

MESYS Tutorial: Single Cylindrical Gear 01

1 Introduction

1.1 Use case

In this tutorial, the geometry calculation for a single cylindrical gear is used. The following aspects are considered

- Helix angle and pressure angle.
- Tooth thickness allowances, tip circle diameter tolerances.
- Tip alteration and tip chamfer.
- Reference profile.
- Calculation of profile shift from inspection measurements.

1.2 Objective

Tutorial	Property
Suitable for	Getting started.
Prerequisites	MESYS license (test license, commercial license).
Learning objectives	Get to know gear geometry inputs. Apply conversions of geometry values. Know geometry data in the report.
File	MESYS-Tutorial-Cyl_gear_single_01-v2500.mSCG.

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1.4 Task

Step	Task
1	Start MESYS, cylindrical gear data input. Running the calculation, arranging graphics, creating report, exporting gear geometry.
2	Influence of profile shift on tooth form. Converting profile shift. Generating profile shift and tooth thickness.
3	Setting tooth height. Adjusting pressure angle. Maximizing root fillet.
4	Calculate tip alteration.
5	Create tip chamfer. Calculate inspection measurements.
6	Gear geometry definition via reference profile input, hob definition and shaper cutter input.

2 Implementation, Step 1

2.1 Starting MESYS and Settings

Start MESYS by double-clicking the file *MesysSingleCylindricalGear64.exe*. The file is in the installation directory, typically in *C:\Programs\MESYS 12-2025*. This starts with the single cylindrical gear calculation.



Figure 2-1 Start of the gear calculation via the corresponding *.exe in the installation directory.

The language is selected in the menu *Extras/Language*.

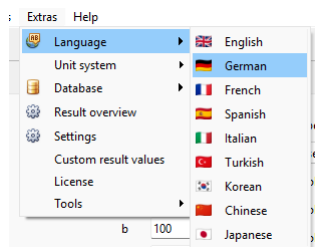


Figure 2-2 Language selection.

In *Extras/Settings* contains relevant predefined settings that are self-explanatory. The selection *Show all messages* should be selected so that, especially at the beginning of using MESYS, errors, warnings, and information are noticed.

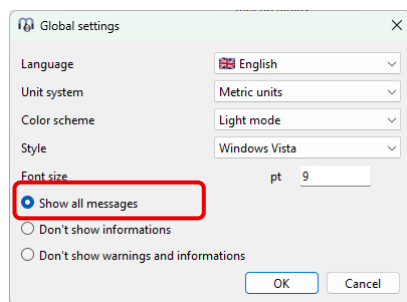


Figure 2-3 *Extras/Settings* with default settings.

In the tab *General*, fields *Project name* and *Calculation description* are freely annotated.

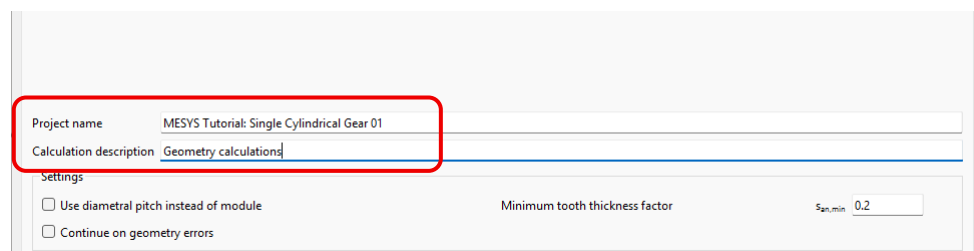


Figure 2-4 Tab *General*, *Project name* and *Calculation description*.

2.2 Entering known data

The following data is known

Normal module $m_n = 10.00$ mm

Number of teeth $z = 37$

Face width $b = 100.00$ mm

Normal pressure angle $\alpha = 20.00^\circ$

Helix angle $\beta = 15^\circ$, left

Inner diameter $d_i = 140.00$ mm

In the tab *Geometry*, the above is entered as follows. To enter the helix direction, press the «+» button at the *Helix angle*.

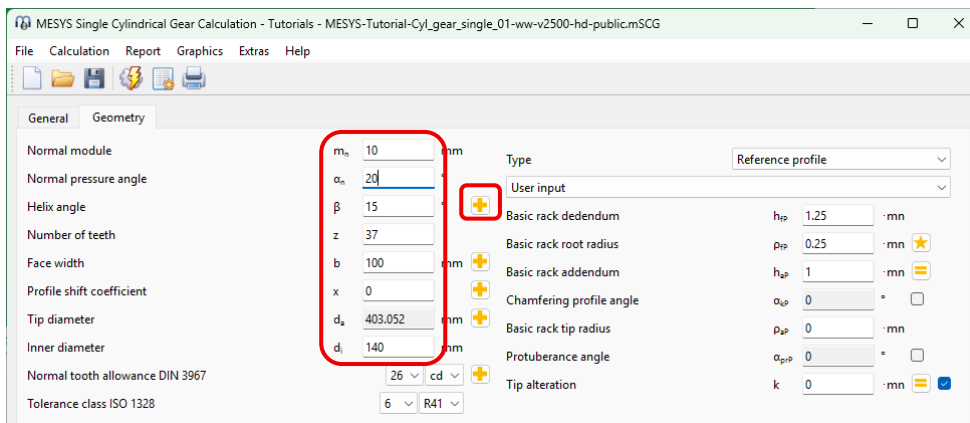


Figure 2-5 Entering the given data. «+» button at the *Helix angle* to enter the helix direction.

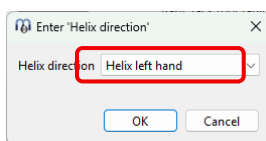


Figure 2-6 Helix direction selection.

2.3 Running the calculation

The calculation can be started in various ways

- Press keyboard shortcut F5.
- Press button, see figure below.
- menu *Calculation/Calculate* select, see second figure below.

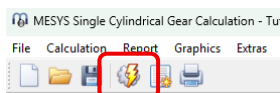


Figure 2-7 Button for running the calculation.

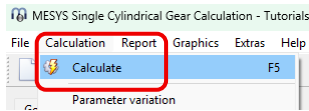


Figure 2-8 menu *Calculation/Calculate* for running the calculation.

Calculation messages are displayed in the *Messages* window. No messages occurred in this calculation; the window is empty.

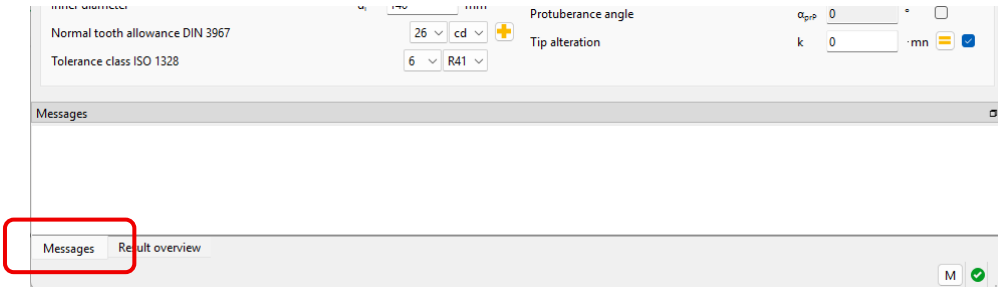


Figure 2-9 window *Messages*.

In the window *Result overview* are relevant results output.

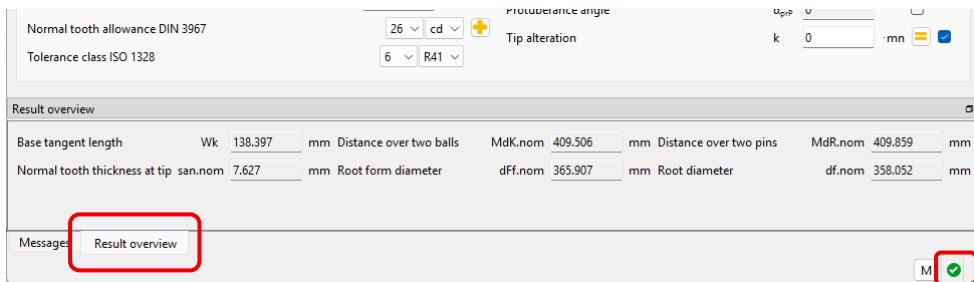


Figure 2-10 window *Results overview*.

At the bottom right is the display *Results are valid*. If it is green, this means that the results in the *Results overview* are consistent with the inputs. If the input is changed, it switches to yellow. This means that input and results are no longer necessarily consistent.

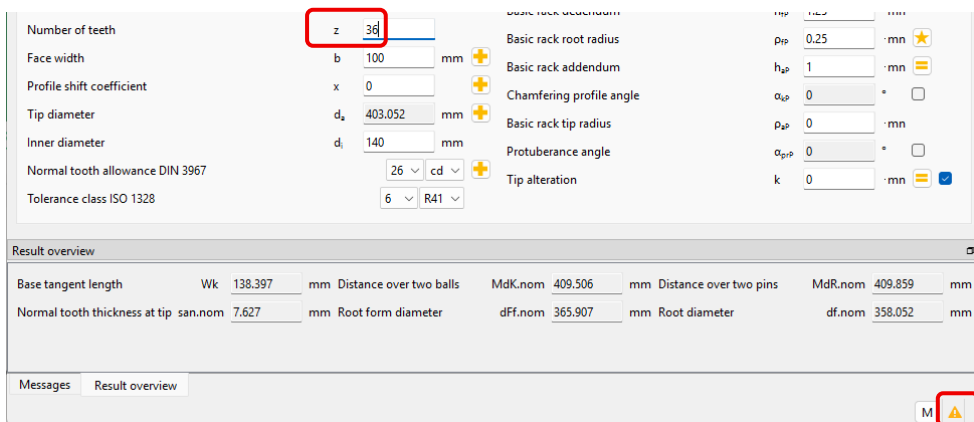


Figure 2-11 Changed input, original results are retained, display *Results are valid* switches to yellow.

When the input is set back to $z = 37$ and the calculation is run again, the consistent state is restored.

2.4 Report output

The calculation report documents the inputs, intermediate values and results. It is generated as a *.pdf file and displayed as such. It can be accessed in three ways

- Press keyboard shortcut F6.
- Press button, see figure below.
- menu *Report/Show report* select, see second figure below.

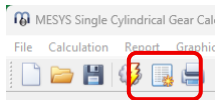


Figure 2-12 Button for generating the report.

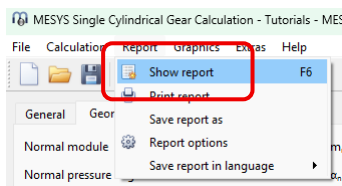


Figure 2-13 menu *Report/Show report* for generating the report.

The report is opened in the *.pdf viewer. Specific results can be found using the search function, Ctrl + F.

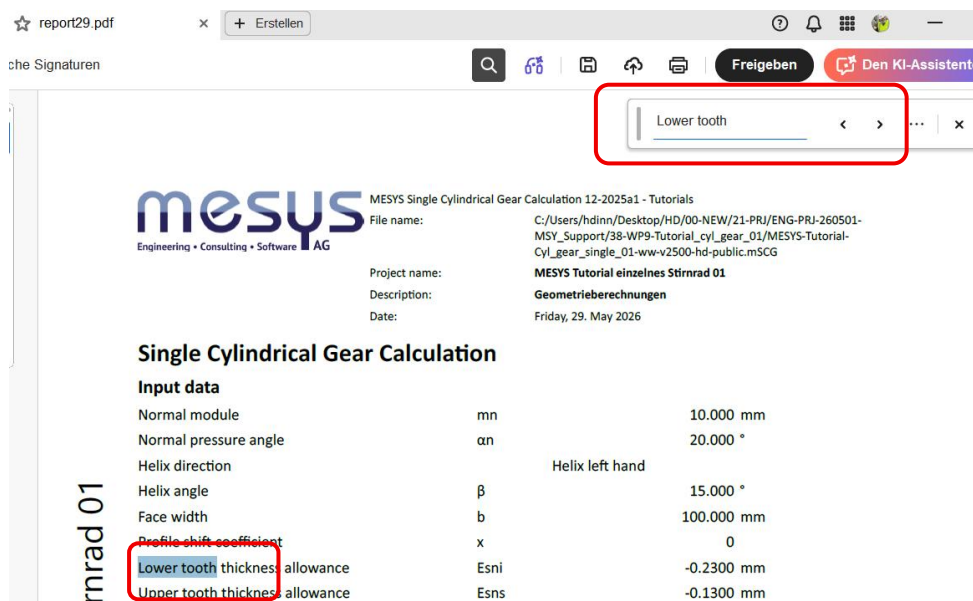


Figure 2-14 Search in report.

Properties of the report can be changed in the file *mesys.ini* in the installation directory. Properties such as paper format, margins or the margin text can be adjusted there. If the entry for the margin text is changed, it is adjusted in subsequent reports.

```
[report]
format=INTERNALPDF
tableformat=XLSX
topmargin=20
bottommargin=20
leftmargin=20
rightmargin=20
papersize=A4
marginbox1\active=true
marginbox1\rect=@Rect(-35 -20 30 20)
marginbox1\text=#page/#pageCount
marginbox1\angle=0
marginbox1\isHtml=false
marginbox1\drawBox=false
marginbox2\active=true
marginbox2\rect=@Rect(5 -50 200 30)
marginbox2\text="<html><center><font size=8>MESYS Tutorial: Single Cylindrical Gear 01</font></center></html>"
marginbox2\angle=0
marginbox2\isHtml=true
marginbox2\drawBox=false
```

Figure 2-15 Adjustment of side entry in the file *mesys.ini*.

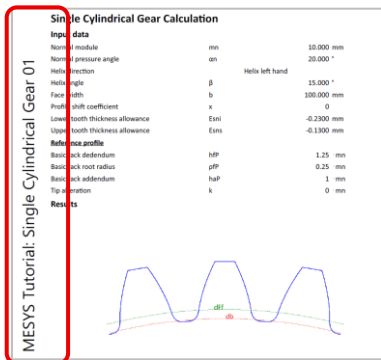


Figure 2-16 Adjusted side entry in the report.

The report is printed via the command in the menu *Report/Print report*. Via *Report/Save report as*, it is saved in various formats, e.g. suitable for Microsoft Word® or Microsoft Excel®.

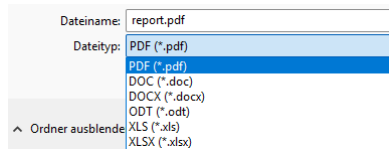


Figure 2-17 Saving the report in various common formats.

The report is saved in various languages. The language for the report is independent of the language setting for the software.

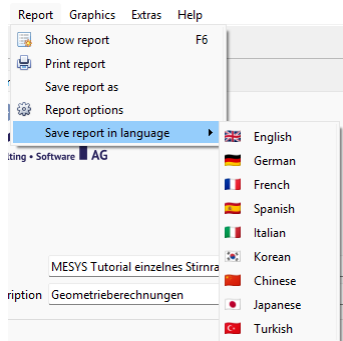


Figure 2-18 Language selection for the command *Report/Save report as*.

2.5 Graphics

Graphics are accessed via the *Graphics* menu.

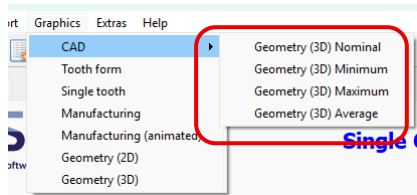


Figure 2-19 Accessing the graphics in the menu *Graphics*.

The graphics in the menu *Graphics/CAD* generate the gear geometry for the nominal dimension (theoretical gear without backlash), the lower allowances, upper allowances and mean allowances.

The graphics context menu is accessed via the right mouse button. The gear geometry is exported via *Export graphic as ...* as a *.stp or *.stl file.

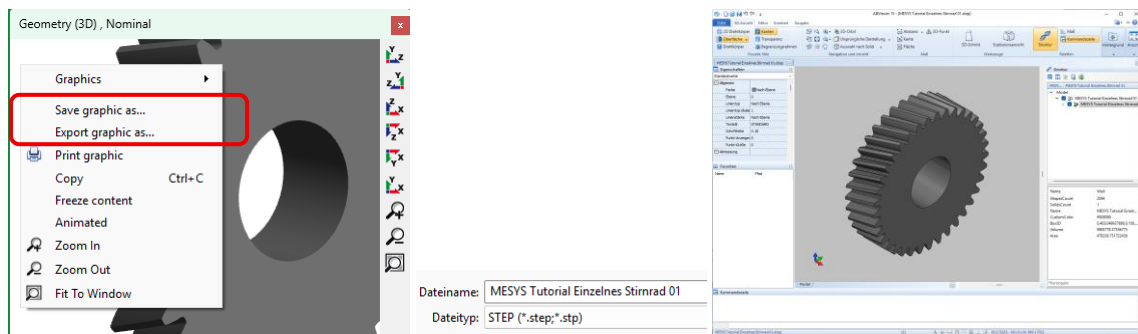


Figure 2-20 Left: Graphics context menu (right mouse button). Centre: Export graphic as, output as *.stp file. Right: Gear geometry in a CAD viewer.

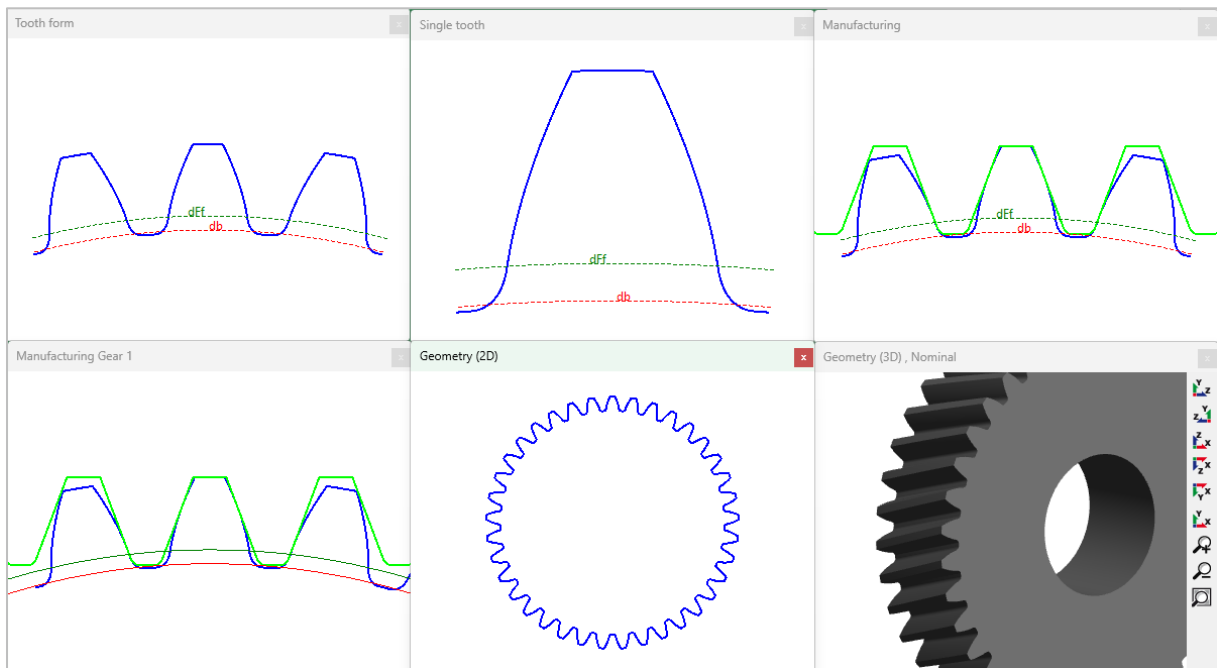


Figure 2-21 Graphics *Tooth form* to *Geometry (3D)*.

Via the context menu (right mouse click) and *Save graphic as*, the graphics content is saved as image file with the desired dimensions. Via the context menu and *Copy*, a screenshot of the graphics is created, e.g. for further use in a report.

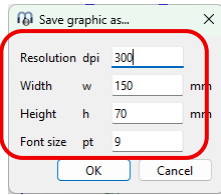


Figure 2-22 Definition of the graphic file, size and resolution.

Via the context menu, *Freeze graphic*, the content of the graphic is frozen. If an input is changed and the calculation is run again, the old frozen and the new just-calculated state are then displayed. Note you need to open the graphic again as second window.

2.6 File

See File *MESYS-Tutorial-Cyl_gear_single_01-ww-v2500.mSCG*. The file will not be overwritten in the following steps.

3 Implementation, Step 2

3.1 Upper and lower limit of profile shift

The profile shift is controlled in the *Geometry* tab, input *Profile shift factor* and the geometry is viewed in the graphic *Graphics/Single tooth*. If the profile shift is reduced, undercut occurs and the tooth form may become unsuitable for operation.

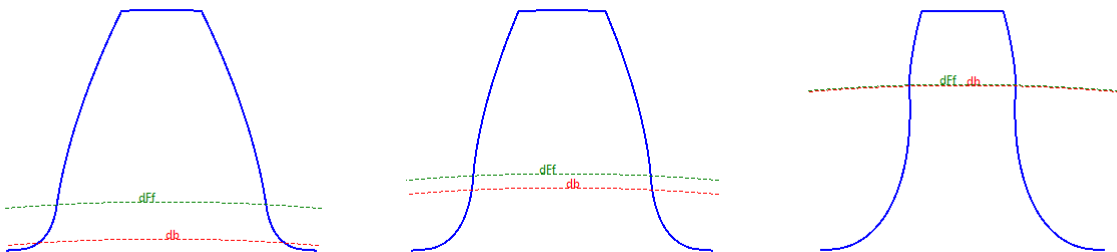


Figure 3-1 Tooth form for various profile shift factors. Left: $x = 0$. Middle: $x = -0.5$. Right: $x = -1.5$.

If the profile shift factor is increased, the tooth becomes wider at the root and thinner at the tip.

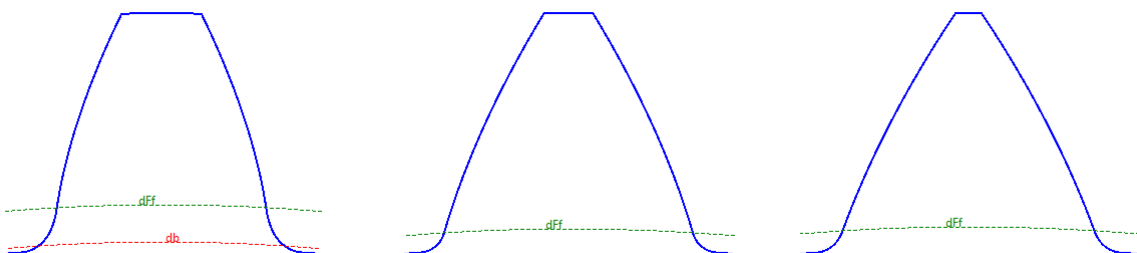


Figure 3-2 Tooth form for various profile shift factors. Left: $x = 0$. Mitte: $x = 1.0$. Right: $x = 1.5$.

If the profile shift factor is chosen too high and the tooth thickness at the tip becomes zero, the tooth height is reduced.

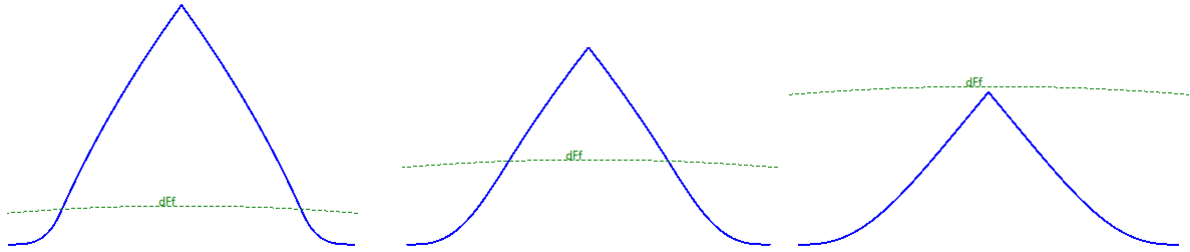


Figure 3-3 Tooth form for various profile shift factors with reduced tooth height. Left: $x=2.0$. Mitte: $x=3.0$. Right: $x=4.0$.

In the *Geometry* tab, via the «+» button at the *profile shift factor*, find the corresponding limits *Limit for undercut*, x_{min} and *Limit for minimum top land*, x_{max} for the profile shift factor. The latter is controlled by the setting in the tab *General*, input of *Minimum tooth thickness factor*, $s_{an,min}$.

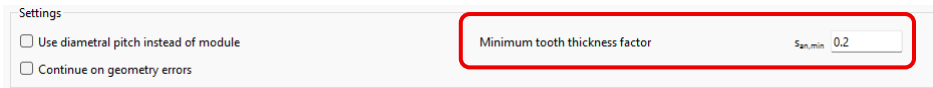


Figure 3-4 Specification for *Minimum tooth thickness factor*, $s_{an,min}$, in the tab *General*.

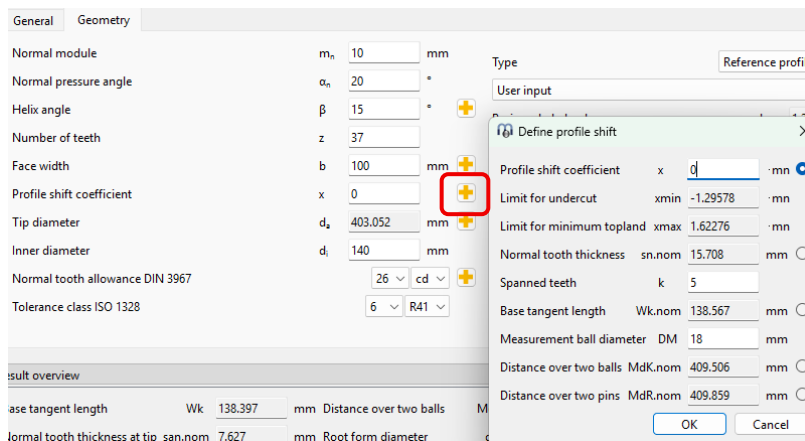


Figure 3-5 «+» button at *Profile shift coefficient* in the tab *Geometry*. Window *Define profile shift*.

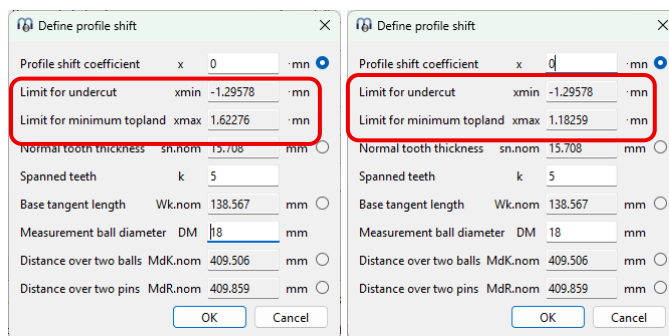


Figure 3-6 Left: Resulting *Limit for minimum top land* for *Minimum tooth thickness factor* $s_{an,min} = 0.20$. Right: For $s_{an,min} = 0.40$.

3.2 Converting profile shift

In the *Geometry* tab, via the «+» button at the *Profile shift coefficient*, a conversion is available. For this tutorial, the base tangent length over four teeth is given as $Wk.nom =$

110.85. If the number of *Spanned teeth* $k = 4$ and the *Base tangent length* $W_{k.nom} = 110.85$ are entered, the profile shift is calculated from this. It is visible after entering the data and pressing the *OK* button in the tab *Geometry*.

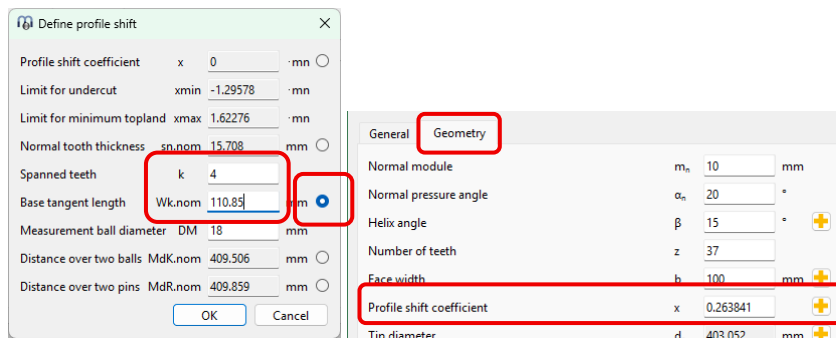


Figure 3-7 LeftMi: Selection input profile shift from base tangent length. input number of *spanned teeth* and *base tangent length*. *OK* button. Right: Resulting *Profile shift factor* in tab *Geometry*.

3.3 Generating profile shift

In the report, four values are given for the profile shift: the nominal value as well as the lower, upper and mean value.

		Nominal	Average	Minimum	Maximum
Profile shift coefficient	x	0.0000	-0.0247	-0.0316	-0.0179

Figure 3-8 Profile shift factor x in the report, various values.

The nominal value corresponds to the value in the user interface, $x = 0.2638$. The minimum and maximum are the upper and lower value of the generating profile shift. They are controlled by the tooth thickness allowance. If the tooth thickness allowance per DIN 3967 is set to zero in the *Geometry* tab via the «+» button, all four values are equal to the nominal dimension.

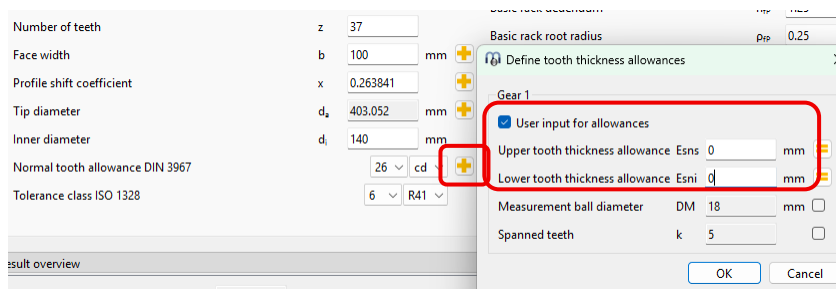


Figure 3-9 Tooth thickness allowances set to zero, *Geometry* tab, «+» button for tooth thickness allowance per DIN 3967.

		Nominal	Average	Minimum	Maximum
Profile shift coefficient	x	0.2638	0.2638	0.2638	0.2638

Figure 3-10 Profile shift factor x in the report, all values equal.

4 Implementation, Step 3

4.1 Setting tooth height

In the *Geometry* tab, the tooth height is now increased. The aim is to achieve a higher transverse contact ratio ε_α in mesh. The dedendum shall remain larger than the addendum by 0.20, i.e. $h_{fP} - h_{aP} = 0.20 \cdot m_n$.

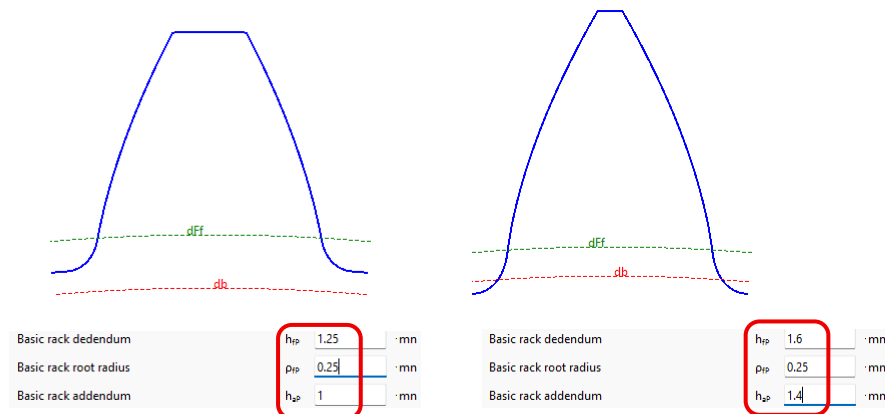


Figure 4-1 Left: Original tooth form with $h_P = h_{fP} + h_{aP} = 2.25 \cdot m_n$. Right: tooth height increased, $h_P = h_{fP} + h_{aP} = 3.00 \cdot m_n$. Graphics not to scale.

4.2 Adjusting pressure angle

To make the tooth still more slender and taller, the pressure angle is reduced, here to $\alpha_n = 17.5^\circ$. Then, the tooth height is further increased, without the tooth getting pointed (thickness at tip remains non-zero).

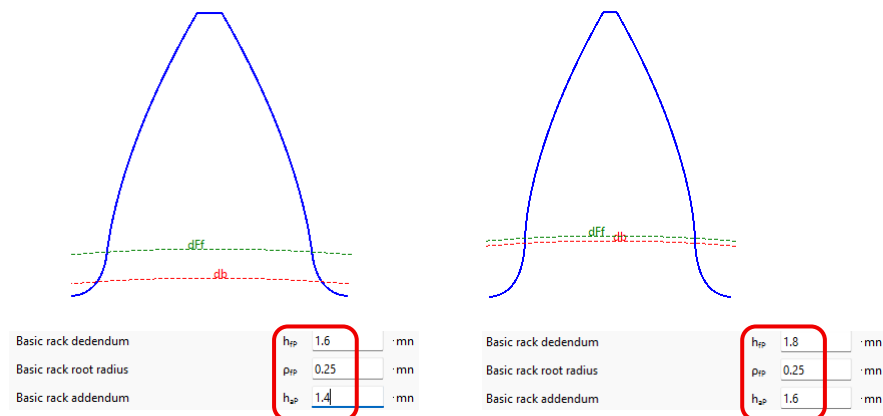


Figure 4-2 Left: Tooth height increased with $h_P = h_{fP} + h_{aP} = 3.00 \cdot m_n$. Right: Normal pressure angle reduced, tooth height further increased, $h_P = h_{fP} + h_{aP} = 3.4 \cdot m_n$. Graphics not to scale.

4.3 Maximizing root fillet.

In the *Geometry* tab, the original tooth height is set again. The calculation is run and the graphic *Graphics/Manufacturing* is displayed. In the context menu (right mouse click in the graphic), select *Freeze content*, for both graphics.

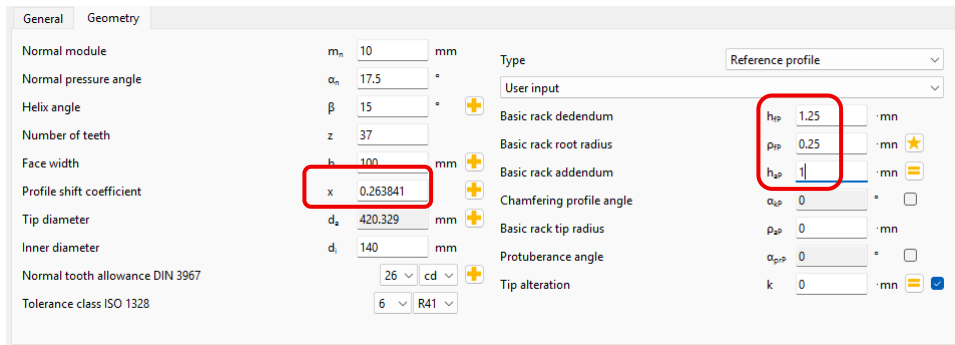


Figure 4-3 Tooth height reset to original value.

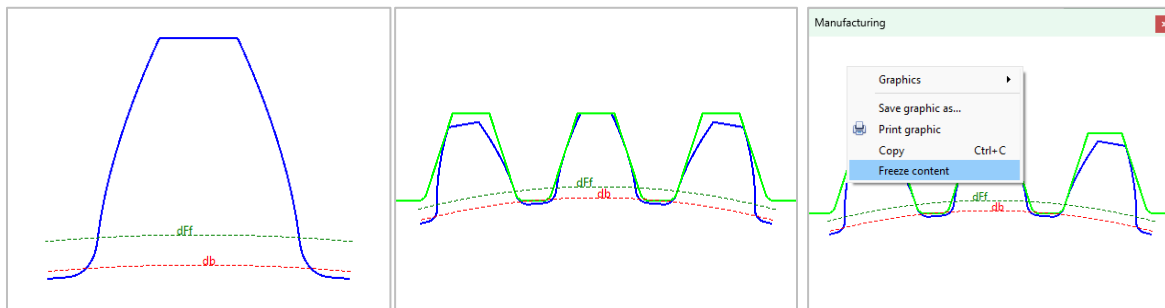


Figure 4-4 Left: Graphic *Graphics/Single tooth*. Middle: Graphic *Graphics/Manufacturing*. Green: Reference profile of tool. Blue: Tooth form, transverse section. Right: *Freeze content* (click right mouse button for context menu).

Now, the root radius of the reference profile is $\rho_{IP} = 0.25$ and then reduced to $\rho_{IP} = 0.10$. The calculation is run again, and the two graphics *Graphics/Single tooth* and *Graphics/Manufacturing* are opened a second time. The previously frozen graphics have not changed and can now be compared with the new ones.

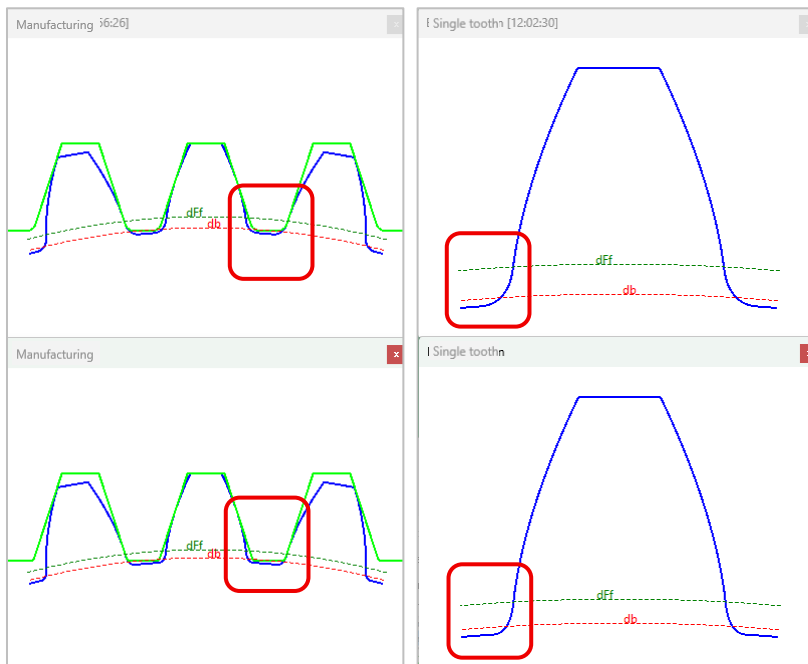


Figure 4-5 Comparison $\rho_{IP} = 0.25$ (above) to $\rho_{IP} = 0.1$ (below). Left: Graphic *Manufacturing*. Right: Graphic *Single tooth*. Note the root fillet.

The «*» button is used to maximize the root fillet. This calculates the maximum possible radius at the tip of the tool. The calculation is then run again, and the tooth root geometry is displayed.

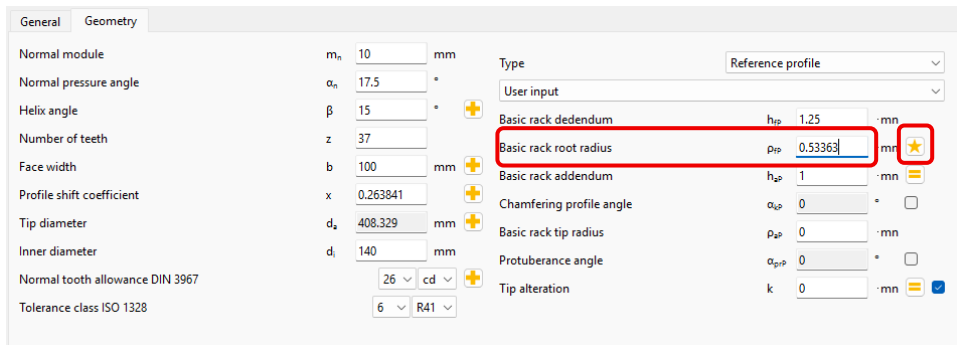


Figure 4-6 Sizing of the maximum value for Root radius reference profile via «*» button.

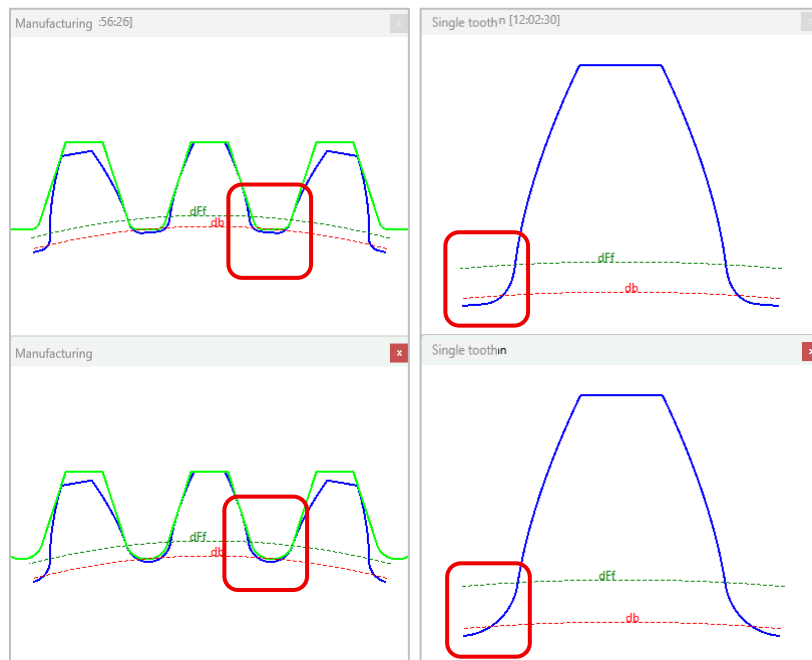


Figure 4-7 Comparison of $\rho_{IP} = 0.25$ (above) to $\rho_{IP} = 0.53$ (below). Left: Graphic *Manufacturing*. Right: Graphic *Single tooth*. Note the root fillet.

5 Implementation, Step 4

5.1 Calculating tip alteration

In the given data, the tip circle diameter is given as nominal dimension $d_a = 408.329$ mm. The *Tip diameter tolerance (ISO 286)* is selected as h8. The upper allowance is equal to the nominal dimension $d_a = d_{a,s}$, the upper allowance is $\Delta d_{a,s} = 0.000$ mm. The lower allowance is lower as the nominal dimension, $d_{a,i} = d_a + \Delta d_{a,i} = 408.329$ mm – 0.097 mm = 408.232 mm.

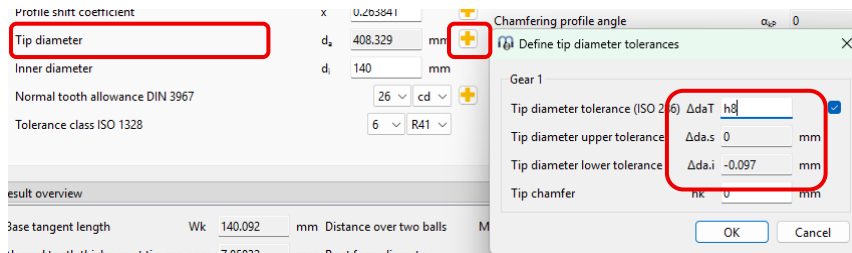


Figure 5-1 Tip diameter tolerance data.

The corresponding values are found in the report.

		Nominal	Average	Minimum	Maximum
Profile shift coefficient	x	0.2638	0.2391	0.2322	0.2460
Tip diameter	d_a	408.3290	408.2805	408.2320	408.3290 mm
Root diameter	d_f	262.2200	262.8245	262.6071	262.0718 mm

Figure 5-2 Tip diameter, nominal dimension, meat value, minimum, maximum.

The tip diameter shall now be $d_a = 408.000$ and the allowances +0.050 -0.100 mm. The tip circle diameter with upper allowance is $d_{a,s} = 408.050$ mm and with lower allowance $d_{a,i} = 407.900$ mm. Such a specification may be realized in different ways, here, three ways are discussed.

5.2 Implementation via tip alteration

The addendum of the reference profile $h_{aP} = 1.00$ is kept. The nominal dimension is chosen as $d_a = 408.050$ mm and realized via a tip alteration. The allowances are then +0.000 – 0.150.

For this, press button “=” at *Tip alteration* and enter the desired *tip circle diameter* $d_a = 408.050$ mm. A *tip alteration k* of $k = -0.014$ results and after the calculation the value is $d_a = 408.050$ mm.

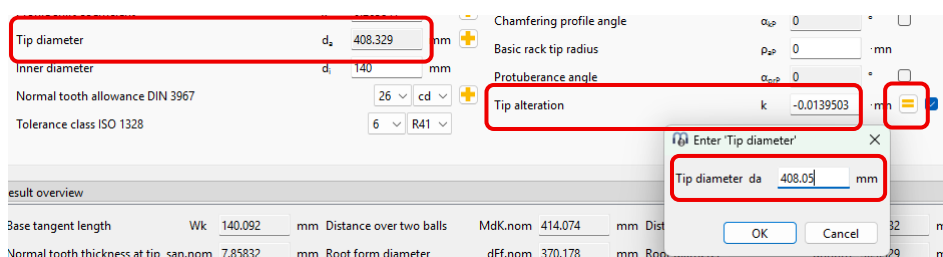


Figure 5-3 Input *Tip diameter*, to calculate the *tip alteration*. Resulting *Tip diameter* after running the calculation.

With this, the nominal dimension is set and in a second step the allowances are to be entered via the «+» button at the tip circle diameter.

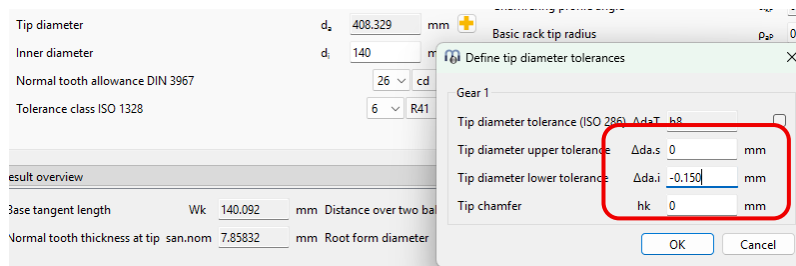


Figure 5-1 Define tip diameter tolerances window, the «+» button.

In the report, after running the calculation:

		Nominal	Average	Minimum	Maximum
Profile shift coefficient	x	0.2638	0.2533	0.2274	0.2432
Tip diameter	d_a	408.0500	407.9750	407.9000	408.0500 mm
Root diameter	d_f	363.3290	362.7581	362.5995	362.9167 mm

Figure 5-4 Tip diameter, nominal dimension $d_a = 408.050$ mm. Minimum and maximum value match the specification, with this also the mean value. The nominal dimension is a reference value.

5.3 Implementation via allowances

The addendum of the reference profile is kept at $h_{aP} = 1.00$. The nominal dimension is chosen as $d_a = 408.329$ mm, the tip alteration is zero. The allowances are then 408.050 mm – 408.329 mm = -0.279 mm and 407.900 mm – 408.329 mm = -0.429 mm.

For this, the *tip alteration* k is set to $k = 0$. Using the «+» button at the *Tip diameter*, the allowances are entered.

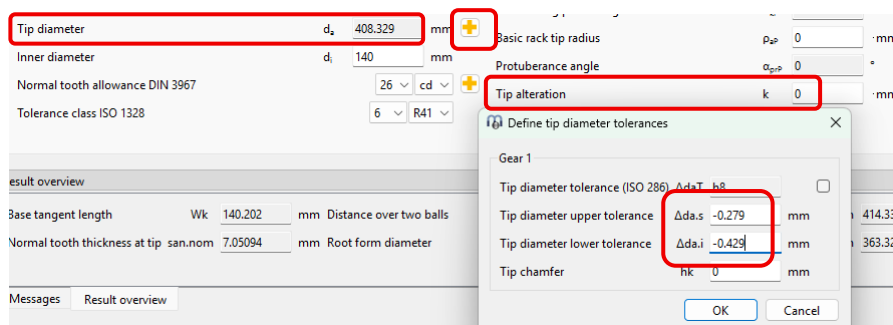


Figure 5-5 Input of the tip diameter allowances via «+» button at the *Tip diameter*. *Tip alteration* k set to zero.

After the calculation, the nominal dimension $d_a = 408.329$ mm is displayed in the user interface, and the report shows the same values for the upper, lower and mean value (but a different nominal dimension) as before.

		Nominal	Average	Minimum	Maximum
Profile shift coefficient	x	0.2638	0.2391	0.2322	0.2460
Tip diameter	d_a	408.3290	407.9750	407.9000	408.0500 mm
Root diameter	d_f	363.3290	362.8345	362.6971	362.9718 mm

Figure 5-6 Tip diameter, nominal dimension $d_a = 408.329$ mm. Minimum and maximum value match the specification, with this also the mean value. The nominal dimension is a reference value.

5.4 Implementation via reference profile

The basic rack addendum is adjusted so that the nominal dimension for the tip circle diameter results as $d_a = 408.000$ mm. The tip alteration coefficient is zero. The allowances are then $+0.050 - 0.100$.

For this, *Tip alteration* k remains set to $k = 0$. The «=» button at the basic rack addendum is used and the desired nominal dimension for the tip circle diameter $d_a = 408.000$ entered. From this, $h_{aP} = 0.984 \cdot m_n$ results.

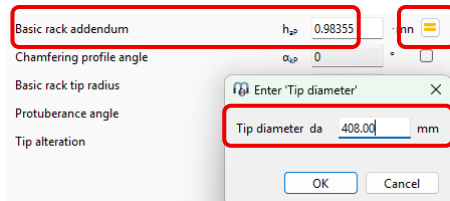


Figure 5-7 Conversion of tip circle diameter nominal dimension to basic rack addendum. Use “=” button.

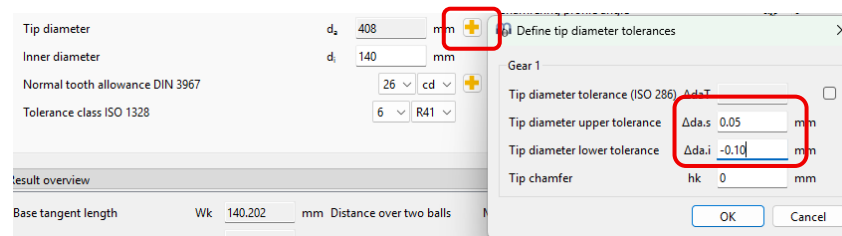


Figure 5-8 Entering tip circle diameter allowances via the «+» button at tip circle diameter.

After the calculation, the changed nominal dimension is found in the report; the other values are the same as above.

		Nominal	Average	Minimum	Maximum
Profile shift coefficient	x	0.2638	0.2391	0.2322	0.2460
Tip diameter	d_a	408.0000	407.9750	407.9000	408.0500 mm
Root diameter	d_f	363.3290	362.8345	362.6971	362.9718 mm

Figure 5-9 Tip diameter, nominal dimension $d_a = 408.000$ mm. Minimum and maximum value match the specification, with this also the mean value. The nominal dimension is a reference value.

6 Implementation, Step 5

6.1 File

Open file *MESYS-Tutorial-Cyl_gear_single_01-v2500.mSCG*, to restore the state per Step 1.

6.2 Tip chamfer

In the *Geometry* tab, is via the input *Chamfering profile angle* $\alpha_{kP} = 45^\circ$ and *Basic rack form addendum* $h_{FaP} = 0.80$ entered. With this a second involute is generated at the tip of the tooth, with pressure angle $\alpha_n = 45^\circ$. The graphics *Graphics/Single tooth* and *Graphics/Geometry (3D), nominal dimension* then show the chamfer.

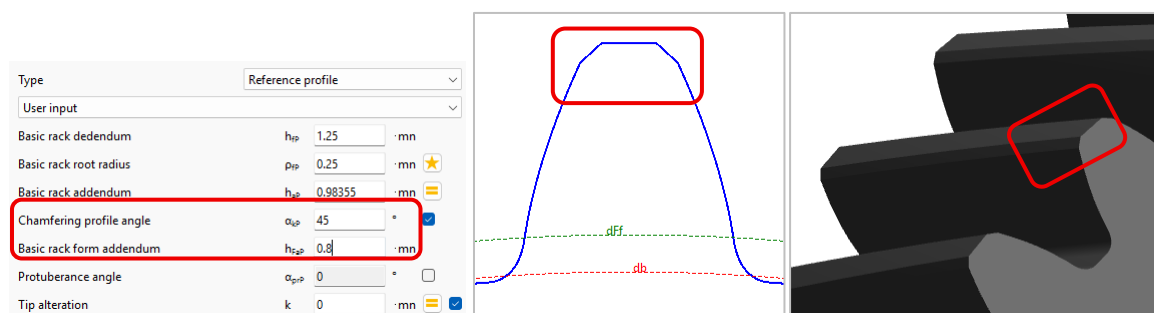


Figure 6-1 Definition of tip chamfer via the reference profile.

To generate the tip chamfer, a second flank (as a straight line) is added at the root of the rack type tool. Through the generating process the second involute (the chamfer) is generated. This means the chamfer is not a straight line but curved, as an involute.

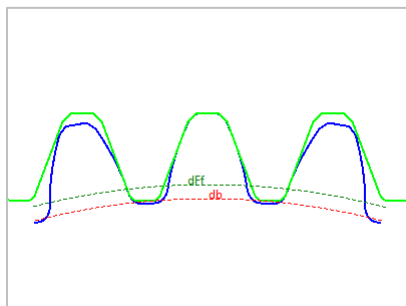


Figure 6-2 Generating the tip chamfer from the tool profile.

6.3 Gear quality specifications

From the input *Tolerance class per ISO 1328* in tab *Geometry* the permissible manufacturing deviations are determined. They are listed in the report in the *Tolerances* section.

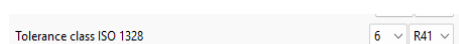


Figure 6-3 Input of the tolerance class in the tab *Geometry*.

Tolerances		
Tolerance class ISO 1328-1	A	6
Single pitch tolerance	fpT	13.000 μm
Cumulative pitch tolerance	FpT	43.000 μm
Profile slope tolerance	fHαT	12.000 μm
Profile form tolerance	ffαT	15.000 μm
Profile tolerance, total	FαT	19.000 μm
Helix slope tolerance	fHβT	12.000 μm
Helix form tolerance	ffβT	14.000 μm
Helix tolerance, total	FβT	18.000 μm
Tolerance class ISO 1328-2	R	41
Tooth-to-tooth radial composite tolerance	fidT	84.000 μm
Total radial composite tolerance	FidT	95.000 μm

Figure 6-4 Tolerances as maximum permissible manufacturing errors, listed in the report.

6.4 Calculating inspection measurements

To calculate the inspection measurements, it is necessary to enter the measuring ball diameter and the number of spanned teeth. It is set automatically or entered via the «+» button at the tooth thickness allowance per DIN 3967 input. For a direct input, the corresponding flag shown below must be enabled.

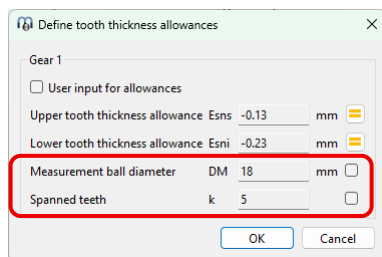


Figure 6-5 Entering measuring ball diameter and number of spanned teeth.

The inspection measurements are listed in the report as follows.

Spanned teeth	k	5.0000	5.0000	5.0000	5.0000
Base tangent length	Wk	140.3713	140.2022	140.1552	140.2492 mm
Contact diameter for base tangent length	dMWk	383.4376	383.3794	383.3633	383.3956 mm
Measurement ball diameter	DM	18.0000	18.0000	18.0000	18.0000 mm
Radial single ball distance	MrK	207.1685	206.9637	206.9066	207.0207 mm
Distance over two balls	MdK	413.9799	413.5706	413.4566	413.6845 mm
Distance over two pins	MdR	414.3370	413.9274	413.8132	414.0413 mm
Contact diameter for ball distance	dMBall	389.2079	388.8340	388.7298	388.9380 mm

Figure 6-6 List of inspection measurements.

If the measurement is not possible, a corresponding message is output. Below, such a message was provoked by reducing the tooth height so that a base tangent length measurement with a gauge is not possible.

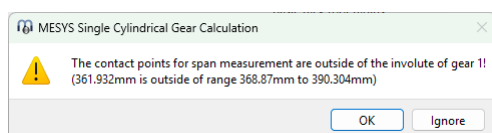


Figure 6-7 Message that measurement is not possible.

6.5 Immediate geometry calculation after each input

The default setting in MESYS is that after one or more inputs the calculation is triggered via the corresponding button or F5. Alternatively, MESYS can be set so that after each input the calculation is performed immediately. If this is limited to geometry calculations (without 3D graphics), it is fast enough not to disrupt the workflow. «M» stands for manual triggering of the calculation, «A» for automatic.

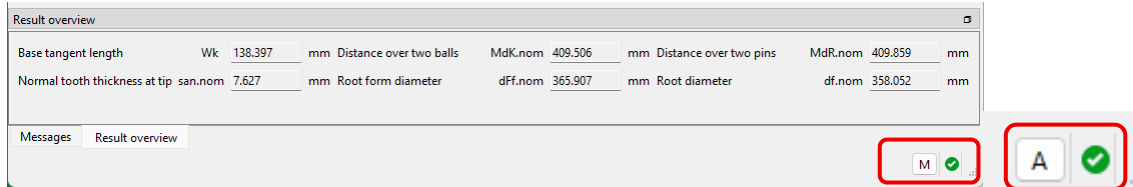


Figure 6-8 Setting for the calculation to be run directly after each input.

7 Gear definition via the tool

7.1 File

Open file *MESYS-Tutorial-Cyl_gear_single_01-v2500.mSCG* open, to restore the status as per Step 1.

Open graphics *Graphics/Single tooth*, *Graphics/Manufacturing* and *Graphics/Manufacturing (animated)*. The animation is not shown in the screenshots below.

7.2 Definition as hob

The parameters for the definition of the reference profile of the rack type tool (the hob) are defined per ISO 21771-1:2024. In the figure below, a chamfer flank with the root form height of the tool h_{FFP0} and chamfering profile angle α_{kP0} is shown. This generates a tip chamfer at the gear (the workpiece). On the right, a root fillet is shown, with root radius tool ρ_{FP0} . This generates a tip rounding at the gear.

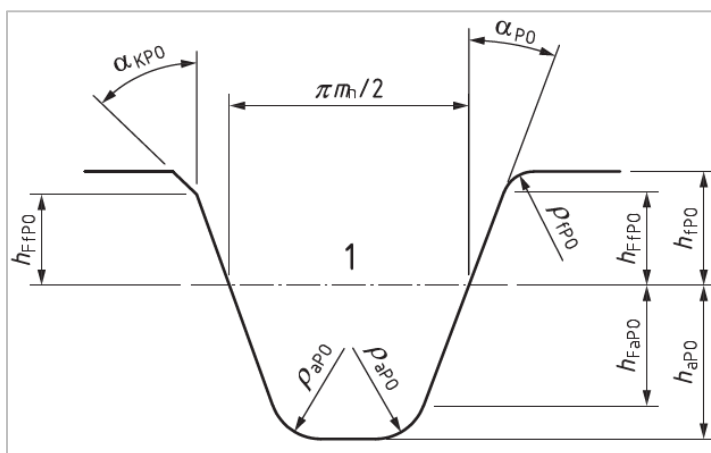


Figure 7-1 Definition of reference profile of a tool as hob. The lengths are measured at, or from, the reference line.

In the *Geometry* tab, the input is now input *Type = hob* instead of *Type = reference profile*. The inputs for the reference profile of the gear are converted to inputs of the reference profile of the rack type tool (referred to here as hob). In the simplest case, if the reference profile of the gear is defined only via the basic rack dedendum h_{fp} , the root radius reference profile ρ_{fp} and the addendum reference profile h_{aP} , the conversion to hob data is trivial. For the tool (here, a hob), the subscript «0» is used in the symbols. The gear addendum h_{aP} becomes the tool dedendum h_{fP0} and the gear dedendum h_{fp} converts to the tool addendum h_{aP0} .

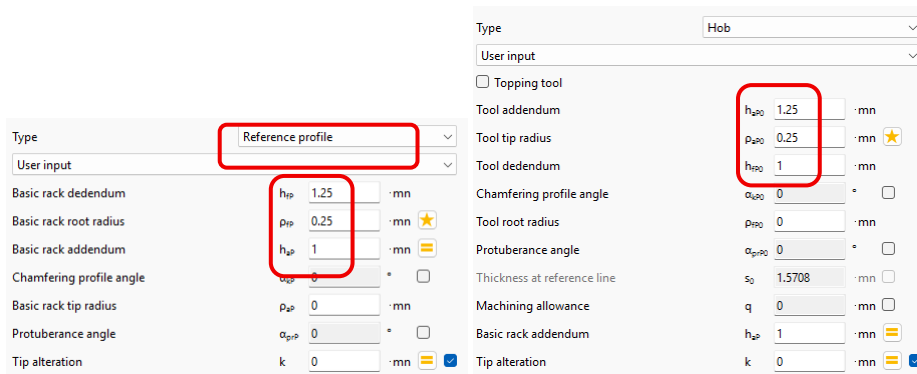


Figure 7-2 Left: Original definition of the gear via its reference profile. Right: Converted to the reference profile of the hob.

The basic rack addendum of the gear is still required, since as a rule the outside diameter of the gear is not determined by the dedendum of the tool, but in a preceding machining step — turning the blank to the outside diameter. Note that the dedendum of the tool is therefore generally entered larger than the addendum of the gear.

In the simplest case, the addendum of the gear is set equal to the dedendum of the hob, see below. In the graphic *Graphics/Manufacturing*, the root area of the tool and the tip area of the gear then touch.

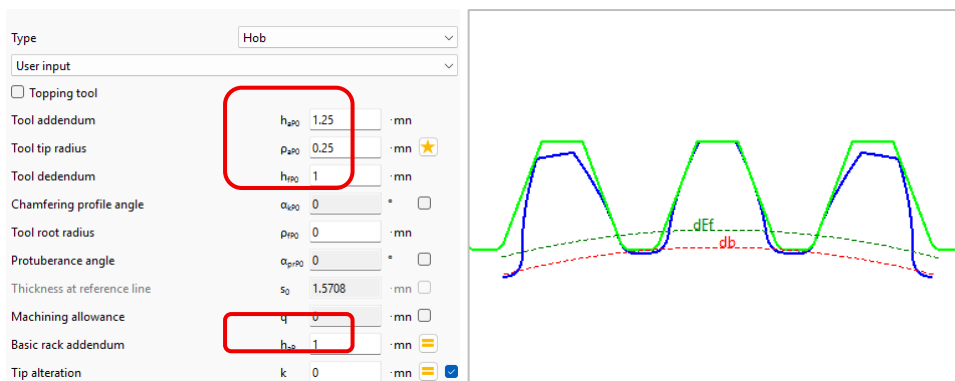


Figure 7-3 Addendum of gear = Dedendum of hob.

Is the dedendum of the hob reduced, e.g. to $h_{fP0} = 0.80$, but the addendum of the gear is kept, e.g. at $h_{aP} = 1.00$, there is a conflict. Then, the tooth form is not changed and calculated for the entered addendum of the gear. I.e. the calculation follows the definition of h_{aP} , not the definition of h_{fP0} .

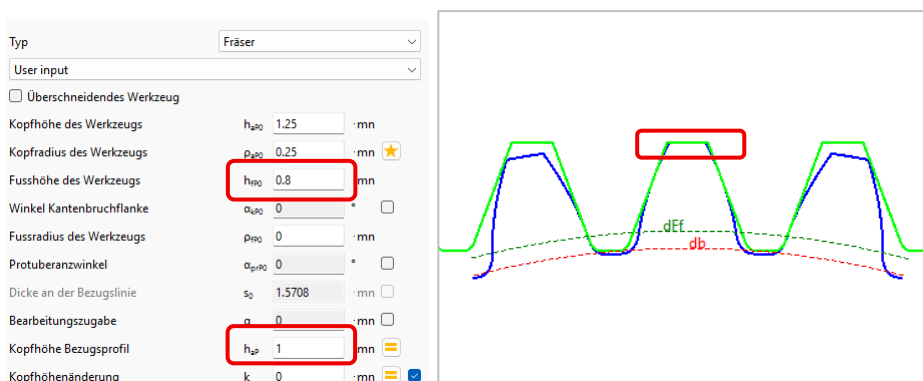


Figure 7-4 Addendum of gear \neq Dedendum of hob. The calculation is controlled by the addendum of the gear.

With the flag *Topping tool* enabled, the geometry of the gear is controlled by the geometry of the hob (the hob root cuts the gear tip). The calculation follows now the tool definition of h_{FP0} , not the gear definition of h_{aP} . With this, the gear addendum becomes equal to the tool dedendum. The inputs for the gear addendum h_{aP} and the input for the tip alteration k are removed.

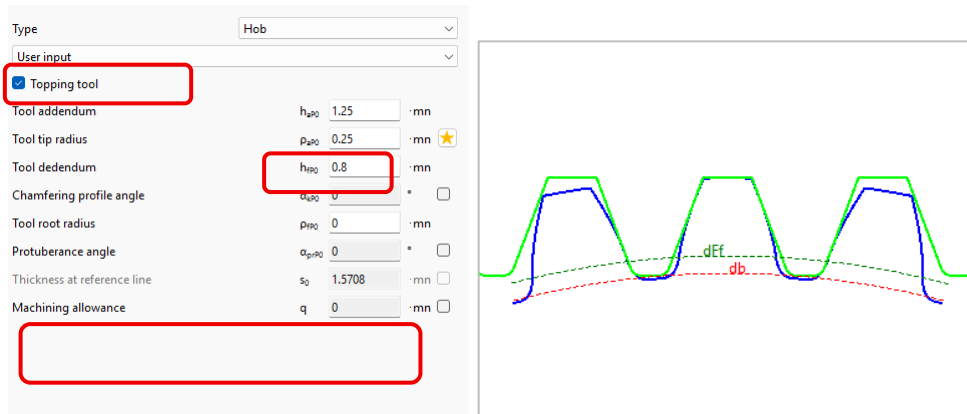


Figure 7-5 Addendum gear is not entered anymore. The gear addendum is now determined from the dedendum of the tool. Flag *Topping tool* enabled.

At the root of the tool, a fillet or radius can be entered; this then generates a tip rounding on the gear via the generating process.

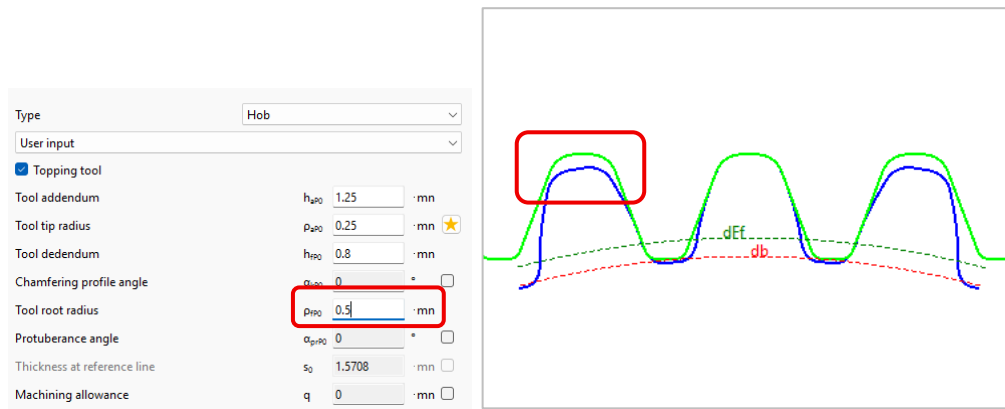


Figure 7-6 Definition of a root fillet on the hob, for a topping tool. A tip rounding is generated at the gear via the generating process.

Alternatively, instead of a fillet in the root of the hob, a chamfer can be defined by enabling the corresponding flag and entering $\alpha_{kp0} = 60^\circ$ and $h_{FFP0} = 0.60$.

In MESYS, the protuberance of the roughing machining tool is defined via input protuberance angle α_{prP0} and one of the below

- The tip form height of the tool h_{FaP0} .
- The height the protuberance h_{prP0} .
- Amount of protuberance p_{rP0}

Note that $h_{prP0} + h_{FaP0} = h_{aP0}$ (addendum of the tool). In below three figures, the three cases are shown. The input of the protuberance is via enabling the flag at *Protuberance angle* and its value, here $\alpha_{prP0} = 10^\circ$.

Protuberance angle	α_{prP0} 10	°	<input checked="" type="checkbox"/>
Tool form addendum	h_{FaP0} 1.1	mn	<input checked="" type="radio"/>
Height of protuberance	h_{prP0} 0.15	mn	<input type="radio"/>
Amount of protuberance	p_{rP0} -0.00617992	mn	<input type="radio"/>

Figure 7-9 Input protuberance angle and Tool form addendum. Height of protuberance and Amount of protuberance follow.

Protuberance angle	α_{prP0} 10	°	<input checked="" type="checkbox"/>
Tool form addendum	h_{FaP0} 1.05	mn	<input type="radio"/>
Height of protuberance	h_{prP0} 0.2	mn	<input checked="" type="radio"/>
Amount of protuberance	p_{rP0} 0.00263643	mn	<input type="radio"/>

Figure 7-10 Input protuberance angle and height of protuberance. Tool form addendum and Amount of protuberance follow.

Protuberance angle	α_{prP0} 10	°	<input checked="" type="checkbox"/>
Tool form addendum	h_{FaP0} 0.497824	mn	<input type="radio"/>
Height of protuberance	h_{prP0} 0.752176	mn	<input type="radio"/>
Amount of protuberance	p_{rP0} 0.1	mn	<input checked="" type="radio"/>

Figure 7-11 Input protuberance angle and Amount of protuberance. Tool form addendum and height of protuberance follow.

For protuberance angle $\alpha_{prP0} = 10^\circ$ and amount of protuberance $p_{rP0} = 0.10$, the tooth form is as follows.

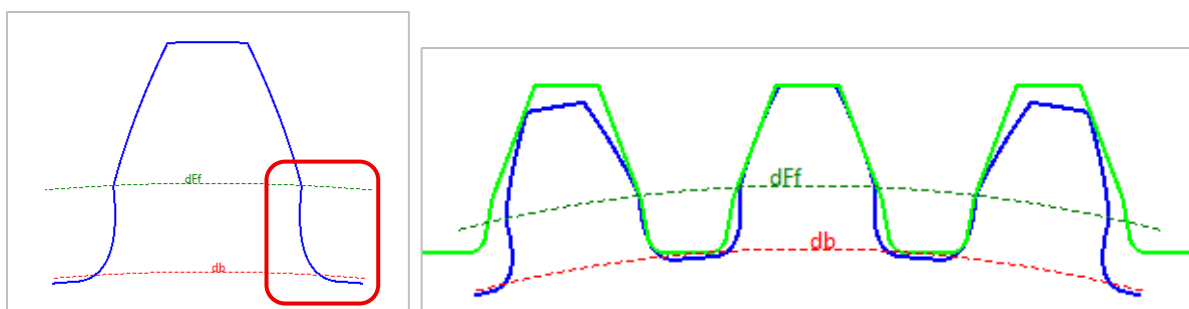


Figure 7-12 Tooth form with undercut due to the protuberance on the tool.

If a finish machining step is defined via the machining allowance input, the relevant geometry of the finish machining tool must be defined. The machining allowance is $q = 0.05 \cdot m_n$, the addendum of the finish machining tool $h_{aP0F} = 1.00$ and the tip radius of the finish machining tool is $\rho_{aP0F} = 0.05 \cdot m_n$.

Amount of protuberance	<input type="text" value="0.1"/>	<input checked="" type="radio" value="mn"/>
Thickness at reference line	<input type="text" value="1.5708"/>	<input type="radio" value="mn"/>
Machining allowance	<input type="text" value="0.05"/>	<input checked="" type="radio" value="mn"/>
Basic rack addendum	<input type="text" value="1"/>	<input type="radio" value="mn"/>
Tip alteration	<input type="text" value="0"/>	<input checked="" type="radio" value="mn"/>
Finishing tool addendum	<input type="text" value="1"/>	<input type="radio" value="mn"/>
Finishing tool tip radius	<input type="text" value="0.05"/>	<input type="radio" value="mn"/>

Figure 7-13 Input for finish machining tool.

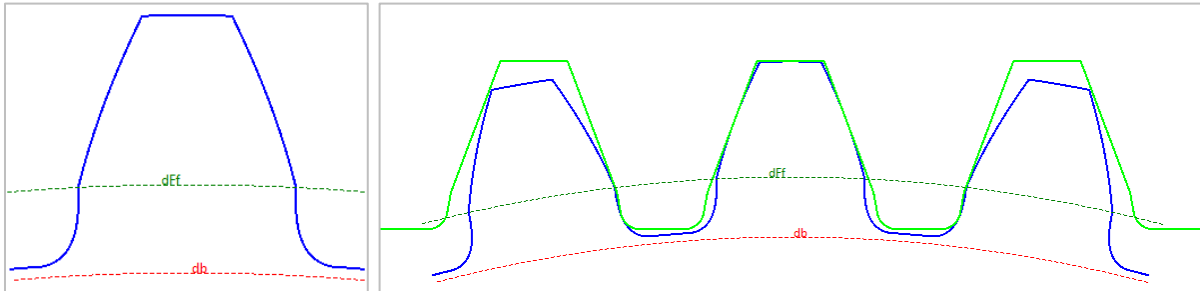


Figure 7-14 Tooth form after finish machining. Right: Hypothetical tool in green.

If the parameters for rough machining and finish machining are chosen unfavorably, a poor tooth form results. In the following calculation, the machining allowance was defined larger than the amount of protuberance, $q = 0.20 > p_{rP0} = 0.10$. The addendum of the finish machining tool is set to a low value, $h_{aPOF} = 0.50$. From this, a reduced tooth height and a grinding notch result.

Amount of protuberance	<input type="text" value="0.1"/>	<input checked="" type="radio" value="mn"/>
Thickness at reference line	<input type="text" value="1.5708"/>	<input type="radio" value="mn"/>
Machining allowance	<input type="text" value="0.2"/>	<input checked="" type="radio" value="mn"/>
Basic rack addendum	<input type="text" value="1"/>	<input type="radio" value="mn"/>
Tip alteration	<input type="text" value="0"/>	<input checked="" type="radio" value="mn"/>
Finishing tool addendum	<input type="text" value="0.5"/>	<input type="radio" value="mn"/>
Finishing tool tip radius	<input type="text" value="0.05"/>	<input type="radio" value="mn"/>

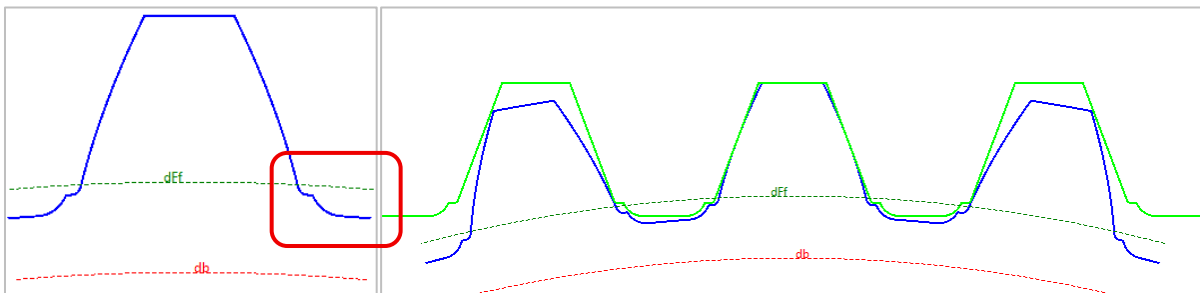


Figure 7-15 Left: Tooth form with unfavorable definition of rough machining and finish machining, resulting grinding notch. Right: Hypothetical tool in green.

7.4 File

Open file *MESYS-Tutorial-Cyl_gear_single_01-v25.mSCG*, to restore the status as per Step 1.

Open graphics *Graphics/Single tooth*, *Graphics/Manufacturing* and *Graphics/Manufacturing (animated)*. The animation is not shown in the screenshots below.

7.5 Definition via shaper cutter

For the use of a shaper cutter to generate the gear geometry, select in tab *Geometry*, *Type = Shaper cutter*. For the shaper cutter, the *Tool number of teeth* $z_0 = 20$ and *Tool profile shift* $x_0 = 0.00$ is entered. The tooth form and the manufacturing are shown in the Graphics *Graphics/Single tooth* and *Graphics/Manufacturing*.

Type	Shaper cutter	
User input		
Tool number of teeth	z_0	20
Tool profile shift	x_0	0
Tool addendum	h_{a0}	1.25 · mn
Tool tip radius	ρ_{a0}	0.25 · mn
Tool dedendum	h_{f0}	1 · mn
Tool root radius	ρ_{f0}	0 · mn
Basic rack addendum	h_{α}	1 · mn
Tip alteration	k	0 · mn

Figure 7-1 Definition of shaper cutter in tab *Geometry*.

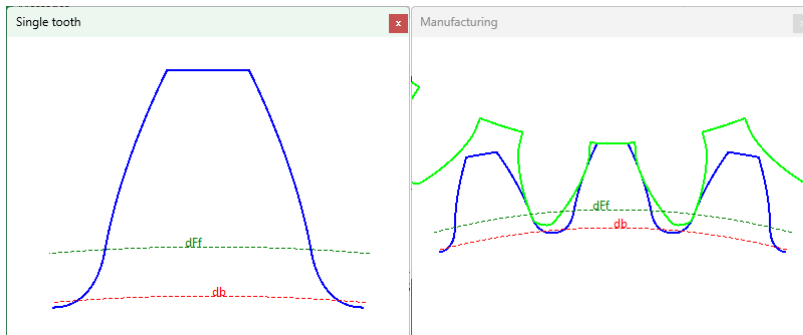


Figure 7-16 Left: Tooth form. Right: Manufacturing with shaper cutter.