EES KISSsoft GmbH
P.O. Box 121
Weid 10
6313 Menzingen
Switzerland

++41 41 755 09 54 (Phone)
++41 41 755 09 48 (Fax)
++41 79 372 64 89 (Mobile)
h.dinner@EES-KISSsoft.ch
www.EES-KISSsoft.ch

KISSsoft for high speed gearing

1 Calculation of gears in KISSsoft 10-2008 following AGMA6011-I03

1.1 Executive summary

AGMA6011 "Specification for High Speed Helical Gear Units" is a standard covering different aspects of high speed gearboxes as gear rating, but also as lubrication, vibrations, testing.
The chapter about gear rating is very short and refers basically to the specific AGMA standard for gear rating, which is AGMA 2101 (metric) or AGMA 2001 (imperial).
This technical report describes how a gear rating has to be performed using KISSsoft, using AGMA 2101 or 2001, when respecting the restrictions given in AGMA6011.
When you follow all the restrictions, as explained here, then the gear rating is performed exactly as required by AGMA6011.
You find an example in the annex showing a comparison between an example documented in AGMA6011 and the corresponding results when using KISSsoft. The results correspond very well.
Instructions written by Dr. Kissling, KISSsoft AG

1.2 Table of content

1.3 Document change record

Revision	Dated	Who	Comments
0	10.3.09	HD	Original document

1.4 Abbreviations

[ ]	Units

1.5 References

[1] ANSI/AGMA6011-I03, Specification for High Speed Helical Gear Units
[2] KISSsoft 10-2008

2 Set up calculation in KISSsoft

2.1 Calculation method:

Use AGMA2101-D04 (metric) or AGMA2001-C95 (imperial) as shown below.
Note : proposed by AGMA6011 is AGMA2101-C95 which is identical to AGMA2101-D04

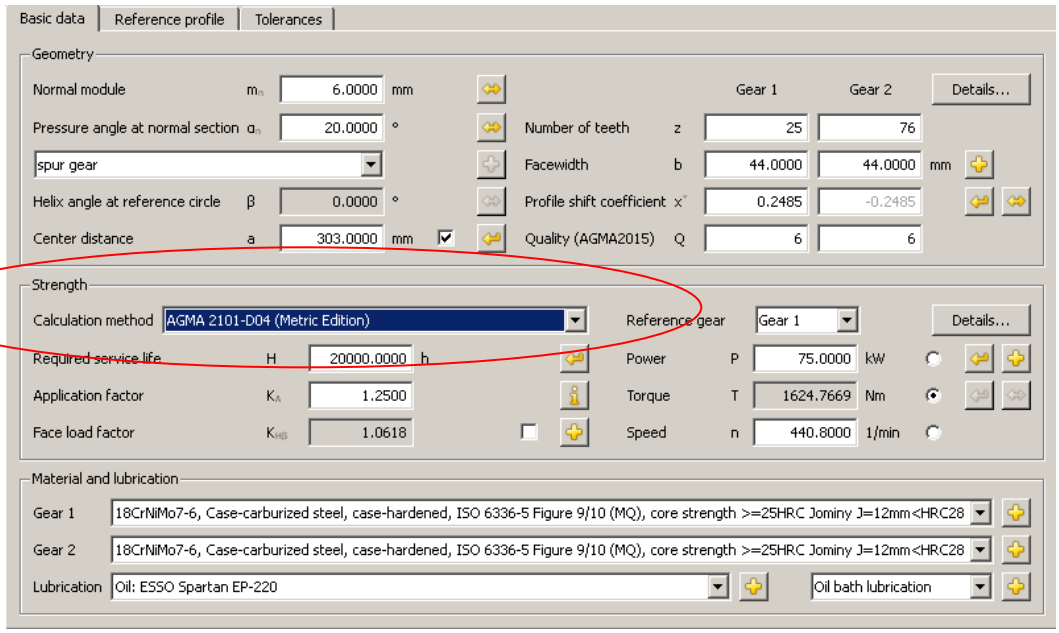

Figure 2-1 Select calculation method

2.2 Lifetime and application factor

Define required service life and application factor as shown below:

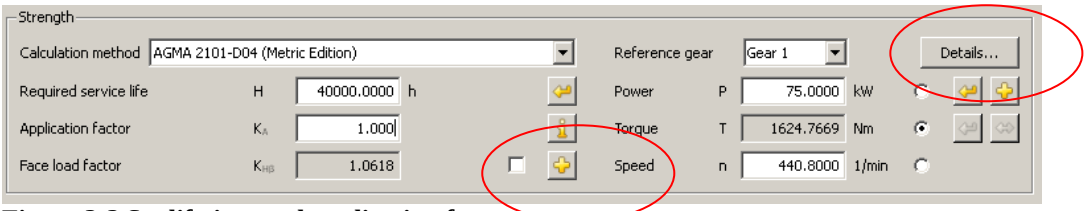

Figure 2-2 Set lifetime and application factor

2.3 Face load distribution factor:

For calculation of face load distribution factor, set data using  (see marking in figure above) as follows:

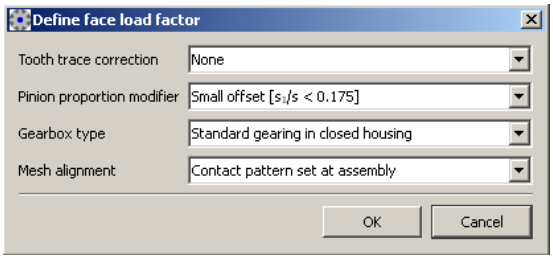

Figure 2-3 Parameters for calculation of face load distribution factor

Check that: KHb >= 1.10 !

2.4 Data in button Details

Press button “Details” as shown in Figure 2-2. Enter Kv value (dynamic factor) manually. Use values as shown in table from AGMA6011:

ANSI/AGMA 2015-1-A01 accuracy grade	Dynamic factor, K_v
A5	1.15
A4	1.13
A3	1.11
A2	1.09

Figure 2-4 Values for Kv to be used along AGMA6011

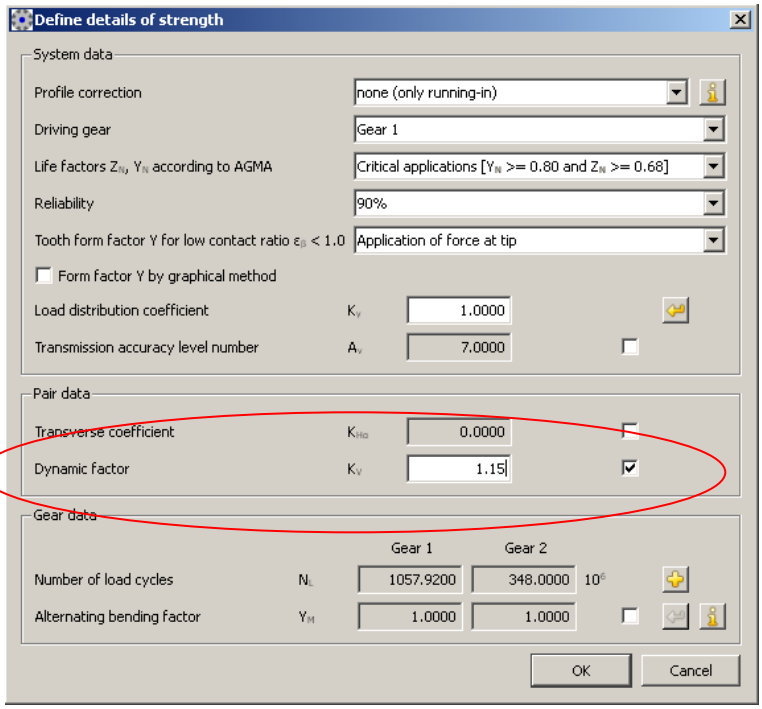

Figure 2-5 Enter Kv value as per table above

2.5 Required service factors as recommended in AGMA6011, Annex A

See in the annex A, table A.1 for recommended Service factors KSF (bending) and CSF (pitting) for the specific application. See Figure 2-6 and Figure 2-7.

Important : In KISSsoft we recommend to introduce KSF and CSF as required safety factors. Note that you must introduce the required service factor for bending as KSF, $SF_{\min} = KSF$, and the required safety factor for pitting as square root of CSF, $SH_{\min} = \sqrt{CSF}$.

Table A.1 - Service factors, C_{SF} and K_{SF}

Application	Service factor, with prime mover			
	Synchronous motors	Induction motors	Gas or steam turbine[1)]	Internal combustion engine (multi-cylinder)
Blowers				
Centrifugal	1.7	1.4	1.6	1.7
Lobe	2.0	1.7	1.7	2.0
Compressors				
Centrifugal				
process gas, except air conditioning	1.6	1.4	1.6	1.6
air conditioning service	1.6	1.2	1.4	1.6
air or pipe line service	1.7	1.4	1.6	1.7
Rotary				
axial flow - all types	1.7	1.7	1.7	1.7
liquid piston (Nash)	2.0	1.7	1.7	2.0
lobe - radial flow	2.0	1.7	1.7	2.0
Reciprocating				
3 or more cylinders	2.0	2.0	2.0	2.0
2 cylinders	2.3	2.0	2.0	2.3
Dynamometer - test stand	1.3	1.1	1.1	1.3
Fans				
Centrifugal	1.7	1.4	1.6	1.7
Forced draft	1.7	1.4	1.6	1.7
Induced draft	2.2	1.7	2.0	2.2
Industrial and mine (large with frequent starts)	2.2	1.7	2.0	2.2
Generators and exciters				
Base load or continuous	1.4	1.3	1.3	1.4
Peak duty cycle	1.7	1.4	1.4	1.7

Figure 2-6 Recommended service/safety factors, part I

Table A.1 *(concluded)*

Application	Service factor, with prime mover			
	Synchronous motors	Induction motors	Gas or steam turbine[1)]	Internal combustion engine (multi-cylinder)
Paper industry				
Jordan or refiner	--	--	1.5	--
Paper machine - line shaft	--	--	1.3	--
Pumps				
Centrifugal (all service except as listed below)	1.7	1.3	1.5	1.7
Centrifugal				
boiler feed	--	1.7	2.0	--
descaling (with surge tank)	--	2.0	2.0	--
hot oil	--	1.7	2.0	--
pipe line	2.0	1.5	1.7	2.0
water works	2.0	1.5	1.7	2.0
Reciprocating				
3 or more cylinders	2.0	2.0	1.7	2.0
2 cylinders	2.0	2.0	2.0	2.0
Rotary				
axial flow - all types	1.8	1.5	1.5	1.8
gear type	1.8	1.5	1.5	1.8
liquid piston	2.0	1.7	1.7	2.0
lobe	2.0	1.7	1.7	2.0
sliding vane	1.8	1.5	1.5	1.8
Sugar industry				
Cane knives	1.8	--	1.5	1.8
Crushers	2.0	--	1.7	2.0
Mills	2.3	--	1.7	2.3

NOTES:
1) Gas turbines seldom operate at full design power while steam turbines often operate at or above rated power. Appropriate design considerations should be made to assure adequate torque capacity.

Figure 2-7 Recommended service/safety factors, part II

Enter required service / safety factors through module specific settings. In module specific settings, go to tab “Required safeties”. You may want to switch off the option “Safeties depending on size” as turbo gears typically have mn>2.00mm

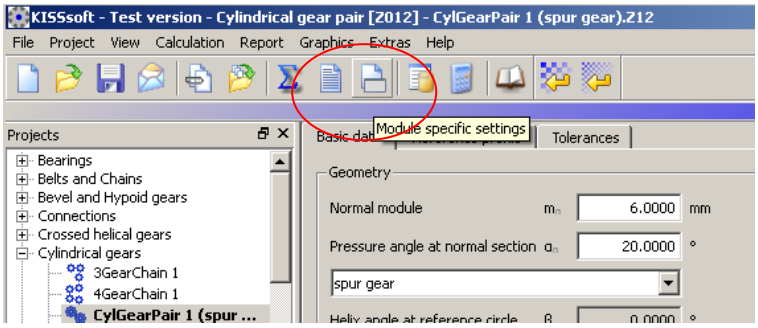

Figure 2-8 Go to module specific settings menu

For example, let be KSF=CSF=1.4 . Then, introduce the required safety factors as shown in figure below.

Remember: Introduce the required service factor for bending as KSF, $SF_{\min} = KSF$ but required safety factor for pitting as square root of CSF, $SH_{\min} = \sqrt{CSF}$.

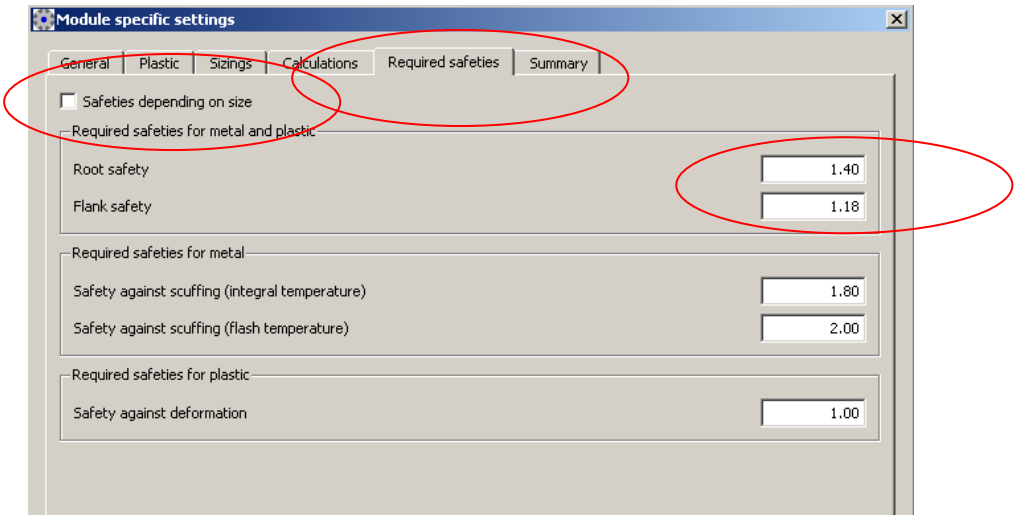

Figure 2-9 Enter values for required safety factors

3 Verification

3.1 Summary, for example 1 in AGMA6011 in Annexe E

Below, a comparison between KISSsoft 10-2008 and the calculation example as shown in AGMA6011 is documented.

	As in AGMA example	Calculated by KISSsoft	
Small difference between KHb as given in the example and calculated by KISSsoft	1.2648	1.301	Calculation by hand shows KHb = 1.3. Error in the AGMA example.
Main result	3311 kW	3222 kW	Small difference, because of the difference in KHb

Figure 3-1 Results and comparison summary

KISSsoft

```
Bending strength power rating (hp)  [Patu,Payu]     6239.97(4653.12 kW)   6049.97(4511.43 kW)
Pitting resistance power rating (hp)   [Pacu,Pazu]  6725.91(5015.48 kW)    6079.15(4533.19
kW)


SERVICE FACTORS:
Service factor for tooth root           [KSF]                1.86                1.80
Service factor for pitting              [CSF]                2.01                1.81
Service factor for gear set             [SF]                          1.80

Required service factors for bending    [KSF]                          1.40
Required service factors for pitting    [CSF]                          1.39
Transmittable power including required service factors (hp)        4321.41(3222.45 kW)
```

AGMA

```
Bending strength power rating (hp)  [Patu,Payu]           4782 kW          4657 kW
Pitting resistance power rating (hp)   [Pacu,Pazu]        5163 kW          4635 kW

Transmittable power including required service factors (hp)        4440 (3311 kW)
```

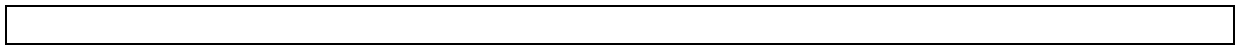

Figure 3-2 Detailed results comparison

3.2 Summary, for example 3 in AGMA6011 in Annexe E

Below, a comparison between KISSsoft 10-2008 and the calculation example as shown in AGMA6011 is documented.

	As in AGMA example	Calculated by KISSsoft	
No difference in KHb as in example 1	1.2369	1.2369	
Geometry (protuberance) is not completely defined; small differences in YJ1, YJ2 and ZI	YJ1=0.4722 YJ2=0.4861 ZI=0.1730	YJ1=0.463 YJ2=0.477 ZI=0.170	
Main result	17240 kW	17003 kW	Small difference, because of the difference in geometry factors

Figure 3-3 Results and comparison summary

KISSsoft

```
Bending strength power rating (hp)  [Patu,Payu]  29642.95(22104.60 kW)   31342.55(23371.98
kW)
Pitting resistance power rating (hp) [Pacu,Pazu] 34304.36(25580.59 kW)   37625.46(28057.12
kW)


SERVICE FACTORS:
Service factor for tooth root           [KSF]                1.47               1.56
Service factor for pitting              [CSF]                1.71               1.87
Service factor for gear set             [SF]                           1.47

Required service factors for bending    [KSF]                          1.30
Required service factors for pitting    [CSF]                          1.30
Transmittable power including required service factors (hp)        22802.27(17003.54 kW)
```

AGMA

```
Bending strength power rating (hp)  [Patu,Payu]          22410 kW         23690 kW
Pitting resistance power rating (hp)   [Pacu,Pazu]       26060 kW         28580 kW

Transmittable power including required service factors (hp)         17240 kW
```

Figure 3-4 Detailed results comparison