

Effect of Gas Seals on Pump Performance at Low Suction Pressure and Flow

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Objective

Understand the interaction between the gas required to lubricate the seal and the effect of the gas on pump performance.

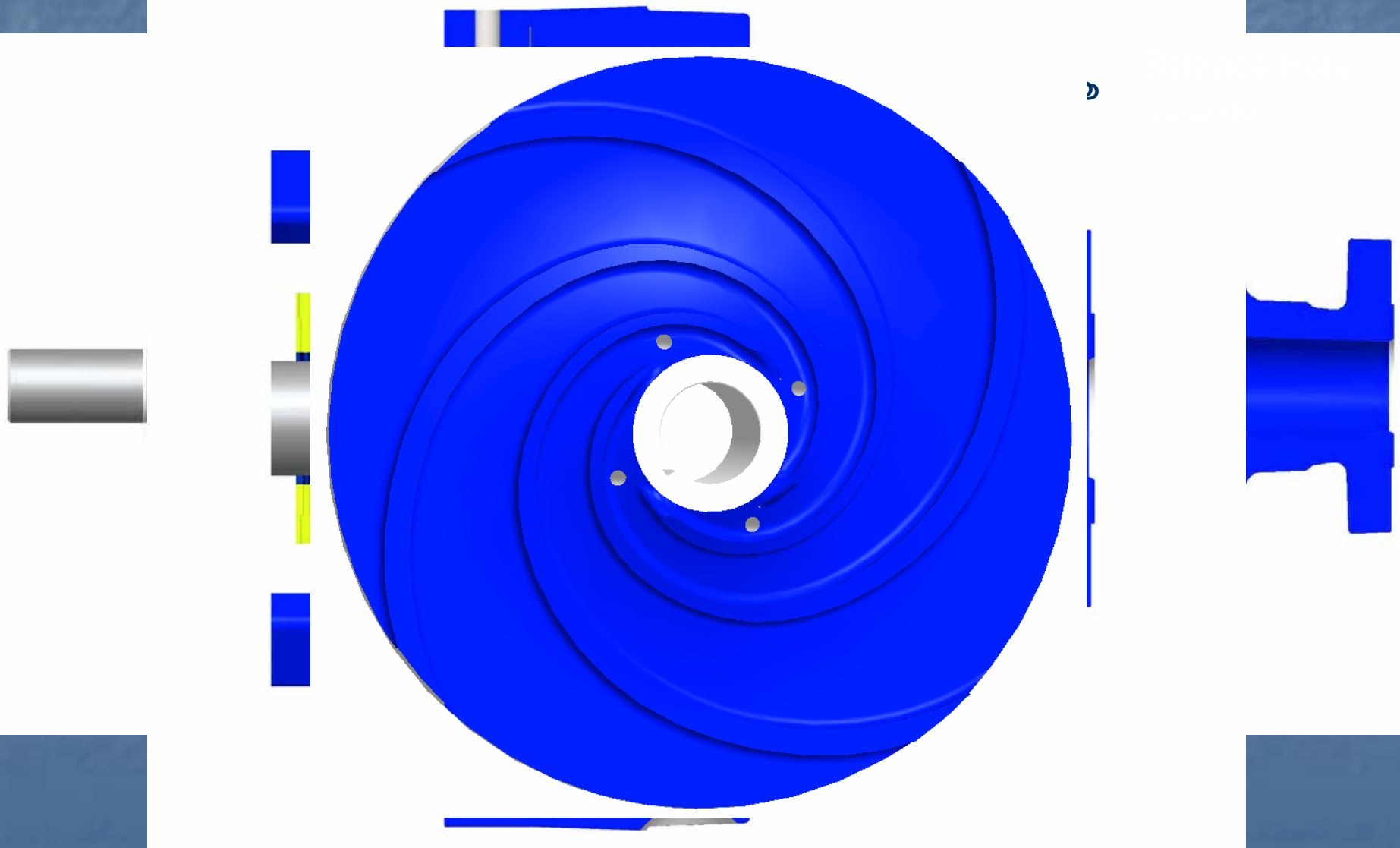
Background

- NPSH test problem with a gas seal
- API end suction pump (1x2-9)
- Tested $NPSH_r$ at the rating was 3.7m
- $NPSH_a$ is 3.0m
- Customer required that the $NPSH_r$ can not exceed 1.5m
- Quoted $NPSH_r$ was 0.6m
- Pump normal flow 10% BEP & rated flow 15% BEP – these are system requirements
 - Pump designed to operate down to 10% BEP

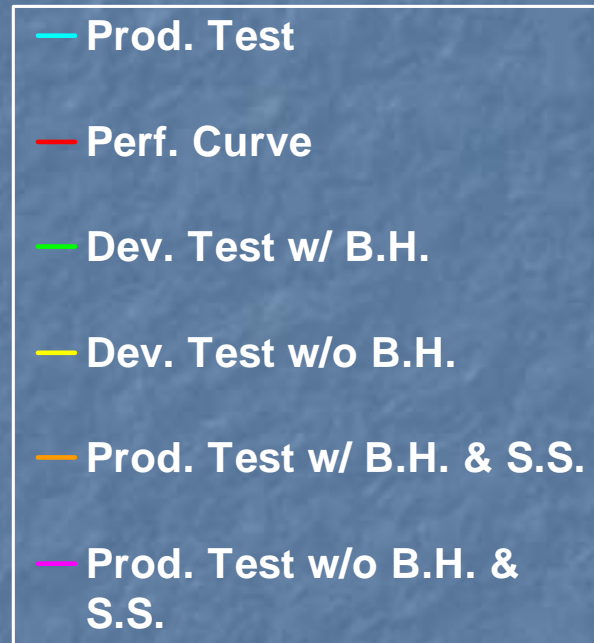
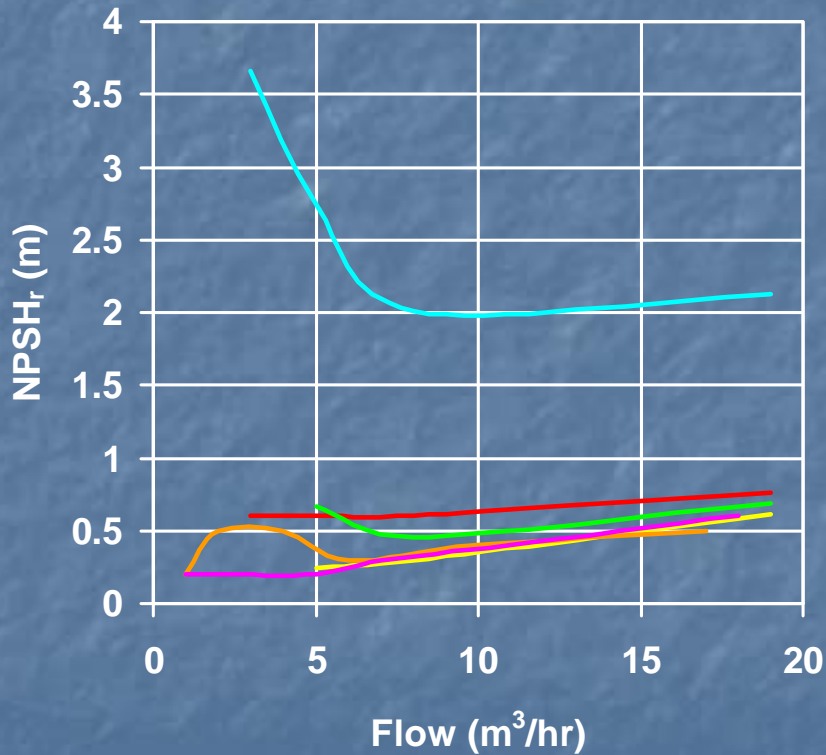
Operating Conditions

- Service: C4700 Suction Condensate Injection
- Liquid: Hydrocarbon
- Temp.: 31° C
- Vapor Pressure: 18 kPa abs. (1.8 m abs.)
- Specific Gravity: 0.666
- Viscosity: 0.330 cp
- Capacity: 2.3 m³/hr Normal, 3.2 m³/hr Rated
- Head: 65 m
- Speed: 2930 rpm
- NPSHr: 0.6 m
- NPSHa: 3.0 m
- Suction Pressure: 40 kPa gauge (4.08 m gauge, 14.29 m abs.)
- Min. Flow: 2.11 m³/hr
- Seal: Non-Contacting Seals Back-to-Back, API Plan 74

Cross Sectional as Tested



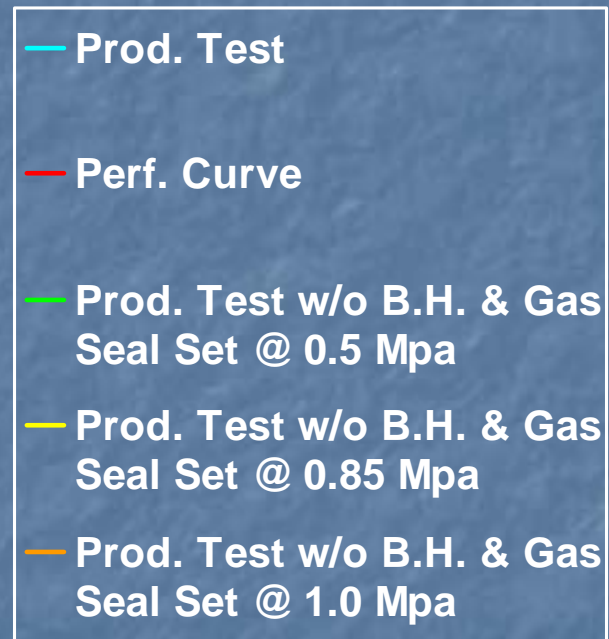
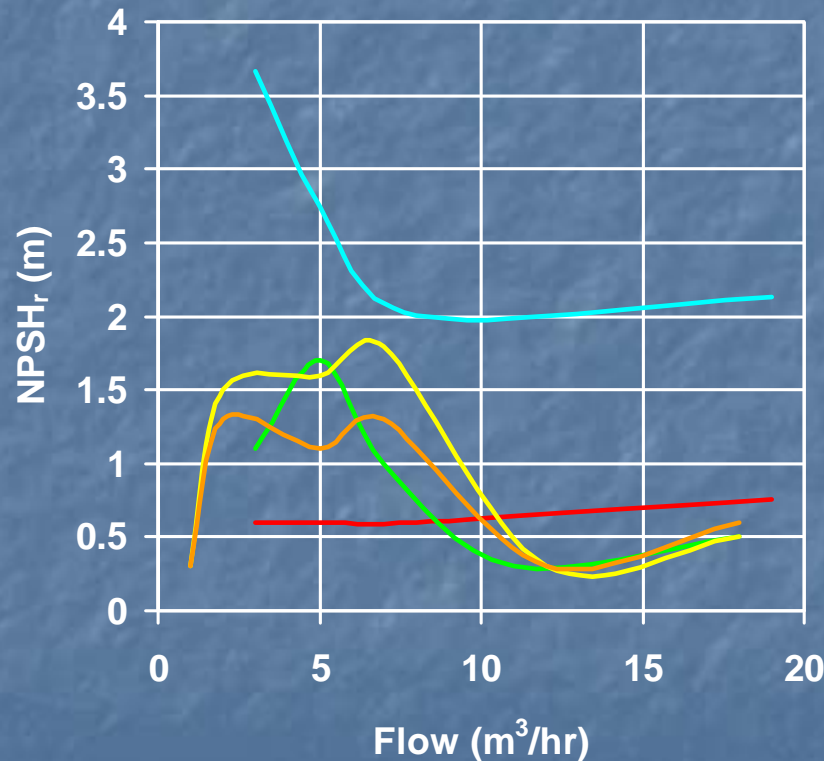
Baseline Data



B.H. = Balance Hole

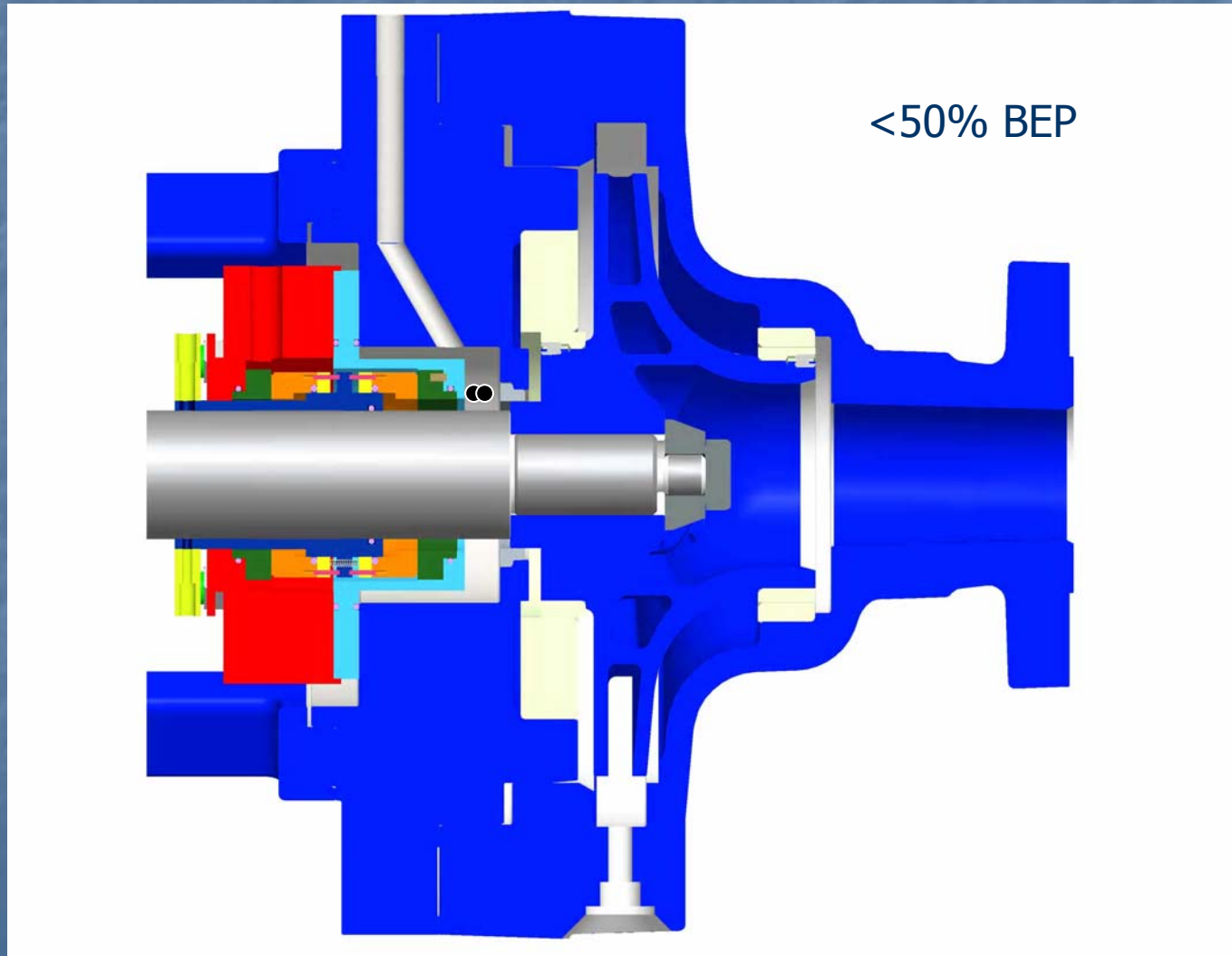
S.S. = Contacting Single Wet Seal w/
Plan 11

Effect of Varying Gas Pressure

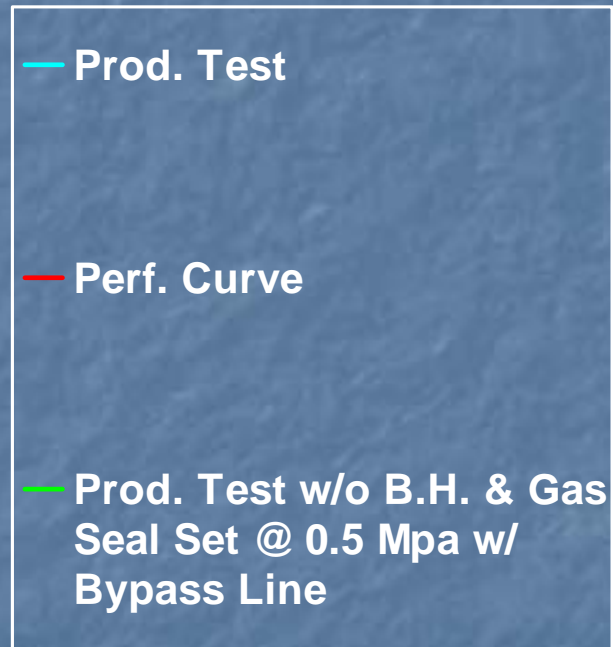
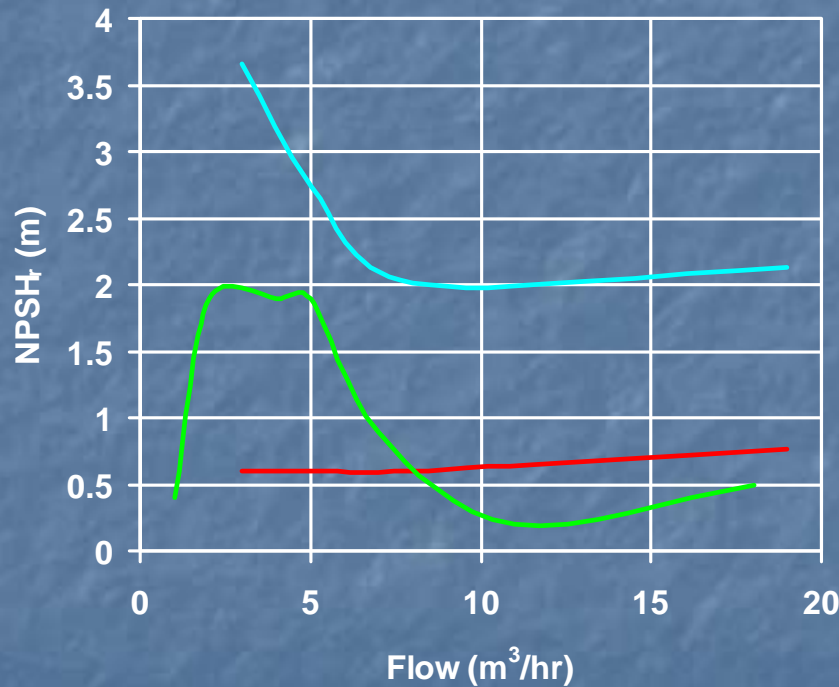


B.H. = Balance Hole

Cross Sectional - Bypass Line to Suction Vessel & Std. Throat Bushing

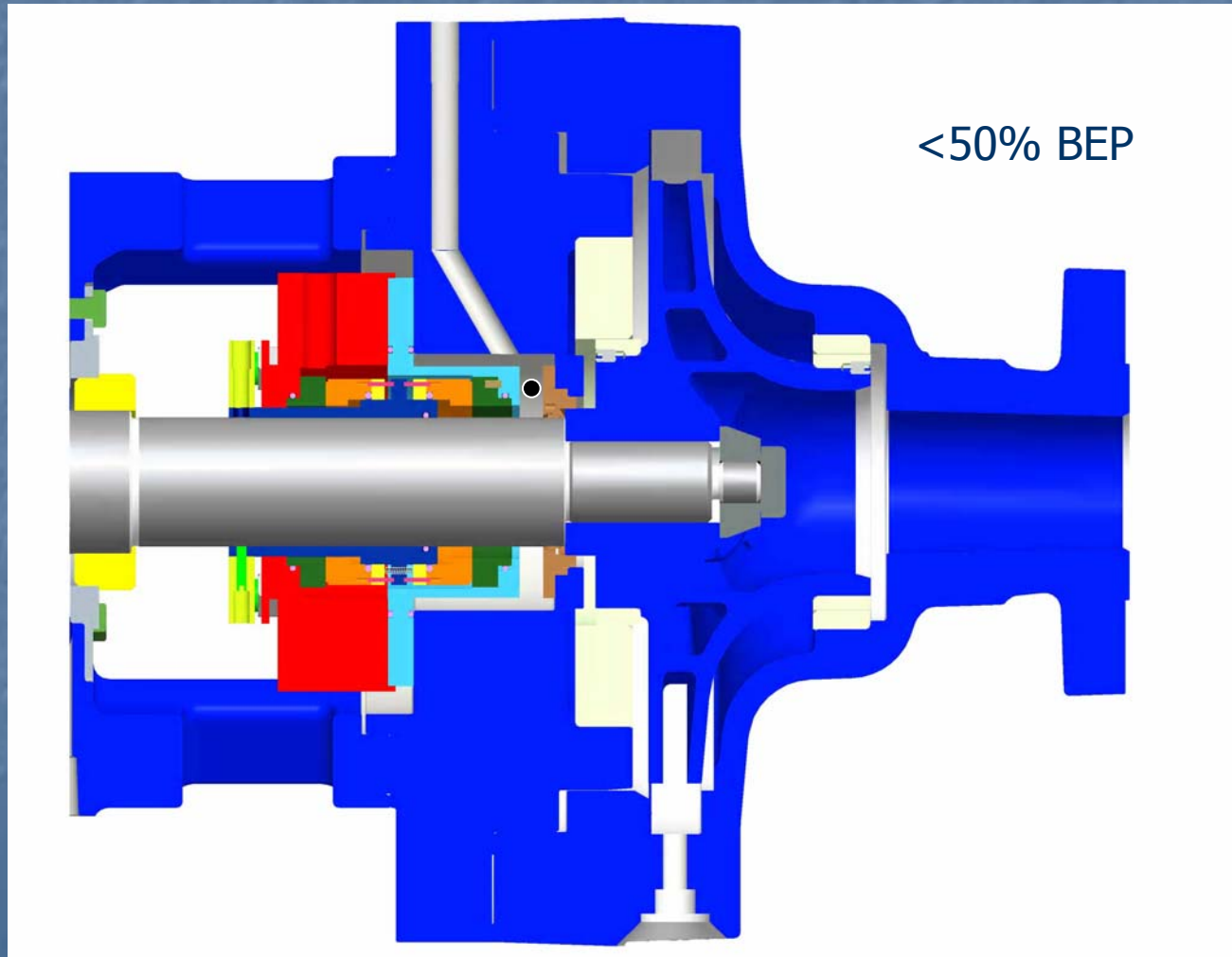


Test with Bypass Line to Suction Vessel & Std. Throat Bushing

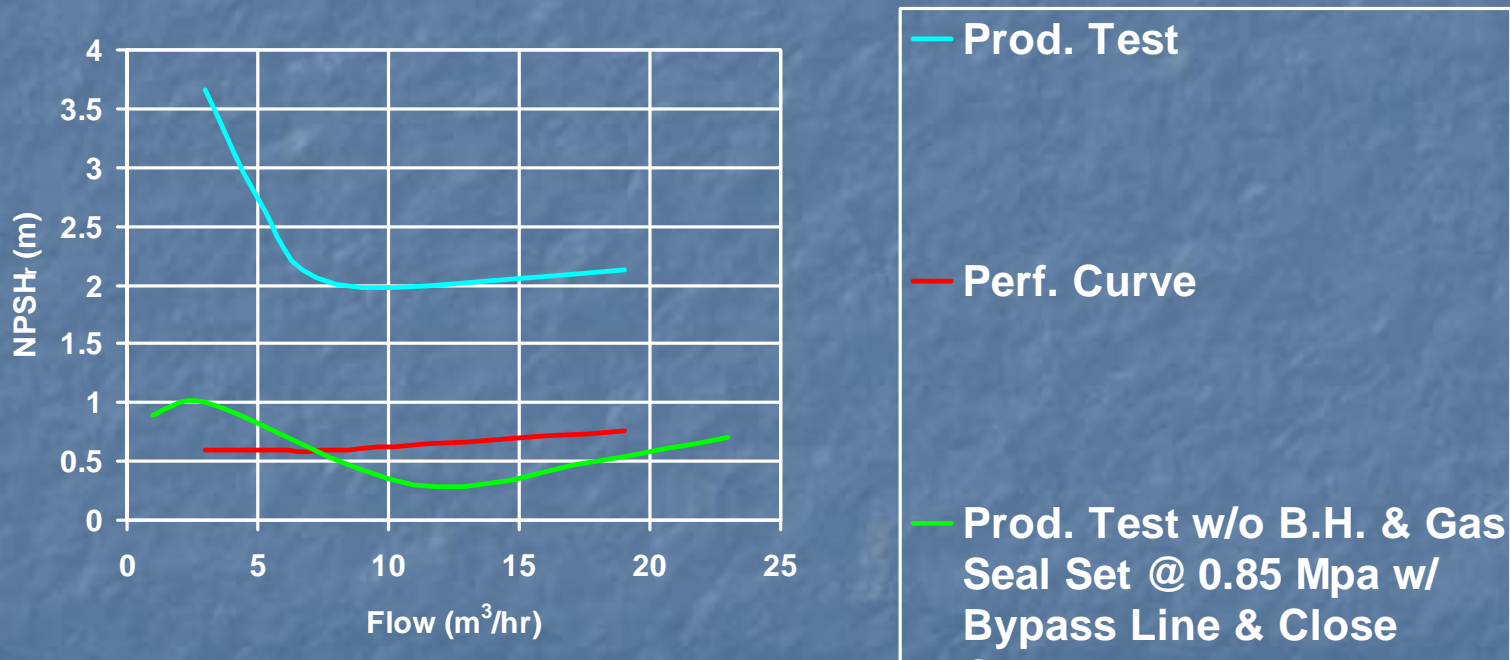


B.H. = Balance Hole

Cross Sectional - Bypass Line to Suction Vessel & Close Clr. Bushing



Test with Bypass Line to Suction Vessel & Close Clearance Throat Bushing



B.H. = Balance Hole

Test Setup



Bypass line was clear to visually see size and quantity of gas bubbles

Installation



Conclusions & Recommendations

- Nitrogen gas caused the impeller to stall
 - Different than impeller cavitation due to insufficient NPSH
- Testing performed on only one pump type
 - Further testing needed to fully understand all of the effects
- Varying gas pressure
 - No significant impact
- Impeller without balance holes
 - Reduces amount of gas reaching impeller inlet
 - Increase in thrust loading
 - Increase seal chamber pressure
 - Requires increase in gas supply pressure
 - At low flow internal recirculation occurs
- Bypass line to suction vessel
 - Reduces amount of gas reaching impeller inlet
 - Larger the size of the line the better (≥ 25 mm)
 - Bringing the line back to vessel assures gas will dissipate prior to reaching impeller inlet

Conclusions & Recommendations

- Close clearance throat bushing
 - Assures gas enters bypass line
- All three were required for this application
- Didn't achieve liquid seal tested value of 0.6m but reduced $NPSH_r$ by 4x from initial test
- Being at 94% vacuum
 - Requires system to be 100% sealed
 - Harder to seal under vacuum than under pressure
 - As pressure is reduced size of bubbles increases
 - .1mm @ atmosphere -> .14mm @ 50% vacuum -> .2mm @ 75% vacuum -> .32mm @ 90% vacuum -> 1mm @ 100% vacuum
 - Avoid gas seals

Questions?