keep it moving

ROTOR SIZING

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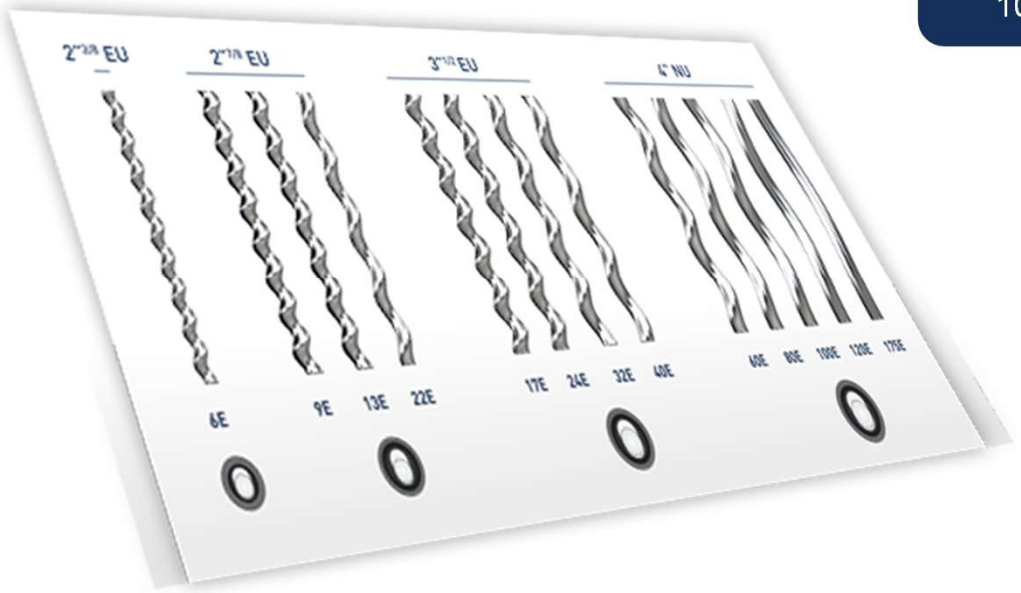

Paul Skoczylas

› OUTLINE

- What is rotor sizing?
- Why is it important?
- How do we choose a rotor size?
- What are the effects of rotor size?
- Conclusion

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WHAT IS ROTOR SIZING?

- **There is usually an interference fit between the rotor and the stator in a PCP**

  This interference fit creates the seal between cavities

- **By adjusting the size of the rotor (the minor diameter), we can control how much interference fit there is**

- **This can be done two ways:**

  1. Always have the same size machined rotor, and change the amount of chrome applied
  2. Adjust the machining of the rotor and always apply the same amount of chrome (PCM's method)

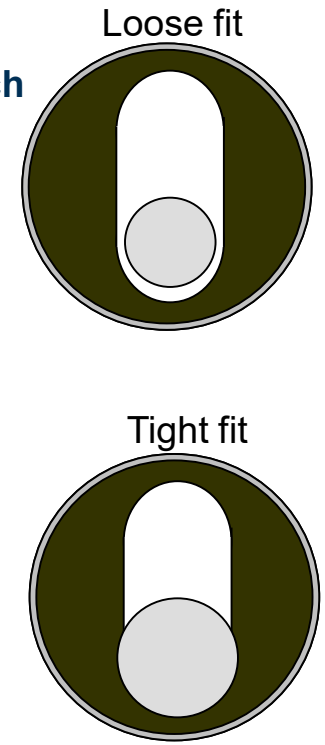
- **Most manufacturers have several rotor sizes available for their pumps**

  At PCM, we have 14 rotor sizes for each pump model. But 80% of rotors sold are covered by just seven of these sizes.

  You may hear references at other companies to "over-sized" or "double under-sized" rotors, for example

- **Often referred to as "Fit"**

  Rotor fit, pump fit, interference fit, etc.



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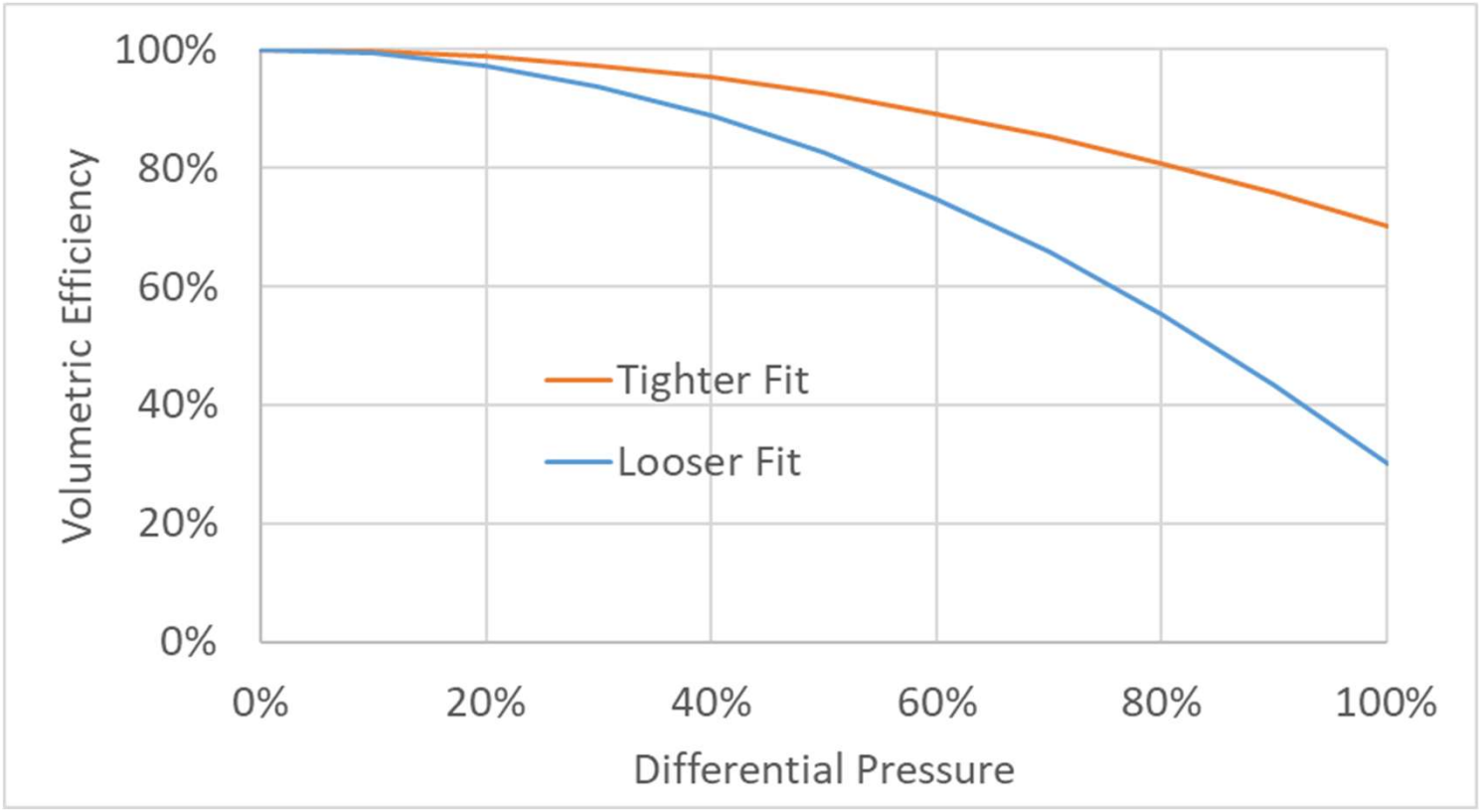
› EXAMPLE



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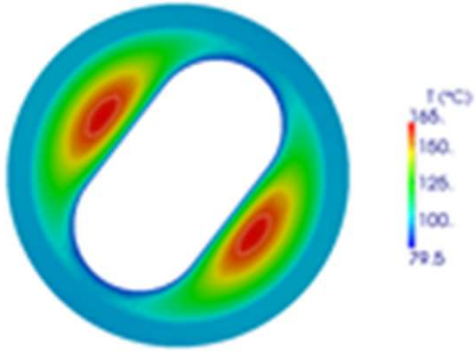
WHY IS ROTOR SIZING IMPORTANT?



- **Several things may be affected by rotor sizing, including:**
  - Volumetric efficiency
  - Pump run life
  - Friction torque
- **Proper rotor sizing gives a good balance between these factors:**
- **A tighter fit improves the seal between cavities, reducing leakage and increasing volumetric efficiency**
- **A tighter fit increases stress in the elastomer, which increases hysteretic heating, and can lead to earlier pump failure**
- **A tighter fit increases the friction between the rotor and stator, requiring more torque**

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* EXCEPTIONS

- **There are some key exceptions to the general statements on the previous slide**
- **Reductions in volumetric efficiency can occur for several reasons, such as:**

  Leakage across the seal lines

  Gas at the pump intake

  The well is pumped off (fluid level is at the pump intake depth)

  The pump cavities are not able to be completely filled

  Reduction in cavity volume due to expansion of the elastomer
- **Of these, only leakage is affected by rotor fit**
- **There are many failure modes of PCP systems that will not be affected by rotor sizing—if these are happening, a change in rotor size will not help**
- **If hysteresis is evident in failures, then it is possible that a looser rotor size may help to increase run-life**
- **There may be cases, such as erosive wear from fluid leaking across seal lines, where a tighter pump may last longer**

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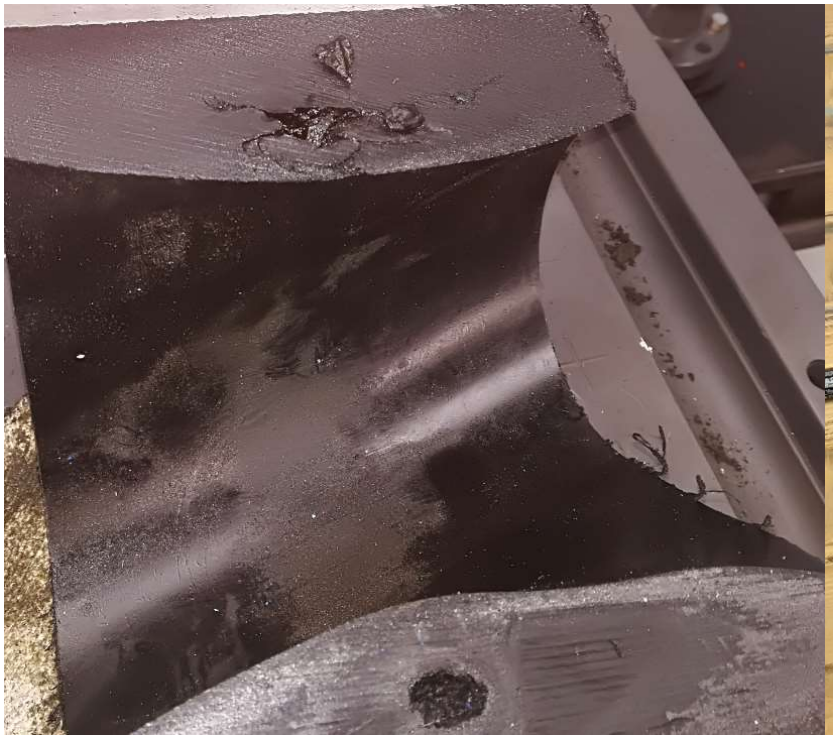
› HYSTERESIS FAILURES



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HOW DO WE CHOOSE A ROTOR SIZE?

- **Different PCP vendors have different methods, and there may methods specific to certain customers or regions**
- **When a vendor has experience in a region, they can use that to choose the optimum rotor size**
- **New regions or applications are more challenging for rotor sizing**
- **Also, any changes in pump geometry or elastomer may require a different rotor size – experience with one geometry / elastomer combination does not always translate to different combinations**
- **At PCM we have a procedure which considers:**

  Temperature

  Pump model

  Elastomer

  Swell test results and/or fluid properties

- **Some customers specify that a certain efficiency is required on a bench test**

  This must specify an efficiency at a certain pressure (often rated pressure) and at a certain speed and temperature.

  Downhole performance should not be expected to match the bench test

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HOW DO WE CHOOSE A ROTOR SIZE?

- **The actual amount of “ideal” interference depends on**

  Temperature 

  Pump geometry 

  Elastomer 

  Fluid 

- **Adjustments can be made to the fit for subsequent installations**

  If a rotor is too tight or too loose, adjust sizing for the next installation in the well or field → process is iterative, especially in new applications

  Some customers may purchase multiple rotors so they can switch rotor size if the performance is not ideal, or if the swell or temperature changes over time

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EFFECT OF TEMPERATURE

- **At higher temperatures, the elastomer expands more, so a smaller rotor can be used**

  The thermal expansion is not the same across the entire cross section

- **As elastomer expands (due to temperature or chemical swell), the cavity volume gets smaller – this will also affect the calculated efficiency**

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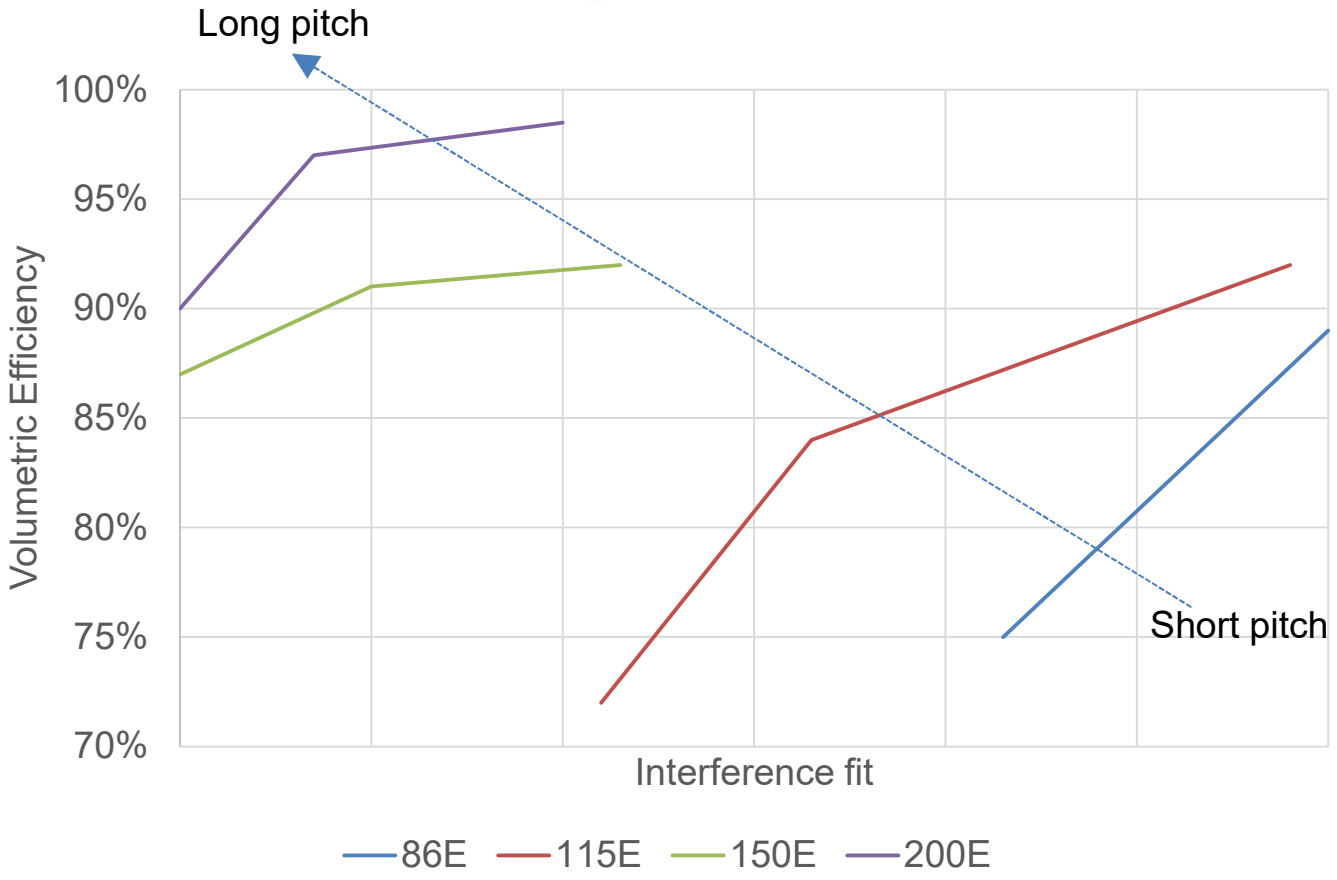
EFFECT OF GEOMETRY (1)



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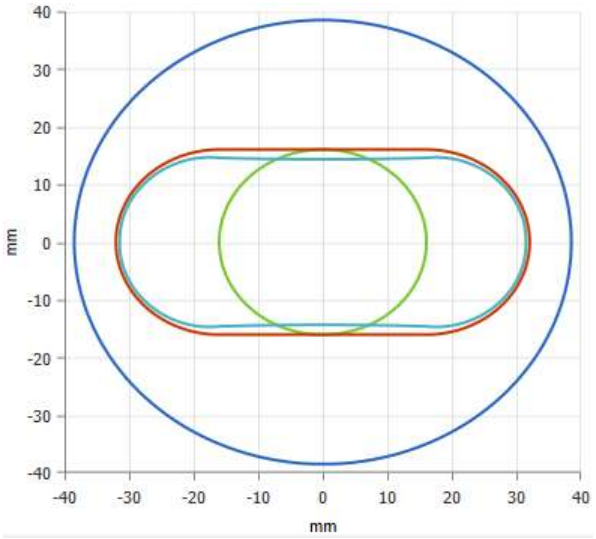
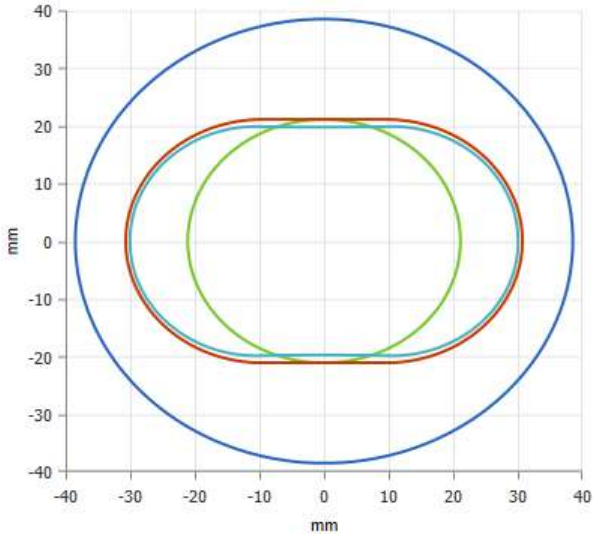
EFFECT OF GEOMETRY (2)

- The D/E ratio of a pump has an effect on how thermal expansion and swelling affect the interference fit
- Shown are pumps with different D/E ratios (3.8 and 8.8), in the same stator tube size
- With the same swell, the interference is 1.7 mm in one and 1.3 mm in the other





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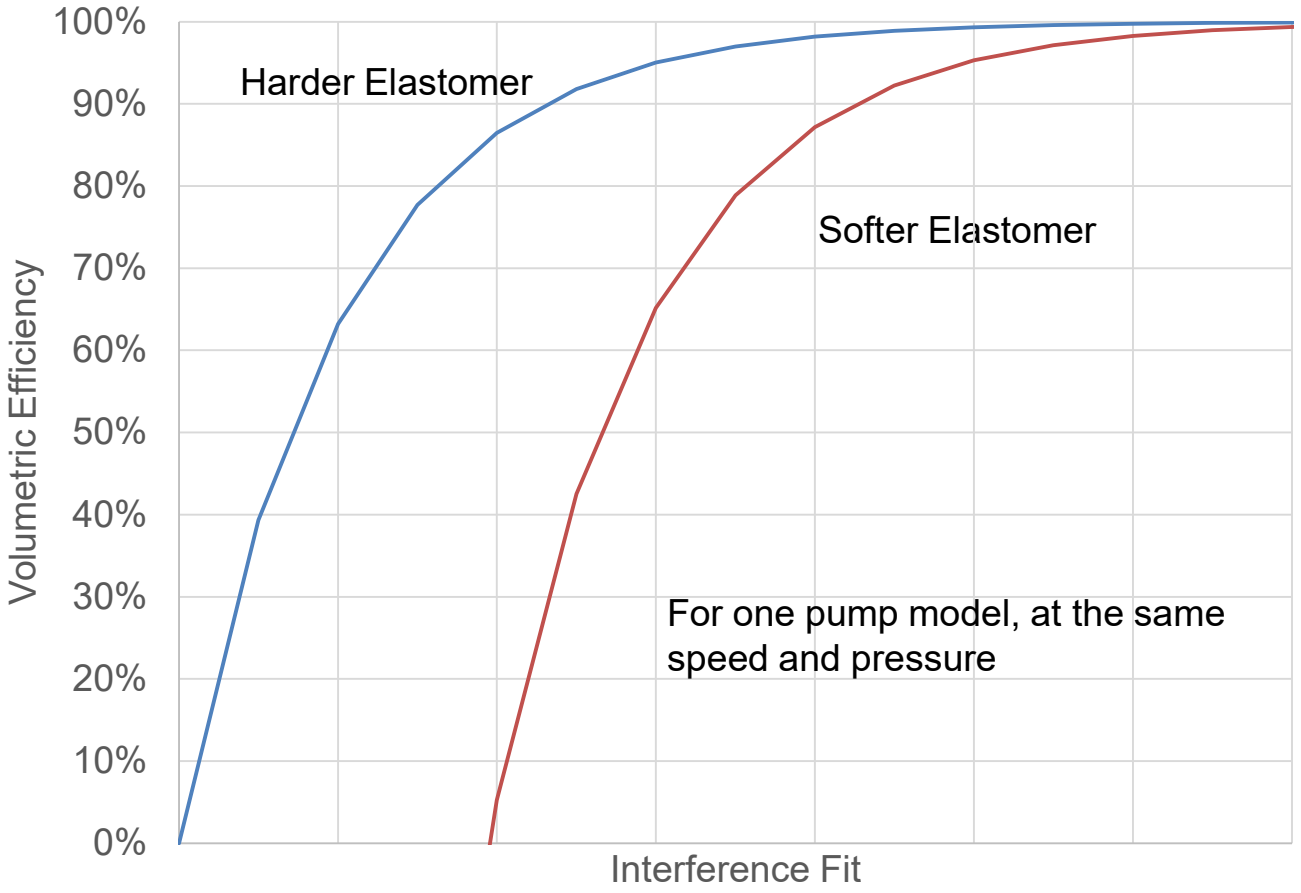
EFFECT OF ELASTOMER



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EFFECT OF FLUID

- **Swelling of elastomer**

  Some fluids will cause more swelling of the elastomer – so a looser rotor is required to give the desired interference fit

- **Effect of viscosity**

  When the fluid is more viscous, less will leak past the seal lines, so a looser rotor can be used without losing efficiency

- **Coalbed Methane / Coal Seam Gas (CBM/CSG)**

  To help avoid stick-slip problems, a looser fit rotor may be used.

- **Solids**

  In harsh solids, a softer elastomer may be used, so a tighter rotor would be selected

  Shorter pitch pumps are generally better in solids

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EFFECTS OF ROTOR SIZE

- **Bigger rotor gives more interference fit (with all other conditions being the same)**
- **Tighter fit rotor will (usually):**

  Reduce fluid leakage across seal lines (increase volumetric efficiency)

  Have higher friction between rotor and stator

  Increase the cyclic stress in the rubber as the rotor moves back and forth across the cavity
- **Ideal rotor fit balances these factors to give good efficiency without having high torque or short run-life**
- **Aiming for 100% efficiency is not the goal**
- **Leakage during pressure testing**

  All PCPs may leak if a pressure test is done, but a looser fit PCP will leak faster

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› OTHER OPTION

- **Can we use a higher head pump with a loose rotor and get the same results as a tighter rotor?**

  Short answer is “Yes”. This might not be advisable in all applications, for example with harsh solids.

  It is probably a good idea with all-metal PCPs, where a tighter rotor might not work. It may also be an option if conditions (temperature, viscosity, swell) may change substantially over the time the pump will be installed

  There is a cost aspect—the longer pump will cost more, while a tighter rotor would not usually have a cost difference

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SUMMARY

- **PCP rotors come in different sizes to allow for different amounts of interference fit with the stator – allowing for "looser" or "tighter" fit**
- **Optimum fit is a balance between high efficiency, low torque, and good run-life**
- **Companies may have a process for selecting a fit going into a new application, but this should be adjusted as needed for subsequent installations, based on results**
- **Some customers specify a desired efficiency on the bench test**

  It is important to understand that bench test efficiency does NOT equal downhole efficiency—but a company may know that a pump with a certain bench test performance gives the desired downhole efficiency

- **Things that can affect the optimum amount of interference fit include:**

  Temperature

  Pump geometry (helix angle and D/E)

  Elastomer swell

  Elastomer hardness

  Fluid viscosity

- **Low efficiency can be caused by factors other than rotor fit**

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THANK YOU!

- **Q&A Session**

- **Please register for our next webinar, with the topic “PCP Monitoring Best Practices” to be held November 17/18/25.**

  Register through our website at https://www.pcmals.com/ or https://www.pcmals.com/artificial-lift-education/webinars

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