ISO TR 15144: Method A and B for Calculating Micropitting in KISSsoft

KISSsoft was the first commercially available software product that provided a procedure for calculating micropitting using the more precise Method A, as specified in the ISO TR 15144 Technical Report. The simplified Method B calculation process is also available since 2010. And today, the revised edition of the TR from 2014 is implemented in KISSsoft.

In 2014, a second part, the ISO TR 15144-2, was published and contains four calculation examples. This document is important, because it explains the application of the ISO TR 15144-1 with practical examples. The examples were all recalculated and documented with KISSsoft, to verify that KISSsoft calculates exactly according to the standard.

Proofs of micropitting as set out in ISO TR 15144 are required by certification bodies, particularly in the wind gearbox manufacturing industry.

The Phenomenon of Micropitting

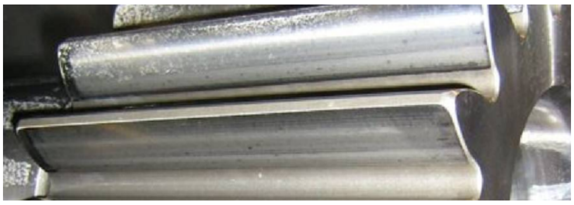
- Specific lubricant film thickness λ_{GF}
- Reduced gear tooth accuracy
- Filtration as standard

If the film thickness gets so small that the gear flanks come into contact with each other – in other words, if the lubricant film gets thinner than the surface roughness and mixed friction is generated – then damages of the surface appear.

The critical factor in assessing whether a gear set is at risk of micropitting is the specific lubricant film thickness λ_{GF} – i.e. the ratio between the lubrication space width and surface roughness.

Micropitting is characterized by surface damage in form of fissures which run from the surface of the tooth face to its interior. These are very small pits (hence the term "micropitting") of around 10 to 20 µm depth, 25 to 100 µm length and 10 to 20 µm width. The resulting grey flecks give the tooth flank a matt appearance.

Although micropitting most often appears in case-hardened gears, it can also occur on nitrided, induction-hardened or non-surface layer hardened gears.



The removal of material from the flank increases the profile error of the toothing and therefore leads to a general reduction of its quality and precision. After a time, the material removal may stop or this process can continue.

The damage this causes may result in higher dynamic loads which, in turn, increase noise levels or place greater load on the teeth until actual pits are formed.

The removed material can itself also damage the bearing unless it can be eliminated by lubricant filtration before this happens. This type of filtration is implemented as standard in the manufacture and operation of wind turbines.

Micropitting should therefore always be considered as a sizing criterion for gears, their modifications and for the lubricant.

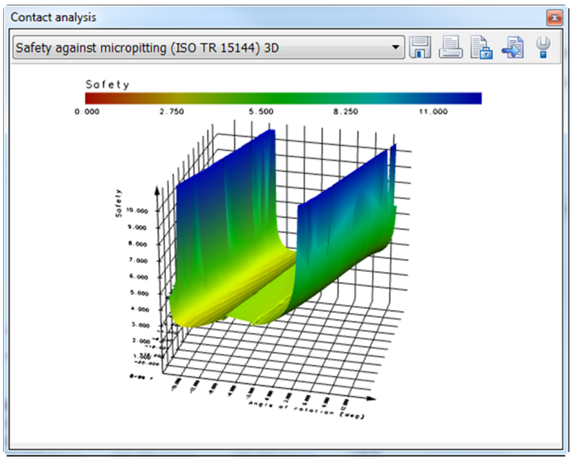
Technical Report ISO/TR 15144

- Determination of the specific lubricant film thickness
- Micropitting risk analysis
- Lubrication, surface structure etc.

A first draft of ISO TR 15144, which involved the calculation of lubricant film thickness and risk analysis with regard to the occurrence of micropitting, did not include data for determining the permissible specific lubricant film thickness λ_{GFP}. The values for λ_{GFP} had to be taken from other technical literature which were often contradictory.

However, the first official version of ISO TR 15144:2010 does include a definition of the permissible specific lubricant film thickness λ_{GFP}.

This extra data makes it possible to perform reliable calculations for safety against micropitting. In the second edition 2014 further details were specified more precisely.



In theory, micropitting will not occur if the lubricant film is thick enough. The permissible specific lubricant film thickness depends on which lubricant is used, in particular which additives are involved, the surface structure, and other parameters such as the hardening process.

As part of the powerful gear calculation functions, optimal meshing parameters may be defined to achieve the highest levels of safety against micropitting.

However, one should always include the results of practical experience in these calculations.

Degree of Detail

The calculation methods described above can be implemented in two different approaches:

Method B, including the analysis of normal force distribution, Hertzian pressure and temperature, can be applied for toothing without profile correction, in accordance with the specifications given in the standard.

Alternatively, one can use a contact analysis (LTCA) for the determination of the required values. This corresponds to Method A in the ISO standard. The second option does of course involve more time and effort. Having said that; powerful, modern computers can quickly perform the calculations involved in this more complex approach.

For reducing the risk of micropitting (e.g. in wind industry), today the toothing is generally made with profile corrections, hence the use of the Method A is essential in the practical experience.

Implementation in KISSsoft

The new version of ISO TR 15144:2014 provides an extremely effective, internationally recognized calculation method. It will give engineers a tool that is not only straightforward and easy to use but also delivers reliable information about the risk of micropitting.

If an actual risk of micropitting can be detected, measures can be taken early in the design to prevent this becoming a problem later on.