Lead correction derivation method for high capacity Turbo-Gears with high pitch line velocities for both single and double helical gears

The tooth flank temperature along the length of the mesh is not uniform during stabilized operating conditions and therefore Artec considers the temperature measurements of the oil flung out of the length of the mesh have no value in the derivation of the lead correction

Artec’s method in the derivation of lead correction’s for Turbo-Gears with high PLV’s is largely empirical. It is based on original MAAG Gear technology and Artec’s 30+ years of experience in observation of tooth bearing patterns at nominal loads. This technology first appeared in the 1960’s and developed rapidly over the following years with exhaustive testing and additional field installations with ever increasing size, power and pitch line velocities.

The application of toothing corrections first considers the mechanical elasticity of the gear teeth. This produces mechanical deflections which are well known and can be calculated. The Maag Gear Handbook section 3.52 on Elastic Deformations describes a method of calculation. Further reference is made to AGMA 927-A01 which was in part developed based on MAAG’s technology.

At the same time these mechanical deflections occur, thermal deformation occurs in the tooth mesh quite instantaneously creating a highly localized deformation. This component is not significant below pitch line velocities of 100 m/sec. and for applications where the pitch line velocities are in excess of 124 m/sec it becomes significant in the operating tooth deformation. However the application of the influence of this value is not easily measured. Moreover there are variations in its influence depending on the ambient environment; i.e. running speeds, size of the rotors, relative size of the rotors to each other, single or double helical, helix angle, housing configuration and tooth module.

There is an added measure of thermal deflection which occurs as the rotors heat up establishing a baseline body bulk temperature in each of the elements. This value increases due to higher quenching losses as the pitch line velocity increases. This adds a thermal deformation component to the operating gearset which is compensated for in the profile correction.

Through many years of R&D these values have been measured through extensive testing of various gear rotors at differing powers and speeds utilizing specialized internal temperature recording and strain gauging techniques.

For each and every unique design the tooth corrections are applied such that the flash temperature limit is never reached. Flash temperature is a product of the physical geometry of the elements and gear toothing of the rotors and is most notably derived by the so-called Blok Flash Temperature calculation first derived by Dr. Blok in the 1940’s.

The dimensional parameters of the rotor configuration define how the lead is modified. Its derivation is specific for a continuous single or double helix. Therefore, this calculation is largely dependent on the experience gained by years of observation of the tooth bearing patterns at nominal loads leading to accumulated empirical values based on well proven Maag Technology.

While AGMA 927-A01 provides only a methodology for calculating toothing deflections it recognizes the presence of thermal distortions affecting tooth form but does not provide a solution method. See section 10.1. Numerous other papers and publication on the matter are available (maybe submitted upon request);

a. Deformation of Gear Teeth and Rotors, J. Amendola 2006
b. Tooth Flank Modifications, Maag 2005
c. Maag Gear Handbook, 1990 chapter 3, section 3.5
d. Gear Toothing, W. Nageli, 1987
e. Thermal Behavior of High Speed Gears and tooth Corrections of High Speed Gears, L. Martinaglia 1972
f. Profile and Longitudinal Corrections on Involute Gears, H. Sigg 1965
g. Longitudinal Tooth Contact Pattern Shift, AGMA Technical Paper 11FTM18, J. Amendola 2011

API 613-5 mandates longitudinal modifications to the gearset be applied but does not specify methodology or referenced values. AGMA 6011-I03, ISO 6336, ISO 13691 do not provide specific methods of calculation.