Artificial Lift R&D Council

2024 Gas Lift Workshop

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DAYAPUMP - A Retrofit Downhole Pump Solution for Depleted Gas Lifted Wellbores

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HANSEN Downhole Pump Solutions AS

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A low complexity downhole pump originally developed for dewatering onshore small-bore gas wells, upgraded to a retrofit pump for larger bore offshore gas lifted wellbores

Kick-start in-efficient gas lifted wells and keep them producing

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Innovations, creativity, competencies, experience and infrastructure

- Established by Henning Hansen – Co-founded a number of tech/service companies in the O&G industry, 60+ patents

- Hansenpumps is partially owned by Aarbakke Innovation, where Henning has been up to Jan-2024 been the R&D manager – 30 engineers – Subsurface heating, robotic wireline downhole machining technologies, umbilical based drilling technologies, and more

- Co-owned also by Westco, 50% owner of Aarbakke AS; Perhaps one of the leading high accuracy and top of the class quality machine shops in the world – 300+ employees

The background

Henning have worked on technology developments for many years

- Downhole permanent reservoir monitoring
- “Intelligent” completion technologies
- Upside down SPM system for reservoir monitoring
- Electric gas lift valve
- Downhole electric wet connect solutions
- Casing/tubing with integrated electric cabling
- Well intervention solutions and technologies
- Artificial lift (including electric permanent magnet-motor based pumps)

www.hansenenergy.biz/activecompletions

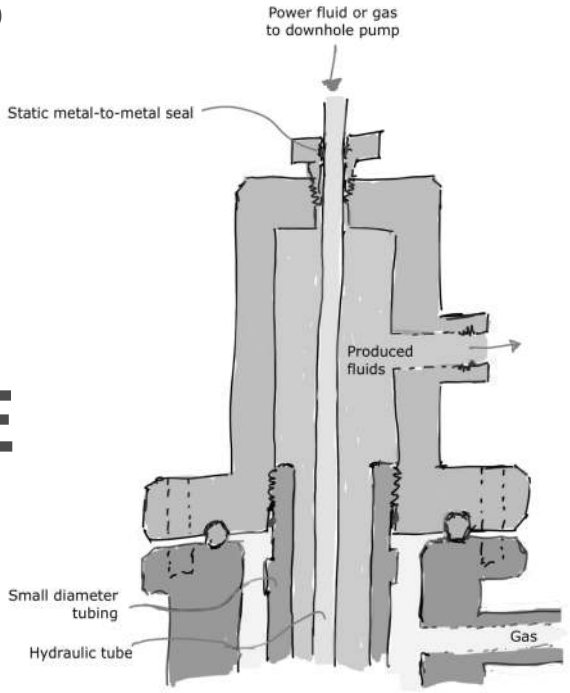
- Instrumental in establishing and building up 17 technology/service companies in Norway, UK, USA and Abu Dhabi
- Inventing and developing complex rod-less downhole pumps, he believed that there must be much less technical complex (and lower cost) solutions for lower producing wellbores

Typical rod pumped well

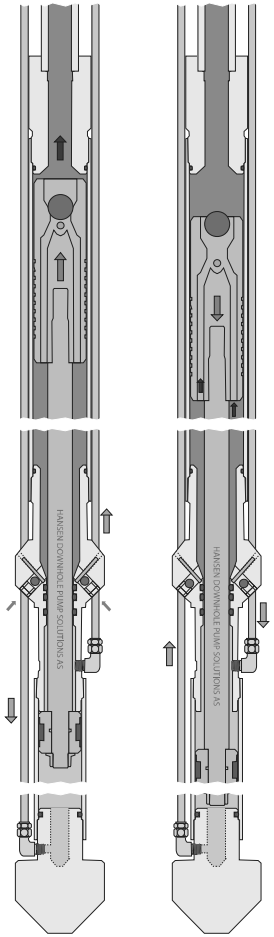
https://vimeo.com/188813242

- Gas leaking to the environment from the stuffing box
- Oil leaks

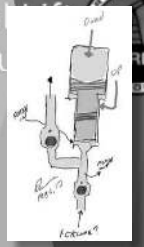
TO REMOVE THE GAS LEAKS AND THE MECHANICAL ROD RELATED PROBLEMS DOWNHOLE, THE USE OF SUCKER RODS MUST BE AVOIDED



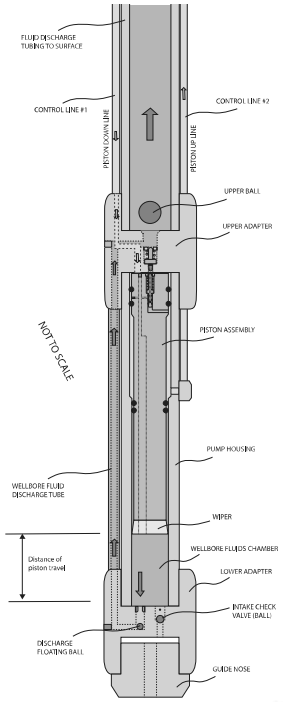
The closed loop, hydraulic operated, downhole rod-less rod pump 1st generation



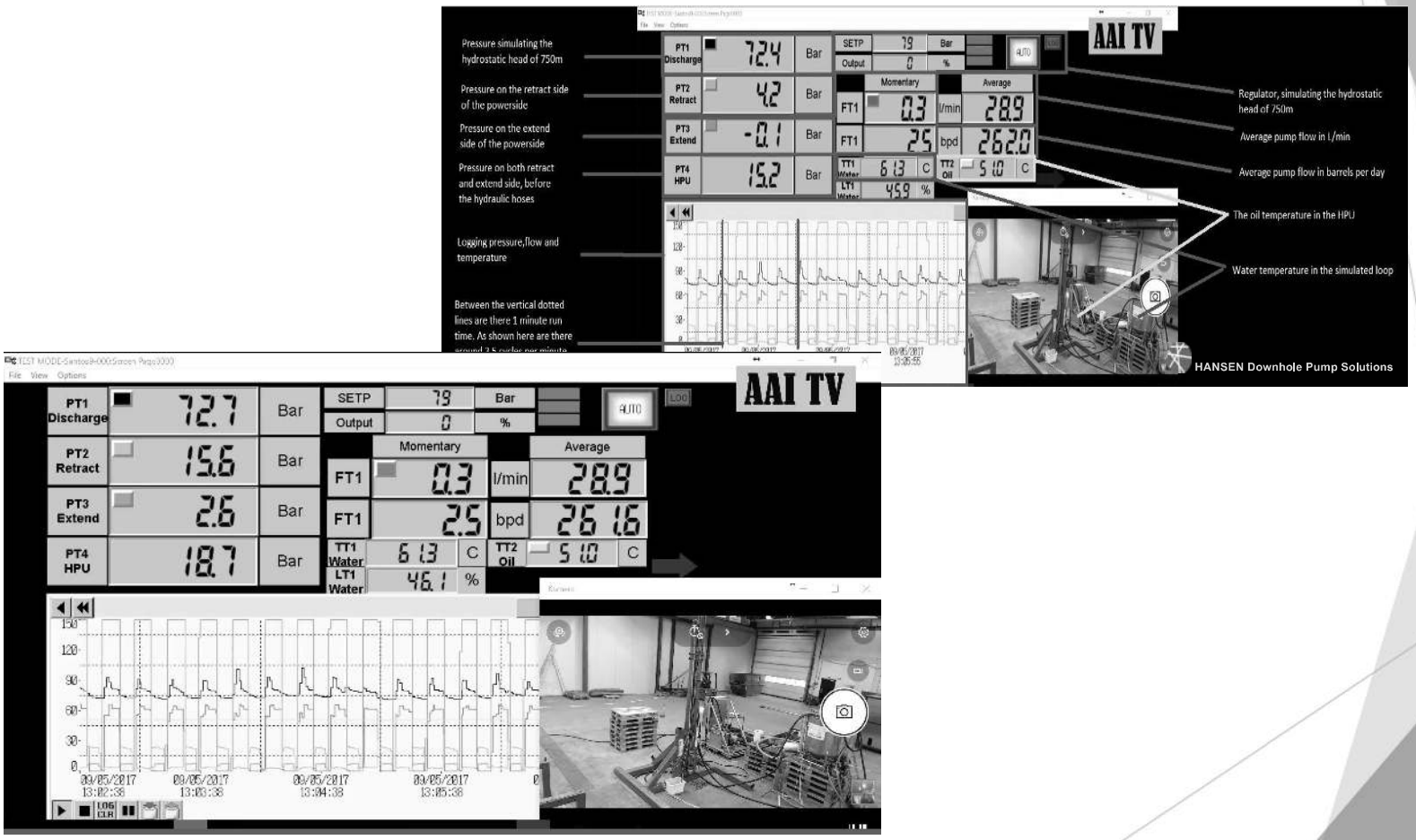
Inverted pump (2nd generation) for CBM (CSG) applications



- Passed rigorous flow loop testing (simulated installation depths)
- Testing completed – Including flowing with slurry and particles – 250BBL/D → 400 BBL/D
- Two complete systems are now in flow loop in Toowoomba, Queensland, Australia

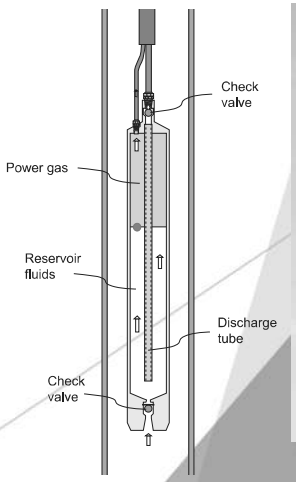


Inverted pump testing



Features of the 1st generation gas powered ”Dayapump”

- The challenge: “Make us a pump costing less than $10K for dewatering onshore gas wells”
- Simplicity = Reliable and low cost
- Down to 1,5” OD – Through tubing deployment in 2-3/8” tubing
- Rig-less installations possible
- Local manufacture/assembly
- No specialists required to install - Can be installed e.g. by local wireline/coiled tubing crew
- No gas locking / No need for fluid level monitoring
- Works also horizontal
- Tolerant to fines
- Ideal for high temperature applications
- Can allow for pumping of chemicals from surface through pump
- No dynamic seals required at surface, significantly reducing risk of pollution



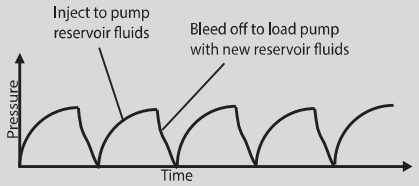
Testing of the 1st generation pneumatic pump

1,5" OD, 5460 mm chamber:
3,2 m^3 (20 BBL) per day
1300' water depth

Increase chamber length and/or strokes per hour = Higher rate per day

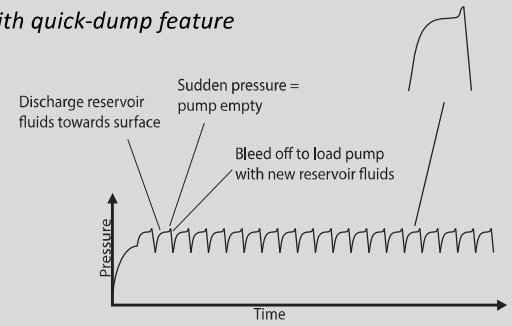
Next: "Power-valve" development and operation

No quick-dump feature



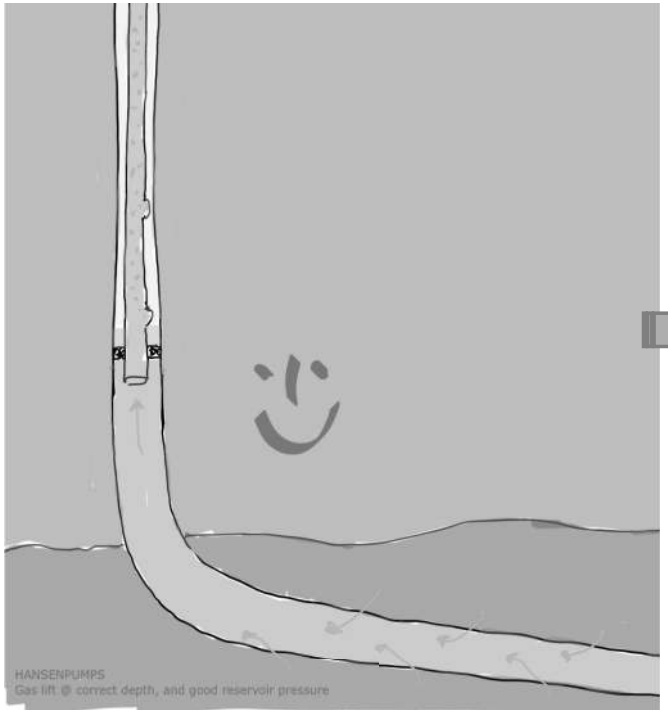
Inject/bleed off cycle from surface pump

With quick-dump feature

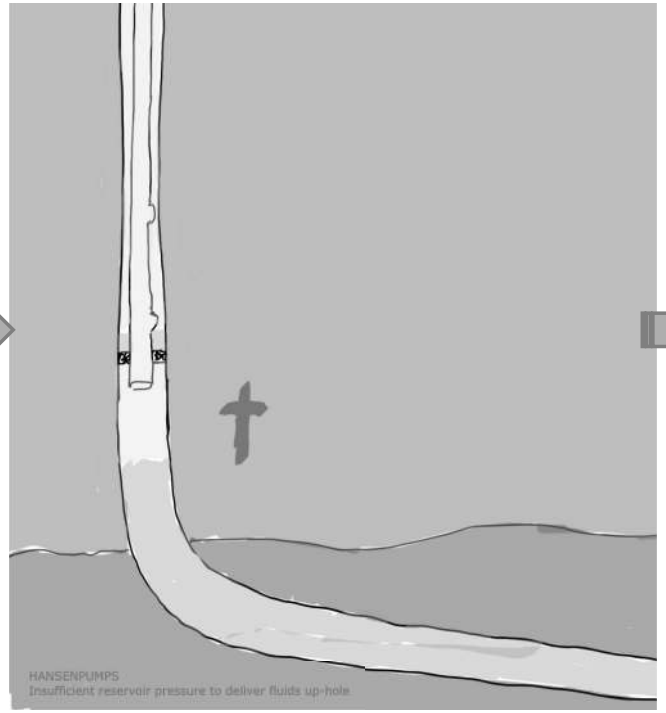


Inject/bleed off cycle from surface pump, where Powervalve feature is implemented for increased pump "stroke" frequency

The life cycle of a gas lifted wellbore



Gas lift mandrel(s) are placed at optimum depth when the well is completed, based on a reservoir pressure that can efficiently deliver fluids to the gas lift valve(s)



As the well is producing, the reservoir pressure eventually drops, where it no longer can deliver fluids to the gas lift valve(s). The well production stops.

Recompleting the well and placing gas lift valve(s) deeper can be an alternative, but often cost prohibitive – Not at least for offshore wells.

Rig-less retrofitting a pump system that delivers fluid from below the gas lift valve is our proposed approach.

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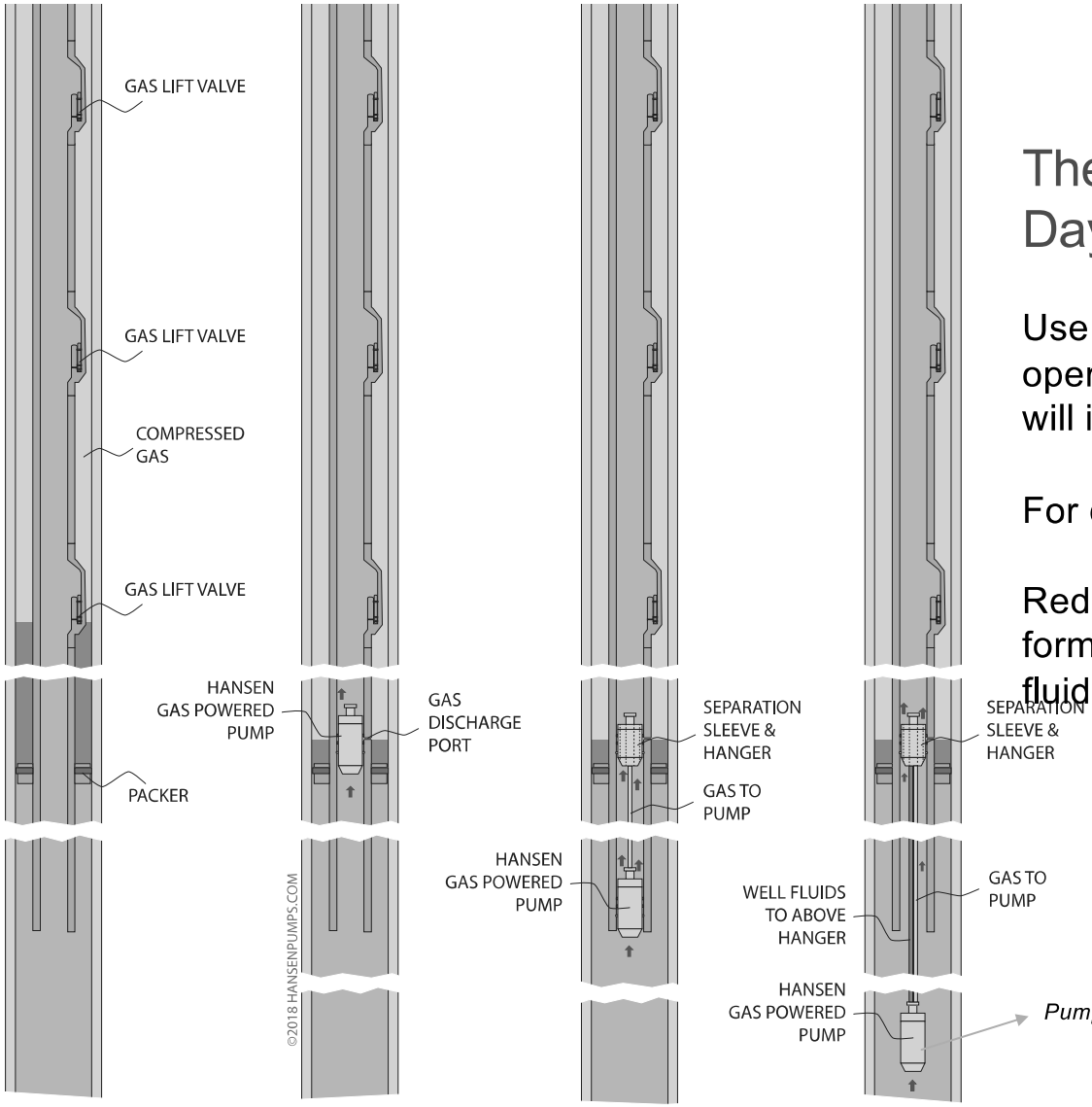
The gas operated downhole Dayapump

Use the compressed gas for gas lift to operate a wireline replaceable pump that will improve fluid lift

For depleted on- and offshore wells

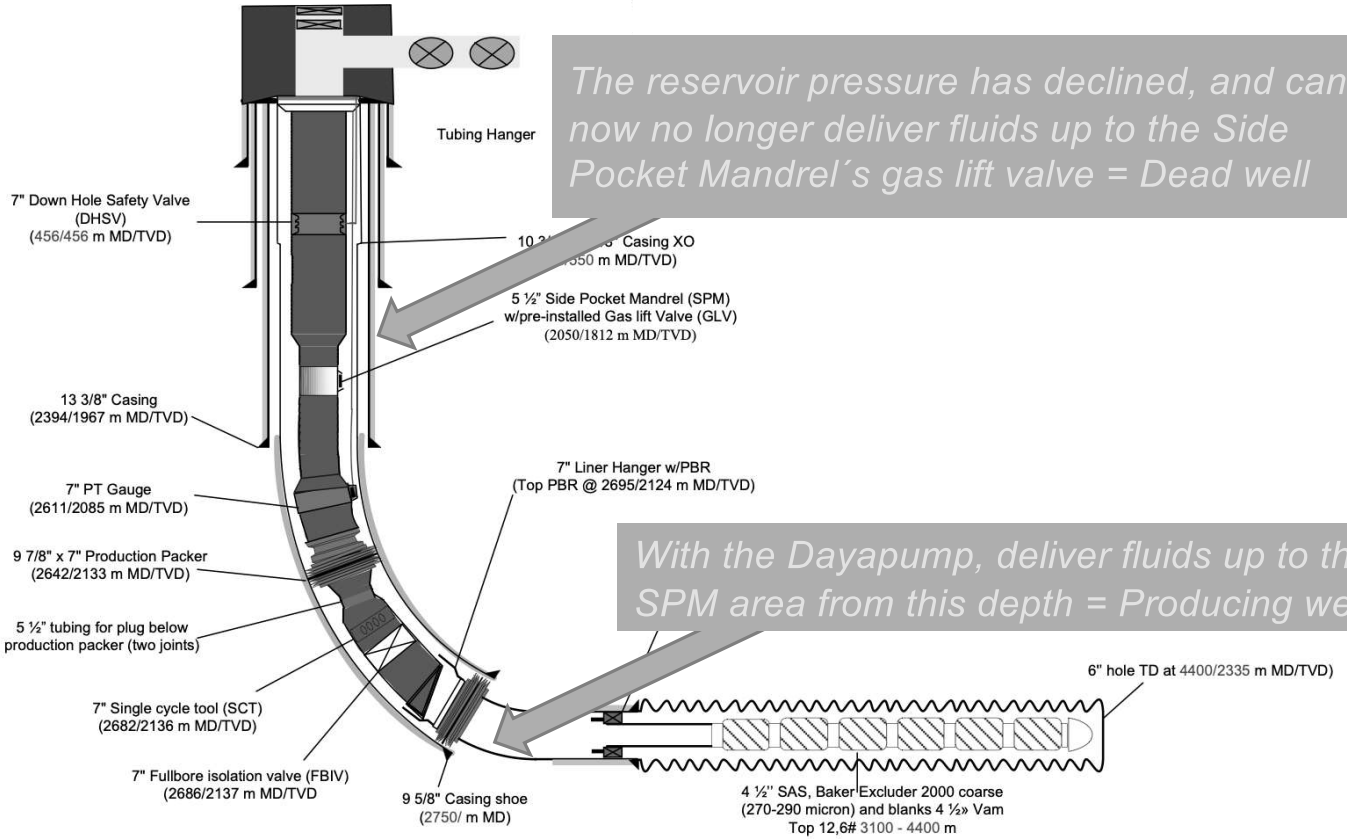
Reduces hydrostatic pressure against formation, allowing reservoir to deliver fluids to the tubing again



US patent
Norway patent
UK patent
Canada patent pending

Pump may be placed into the close to horizontal wellbore section

The depleted subsea well challenge



The reservoir pressure has declined, and can now no longer deliver fluids up to the Side Pocket Mandrel´s gas lift valve = Dead well

With the Dayapump, deliver fluids up to the SPM area from this depth = Producing well

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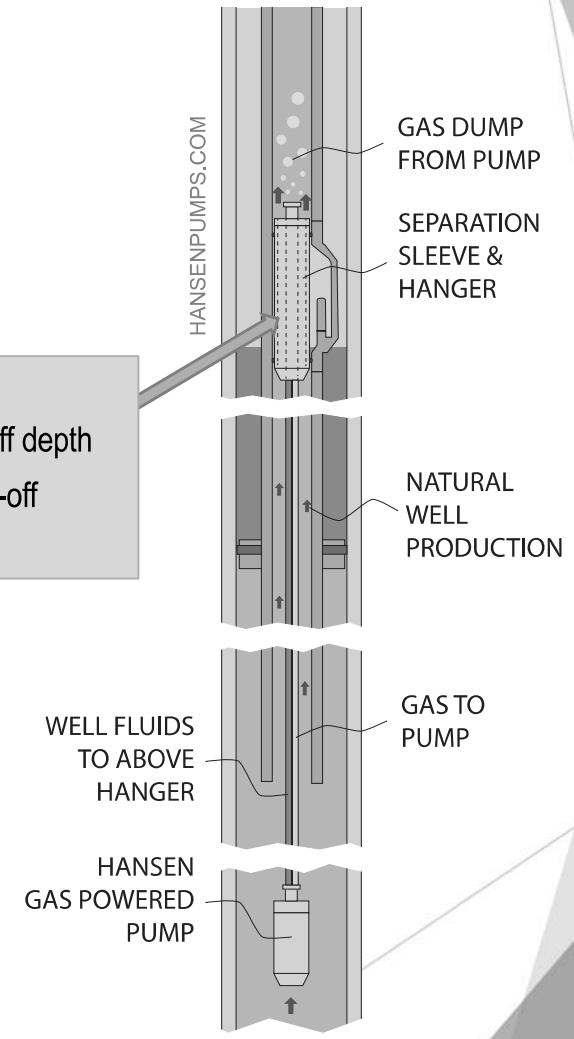
The retrofit subsea wellbore pump system

- Routes the gas from the A-annulus to the downhole pump
- Allows gas discharge from the pump to assist by gas lift from pack-off depth
- Allows the well to start producing “naturally” and bypassing the pack-off
- Allows bull-heading into the reservoir for system retrieval/P&A



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The retrofit subsea wellbore pump system

Design, manufacture and testing (10 weeks flow testing) completed

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Current program – Subsea well pump

Completed design end of 2022

4000 mm x 111.2 mm
(158” x 4.375”)

Approx. 86.4m^3 per day (540 BBL/D)
@ 690 l/min gas delivery – Will very likely be lower (To be tested at full scale)

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Current program – Subsea well pump

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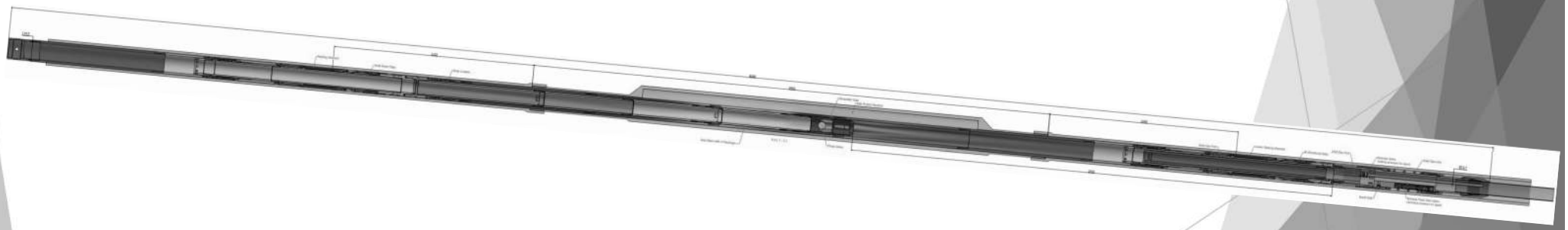
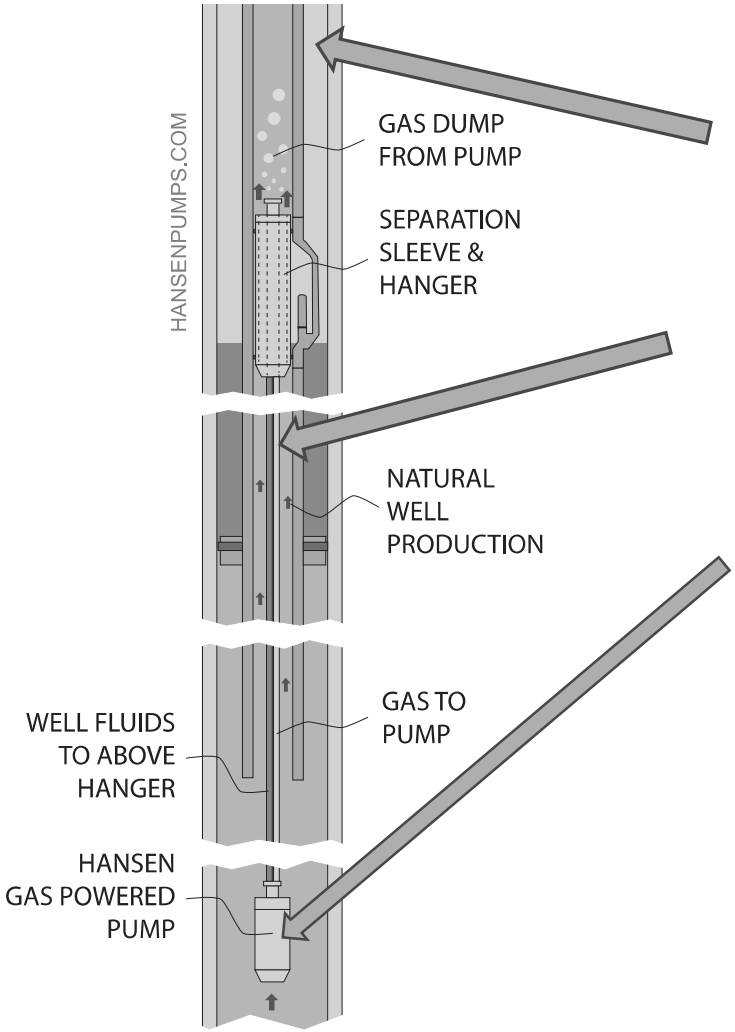
- Upgraded the downhole pump to an autonomous technology, providing much faster “stroking”
- Designed the complete system for rig-less installation in a subsea well
  - The pump with the “smart” valve
  - Umbilical (500 meters length) from pump to the gas lift mandrel
  - Gas lift mandrel pack-off
- Build and in-house flow-test the pump
- Created installation procedure (Stiff riser to surface and new (own) riser-less concept)



Other



- Can be powered by fluid, as an alternative to pressurized gas
- Can be connected to “any” length of tube between the pack-off and the pump, or no tube at all
- Can be scaled and configured to deliver higher flow rates

Thank You

- Questions?
- Partnering?
- Candidate wells?

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