ConocoPhillips

GLV - testing
Gas Liquid Calculator

June 15, 2017

GLV testing in ConocoPhillips

- Well design makes GLV part of primary barrier envelope.

- According to NORSOK:
  - "Gas lift valves and chemical injection valves shall be periodically tested according to EAC 8.“

- According to EAC 8:
  - The valve shall be leak tested at specified regular intervals as follows:

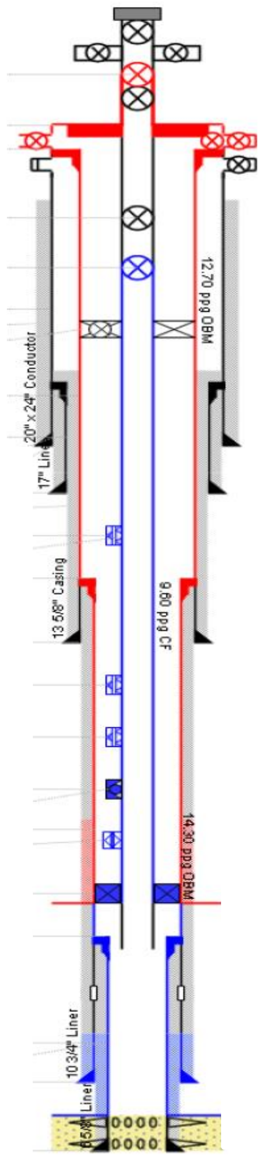
    a) monthly, until three consecutive qualified tests have be performed; thereafter

    b) every three months, until three consecutive qualified tests have been performed

    c) every six months;

    d) test evaluation period is volume and compressibility dependent and shall be held for a period that will give measurable pressure change for the allowed leak rate, minimum 30 min.

- 1-1-1-3-3-3-6



GLV testing in ConocoPhillips

- Direct Measurement (LMS-testing)
  - Bleed A-ann to 50% of tubing pressure
  - Liquid leak measured

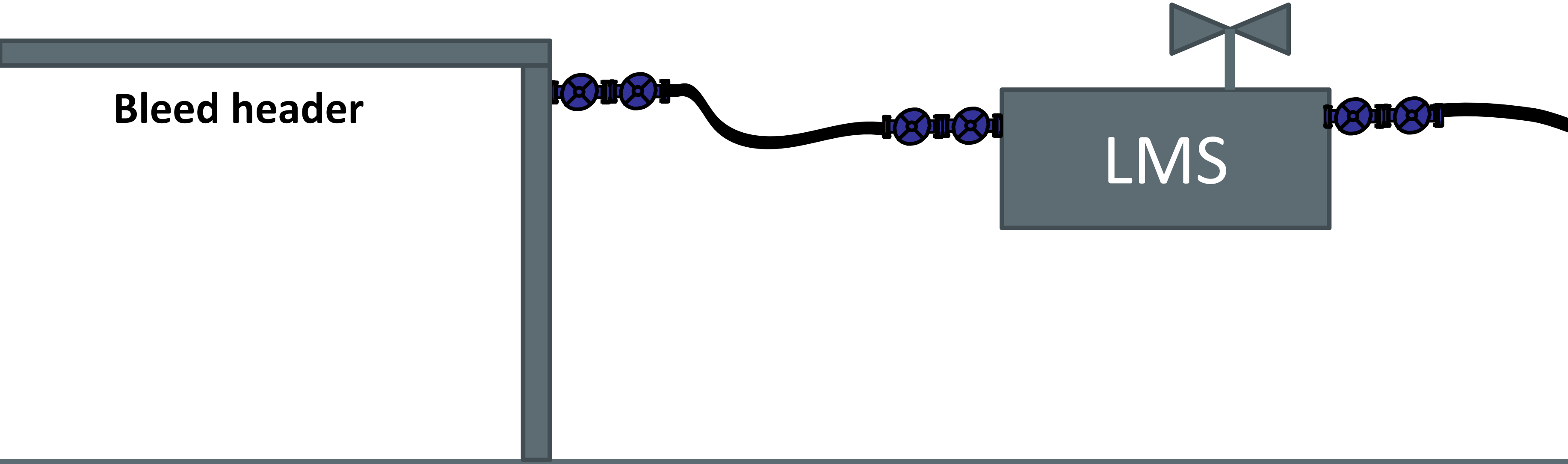
- Inflow Test (Calculator)
  - Bleed A-ann to 0 psig
  - Liquid level is known

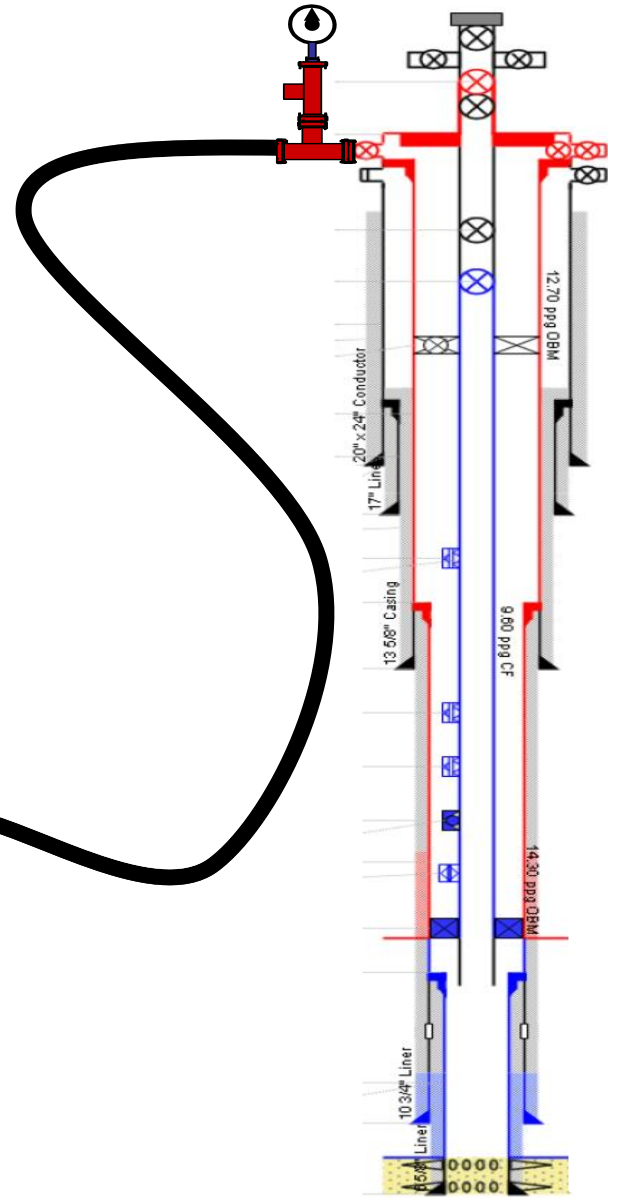
- Gas leak criteria - 15 scf/min

- Liquid leak criteria - 0,4 l/min

LMS testing

- Annulus A is depressurized and tubing is pressurized to create a differential pressure across GLV/Tubing.
- LMS measures leak into annulus A by bleeding through unit while keeping annulus A pressure constant.
- Acoustic measurements is used to detect changes in liquid level.





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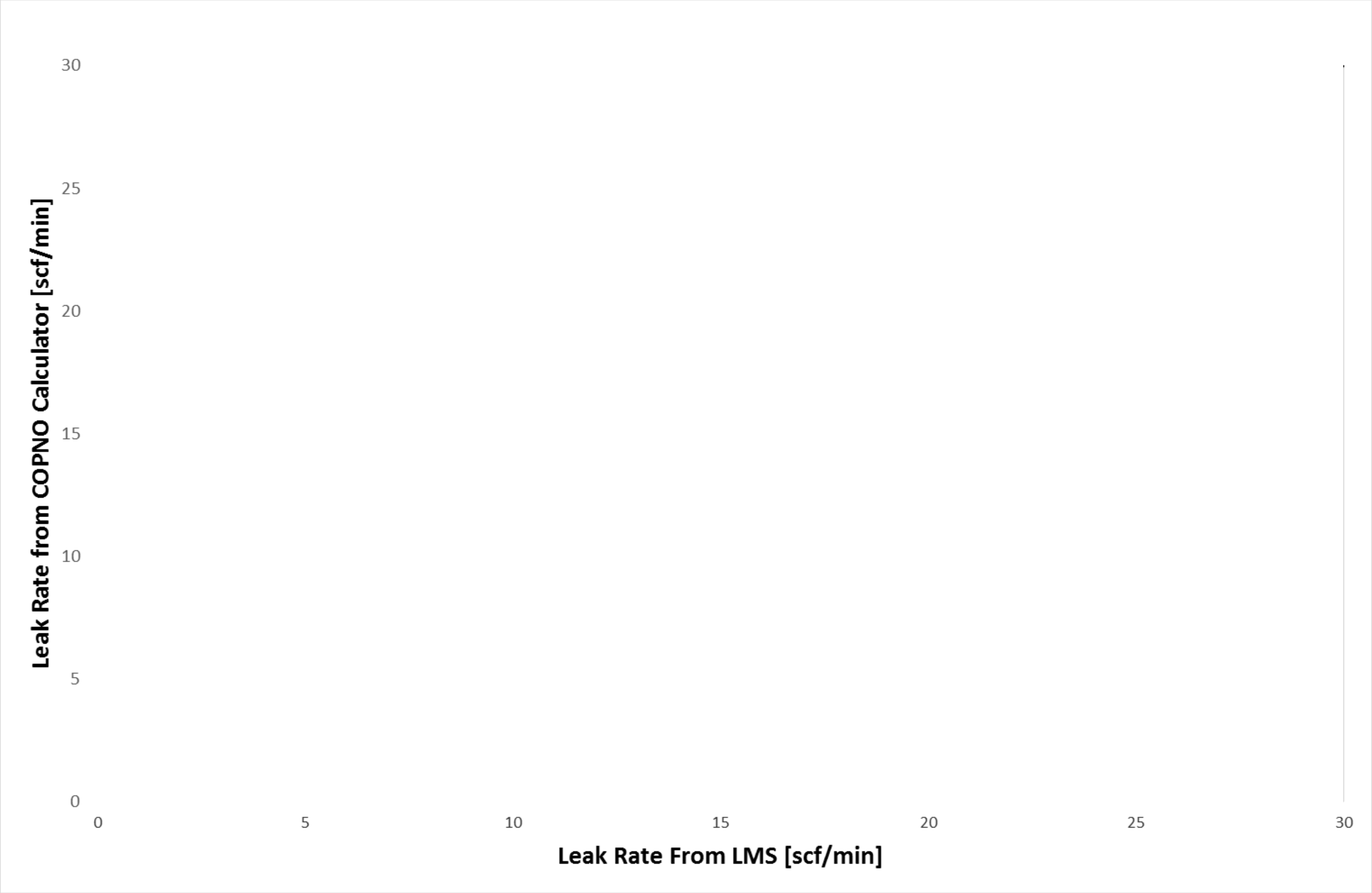
Excisting GLV calculator

- A project was initiated in 2016.
  - LMS vs. Calculator
  - Possible using calculator while bleeding annulus A to 50% of tubing pressure?

- The existing calculator was analyzed – built on ideal gas law
  - $\bar{Q}_{gas} = \left(1 - \frac{p_i+14.7}{p_t+14.7}\right) * 70.75 * V_{gas} * \frac{p_t+14.7}{(FTHT+1170)*t}$

- Approach
  - Tests was evaluated in order to compare results from LMS vs. Calculator.
  - Plotted result using calculator on PBU-data vs. leak rate measured

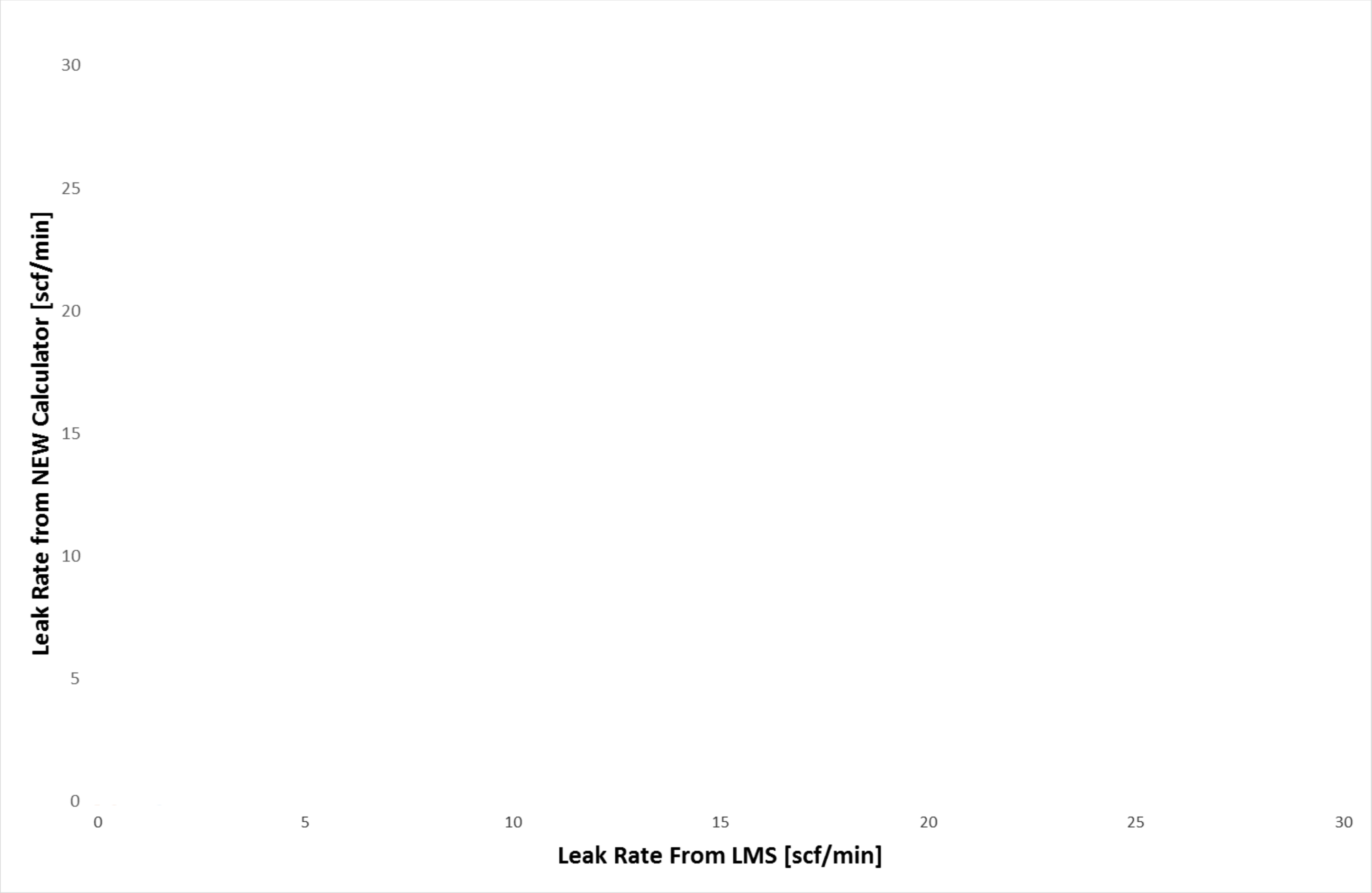
Results using old calculator



New GLV Calculator

- Analysis
  - Old gas calculator slightly underestimates leak rate when not bleeding to zero.
  - Introduced Z-factor (real gas law)
  - $\bar{Q}_{gas} = \left(1 - \frac{(p_i+14.7)Z_t}{(p_t+14.7)Z_i}\right) * 70.75 * V_{gas} * \frac{p_t+14.7}{(FTHT+1170)*t}$
- Performed same analysis on tests using new formula

Results using new calculator

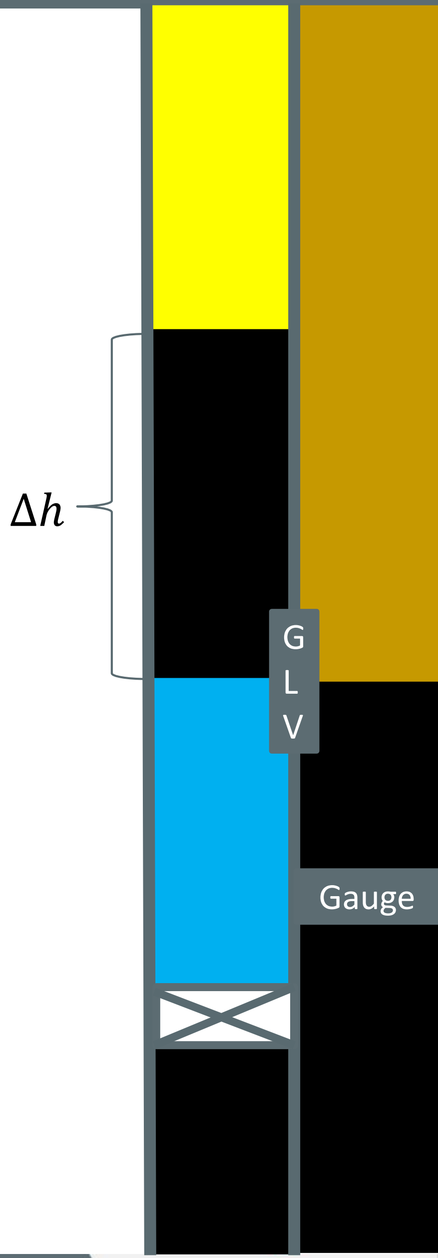


Liquid leaks

- Calculator was developed
  - utilizing pressures on both downhole and topside gauges to calculate changes in liquid level.

- Weight of leaking fluid. Assumed to be equal to produced fluid
  - $P = \rho * g * h \;\rightarrow\; \Delta h = \frac{\Delta P_{Downhole}**}{\rho * g}$
    - **Changes in surface pressure is also taken into account.
  - Use Δh to calculate volume : $V_{liquid} = \Delta h * Volume\ capacity$
  - $Q_{liquid} = \frac{V_{liquid}}{time}$

- Calculator verified against acoustic surveys performed on wells with down hole gauges.
  - Tests was evaluated in order to compare calculator vs. acoustics



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End product

GLV Gass-Lekkasjekalkulator

Celler med grå bakrunn må fylles ut

Felt	Ekofisk
Platform	EKOM
Brønn	M-01
Element	SPM A

Dato:	08.06.2017
Tid test startet:	00:00
Utført av:	

Steg 1		
Vgass	4739	ft3
Trykk start		barg
Trykk slutt		barg
Tid	30	min
Temp.		°C

Mangler data

Steg 2		
Vgass	4739	ft3
Trykk start	0,000	barg
Trykk slutt		barg
Tid	60	min
Temp.	0	°C

Mangler data

Steg 3		
Vgass	4739	ft3
Trykk start	0,000	barg
Trykk slutt		barg
Tid	180	min
Temp.	0	°C

Lekkasjerate:

Qgass	0,000	scf/min

Lekkasjerate:

Qgass	0,000	scf/min

Lekkasjerate:

Qgass	0,000	scf/min	Mangler data

GLV Væske-Lekkasjekalkulator

Avblødningstest				
	Før avblødning		Etter avblødning	
Trykk overflate		psi		psi
Trykk nedihulls		psi		psi
Gauge Dyp	9074,6	TVD		
Tid	120	min		
Væsketetthet	5,92	ppg		
Væskelekkasjerate	0,000	l/min	Godkjent	

Steg 1				
	Start		Slutt	
Trykk overflate		psi		psi
Trykk nedihulls		psi		psi
Gauge Dyp	9074,6	TVD		
Tid	30	min		
Væsketetthet	5,92	ppg		
Væskelekkasje	0,000	l/min	Godkjent	

Steg 2				
	Start		Slutt	
Trykk overflate		psi		psi
Trykk nedihulls		psi		psi
Gauge Dyp	9074,6	TVD		
Tid	30	min		
Væsketetthet	5,92	ppg		
Væskelekkasje	0,000	l/min	Godkjent	

		Konvertering og tetthetskalkulator			
		50,162	bar	727,538	psi
Vannkutt	Auto	25,69	% WC	5,92	ppg
	Manuel	50	% WC	6,80	ppg

GLC - Gas Liquid Calculator v. 2,00

Lagre som PDF

Strategy

- GLC wells
  - All wells with working annulus downhole pressure monitoring
  - Wells without liquid level monitoring possibilities (acoustic measurements or pressure)

- LMS wells
  - Wells with no downhole pressure monitoring where possible to measure liquid changes using acoustics.

Implementation

- Identified test-installations for building experience
- Created a detailed guideline for using GLC
- Weekly training sessions by video with all involved personell
- Optimized GLC and guideline based on feedback from offshore

Results

- Increased safety
  - Less personell exposure in wellhead area
  - Reduced number of leak points during testing

- Reduced cost
  - All testing performed by COP personnel
  - No extra equipment required
  - Increased flexibility

- Increased well uptime
  - Well downtime related to testing of GLV's reduced by >30%.