INTRODUCTION
Fineblanking is one of the most economical processes for the manufacture of spur gear-tooth systems. Fineblanked gear wheels are more precise than milled ones and also run more quietly. For certain applications the process-dependent roll down can be a disadvantage. In addition, for a given module, the strength of the tool results in a limitation of the fineblanking thickness.

The following report will deal with the possibilities and limitations in the fineblanking of gear wheels with involute external tooth systems.

TOOTH PARAMETERS
Module, number of teeth, addendum and dedendum circle diameters, pressure angle and addendum modification determine the shape of the teeth and hence also the contour of the punch and die plate of the fineblanking tool. Tooth shape and max. tensile strength of the workpiece material limit the fineblanking thickness.

The absolute loading of the tooth section of the fineblanking tool cannot be accurately calculated.

Hydrel has many years of practical experience in fineblanking of over 200 different gear wheels. The information received concerning quality and number of cut parts leads to the quotient of relative tooth loading of the cutting elements.

The formula for the quotient of relative tooth loading of the cutting elements is expressed as:

$$Q = \frac{b \cdot R_m}{m \cdot K}$$

where:
- \(Q\) is the quotient of relative tooth loading of the cutting elements,
- \(R_m\) is the max. tensile strength of the workpiece material,
- \(m\) is the module,
- \(b\) is the material thickness (width of tooth face),
- \(K\) is the coefficient of tooth shape.

Further K-values can be calculated depending on number of teeth, addendum modification coefficient, pressure angle and addendum factor.
VALUES FOR K

| Number of teeth for $\alpha = 20^\circ$ | 17 | 25 | 40 | 63 | 100 | 160 |
| Number of teeth for $\alpha = 15^\circ$ | 30 | 50 | 80 | 125 | 200 | 320 |
| Characteristic value $K$ | 1 | 1.06 | 1.16 | 1.28 | 1.46 | 1.75 |

K-values for other numbers of teeth can be linearly interpolated.

For standardized tooth arrangements:

Addendum factor $y = 1$;
Addendum $h_a = y \cdot m$; for $y = 1$ then $h_a = m$

For addendum $h_a = m$ and dedendum $h_f = 1.2 \cdot m$, then:
Critical number of teeth $z_g = \frac{2 \cdot h_a}{m \cdot \sin \alpha} = \frac{2 \cdot m}{m \cdot \sin \alpha} = \frac{2}{\sin \alpha}$

For $\alpha = 20^\circ$ and $y = 1$ this gives
Critical number of teeth $z_{g20} = \frac{2 \cdot m}{m \cdot \sin 20^\circ} = 17.09$

For $\alpha = 25^\circ$ and $y = 0.8$ by analogy
Critical number of teeth $z_{g25} = \frac{2 \cdot m}{m \cdot \sin 25^\circ} = 8.96$

Positive minimum addendum modification coefficient for teeth without undercut.

$$x_{\text{min.}} = \frac{z_{g} - z}{z_g} = (\cdot)$$

Teeth with undercut are not considered.

### CALCULATION EXAMPLE FOR THE QUOTIENT OF RELATIVE TOOTH LOADING OF THE CUTTING ELEMENTS

Data provided:
- Reference circle diameter $d = 48$ mm
- Addendum circle diameter $d_a = 52$ mm
- Dedendum circle diameter $d_f = 43.2$ mm
- Module $m = 2$ mm
- Number of teeth $z = 24$
- Critical number of teeth $z_g = 17$
- Pressure angle $\alpha = 20^\circ$
- Material thickness $b = 6$ mm
- Max. tensile strength $R_m = 520$ N/mm$^2$

$$Q = \frac{b \cdot R_m}{m \cdot K} = \frac{6 \cdot 520}{2 \cdot 1.052} = 1483 < 1600 \text{ (N/mm}^2\text{)}$$

$K_{24}$ linearly interpolated from $K_{17}$ and $K_{25}$ gives

$$K_{24} = 1 + 0.06 \cdot \frac{(24-17)}{(25-17)} = 1.052$$

$$Q = \frac{6 \cdot 520}{2 \cdot 1.052} = 1483 < 1600 \text{ (N/mm}^2\text{)}$$

### REMARKS CONCERNING ADDENDUM RADIUS $r_a$ ANDDEDENDUM RADIUS $r_f$

Gear wheels which are to be manufactured by fineblanking must have a radius $r_a$ at the transition from the tooth flank to the addendum circle and a radius $r_f$ at the transition from the tooth flank to the dedendum circle.

These radii considerably increase the number of parts which can be produced by the cutting elements. They are to be dimensioned according to the transition radii of general contours, as mentioned in the VDI Guidelines 3345.

Whereas the addendum radius $r_a$ has a negative effect on the pressure section of the tooth, the dedendum radius $r_f$ has a positive effect on the strength of the tooth root.

![Graph of critical number of teeth vs. pressure angle]

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