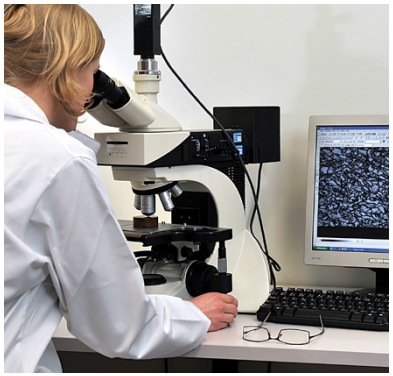
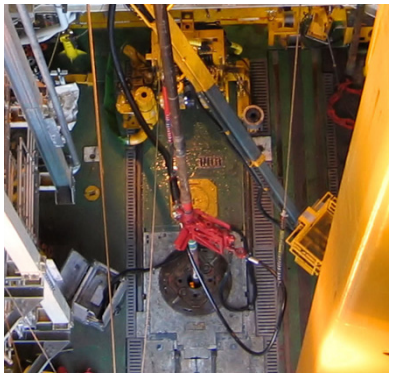
Sour Service

Vincent Flores – IADC Webinar

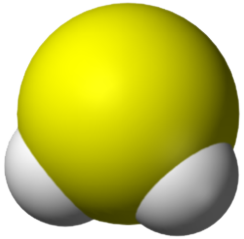




Sour Service Environment

Our challenge: Minimize risks

- **What is Sour Service?**
  - Sour Service: Well containing H_2S
  - Origin: H_2S comes from decomposition of organic material.



- **Consequences?**
  - HSE Risk & Environmental Impact concerns: hazardous to human health, living organisms and environment.
  - NPT & OPEX:
    - Loss of DP and/or BHA due to Sulfide Stress Cracking (SSC)
    - Fishing job required in case of failure
    - Non Productive Time in case of loss of well control

Risks Associated to Sour Service

Failure example

Risks on standard API grades (= non Sour Service grade):

- **Sulfide Stress Cracking**
  - → Unpredictable brittle failure
  - →Fishing costs
  - →Non-productive time for drilling contractors
- **Failure example on 5 ” DP, S-135 API grade**

Drilling Challenges

Catastrophic Failure

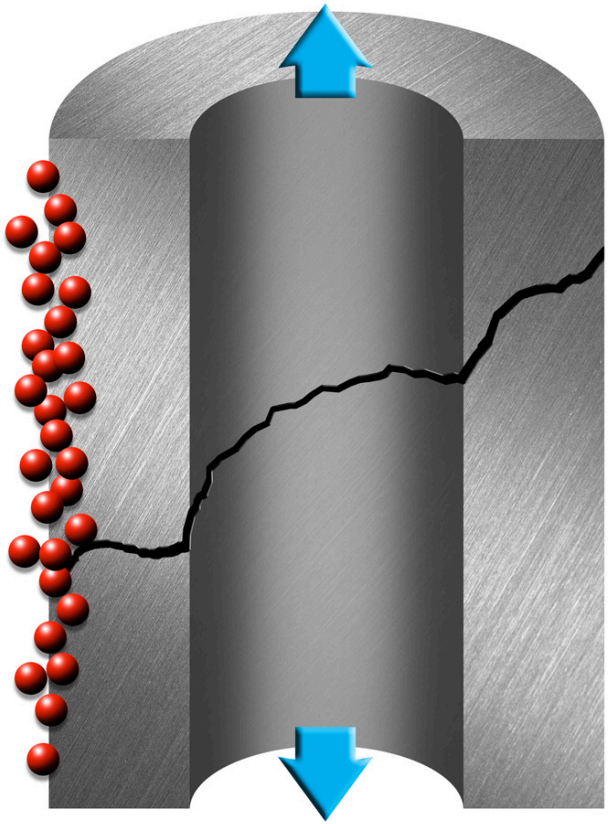
- **Failure mechanism: Sulfide Stress Cracking (SSC)**

Low pH
Water
High H_2S
⇒ Corrosion

⇓

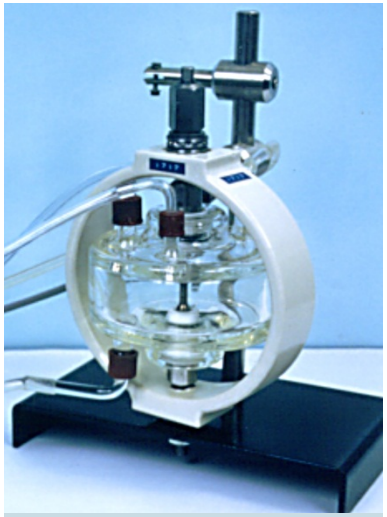
H Charging
Low temperature
Applied load

→



- **Escalation factors:**
  - When Yield strength ↗
  - Grade H_2S resistance ↘
  - SSC phenomenon occurrence
  - Failure risks ↗

NACE
Testing Methods



NACE A

NACE “Tensile Test” under uniaxial tensile load.

- Failure/no failure test
- Test duration: 720h

NACE TM 0177 (2005) defines 4 testing methods

- Method A is the most used for drilling products
- Solution A is the most used environment (Severe Sour environment)

Acceptance Criteria:

PASS	FAIL

NACE
Testing Method A

NACE Test A: Laboratory Procedure

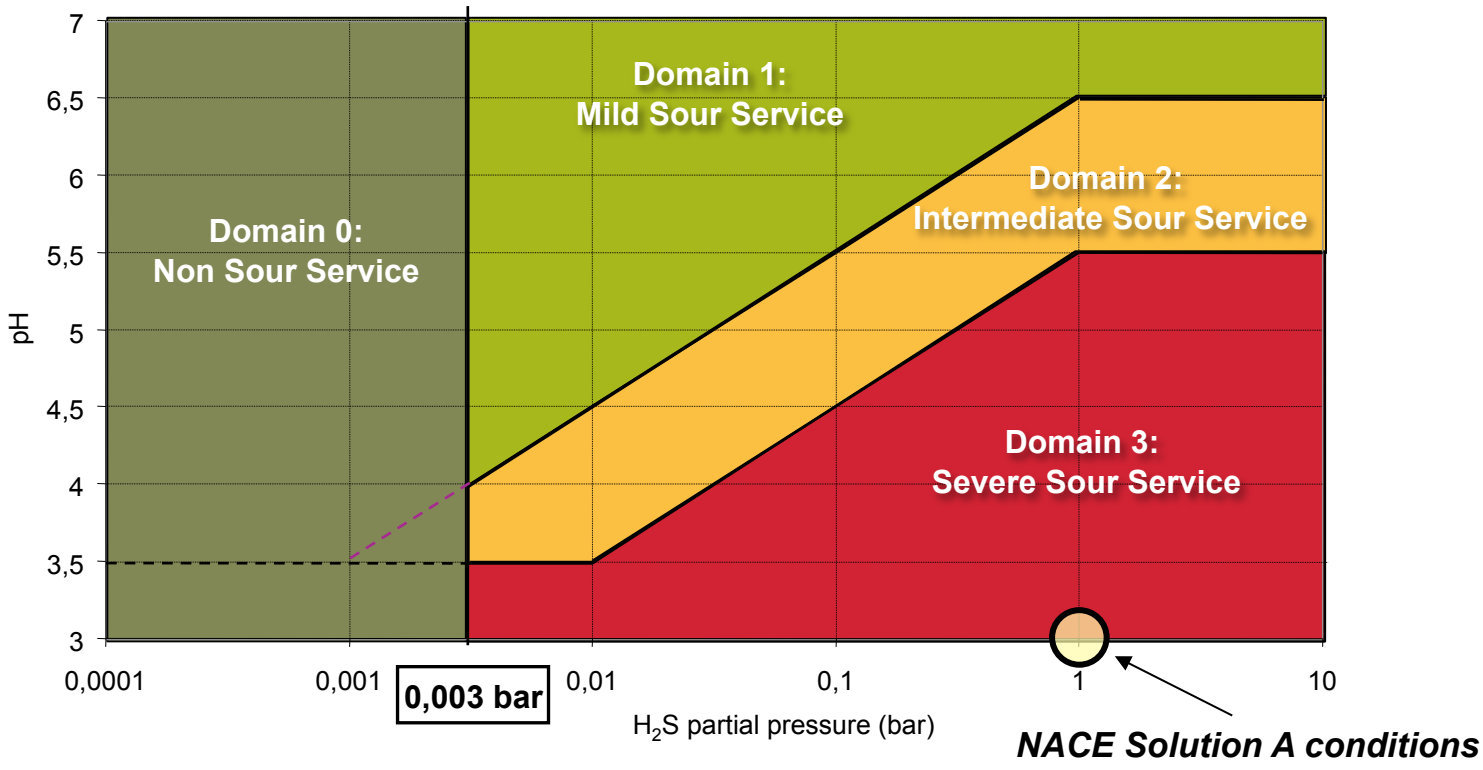
Environmental Testing Chamber

Application of tensile load = % SMYS

Example of samples under testing process

Sour Service
Severity Domains

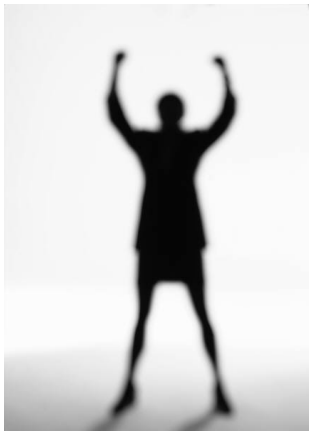
- **NACE Material Recommendations: NACE MR0175**
  - 4 domains of susceptibility to H_2S
  - pH and partial pressure of H_2S as major parameters
    - Partial pressure = $\%H_2S$ x total pressure



Material Selection for H_2S resistant Drill Pipe

American Petroleum Institute

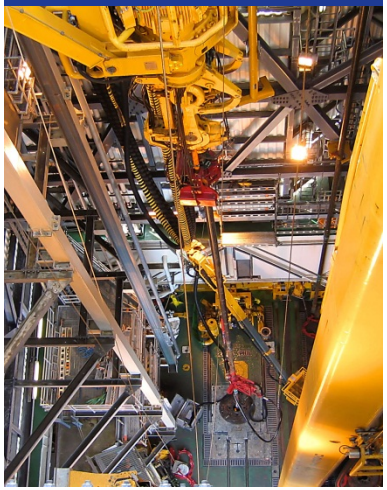
NACE INTERNATIONAL



- **International standards:**
  - No guideline in API 5DP & ISO11961
  - Not included in the scope of the NACE MR0175 / ISO15156
- **Industry initiatives:**
  - Regional regulations: in Canada → Industry Recommended Practices (IRP) Volume 1 & 6 issued in 2004 ***(Vallourec produced its first IRP grade in 2007 for Sinopec)***
  - Manufacturers: developing a variety of proprietary grades using NACE TM0177 testing since the 90's
  - VNIIGAS qualification for Gazprom in Russia ***(Vallourec passed in 2009 and produced its order for Burgas-Gazprom in 2010)***
- **A decade of IRP Drill Pipe use:**
  - Worldwide supply: from one manufacturer in 2004 to > 5 in 2014
  - Originated in Canada but used in several parts of the world, mainly: Russia, Middle East, China and Brazil
  - Successful switch from API to IRP products with safe operations

vallourec

Evolution of the drilling environments & new frontiers



- **Pushing towards harsher drilling environments:**
  - Due to increase of domestic gas demand, fields with higher and higher H_2S content are being explored and developed
  - Managed Pressure Drilling & Underbalanced Drilling increase the risk of Drill Pipe exposure to fluids coming from the formation
  - HSE concerns is a first priority
  - Integrity of the entire Drill Pipe should now be considered
- **New frontiers:**
  - Highly sour fields (higher H_2S content). Example: Shah-24%, Bab-35% (UAE), SRAK-38% (KSA), Kurdistan-36% (Iraq)
  - HPHT conditions increasing the H_2S partial pressure → SSC risk
- **Technological challenges:**
  - SSC resistance in norms consider the pipe body and tool joint separatly and ignore the weld zone and upsets
  - The weld zone and upsets have metallurgical heterogeneities and often high hardness points, potentially detrimental to SSC
  - Even IRP 1.8 specification does not cover these areas

Sour Service Grades

- **Sour Service steel = material with resistance to H_2S**

- **Key processes control:**
  - — Steelmaking:
    - Supreme cleanliness
    - Dedicated steel chemistries
  - — Heat treatment:
    - Homogeneous and fine microstructure
    - Specific heat treatments (double Q & T)
  - — Welding:
    - Controlled hardness
    - Dedicated tempering

Sour Service Grades = Specific Chemistry + Specific Heat Treatment

Conclusion

- **Sour Service supplier of choice**
  - Vertical integration of Vallourec mills
  - In-house R&D expertise and NACE testing facilities
  - Proven manufacturer of IRP 1.8 compliant products
  - Manufacturer of Sour Service BHA
  - Reliable quality products through more than 2,000,000 ft of Sour Service products used worldwide since 2007 without any failure!

- **Sour Service technical leader**
  - On board of NACE committee and contributing to IRP & ISO standards
  - Yearly publications in international conferences
  - Industry recognized expertise in specialized workshops and technical conferences
  - Four new grades developed since the past 2 years, to address new frontiers and the extension of the drilling envelope