UNDERSTANDING GAS-LIFT EQUIPMENT ISSUES IN DEEP WATER, HIGH PRESSURE, HIGH TEMPERATURE APPLICATIONS

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Outline

- Overview
- Well design limitations forced upon gas-lift
- Deepwater intervention understandings
- Traditional gas-lift equipment understanding
- Design approach for developing high temp/high pressure gas-lift equipment
- Conclusion

High reliability gas-lift for critical service

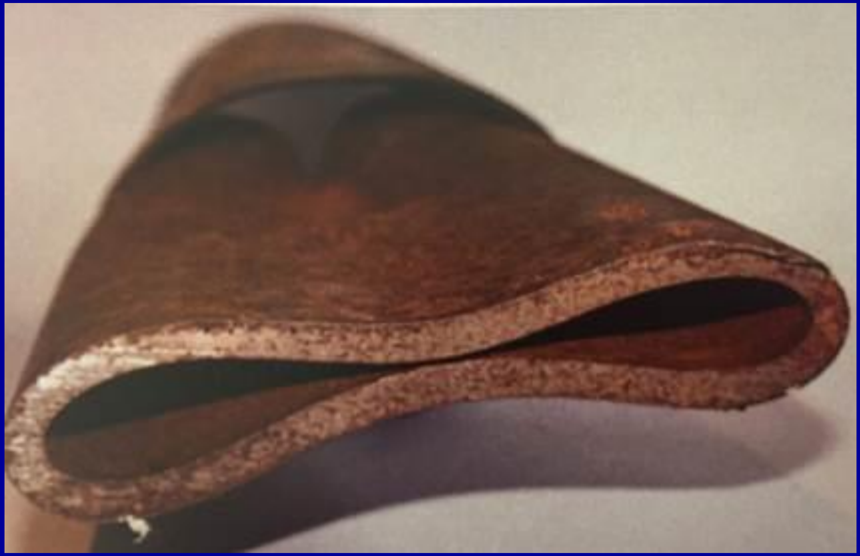
- **2016 BSSE & NASA announce 5yr agreement**
- **BSSE will use NASA's risk management process**
  - **Further develop the BSSE's risk management capability**
  - **Evaluate: design, test technologies, hardware, including emerging technologies and best available and safest technologies**
  - **Use NASA's accredited failure analysis laboratory at the Johnson Space Center**
    - » Source Offshore –May 2016 pg.18

Typical candidate wells

- **BSSE-Deepwater <1000Ft depth**
- **SBHP < 20Ksi**
- **BHT < 285ºF (140ºC)**

Well design limitations forced upon gas-lift

- **Reservoir management?**
- **Compression**
- **Injection Gas**
- **Casing**
  - **collapse**
  - **point of injection**
- **Completion accessories**
- **Understanding crater depth**



Deepwater Intervention

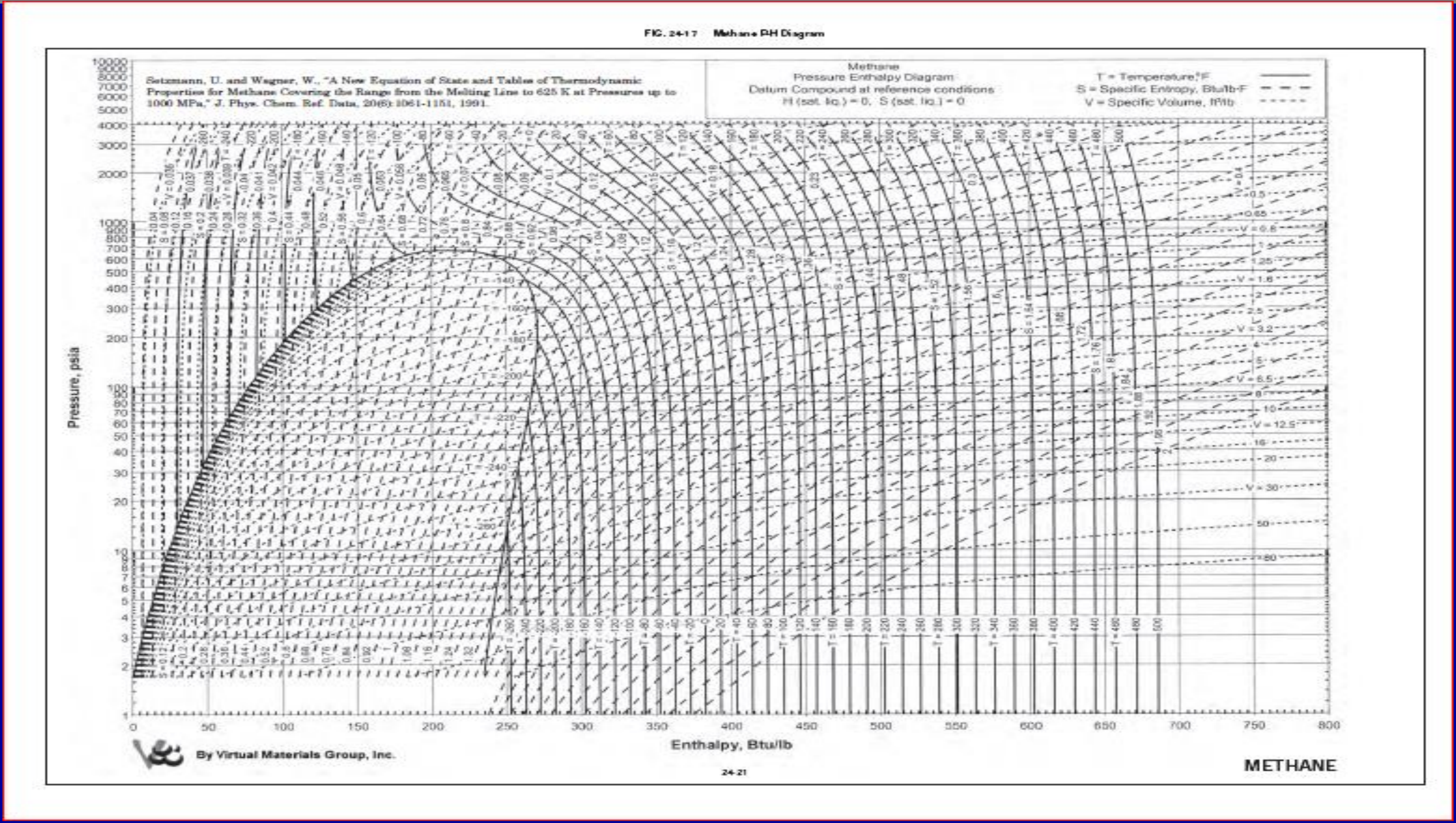
- **Intervention cost & frequency must be understood by GL suppliers**
- **Est. valve trip 12 Million USD**
- **Est. tubing trip 100 Million USD**

Collaborative work by O&G and product suppliers is a must

Concerns with flow control devices & latches

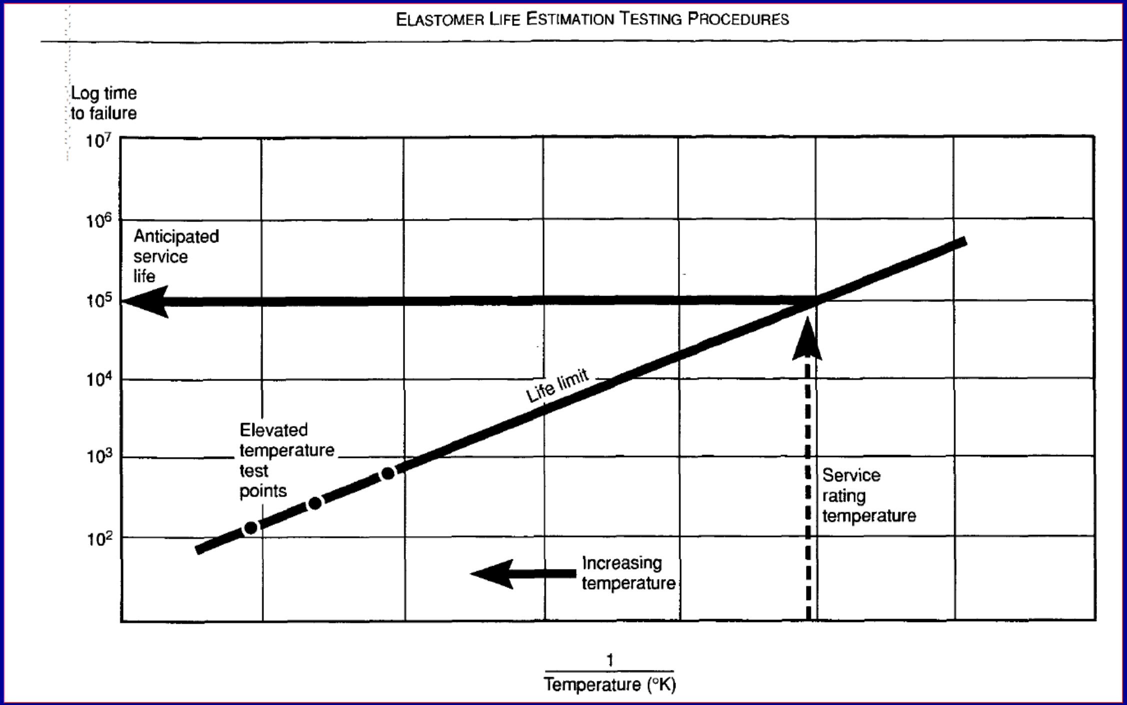
- IPO & Back-Check
  - Bellows & Dome
  - Full open stem travel
  - FEA of valve design
  - CFD flow path and anticipated rate of injection
  - Actual flow testing
- Orifice & Back Check
- Dummy
- Latch
- Non-metallics

Methane phase envelope



How critical are non-metallics

- Due to operating environment & intervention cost accelerated aging is recommended
- Arrhenius equation for accelerated aging helps predict meantime to failure
  - Thermo-Mechanical
  - Thermo-Chemical



Temp rating in time

DuPont™ Viton® Selection Guide

Technical Information—Rev. 7, July 2010

Introduction

DuPont™ Viton® fluoroelastomer was introduced in 1957 to meet the needs of the aerospace industry for a high-performance seal elastomer. Since then, the use of Viton® fluoroelastomer has expanded to many other industries, especially in the automotive, fluid power, appliance, and chemical fields. With over 40 years of proven performance, Viton® fluoroelastomer has developed a reputation for outstanding performance in high temperature and extremely corrosive environments.

Valuable Properties of Viton® Fluoroelastomer

Vulcanizates based on Viton® provide an exceptional balance of physical property characteristics, including the following features:

- Resistance to temperature extremes:

  Heat—Compared to most other elastomers, Viton® is better able to withstands high temperature, while simultaneously retaining its good mechanical properties. Oil and chemical resistance are also essentially unaffected by elevated temperatures. Compounds of Viton® remain substantially elastic substantially indefinitely when exposed to laboratory air oven aging up to 204 °C or to intermittent exposures up to 316 °C. High temperature service limits are generally considered to be:

  3,000 hr at 232 °C
  1,000 hr at 260 °C
  240 hr at 288 °C
  48 hr at 316 °C

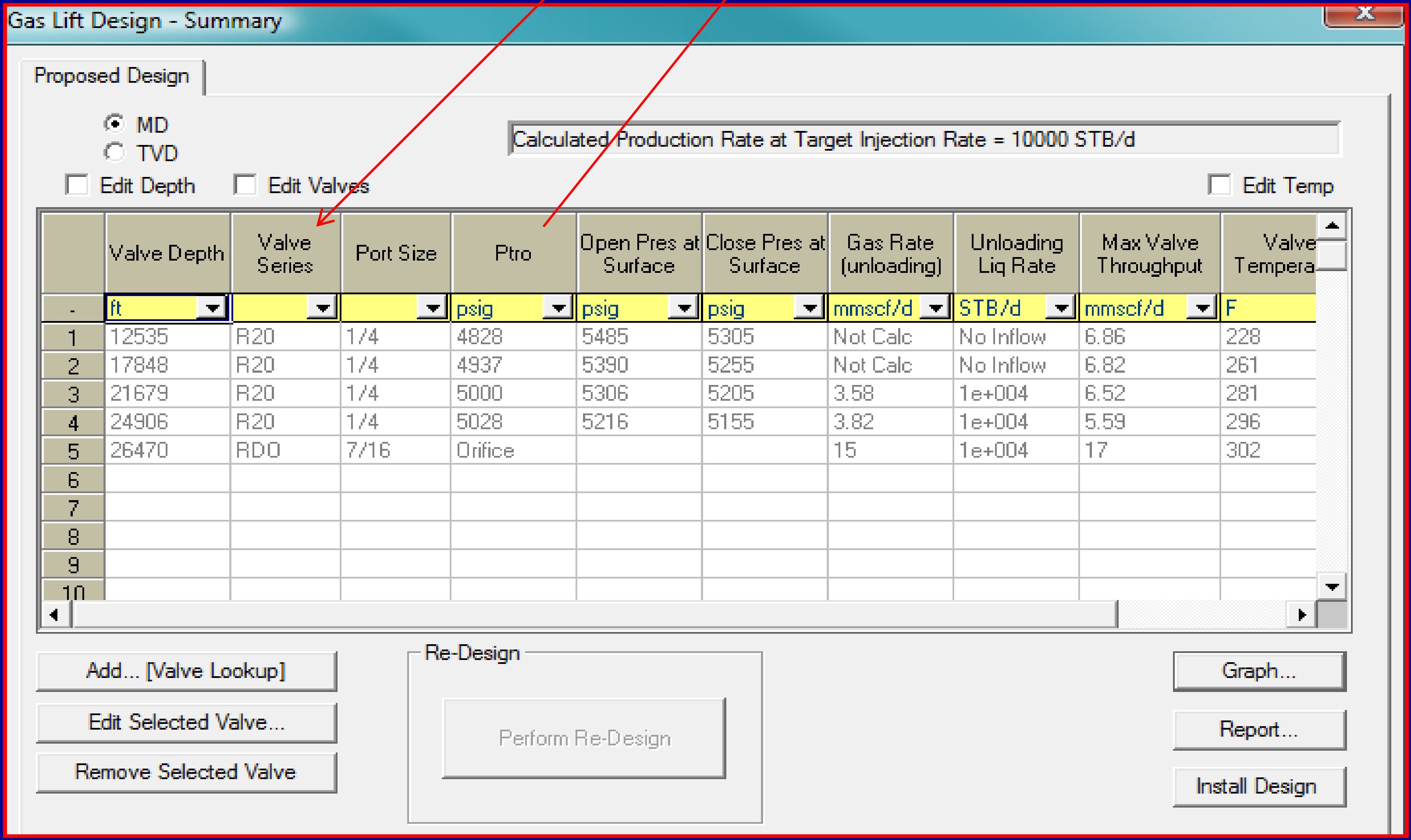
  Cold—Viton® is generally serviceable in dynamic applications to temperatures of –18 to –23 °C. Special formulations permit its use in static applications down to –54 °C. Also, Viton® has proven to be satisfactory for static seals used under conditions approaching absolute zero. Viton® is characterized by its:

Barrier side pocket mandrels-SPM

Dual pocket SPM design that creates a barrier from tubing to annulas and annulas to tubing while performing intervention on the operating valve

- Proven concepts & commercially available
- Material selection must be right for the operating environment
- Design must be validated via FEA & CFD
- If welded proper WPS & Heat treatment procedures must be validated
- Creates a more complex intervention process

Design soft ware concerns for HPHT GL



	Valve Depth	Valve Series	Port Size	Ptro	Open Pres at Surface	Close Pres at Surface	Gas Rate (unloading)	Unloading Liq Rate	Max Valve Throughput	Valve Tempera
-	ft			psig	psig	psig	mmscf/d	STB/d	mmscf/d	F
1	12535	R20	1/4	4828	5485	5305	Not Calc	No Inflow	6.86	228
2	17848	R20	1/4	4937	5390	5255	Not Calc	No Inflow	6.82	261
3	21679	R20	1/4	5000	5306	5205	3.58	1e+004	6.52	281
4	24906	R20	1/4	5028	5216	5155	3.82	1e+004	5.59	296
5	26470	RDO	7/16	Orifice			15	1e+004	17	302
6										
7										
8										
9										
10										

SwRI HPHT test loop

Conclusion

- Deepwater Gas-lift technology development is viable
- Shell's knowledgeable SME staff is beneficial and ability to pay upfront for development is critical
- Testing of FCD & SPM flow path prototypes at SwRI will lead to validation Q4 2016
- In-well intervention on land to validate intervention process and tools Q1 2017

Reference material

- **Wikipedia.org/wiki/Arrhenius-equation**
- Sudsea IQ search Vito
- Offshore May 2016 edition pg.18
- Island Offshore /service / light-well-intervention
- API TR6J1
- GPSA Data Book cahp.24 pg. 21. FG. 24-17 Methane Phase Diagram

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