Appendix 5

Example problem: Annular piston reservoir sizing

Revision 3  December 9, 2015

Individual appendices of the Kalsi Seals Handbook are periodically updated. To determine if a newer revision of this appendix exists, please visit www.kalsi.com/seal-handbook.htm.

NOTICE: The information in this chapter is provided under the terms and conditions of the Offer of Sale, Disclaimer, and other notices provided in the front matter of this handbook.
1. Example Problem: Calculate the minimum piston stroke length for a mud motor

GIVEN:  
Maximum Rotary Speed: 480 RPM  
Fixed location Seal ID (S1): 4.00”  
Compensation piston Seal ID (S2): 3.25”  
Lubricant Viscosity: ISO 680 VG  
\[ Y = 2.056 \times 10^{-4} \text{ (per Chapter C3)} \]
Tool Life: 200 hrs  
Housing ID (H): 6.50”  
Tool lubricant volume: 173.25 in³  
Assume lubricant volumetric thermal expansion of 10%

FIND:  
Minimum piston stroke length (Stroke_min).

SOLUTION:  
(a) Calculate lubricant volume pumping rate, Q2, for Compensation Piston seal.  
\[ Q_2 = Y \times S_2^2 \times V_{rpm} \]
\[ Q_2 = 2.056 \times 10^{-4} \times 3.25^2 \times 480 \text{ RPM} \]
\[ Q_2 = 1.04 \text{ ml/hr} \]
(b) Calculate lubricant volume pumping rate, Q1, for Fixed location Seal.  
\[ Q_1 = Y \times S_1^2 \times V_{rpm} \]
\[ Q_1 = 2.056 \times 10^{-4} \times 4.00^2 \times 480 \text{ RPM} \]
\[ Q_1 = 1.58 \text{ ml/hr} \]
(c) Calculate total lubricant volume pumping rate, \( Q_{\text{total}} \), for both Kalsi Seals.  
\[ Q_{\text{total}} = Q_1 + Q_2 \]
Example problem: Annular piston reservoir sizing

\[ Q_{\text{total}} = 1.04 \text{ ml/hr} + 1.58 \text{ ml/hr} \]
\[ Q_{\text{total}} = 2.62 \text{ ml/hr} \]

(d) Calculate the total required lubricant volume, \( V_{\text{lub}} \), for tool service life.
\[ V_{\text{lub}} = Q \times \text{Tool Life} \]
\[ V_{\text{lub}} = 2.62 \text{ ml/hr} \times 200 \text{ hrs} \]
\[ V_{\text{lub}} = 524 \text{ ml or 31.97 in}^3 \]

(e) Calculate piston stroke length, \( \text{Stroke}_{SL} \), for tool service life.
\[ \text{Stroke}_{SL} = \frac{V_{\text{tool}}}{\text{Annular Area}} \]
\[ \text{Stroke}_{SL} = \frac{V_{\text{lub}}}{(H^2 - S_1^2) \times \pi/4} \]
\[ \text{Stroke}_{SL} = 31.97 \text{ in}^3 / ((6.50''^2 - 4.00''^2) \times \pi/4) \]
\[ \text{Stroke}_{SL} = 1.55'' \]

Calculate piston stroke length, \( \text{Stroke}_{TE} \), required for thermal expansion of lubricant.
\[ \text{Stroke}_{TE} = \frac{(V_{\text{tool}} + V_{\text{lub}}) \times 10\%}{((H^2 - \text{Shaft OD}^2) \times \pi/4)} \]
\[ \text{Stroke}_{TE} = \frac{(173.25 \text{ in}^3 + 31.97 \text{ in}^3 \times 10\%)}{((6.50''^2 - 4.00''^2) \times \pi/4)} \]
\[ \text{Stroke}_{TE} = 1.00'' \]

(f) Calculate total minimum piston stroke length \( \text{Stroke}_{min} \).
\[ \text{Stroke}_{min} = \text{Stroke}_{SL} + \text{Stroke}_{TE} \]
\[ \text{Stroke}_{min} = 1.55'' + 1.00'' \]
\[ \text{Stroke}_{min} = 2.55'' \]