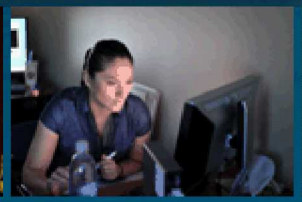
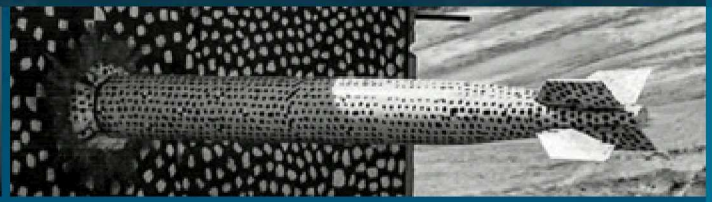
SAND2019-13959PE

WH109 Cemented-Annulus Flow Monitoring During Seal-Tite Treatment





SNL-SPR PROJECT REVIEW – NOVEMBER 2019

Martin B. Nemer

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

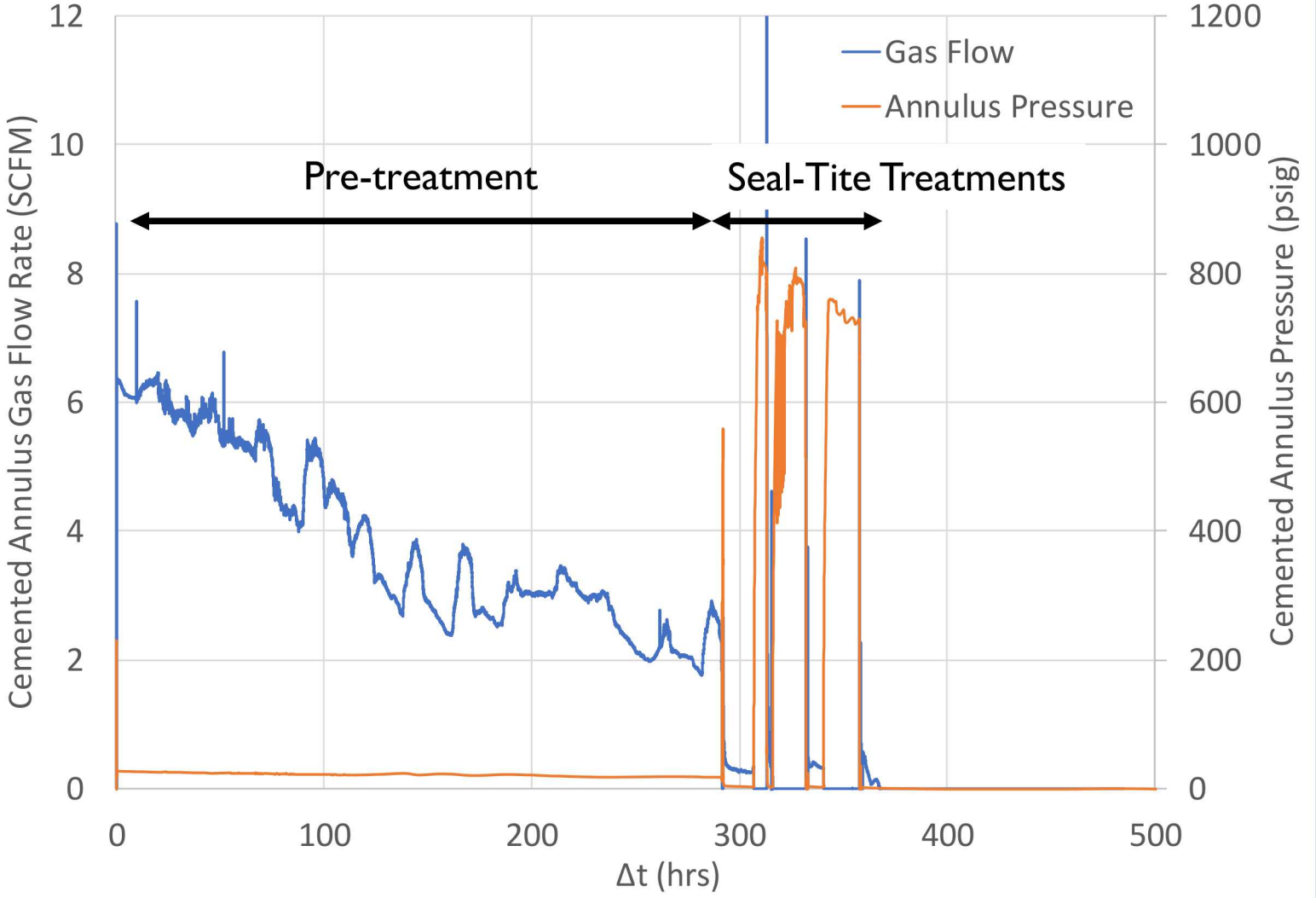
Background

- West Hackberry WH109 showed crude oil migration through the 20” x 26” cemented annulus.
  - Fast pressure rise in the cemented annulus
  - Flow of crude oil out of cemented annulus valve
- Fluor/DOE decided to attempt a Seal-Tite treatment to seal off the leaking section of the well.
- Well was put under nitrogen to determine the location of the leak.
  - Leak location was determined to be at 117’.

Background, continued

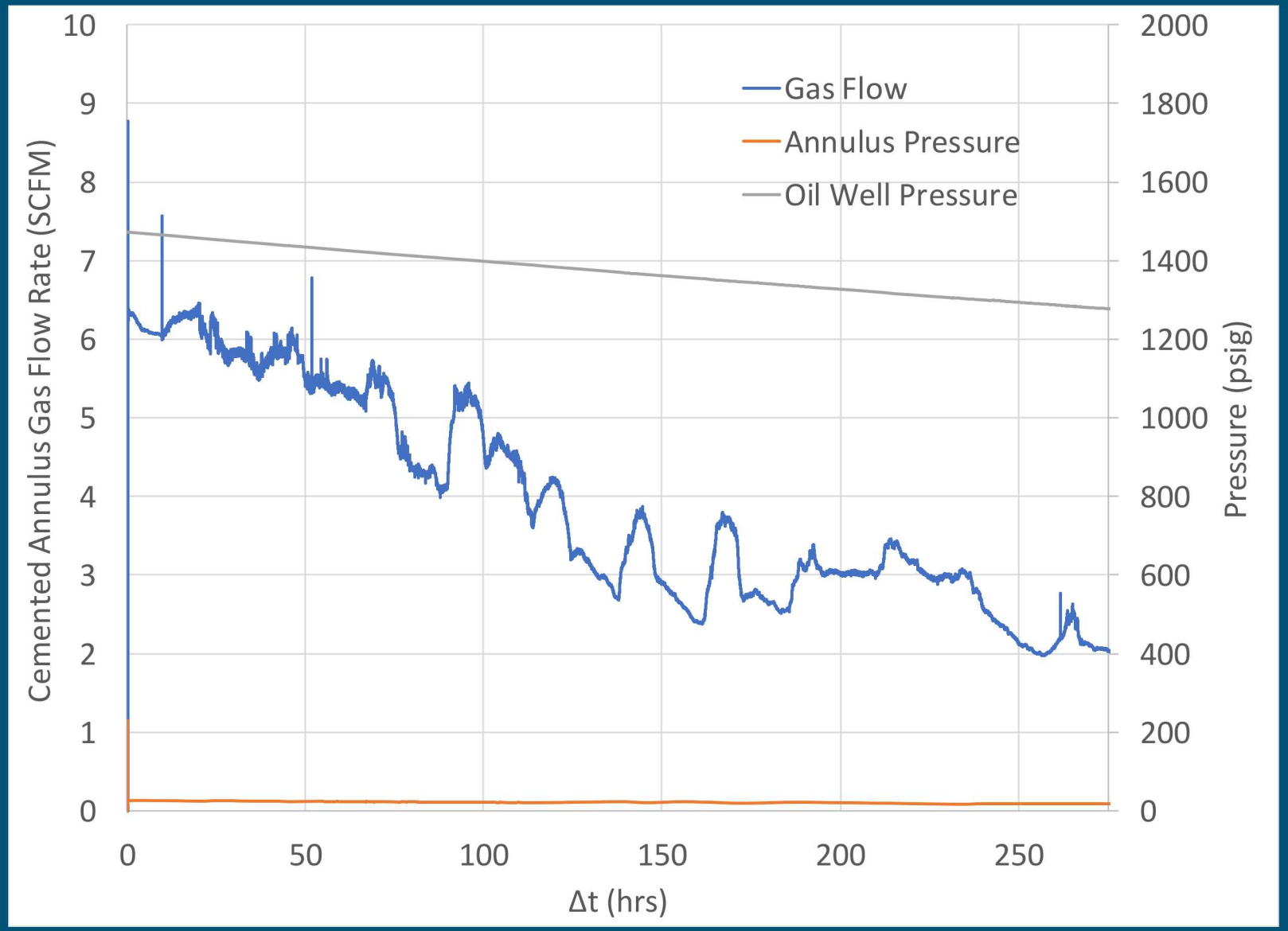
- During the WH109 Seal-Tite treatment, a flow meter was placed after the 20” x 26” cemented-annulus valve
  - Calscan Hawk
- First time this has been attempted at SPR
- Purpose was to determine whether Seal-Tite treatments were effective
  - Semi real-time measurement of the tightness of the cemented annulus
  - Potentially see if cemented-annulus diagnostic information can be obtained via flow and pressure measurements

Background, continued



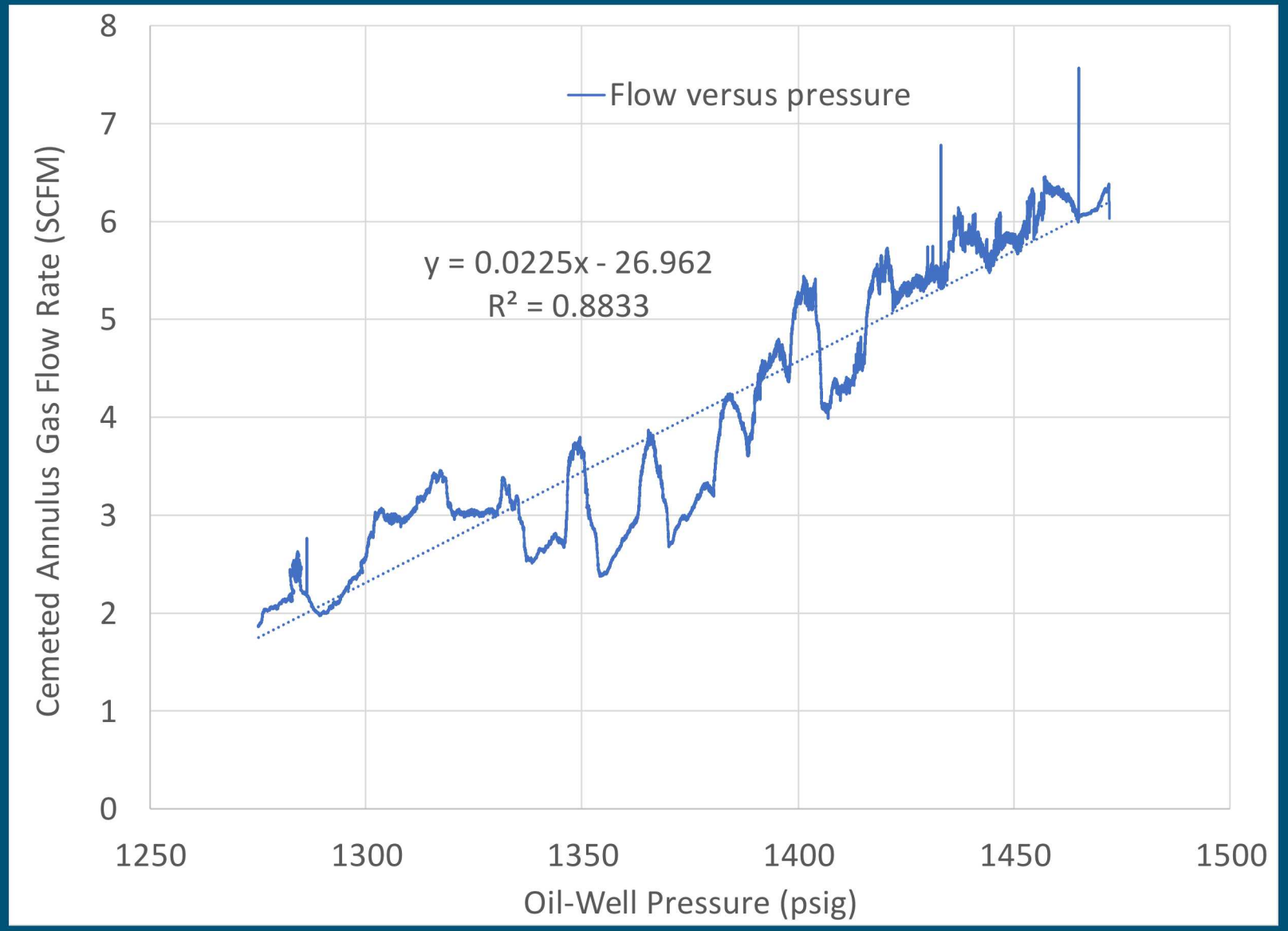
- Δt = time - t_0, t_0 is when the Calscan flow meter was turned on
- t_0 := 11/28/18 1:14 PM
- Three Seal-Tite treatments were attempted
  - 2 Foam treatments
  - 1 Misting treatment
- All of the Seal-Tite treatments used on WH109 were **water based**
  - Probably chosen because of the lower viscosity, and because it doesn't mix with the oil
  - Downside of the water-based sealant is that it may not displace oil from oil-wetted leak-path surfaces.

Pre-Treatment Time Period



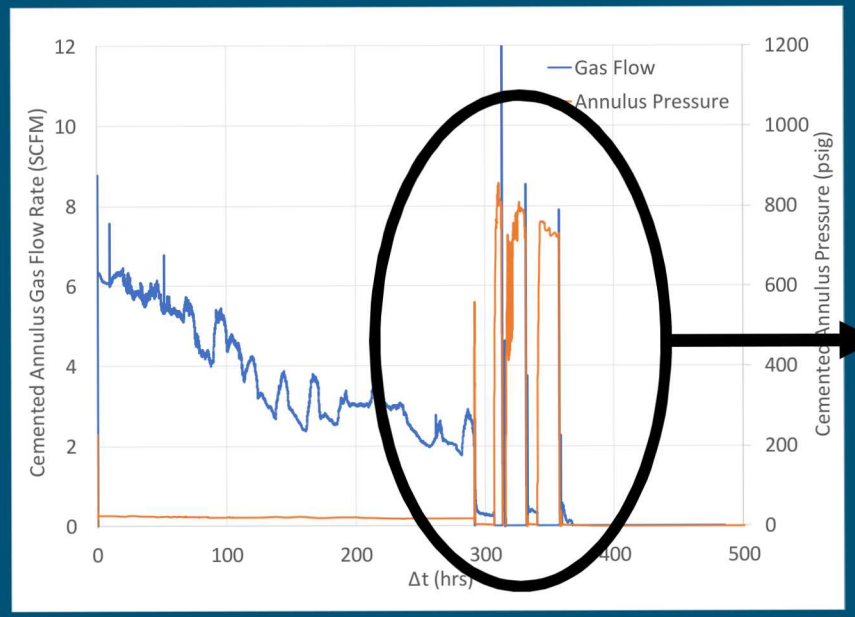
- Oil well is under nitrogen
- Pressure is being decreased to bring the interface to 117’
- Calscan flow meter is open and recording cemented-annulus flow rate

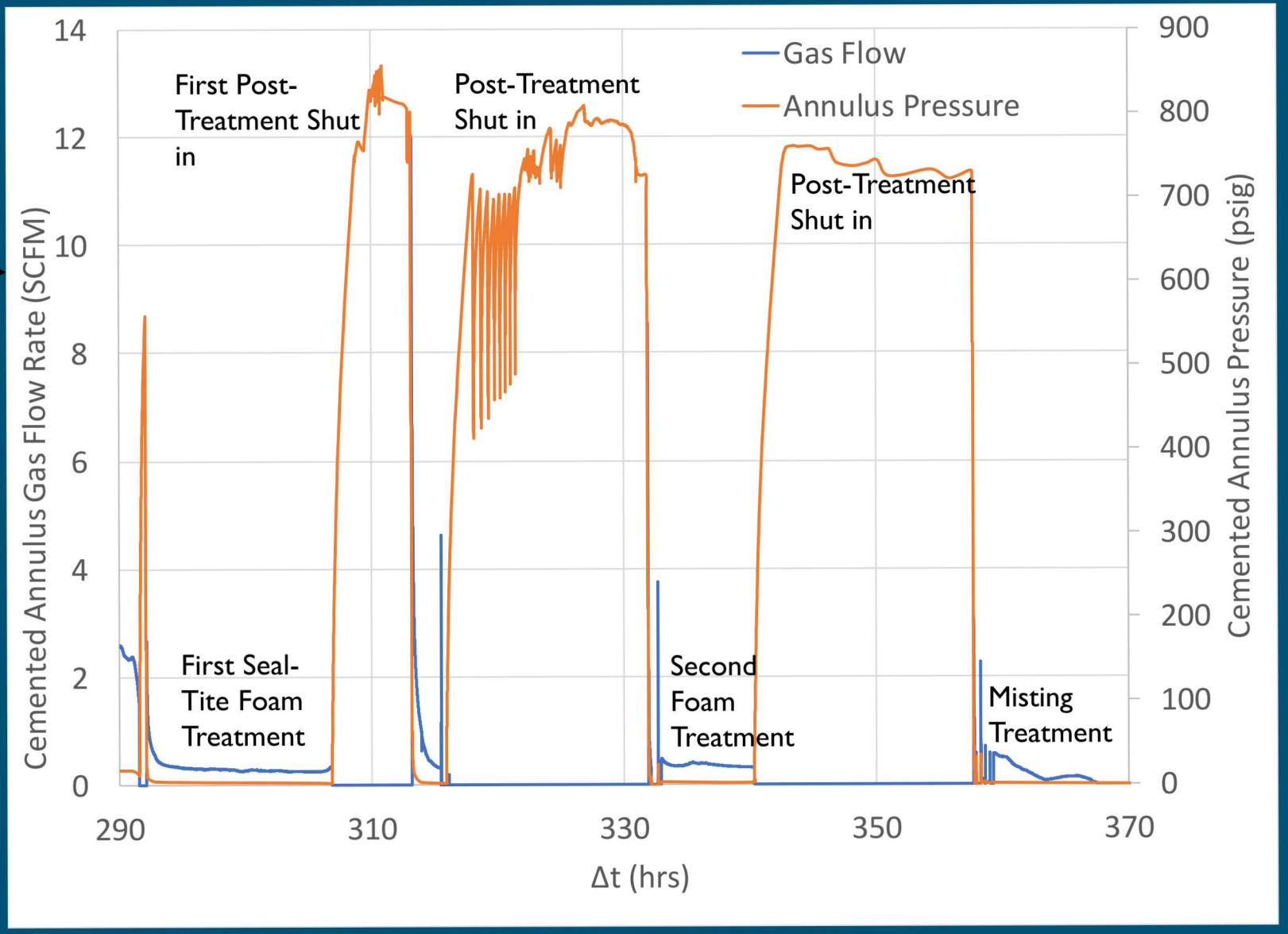
Pre-Treatment Time Period



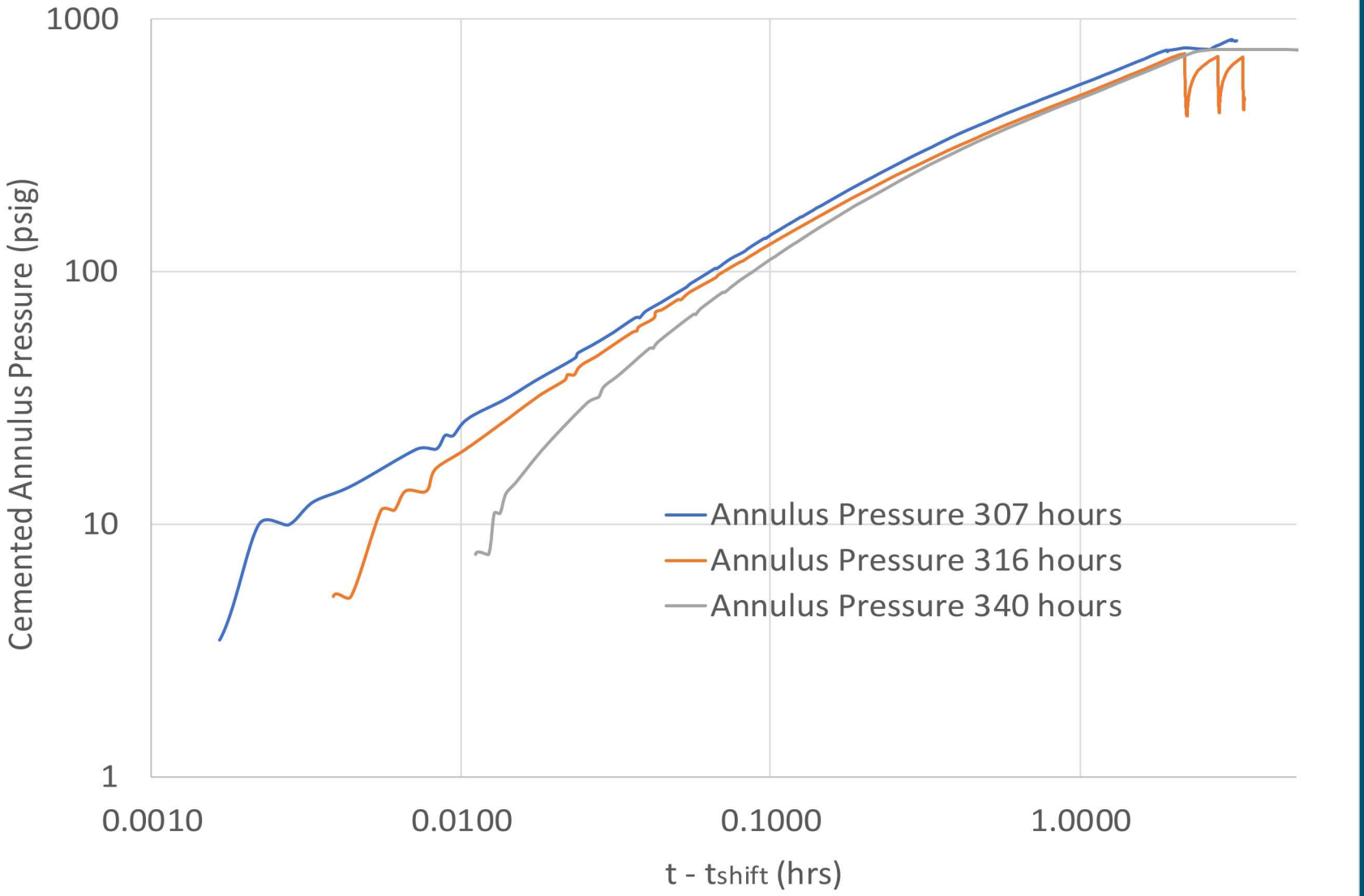
- Darcy flow is linear in pressure (neglecting gas compressibility)
- Higher *Re* number flow (e.g. through a pipe, a valve or large fractures) ~ $P^{1/2}$
- Pressure range is probably insufficient to conclude flow regime

Seal-Tite Treatments



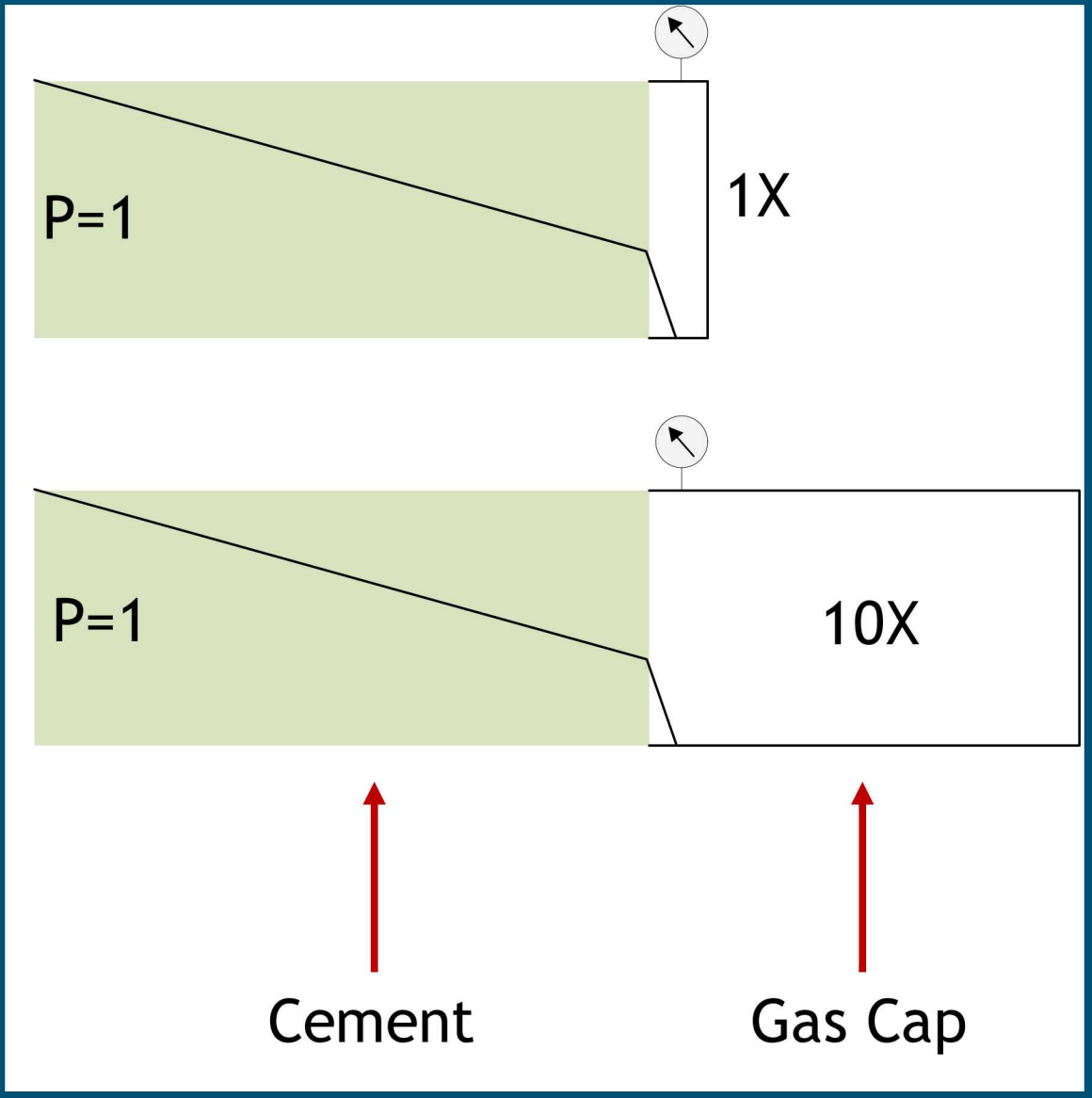


Pressure Buildup Curves during Shut-In



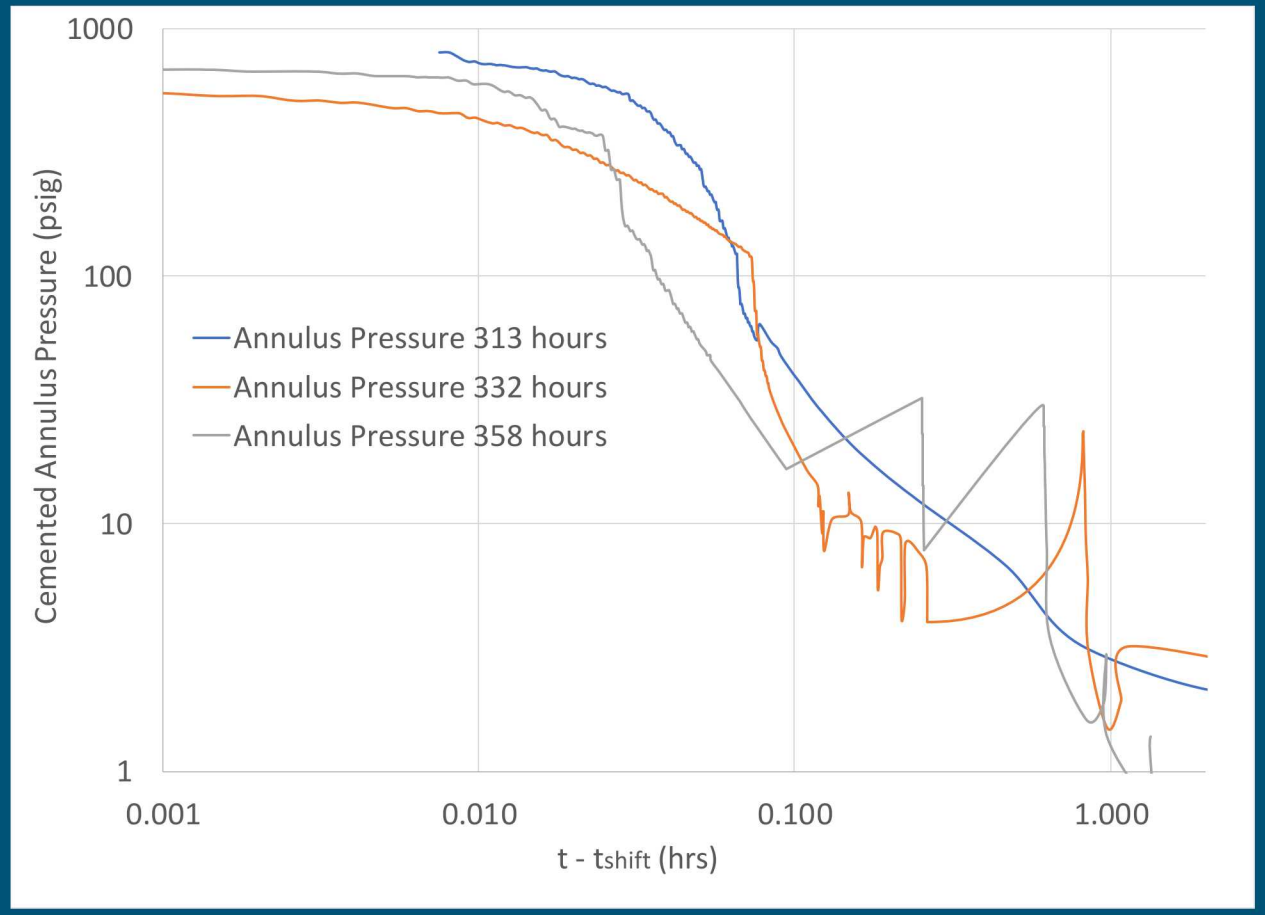
- Collapse shut in curves in time by shifting time such that initial pressure rise occurs at $t - t_{shift} \approx 0$.
- Slope of curves on log-log plot appear similar
- Time required for pressure to equilibrate is ≈ 2 hrs for all three shut-ins
  - This time scale may be due to the presence of a large gas-cap in the system.
  - May not be diagnostic of the cemented annulus

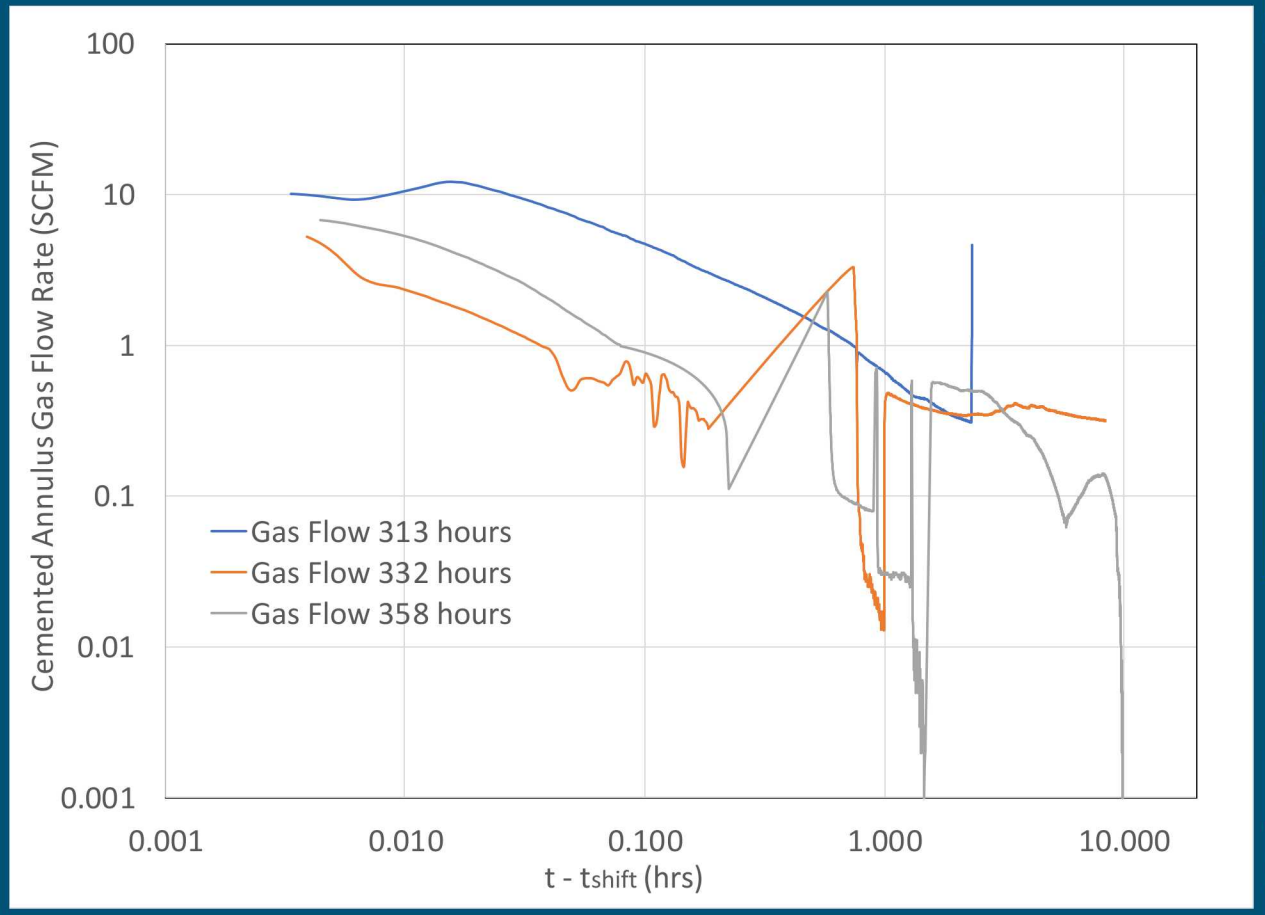
Pressure Buildup Curves during Shut-In



- Open gas volume between the top of cement and the location of the pressure sensor provides a reservoir to hold gas
- More gas held in the reservoir → slower rate of pressurization.
- Large open gas volume gives the appearance of a tighter annulus when in fact it's only tangentially related to the annulus permeability and porosity.

Pressure and Flow Decay





- Slopes of Flow curves are similar in time, expect after the last Seal-Tite treatment where flow rate drops significantly

Conclusions and Discussion

- Uncertain whether dynamic changes in pressure and flow rates can be attributed to the cemented annulus or other factors, e.g.:
  - Volume of a gas cap
  - Flow restrictions in the flow meter
- Use of an industrial gas chromatograph (GC) on the exhaust of the flow meter might help look for components in the Seal-Tite, allow for tracer studies to be performed.