owoyemi, PT & Gas-Lift aSME and

James W. Hall, Principal PT, Global PTE Artificial Lift
Brunei Shell Petroleum

Agenda

- Introduction
- Candidate Selection
- Foamer Agent Selection
- Results
- Conclusion and Way forward

Introduction

- East asset in BSP has several hundred producing wells. Mainly gas-lifted oil and gas wells

- Some oil wells have high water cut (> 70% BS&W). Here there is an opportunity to use batch foaming to provide short term production improvement and reduce Gas-lift (GL) consumption

- Some high rate gas wells have also gradually become liquid loaded and suffer kick off issues. Potential to use foamers to accelerate well kick off and reduce deferment

Candidate Selection

- **5 wells were selected for the foam trials (3 gas-lifted oil wells & 2 gas wells)**

Well	A	B	C	D	E
Fluid	Oil	Oil	Oil	Gas	Gas
Type	Flowing (Gas-lifted)	Flowing (Gas-lifted)	Flowing (Gas-lifted)	Dead	Huff and Puff

- **A, B & C –Partially loaded – Producing water**
- **D – Well with suspected inflow issue**
- **E – Flowing well with transient loading behaviour**

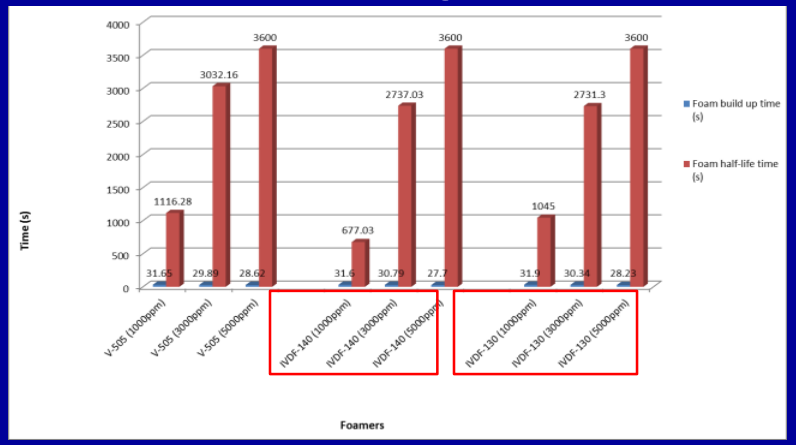
Foamer Agent Selection

Water samples from Well A and B were tested with 3 foamers supplied by Champion Nalco

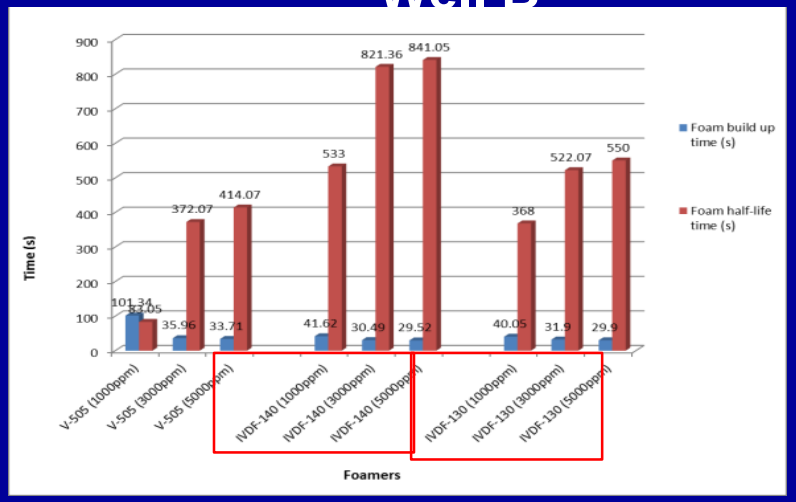
- **V-505 (water-foaming foamer)**
- **IVDF-140 (water-foaming foamer)**
- **IVDF-130 (water-foaming foamer)**

Foamer IVDF-140 and IVDF-130 performed better than V-505. IVDF140 Selected

Well A



Well B



Foam Build up

Foam Build-up time (s)	Result
< 80 s	Good
80 < x < 120 s	Moderate
> 120 s	Poor

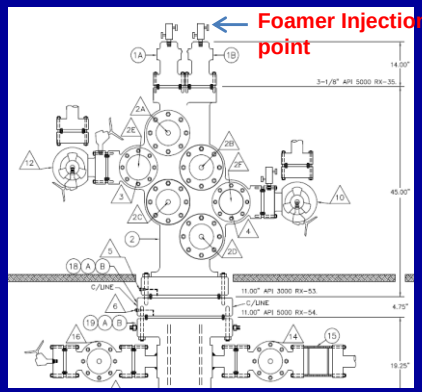
Foam half Life

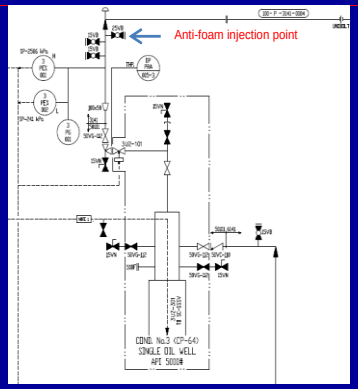
(s)	Result
> 180 s	Good
60 < x < 180 s	Moderate
> 60 s	Poor

DEPLOYMENT & APPLICATION METHOD

- The liquid foamer was batched into tubing via ½" NPT connection at the top of the wellhead shown below.

Anti-foam chemical was injected after flow back to minimize oil carry-over into gas line and avoid complication with level control in a separator or tank.





Foam Application Procedure

- An average of 120 liters of foamer (IVDF-140), followed by an average of 170 litres of overflush (KCL) was pumped into each well candidate.

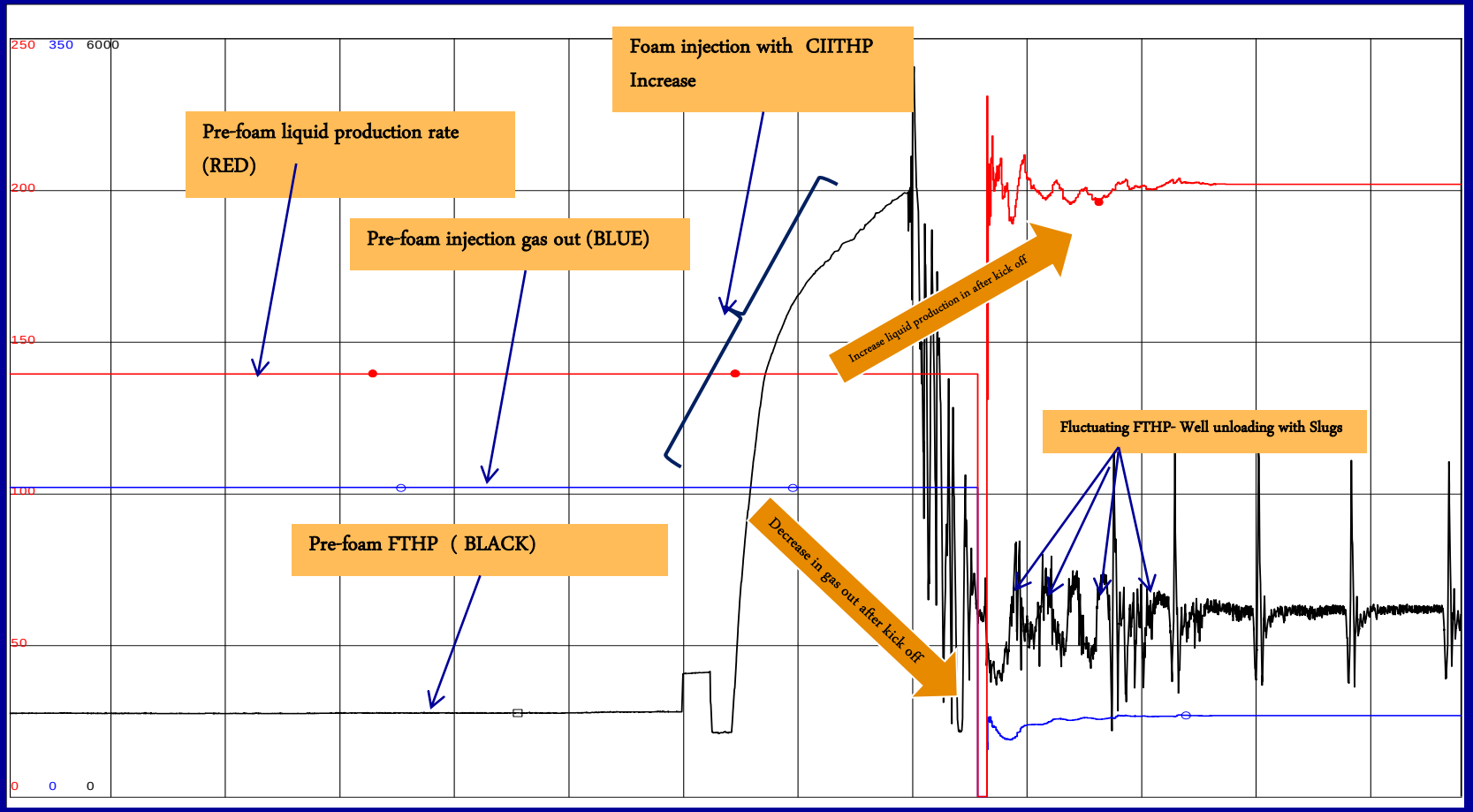
- This was followed by a shut-in period of 18-24 hrs. Wells were flowed back to the test separator or main oil line (if a test separator was not avialable)

Results Overview

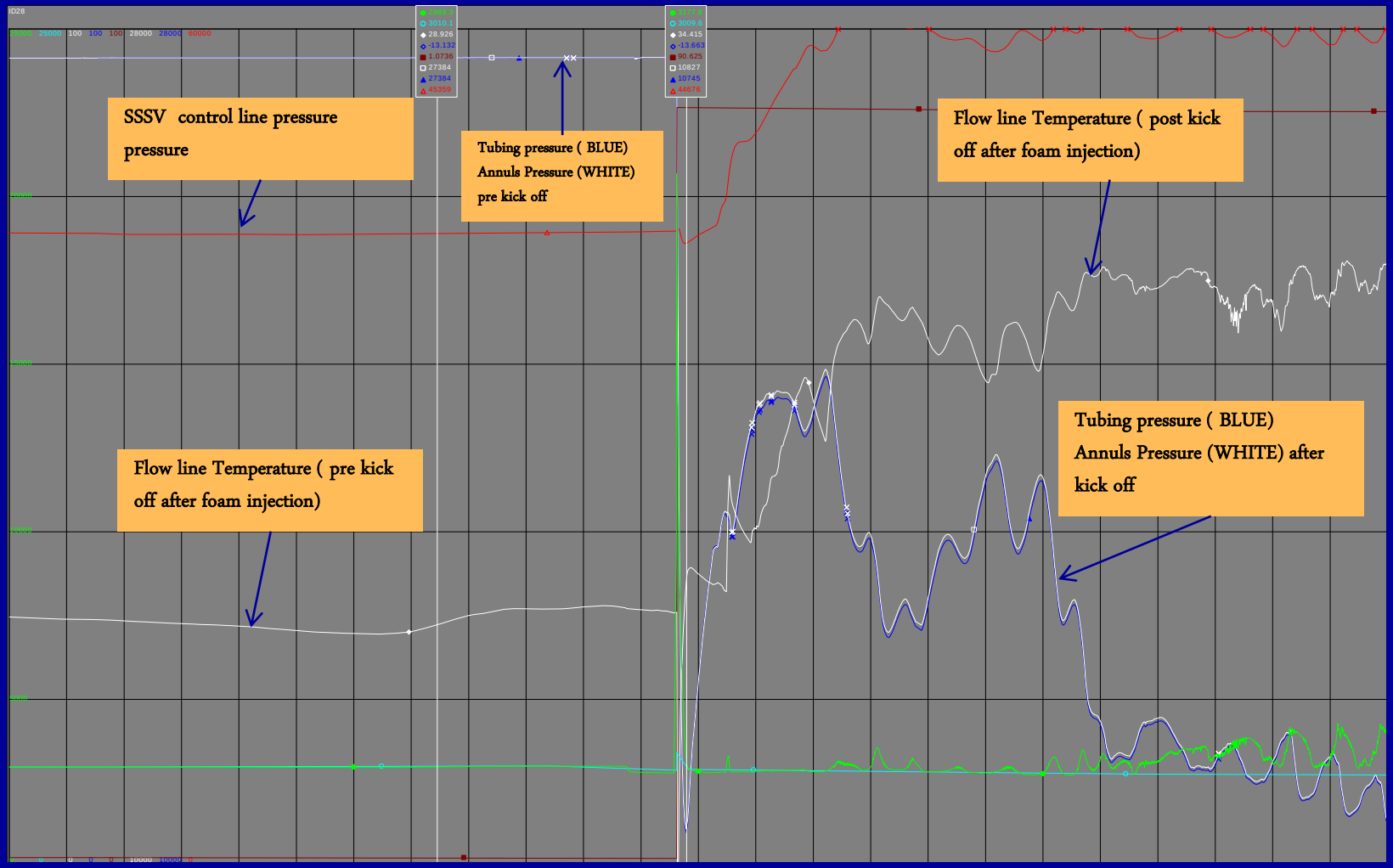
Overall the trial was successful with :

- Well A (oil well)
  - Initial flow back : Transient slugs
  - ~ 40% increase in gross (after two well tests 5 days apart) . Some reduction in initial Gas-lift consumption . The was maintained for around 5 months
- Well B (Oil Well)
  - Initial flow back showed ~10% increase in gross rate maintained for around 3 months
- Well C (Oil Well)
  - Initial flow back showed no change in measured gross
- Well D (Gas well)
  - 2 attempts at kicking off well . Well failed to respond
  - It was concluded that remediation must be performed to return well back to production
- Well E (Gas well)
  - 3 attempts at kicking off well . Well kicked off strongly after 3rd foam injection attempt. ~ 200ksm3/d gas production restored . Well is a gas-lift supplier supporting ~1000m3/d production

Results Detail – Well A- Gas-lifted Oil Well



Results Well E – High Gas Rate Well (Kick off)



Lessons Leant & Conclusion

Lessons Learnt

- Aggressive well start-up for initial foam unloading
- Alignment of Injection period and flow back periods with availability of onshore support
- If a wells fails to respond, try successive treatments of batch foam chemical before discontinuing trial

Conclusions and Way forward

- Batch foam injection is a viable low cost method of providing short term production improvement by reducing fluid level in the wellbore under flowing conditions.
- Batch foaming may also provide an alternative “poor boy” stimulation method for oil and gas wells
- Current efforts within BSP to mature continuous foam injection via Gas-lift

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