KISSsoft
Drivetrain Design Solutions

KISSsoft 2019 – Tutorial 16

Analysing the Geometry of Cylindrical Worm Gears with Enveloping Worm Wheel

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Sharing Knowledge

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1 Task

1.1 Task

To calculate a worm gear with center distance 100 mm. The worm has 2 teeth and the worm wheel has 41 teeth. The axial/transverse module is 4. The pressure angle at the normal section is 20°. The worm's facewidth is 60 mm. You should select a sensible facewidth for the worm wheel. The axis tolerance is js7.

The worm's tooth thickness deviation in the normal section is between 0 and -0.04 mm. The tooth thickness deviation for the worm wheel is between -0.128 and -0.168. The external diameter of the worm is 44 -0.01 mm. The root diameter is 26.4 -0.110 mm. The effective tip clearance is 0.8 mm. The root radius coefficient is 0.2. The inside radius diameter is 134.4 mm.
The tolerance for the external diameter of the worm wheel is between 0 and -0.01 and for the active root diameter it is between -0.360 and -0.473. The worm is to be manufactured with accuracy grade 6 as specified in DIN 3974. The worm wheel is to be manufactured with quality 7. The lead direction is to the left. The worm's flank form is ZI.

1.2 Starting the drive element of worm gear with enveloping (globoid) worm wheel

You can call KISSsoft as soon as the software has been installed and activated. Usually you start the program by clicking «Start→Program Files→KISSsoft 2019→KISSsoft». This opens the following KISSsoft user interface:

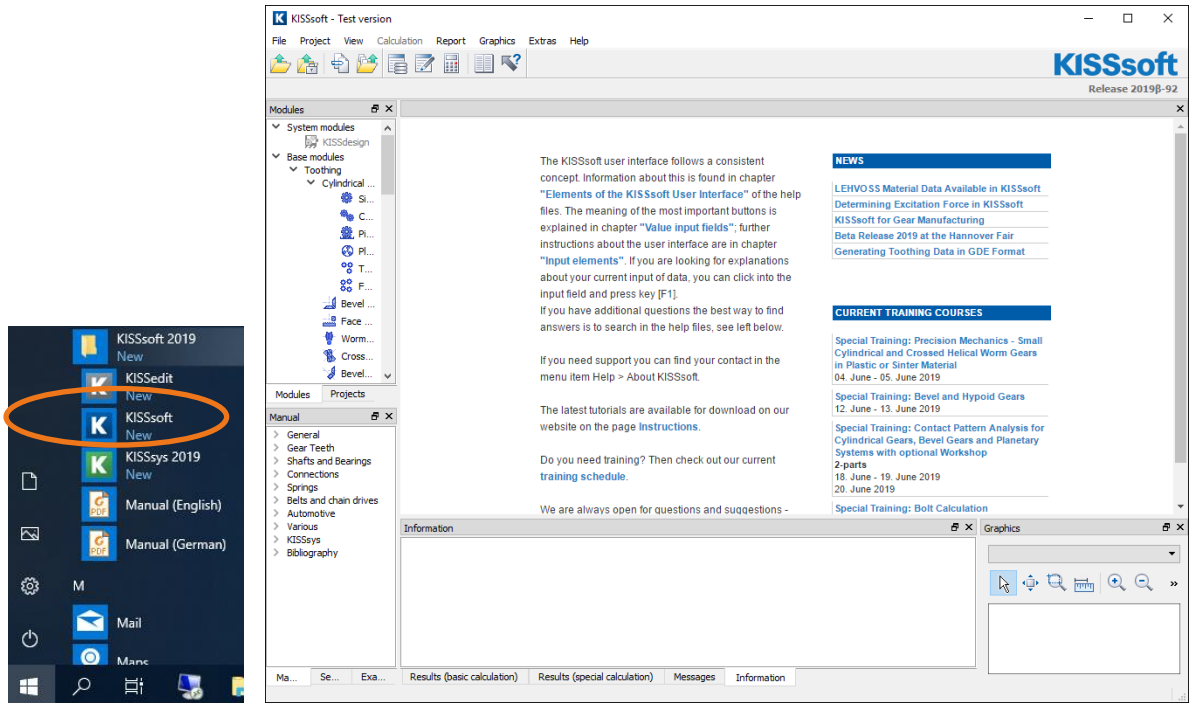

Figure 1. Starting KISSsoft, initial window

In the Modules tree window, click the **«Modules»** tab to call the «Worms with enveloping worm wheels» calculation:

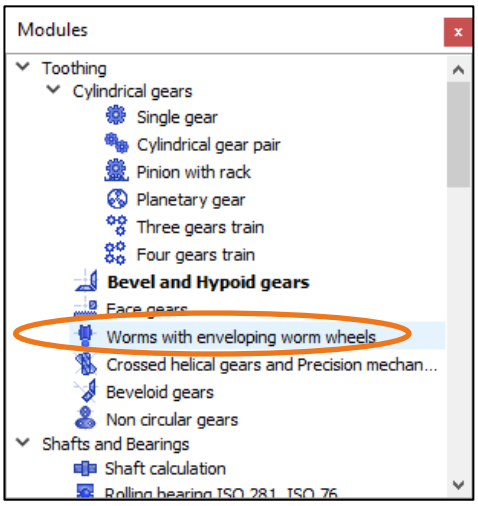

Figure 2. Call to the worm gear calculation

1.3 Input data in the main screen

After you call the 'Worms with enveloping worm wheels', the input screen appears. To only perform a geometry calculation, disable the «Calculation -> Rating» option in the menu.

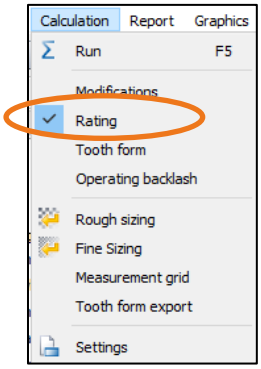

Figure 3. Input screen for worms

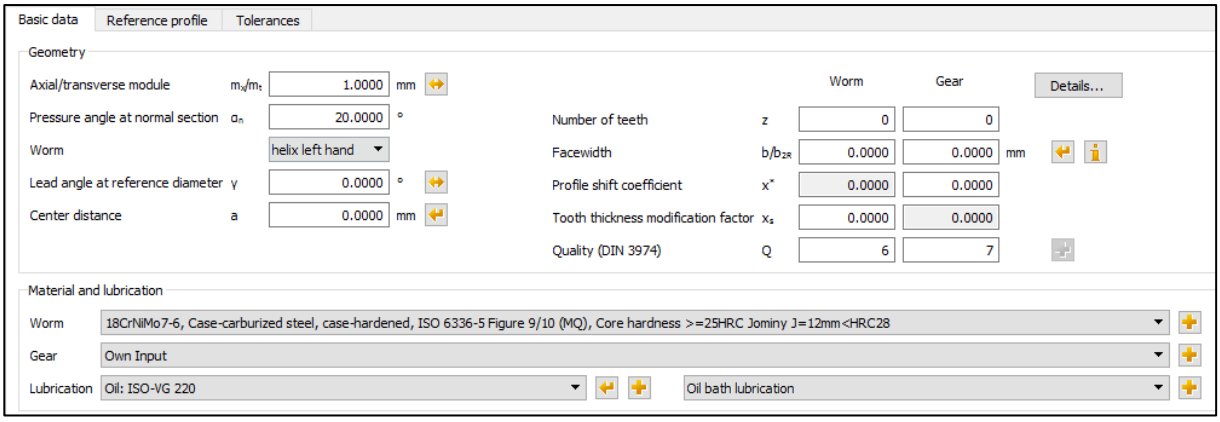

Figure 4. Input screen for worms

Input values for the axial/transverse module, number of teeth, quality, and worm face width in the **«Basic data»** tab. You must also input the center distance (1). The subsequent interim value is calculated because only the lead angle needs to be calculated. To do this, click the **«Convert button»** (2) and then click **«Calculate»** (3) to determine the lead angle. Finally, click Accept (4) to transfer this data to the main screen (see Figure 5).

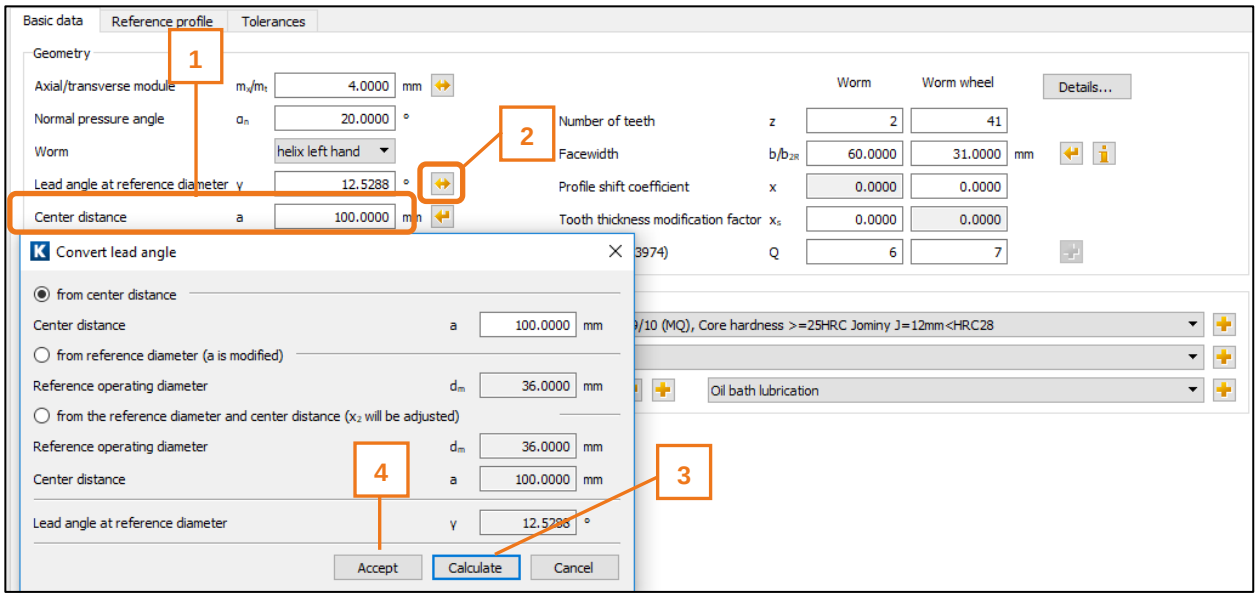

Figure 5. Interim state with the Sizing lead angle input screen

Click the **«Details»** button to call the «Define details of geometry» sub-screen and then select the appropriate flank form ZI. You must also input the inside diameter of the worm gear as 134.4 mm.

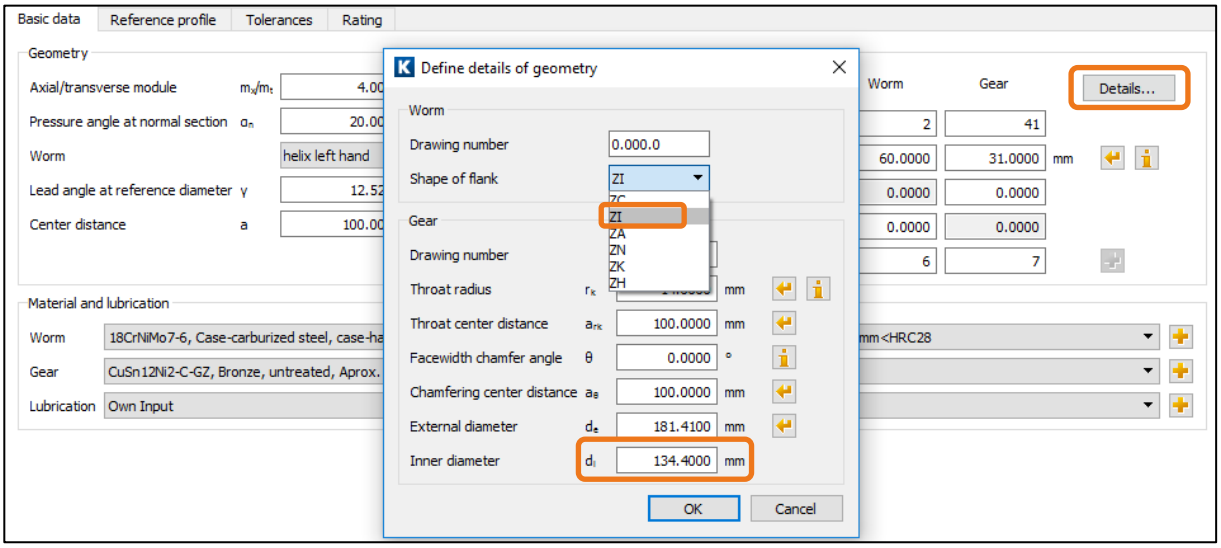

Figure 6. Interim status with «Define details of geometry» input screen

1.4 Special features of worm gear teeth flank surfaces

The flank surfaces of a worm gear are defined in a different way from those in cylindrical gears.

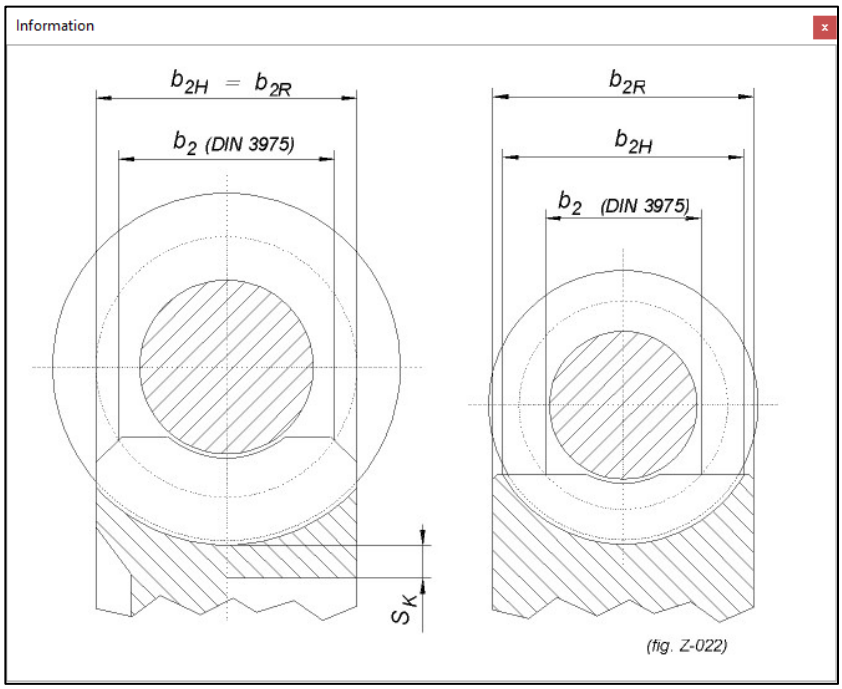

Figure 7. Calling the information graphic to describe wheel rim width b2R and wheel width b2H

Then click the **«Sizing»** button to calculate the facewidth.

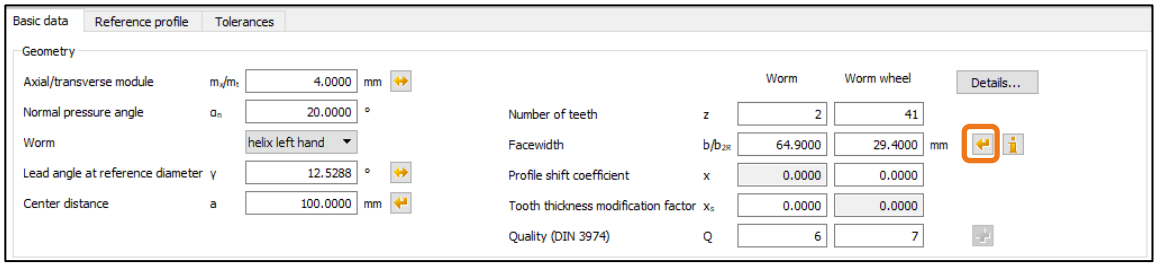

Figure 8. Calculated wheel rim width b2R

1.5 Input data for the gear pair

In the **«Reference profile»** tab, select **«Own Input»** as the predefined tool profile. Then click the appropriate **Convert** button to calculate the tip and the addendum and dedendum coefficients for the worm. When you click Accept, these values are transferred to the main screen.

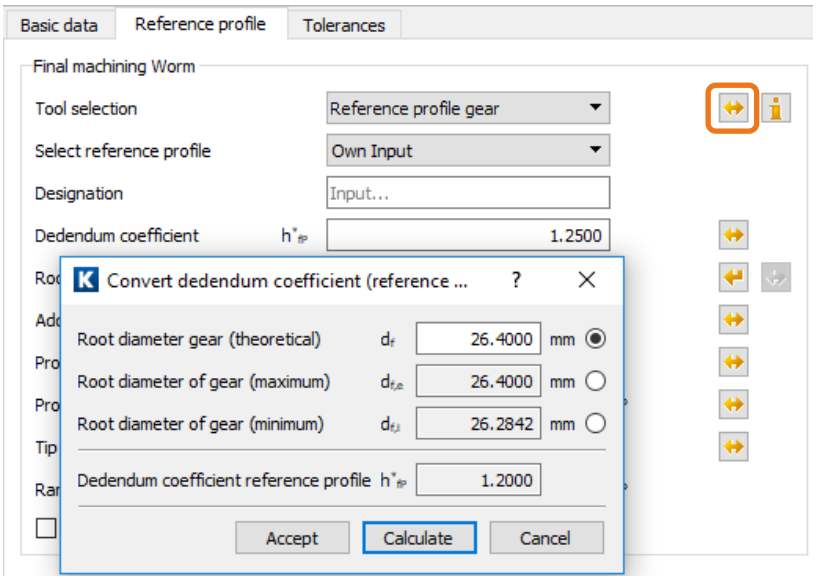

Figure 9. Calculating the worm root or tip diameter

Input 0.2 as the root radius factor. The effective tip clearance is then used to determine the root or tip diameter for the worm wheel. The root diameter is calculated from:
(center distance - tip diameter of worm/2 - tip clearance)·2 = (100 - 44/2 - 0.8) ·2 = 154.4 mm.
The tip diameter is calculated from:
(center distance - root diameter of worm/2 - tip clearance) ·2 = (100 - 26.4/2 - 0.8) ·2 = 172 mm.

Once again, click the relevant **«Convert»** button to convert the dedendum and addendum coefficient at the worm wheel. Then click Accept to transfer the values to the main screen.

Explanation: when you call the worm gear calculation, the system already provides predefined base settings. However, the default profile 1.25 / 0.38 / 1 ISO 53 A does not match what we want. The software already shows that it has calculated the tip diameter detailed above.
The particular geometry of globoid worm gears also means that you need to calculate the throat radius and the external diameter d_{e2}.

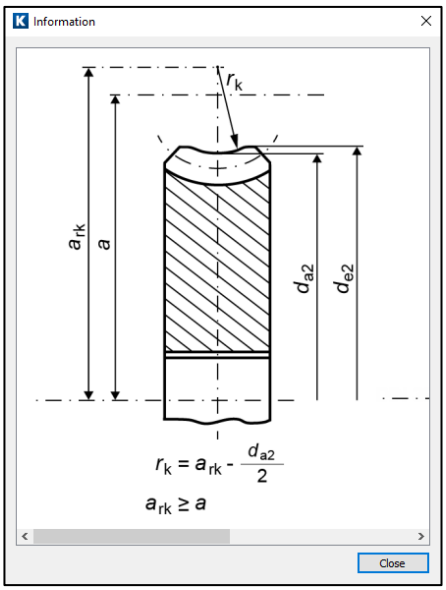

Figure 10. Geometry of globoid worm gears

In the «Basic data» tab, click the **«Details»** button to open the «Define details of geometry» sub-screen. Then click the Sizing button to run the required calculations for the throat radius r_k and the external diameter d_{e2}. For more information see Figure 11.

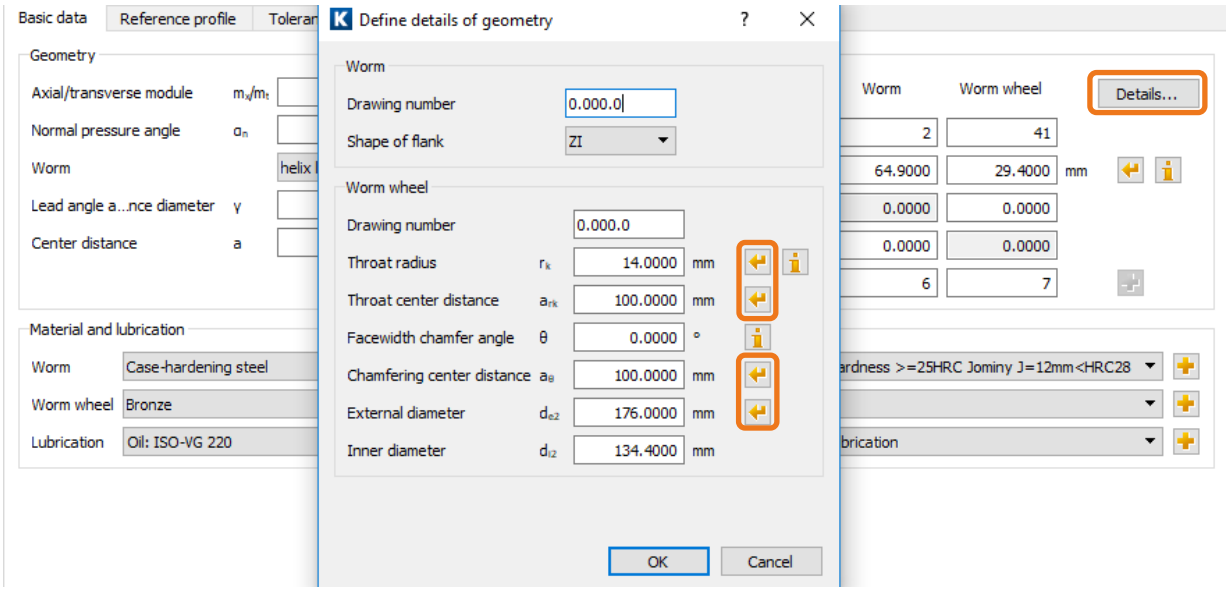

Figure 11. Calculating throat radius r_k, the external diameter d_e, throat center distance a_{rk} and chamfering center distance a_e

1.6 Inputting tolerances

In the **«Tolerances»** tab, select **«Own Input»** instead of using the predefined dimensions. Then input the tooth thickness allowance in accordance with the default values and then enter the tip diameter allowance.

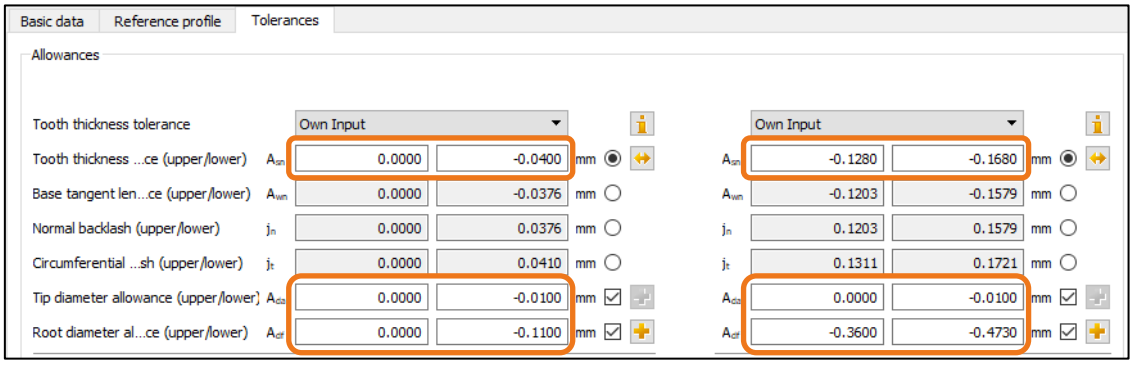

Figure 12. Inputting tooth thickness tolerance and tip diameter allowances

Then check the root diameter allowance and modify it if necessary.
Now select the center distance tolerance.

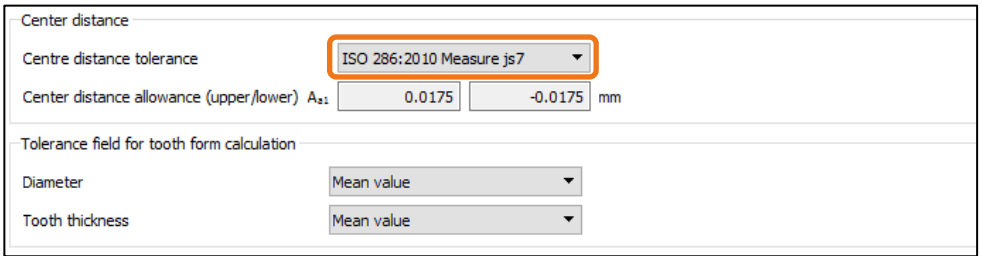

Figure 13. Center distance tolerance input

The following changes must now be made so you can perform the strength calculation later on: facewidth of worm is 60 mm, increase the required facewidth of the worm wheel b_{2R} to 31 mm and the external diameter d_{e2} to 181.41 mm.

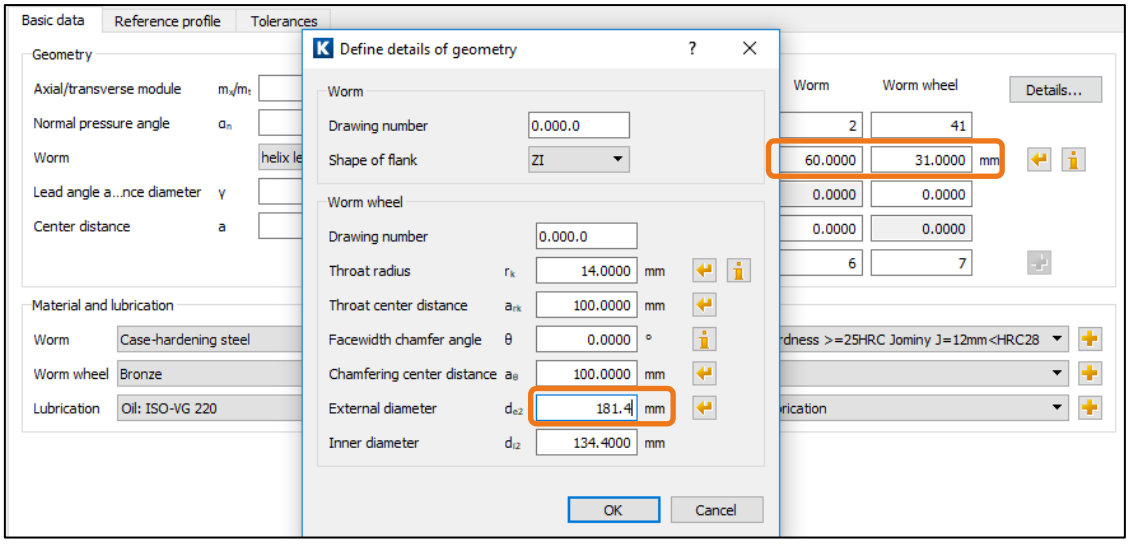

Figure 14. Final inputs

These are the results of the calculation.

2 Strength calculation

The various different calculation methods are documented in the manual (Chapter 16). Please refer to the notes if you have any questions. To open the prepared example used in this tutorial, click «File→Open» and select «WormGear 1 (DIN3996 Example 1)».

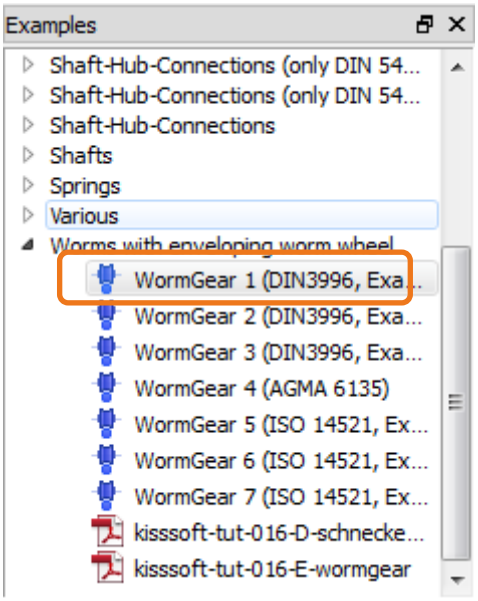

Figure 15. Opening the example calculation

2.1 Results of the rating and geometry calculation

Name : WormGear 1 (DIN3996, Example 1)
Description: KISSsoft example
Changed by: KISSsoft AG on: 15.05.2019 at: 13:38:57

Worm analysis

Drawing or article number:
Worm: 0.000.0
Worm wheel: 0.000.0

Calculation method DIN 3996:2012
Geometry: DIN 3975:2002
Geometry calculation from axial module

		------- Worm	---------- Worm wheel ----
Worm driving			
Working flank gear 1: Right flank			
Power (kW)	[P]	5.302	4.500
Speed (1/min)	[n]	1500.0	73.2
Torque (Nm)	[T]	33.754	587.282
Application factor	[KA]	1.00	
Required service life	[H]	25000.00	
Number of starts (1/h)	[Ns]	0.00	

Tooth geometry and material

Shape of flank: ZI (ISO/TR 10828:2015)

		------- Worm	--------- Worm wheel ----
Center distance (mm)	[a]	100.000	
Center distance tolerance	ISO 286:2010 Measure js7		
Shaft angle (°)	[σ]	90.0000	
Transverse module (mm)	[mt]	4.0000	
Normal module (mm)	[mn]	3.9047	
Axial module (mm)	[mx]	4.0000	
Normal pressure angle (°)	[αn]	20.0000	
Mean lead angle (°)	[γ]	12.5288	
Hand of gear		left	left
Number of teeth	[z]	2	41
Facewidth (mm)	[b1]	60.00	
Worm wheel rim width b2R (mm)	[b2R]	31.00	
Worm gear wheel width b2H (mm)	[b2H]	31.00	
Facewidth for calculation (mm)	[b1, b2]	60.00	30.83
Accuracy grade (manufacturing)	[Vqual]	6	7
Internal diameter gearbody (mm)	[di]	0.00	134.40

Material
Worm 16 MnCr 5 (1), Case-carburized steel, case-hardened
ISO 6336-5 Figure 9/10 (MQ), Core hardness >=25HRC
Jominy J=12mm<HRC28
Worm wheel CuSn12Ni2-C-GZ, Bronze, untreated
DIN 3996:2005

	------- Worm	--------- Worm wheel ----

Surface hardness		HRC 59	HBW 95
Pulsating shear strength (N/mm²)	[τFlim]	430.00	90.00
Fatigue strength for Hertzian pressure (N/mm²)	[σHlim]	1500.00	520.00
Material Coefficient YW	[YW]	0.95	
Material lubrication coefficient	[WML_PolyG]	1.75	
Tensile strength (N/mm²)	[σB]	1000.00	300.00
Yield point (N/mm²)	[σS]	695.00	180.00
Young's modulus (N/mm²)	[E]	206000	98100
Poisson's ratio	[v]	0.300	0.350
Roughness average value DS, flank (µm)	[RAH]	0.50	2.00
Roughness average value DS, root (µm)	[RAF]	0.50	2.00
Mean roughness height, Rz, flank (µm)	[RZH]	3.00	8.00
Mean roughness height, Rz, root (µm)	[RZF]	3.00	8.00

Gear reference profile 1 :

Reference profile	1.20 / 0.20 / 1.0 DIN 867:1986	
Dedendum coefficient	[hfP*]	1.200
Root radius factor	[ρfP*]	0.200 (ρfPmax*= 0.498)
Addendum coefficient	[haP*]	1.000
Tip radius factor	[ρaP*]	0.000
Protuberance height coefficient	[hprP*]	0.000
Protuberance angle	[αprP]	0.000
Tip form height coefficient	[hFaP*]	0.000
Ramp angle	[αKP]	0.000
	not topping	

Gear reference profile 2 :

Reference profile	1.20 / 0.20 / 1.0 DIN 867:1986	
Dedendum coefficient	[hfP*]	1.200
Root radius factor	[ρfP*]	0.200 (ρfPmax*= 0.498)
Addendum coefficient	[haP*]	1.000
Tip radius factor	[ρaP*]	0.000
Protuberance height coefficient	[hprP*]	0.000
Protuberance angle	[αprP]	0.000
Tip form height coefficient	[hFaP*]	0.000
Ramp angle	[αKP]	0.000
	not topping	

Summary of reference profile gears:

Dedendum reference profile	[hfP*]	1.200	1.200
Tooth root radius Refer. profile	[ρfP*]	0.200	0.200
Addendum Reference profile	[haP*]	1.000	1.000
Protuberance height coefficient	[hprP*]	0.000	0.000
Protuberance angle (°)	[αprP]	0.000	0.000
Tip form height coefficient	[hFaP*]	0.000	0.000
Ramp angle (°)	[αKP]	0.000	0.000

Type of profile modification:	none (only running-in)	
Tip relief by running in (µm)	[Ca L/R]	0.0 / 0.0 0.0 / 0.0

Lubrication type		Oil bath lubrication
Oil grade, Own Input		Öl: ISO-VG 220
Lubricant base		Synthetic oil based on Polyglycol
Oil nominal kinematic viscosity at 40°C (mm²/s)	[v40]	220.00
Oil nominal kinematic viscosity at 100°C (mm²/s)	[v100]	37.00
Specific density at 15°C (kg/dm³)	[ρ]	1.020
Oil temperature (°C)	[TS]	73.226
Ambient temperature (°C)	[TU]	20.000

		------- Worm --------- Worm wheel ----
Generating angle (°)	[α0]	20.000
Normal pressure angle (°)	[αn]	20.000

Details for manufacturing the worm wheel according to ISO 14521:
Only valid for worm wheels that were manufactured using a cutter that is similar to a worm.

Mean lead angle of the worm (°)	[γ]	12.5288
Transverse module (mm)	[mt]	4.0000
Reference diameter (mm)	[d]	164.000
Reference operating diameter	(mm)	[dm] 164.000
Throat radius (mm)	[rk]	14.000
Throat center distance (mm)	[ark]	100.000
Facewidth chamfer angle (°)	[θ]	0.0000
Chamfering center distance (mm)	[aθ]	100.000
External diameter (mm)	[de]	181.410
Tip diameter (mm)	[da]	172.000
Profile shift coefficient	[x-worm]	0.0000
Transverse pitch (mm)	[pt]	12.566

Values for manufacturing the worm wheel as a cylindrical gear or for mold making:
These values are only intended to be an indication. Use the crossed helical gear calculation to calculate the exact geometry!

Transverse pressure angle (°)	[αt]	(59.205)	20.448
Axial pressure angle (°)	[αχ]	(20.448)	59.205
Helix angle at reference circle (°)	[β]	(77.471)	12.529
Lead angle at reference diameter (°)	[γ]	(12.529)	77.471
Transverse module (mm)	[mt]	(18.000)	4.000
Axial module (mm)	[mx]	(4.000)	18.000
Helix angle at operating pitch circle (°)	[βs]	(77.471)	12.529
Operating pitch diameter (mm)	[dw]	(36.000)	164.000
Profile shift coefficient	[x-DIN3960]	(0.0000)	0.0000

Overall transmission ratio	[itot]	-20.500	
Gear ratio	[u]	20.500	
Base helix angle (°)	[βb]	11.762	
Reference center distance (mm)	[ad]	100.000	
Diametral factor q	[q]	9.000	
Sum of profile shift coefficients	[Σxi]	0.0000	
Profile shift coefficient	[x-worm]	0.0000	0.0000
Profile shift (x*m) (mm)	[x*mx]	0.0000	0.0000

The profile shift is related to the axial module of the worm subject to ISO TR 14521:2010/DIN 3975:2002..

Tip alteration (mm)	[k*mn]	0.000	0.000
Theoretical tip clearance (mm)	[c]	0.800	0.800
Effective tip clearance (mm)	[c.e/i]	1.059 / 0.963	0.877 / 0.782

Reference operating diameter	(mm)	[dm]	36.000	164.000
Reference diameter (mm)	[d]		164.000	
Base diameter (mm)	[db]		153.666	
Tip diameter (mm)	[da]	44.000	172.000	
Tip form diameter (mm)	[dFa]	44.000	172.000	
(mm)	[dFa.e/i]	44.000 /43.990	172.000 /	171.990
Tip diameter allowances (mm)	[Ada.e/i]	0.000 /-0.010	0.000 /-0.010	
Root diameter (mm)	[df]	26.400	154.400	
Generating Profile shift coefficient	[xE.e/i]		-0.0450/	-0.0591
Manufactured root diameter with xE (mm)	[df.e/i]	26.400 /26.290	154.040 /	153.927

Lead height (mm)	[pz]	25.133
Axial pitch (mm)	[px]	12.566
Transverse contact ratio (guide value in accordance with Thomas-Charchut)		
	[εα]	1.911

For ZI-worms:		
Base diameter (mm)	[db]	18.431
Base lead angle (°)	[γb]	23.463
Base pitch (mm)	[pb]	11.527

General influence factors

		------- Worm	--------- Worm wheel ----	
Nominal circum. force at pitch circle (N)	[Ft]	1875.2	7162.0	
Axial force (N)	[Fa]	-7162.0	-1875.2	
Radial force (N)	[Fr]	2847.3	-2847.3	
Normal force (N)	[Fn]	8343.7		
Circumferential speed reference circle (m/s)	[v]	2.827	0.628	
Sliding velocity an mean circle (m/s)	[vgm]		2.896	
Number of load cycles (in mio.)	[NL]	2249.999	109.756	

Data of reference gearbox:				
Equivalent Young's modulus (N/mm²)	[EredT]	150622.00		
Surface roughness of worm (µm)	[RaT]	0.500		
Center distance (mm)	[aT]	100.000		
Transmission ratio	[uT]	20.500		
Reference operating diameter	(mm)	[dm1T]	36.000	164.000
Characteristic value for mean Hertzian pressure	[pmT*]	0.962		
Characteristic value for mean lubricant gap thickness	[hT*]	0.070		
Characteristic value for mean sliding path	[sT*]	30.800		

Physical characteristic values:		
Characteristic value for mean lubrication Space width	[h*]	0.0692
Characteristic value for mean Hertzian pressure	[pm*]	0.9470
Characteristic value for mean sliding path	[s*]	30.2850

Efficiency according method C:		
Rolling bearing with set support		
Bearing loss-power (kW)	[PVLP]	0.126
Number of sealing gaskets (integral worm shaft)	[nVD]	2
Sealing power loss (kW)	[PVD]	0.046
Idle power loss (kW)	[PV0]	0.153
Base friction number	[µOT]	0.0245
Size factor	[YS]	1.000
Geometry factor	[YG]	1.006

Roughness factor	[YR]	1.000
Material Coefficient YW	[YW]	0.950
Mean tooth friction number	[µzm]	0.0234
Tooth friction angle (°)	[ρz]	1.341
Meshing power loss (kW)	[PVZ]	0.477
Meshing efficiency (%)	[ηz]	90.002
Total power loss (kW)	[PV]	0.802
Total efficiency (%)	[ηGes]	84.872

Gear mass temperature:		
Lubrication type	Oil bath lubrication	
Worm submerges into lubricant		
Cooling area of wheel-pair (cm²)	[AR]	50.840
Heat-transfer coefficient wheels (W/m²/K)	[αL]	24439.990
Gear mass temperature (°C)	[θM]	77.1
Oil sump temperature (°C)	[θS]	73.2

Wear strength according method B,C

Mean lubricant gap thickness (µm)	[hminm]	0.2480
h_{minm} calculated with ηOM= 0.0642 Ns/m², θM= 77.1 °		
Pressure factor	[WH]	1.0000
Factor for lubricant structure	[WS]	2.6140
Factor for start	[WNS]	1.0000
Characteristic value	[Kw]	0.6484
Wear intensity	[JOT]	5.10181e-10
Wear intensity	[Jw]	8.92817e-10
Wear path (m)	[sWm]	815829
Wear removal (mm)	[δWn]	0.728
Permissible tooth thickness reduction (coefficient in module)	[ΔS]	0.300
Permissible mass decrease (kg)		
Normal tooth thickness at tip circle (mm)	[san]	2.907
(mm)	[san.e/i]	2.778 / 2.731
Permissible wear on flank (mm)	[δWlimn]	1.171
Limited by: Permissible tooth thickness decrease		
Safety against wear	[SW]	1.608
Required safety	[SWmin]	1.100
As information:		
Achievable service life (with SW) = 1.100 (h)	[Lh]	36551.07

Pitting resistance according to Method B or C

		------- Worm ---------	Worm wheel ----
Equivalent Young's modulus (N/mm²)	[Ered]	149673.38	
Mean contact stress (N/mm²)	[σHm]	367.36	
Life coefficient	[Zh]	1.000	
Speed factor	[ZV]	0.851	
Size factor	[ZS]	1.000	
Lubrication factor	[Zoil]	1.000	
Ratio factor	[Zu]	1.000	
Boundary value of average contact stress (N/mm²)	[σHG]	442.766	
Safety factor for contact stress	[SH]	1.205	

Required safety	[SHmin]	1.000
As information:		
Achievable service life (with SHmin) = 1.000 (h)	[Lh]	76640.67

Deflection safety

Bearing distance l1 (mm)	[l1]	150.000
Distance l11 (mm)	[l11]	75.000
Deflection (mm)	[δm]	0.030
Boundary value bending (mm)	[δlim]	0.080
Safety for deflection	[Sδ]	2.632
Required safety	[Sδmin]	1.000

Tooth root load capability according to Method C

		------- Worm --------- Worm wheel ----
Calculation takes into account the decrease in tooth-thickness due to wear with minimum, δWn, δWlimn		
Tooth thickness at root (mm)	[sft2]	9.663
Tooth form factor	[YF2]	1.200
Contact ratio factor	[Yε]	0.500
Lead coefficient	[Yγ]	1.024
Rim thickness (mm)	[sk2]	10.000
Rim thickness coefficient	[YK2]	1.000
Nominal shear stress at tooth root (N/mm²)	[τF2]	35.51
No Quality reduction by small plastic deformation is accepted.		
Life coefficient	[YNL]	1.000
Boundary value of shear stress at tooth root (N/mm²)	[τFG]	90.00
Safety for tooth root stress	[SF]	2.534
Required safety	[SFmin]	1.100

Temperature safety according to Method C

Housing with cooler		
Ambient temperature (°C)	[TU]	20.0
Oil temperature (°C)	[θOil]	73.2
Boundary value oil temperature (°C)	[θSlim]	100.0
Temperature safety	[ST=θSlim/θOil]	1.366
Required safety	[STmin]	1.100
Oil sump temperature (°C)	[θS]	73.2
Safety	[θSlim/θS]	1.366

Allowances for tooth thickness

Tooth thickness deviation	
Worm:	Own Input
Worm wheel:	Own Input

		------- Worm --------- Worm wheel ----
Tooth thickness allowance (normal section) (mm)	[As.e/i]	0.000 /-0.040 -0.128 /-0.168
Backlash free center distance (mm)	[aControl]	99.820 / 99.707
Backlash free center distance, allowances (mm)	[jta]	-0.180 /-0.293

Number of teeth spanned	[k]		5.000
Base tangent length (mm)	[Wk]		54.275
Actual base tangent length ('span') (mm)	[Wk.e/i]		54.155 /54.117
Diameter of measuring circle (mm)	[dMWk.m]		162.549

Base tangent length (span): Can only be measured, if the worm-wheel is manufactured like a cylindrical gear!

Theoretical diameter of ball/pin (mm)	[dm]	6.565	6.615
Effective diameter of ball/pin (mm)	[DMeff]	7.000	7.000
Radial single-ball measurement backlash free (mm)	[MrK]		87.190
Radial single-ball measurement (mm)	[MrK.e/i]		87.034 /86.985
Diameter of measuring circle (mm)	[dMMr.m]	37.166	164.455
Diametral measurement over two balls without clearance (mm)		[MdK]	174.257
Diametral two ball measure (mm)	[MdK.e/i]		173.946 /173.848

Theoretical dim. over 3 wires (mm)	[Md3R]	46.559
Measurement over 3 pins (mm)	[Md3R.e/i]	46.559 /46.452

Normal tooth thickness (chord) in the reference circle (mm)			
	[sc]	6.133	6.132
(mm)	[sc.e/i]	6.133 /6.093	6.003 /5.962
Tooth thickness in the transverse section (chord) in the reference circle (mm)			
	['st]	6.282	
(mm)	['st.e/i]	6.151 /6.110	
Tooth thickness in the transverse section (chord) in the reference circle (mm)			
	[st]	6.283	
(mm)	[st.e/i]	6.152 /6.111	
Tooth thickness on axial cut (mm)	[smx]	6.283	
(mm)	[smx.e/i]	6.283 /6.242	
Tooth space in axial cut (mm)	[emx]	6.283	
(mm)	[emx.e/i]	6.283 /6.324	
Reference chordal height from da.m (mm)	[ham1, ha2]	3.997	4.052

Center distance allowances (mm)	[Aa.e/i]	0.018 /-0.018
Circumferential backlash, transverse section (mm)	[jt]	0.226 /0.118
Normal backlash (mm)	[jn]	0.207 /0.108
Angle of rotation on input with fixed output.:		
Entire torsional angle (°)	[j.tSys]	3.2390/ 1.6913

Toothing tolerances

		------- Worm ---------	Worm wheel ----
According to	DIN 3974:1995:		
Accuracy grade	[Vqual]	6	7
Single pitch deviation (µm)	[fpx, fp2]	8.50	13.00
Adjacent pitch difference (µm)	[fux, fu2]	11.00	16.00
Total deviation of the slope (µm)	[Fpz]	11.00	
Total cumulative pitch deviation (µm)	[Fp2]		51.00
Profile slope deviation (µm)	[fHα]	7.50	11.00
Profile form deviation (µm)	[ffα]	11.00	15.00
Total profile deviation (µm)	[Fα]	13.00	19.00
Runout (µm)	[Fr]	18.00	35.00
Single flank composite, total (µm)	[Fi']	29.00	56.00
Single flank composite, tooth-to-tooth (µm)	[fi']	15.00	22.00

Supplementary data

Weight - calculated with da (kg)	[Mass]	0.456	1.812
Start under load:			
Tooth friction number, acc. to Niemann	[µzmS]	0.140	
Torque (Nm)	[T1S]	48.195	587.282

Service life, damage

Required safety for tooth root	[SFmin]	1.10	
Required safety for tooth flank	[SHmin]	1.00	
Service life (calculated with required safeties):			
System service life (h)	[Hatt]	36551	
Tooth root service life (h)	[HFatt]	1e+06	1e+06
Tooth flank service life (h)	[HHatt]	1e+06	7.665e+04

Note: The entry 1e+006 h means that the Service life > 1,000,000 h.

Damage calculated on the basis of the required service life [H] (25000.0 h)

F1%	F2%	H1%	H2%
0.00	0.0000	0.0000	32.6166

Damage calculated on basis of system service life [Hatt] (36551.1 h)

F1%	F2%	H1%	H2%
0.00	0.0000	0.0000	47.6869

Calculation of the factors required to define reliability R(t) according to B. Bertsche with Weibull distribution; t in (h):

R(t) = 100 * Exp(-((t*fac - t0)/(T - t0))^b) %

Gear		fac	b	t0	T	R(H)%
1	Tooth root	90000	1.7	9.654e+29	1.484e+30	100.00
1	Tooth flank	90000	1.3	9.014e+29	4.295e+30	100.00
2	Tooth root	4390	1.7	9.654e+29	1.484e+30	100.00
2	Tooth flank	4390	1.3	3.033e+08	1.445e+09	100.00

Reliability of the configuration for required service life (%)100.00 (Bertsche)

Remarks:
- Specifications with [.e/i] imply: Maximum [e] and minimum value [i] for
taking all tolerances into account
The value entered for the circumferential backlash, and the center distance without backlash,
used to verify the tooth thickness has not yet been investigated exactly.
It is only to be used as an indication.
The details of the normal chordal tooth thickness are imprecise and merely an indication.
The calculation is performed according to ISO TR 14521:2010/DIN 3975:2002, without taking the exact shape of flank into account.
- ISO 14521 and DIN 3996 do not always provide the necessary data for every material.
In these cases, this message is displayed:
"Not calculated: material data missing"'

End of Report lines: 442