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Hydrodynamic journal bearing

Comparison DIN 31652:2017 with KISSsoft 03-2017

In the following KISSsoft report, the different results from the standard are printed bold on the right side of the report.

For the comparison the 2 examples from the standard were used.

Example 1

- In this example were used for $\nu40$ = 108.9 and for $\nu100$ = 10.78 mm^2/s
- The chapter 'heat output by the lubricant' has been calculated.
- In the example from the standard are taken the values (ε, β, $\mu/\psi eff$) from tables and in KISSsoft were the values calculated with formulas, that is the main reason for the small differences in the results.

→ The calculation corresponds to an accuracy of +/- 5%.

KISSsoft Release 03/2017

KISSsoft-Entwicklungs-Version KISSsoft AG CH-8608 BUBIKON

File

Name : DIN 31652 Example 1
Description: KISSsoft Datensatz
Changed by: KISSsoft AG on: 16.08.2017 at: 13:46:02

Important hint: At least one warning has occurred during the calculation:

1-> Bearing 1:
The temperature increase (15.4 °C.) of the oil is higher than 15 °C. !
The performance may be limited.

ANALYSIS OF HYDRODYNAMIC JOURNAL BEARINGS

Calculation according to DIN 31652:2017

Closed bearing
Heat transfer by lubricant

Oil inlet overpressure (bar)	[pen]	5.00
Speed (1/min)	[n]	2000.00

Type of oil			
Kinem. viscosity oil at 40 °C (mm^2/s)	[v40]	108.90	
Kinem. viscosity oil at 100 °C (mm^2/s)	[v100]	10.78	
Directional constants	[m]	3.714	
Specific density at 15 °C (kg/dm3)	[ρ]	0.900	
Bearing diameter (mm)	[D]	120.00	
Bearing width (mm)	[B]	60.00	
Radial force (N)	[Fr]	36000.00	
Bearing clearance at 20 °C (mm)	[s]	0.1200	
Relative bearing clearance at 20 °C (%)	[s/D]	0.001000	
Material shaft (Own input)	Steell		
Young's modulus (N/mm^2)	[E]	206000.00	
Poisson's ratio	[v]	0.300	
Coefficient of thermal expansion (1/°C)	[α]	11.00 10exp-6	
Material hub (Own input)	Aluminium alloy		
Young's modulus (N/mm^2)	[E]	70000.00	
Poisson's ratio	[v]	0.330	
Coefficient of thermal expansion (1/°C)	[α]	23.00 10exp-6	
Lubrication arrangement (according to ISO 7902-2:1998/ DIN 31652:2017):			
On lubrication hole, in opposite direction to load			
Lubrication hole diameter (mm)	[dH]	5.00	
Heat transfer surface (m^2)	[A]	300000.0000	
Heat transfer coefficient (W/m^2/K)	[kA]	20.0000	
Mean surface pressure (N/mm^2)	[p]	5.00	
Circumferential speed (m/s)	[U]	12.57	
Ambient temperature (°C)	[Tamb]	40.00	
Oil inlet temperature (°C)	[Ten]	58.00	
Oil outlet temperature (°C)	[Tex]	73.40	**74.2**
Operating temperature (°C)	[TB]	65.70	
Lubricant at service temperature:			
Specific weight (kg/dm^3)	[ρ]	0.8680	
Kinematic viscosity (mm^2/s)	[veff]	32.4657	
Dynamic viscosity (mPa*s)	[ηeff]	28.1806	
Volume specific heat (J/m^3/K)	[ρ*c]	1907351	
Reynolds number (-)	[Re]	35.9971	**44.6**
Critical Reynolds number (-)	[Recr]	1049.0210	**1300.2**
Effective relative bearing clearance	[Ψeff]	0.0015	**0.00154**
Operating bearing clearance (mm)	[seff]	0.1860	
Thinnest lubricant film thickness (mm)	[h0]	0.0172	**0.01557**
permissible lubricant film thickness (mm)	[h0lim]	0.0090	
Sommerfeld number	[So]	2.0310	**2.086**
Coefficient of friction	[μ]	0.00444	
Friction power (kW)	[Pf]	2.0108	**2.016**
Eccentricity (mm)	[e]	0.0978	
Relative eccentricity	[ε]	0.8148	**0.82**
Misalignment angle (°)	[β]	29.88	**32**
Related lubricant throughput	[Q1*]	0.096	
Related lubricant throughput	[Qp*]	0.128	**0.1229**
Oil flow due to shaft rotation (l/min)	[Q1]	3.233	**3.288**
Oil flow due inlet pressure (l/min)	[Qp]	0.875	**0.918**
Oil requirement (l/min)	[Q]	4.108	**4.21**

Additional information:

Cooling water requirement (l/min)	[Qw]	5.759
(at 5 °C temperature difference)		
Hole for oil supply (mm)	[bOil]	1.77
(dimensioned of oil requirements at corresponding inlet pressure)		

Code parameters for the shaft calculation:

Bearing stiffness at working point (N/µm)	[c_lag]	3383.9
Radial misalignment during operation (µm)	[Δs']	87.1299
X-direction:		
Stiffness (N/µm)	[cx]	-1686.1198
Clearance (µm)	[u0]	43.4142
Clearance (µm)	[u1]	-43.4142
z-direction:		
Stiffness (N/µm)	[cz]	-2933.9527
Clearance (µm)	[w0]	75.5435
Clearance (µm)	[w1]	-75.5435

The code parameters for the shaft calculation only apply when force is applied at 90°.

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Example 2

- In this example were used for ν40 and ν100 = 85.6 mm^2/s
- The heat disspipation is only though the lubrication, the heat emitting surface was set to A = 0 m^2
- The oil supply pressure was also set to 0, because there is no additional pressure load.
- In the example from the standard are taken the values (ε, β, μ/ψeff) from tables and in KISSsoft were the values calculated with formulas, that is the main reason for the small differences in the results.

→ The calculation corresponds to an accuracy of +/- 5%.

KISSsoft Release 03/2017

KISSsoft-Entwicklungs-Version KISSsoft AG CH-8608 BUBIKON

File

Name : DIN 31652 Example 2
Description: KISSsoft Datensatz
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ANALYSIS OF HYDRODYNAMIC JOURNAL BEARINGS

Calculation according to DIN 31652:2017

Half closed bearing		
Heat transfer by lubricant		
Oil inlet overpressure (bar)	[pen]	0.00
Speed (1/min)	[n]	85.70
Type of oil		
Kinem. viscosity oil at 40 °C (mm²/s)	[v40]	85.60
Kinem. viscosity oil at 100 °C (mm²/s)	[v100]	85.60
Directional constants	[m]	0.000
Specific density at 15 °C (kg/dm3)	[ρ]	0.900
Bearing diameter (mm)	[D]	1000.00
Bearing width (mm)	[B]	750.00
Radial force (N)	[Fr]	1000000.00
Bearing clearance at 20 °C (mm)	[s]	1.0000
Relative bearing clearance at 20 °C (%)	[s/D]	0.001000
Material shaft (Own input) Steel		
Young's modulus (N/mm²)	[E]	206000.00
Poisson's ratio	[v]	0.300
Coefficient of thermal expansion (1/°C)	[α]	11.00 10exp-6
Material hub (Own input) Aluminium alloy		
Young's modulus (N/mm²)	[E]	206000.00
Poisson's ratio	[v]	0.300
Coefficient of thermal expansion (1/°C)	[α]	11.00 10exp-6

Lubrication arrangement (according to ISO 7902-2:1998/ DIN 31652:2017):
One lubrication pocket, opposite to load direction

Lubricant pocket width (mm)	[bP]	200.00
Heat transfer surface (m²)	[A]	0.0000

Heat transfer coefficient (W/m²/K)	[kA]	20.0000	
Mean surface pressure (N/mm²)	[p]	1.33	
Circumferential speed (m/s)	[U]	4.49	
Ambient temperature (°C)	[Tamb]	20.00	
Oil inlet temperature (°C)	[Ten]	24.00	
Oil outlet temperature (°C)	[Tex]	29.32	**31.3**
Operating temperature (°C)	[TB]	34.00	
Lubricant at service temperature:			
Specific weight (kg/dm³)	[ρ]	0.8902	
Kinematic viscosity (mm²/s)	[veff]	85.6000	
Dynamic viscosity (mPa*s)	[η]	76.2011	**76.25**
Volume specific heat (J/m³/K)	[ρ*c]	1800000	
Reynolds number (-)	[Re]	26.2105	
Critical Reynolds number (-)	[Recr]	1306.0207	
Effective relative bearing clearance	[Ψeff]	0.0010	
Operating bearing clearance (mm)	[seff]	1.0000	
Thinnest lubricant film thickness (mm)	[h0]	0.1235	
permissible lubricant film thickness (mm)	[h0lim]	0.0090	
Sommerfeld number	[So]	1.9497	**1.95**
Coefficient of friction	[μ]	0.00139	
Friction power (kW)	[Pf]	6.2575	**7.625**
Eccentricity (mm)	[e]	0.7555	
Relative eccentricity	[ε]	0.7555	**0.77**
Misalignment angle (°)	[β]	36.85	
Related lubricant throughput	[Q1*]	0.073	**0.07**
Related lubricant throughput	[Qp*]	0.000	
Oil flow due to shaft rotation (l/min)	[Q1]	39.184	**37.7**
Oil flow due inlet pressure (l/min)	[Qp]	0.000	
Oil requirement (l/min)	[Q]	39.181	
Additional information:			
Code parameters for the shaft calculation:			
Bearing stiffness at working point (N/µm)	[c_lag]	0.0	
Radial misalignment during operation (µm)	[Δs']	0.0000	

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