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.

1. Example Problem: Calculate the minimum piston stroke length for a mud motor

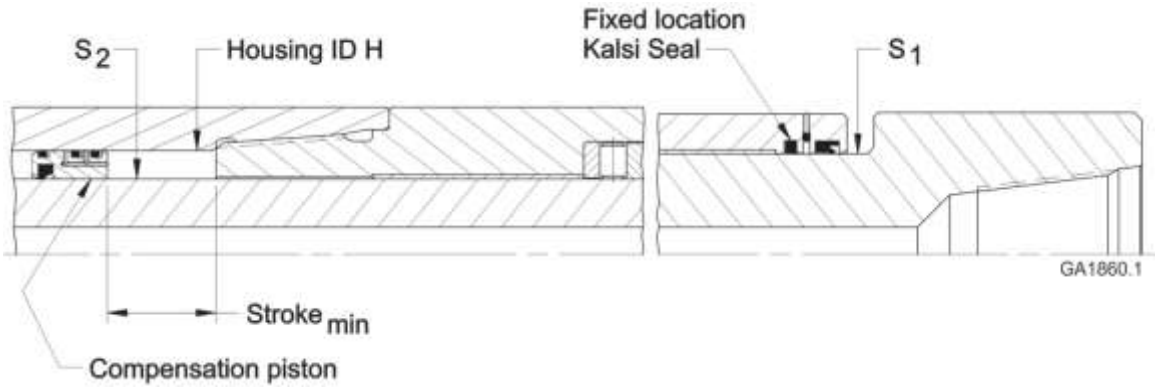

Figure 1
Schematic of a typical oilfield sealed bearing downhole drilling mud motor

GIVEN: Maximum Rotary Speed: 480 RPM
Fixed location Seal ID (S_1): 4.00”
Compensation piston Seal ID (S_2): 3.25”
Lubricant Viscosity: ISO 680 VG
$Y = 2.056 \times 10^{-4}$ (per Chapter C3)
Tool Life: 200 hrs
Housing ID (H): 6.50”
Tool lubricant volume: 173.25 in^3
Assume lubricant volumetric thermal expansion of 10%

FIND: Minimum piston stroke length ($Stroke_{min}$).

SOLUTION:

(a) Calculate lubricant volume pumping rate, Q_2, for Compensation Piston seal.

$Q_2 = Y \times S_2\text{^}2 \times V_{rpm}$

$Q_2 = 2.056 \times 10^{-4} \times 3.25\text{”^}2 \times 480$ RPM

$Q_2 = 1.04$ ml/hr

(b) Calculate lubricant volume pumping rate, Q_1, for Fixed location Seal.

$Q_1 = Y \times S_1\text{^}2 \times V_{rpm}$

$Q_1 = 2.056 \times 10^{-4} \times 4.00\text{”^}2 \times 480$ RPM

$Q_1 = 1.58$ ml/hr

(c) Calculate total lubricant volume pumping rate, Q_{total}, for both Kalsi Seals.

$Q_{total} = Q_1 + Q_2$

Q_{total} = 1.04 ml/hr + 1.58 ml/hr

Q_{total} = 2.62 ml/hr

(d) Calculate the total required lubricant volume, Vol_{lub}, for tool service life.

Vol_{lub} = Q x Tool Life

Vol_{lub} = 2.62 ml/hr x 200 hrs

Vol_{lub} = 524 ml or 31.97 in^3

(e) Calculate piston stroke length, $Stroke_{SL}$, for tool service life.

$Stroke_{SL}$ = $Volume_{lub}$/Annular Area

$Stroke_{SL}$ = $Volume_{lub}$/((H^2 – S_1^2) x PI/4)

$Stroke_{SL}$ = 31.97 in^3/((6.50”^2 - 4.00”^2) x PI/4)

$Stroke_{SL}$ = 1.55”

Calculate piston stroke length, $Stroke_{TE}$, required for thermal expansion of lubricant.

$Stroke_{TE}$ = (Vol_{tool} + Vol_{lub}) x 10% / ((H^2 - Shaft OD^2) x PI/4)

$Stroke_{TE}$ = (173.25 in^3 + 31.97 in^3 x 10%) / ((6.50”^2 - 4.00”^2) x PI/4)

$Stroke_{TE}$ = 1.00”

(f) Calculate total minimum piston stroke length $Stroke_{min.}$

$Stroke_{min}$ = $Stroke_{SL}$ + $Stroke_{TE}$

$Stroke_{min}$ = 1.55” + 1.00”

$Stroke_{min}$ = 2.55”