MATERIALS MATTER

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Changes ahead in the roughness standards

Just when you thought it was safe to calculate a tooth flank surface roughness measurement, think again.

I have written numerous articles on tooth flank surface roughness measurement. This is such a page-turner of a subject! Actually, I was thinking I was done with this topic. After all, I occasionally get a comment that "such and such" gear shop now has a profilometer. In addition, several AGMA or ISO gear standards now have sections on tooth flank roughness measurement. Mission accomplished.

What more could I possibly write about on flank roughness and its measurement, right?

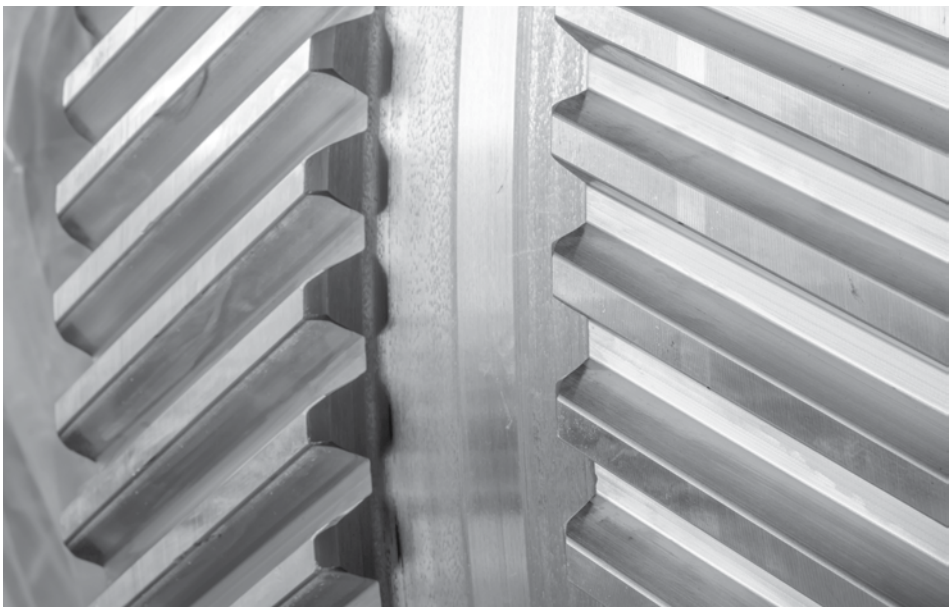
Time for a mea culpa. I have sort of misguided you. My quest to get repeatable and reproducible tooth flank roughness measure was based on four key ISO standards:

- **ISO 4287:** the definitions of the roughness parameters *Ra, Rq* etc.
- **ISO 4288:** the process of roughness measurement, the filter, cut-off length, etc.
- **ISO 3274:** the requirements of a contact stylus profilometer.
- **ISO 1302:** the roughness diagram, the checkmark.

Unfortunately, I recently found out these and several related ISO Standards are about to be withdrawn and replaced with different standards. So, time for one last article on surface roughness.

THE ISO STANDARDS

The four ISO standards listed above are part of a family of GPS (Geometrical Product Specifications) standards related to two-dimensional (2D) surface texture analysis. There are many more 2D GPS standards, such as ISO 16610-21 (the Gaussian profile filter) or ISO 12179 (calibration of a contact stylus profilometer). Most of these standards were published in the late 1990s and have been regularly reaffirmed but without significant updating.



Gear designers and manufacturers will need to review and update their tooth flank roughness specifications based on the new ISO 21920 GPS family of standards. (Shutterstock)

Between 2012 — 2016, a new GPS family of standards was published — the ISO 25178 family. These establish a new universal basis for surface texture analysis by first defining areal (3D) surface texture. Concurrently, ISO TC213, WG16 (TC = Technical Committee, WG = Working Group) began a project to update the family of 2D GPS profilometry standards.

In the fall of 2012, WG16 started revising the 2D standards to align them with the planned structure of the new ISO 25178, 3D surface texture family. In August 2016, the project was officially registered under the reference code ISO 21920.

To date, three new ISO 21920 standards have been drafted and are classified as ISO/DIS (Draft Standard). These three new GPS standards will consolidate the majority of the previous 2D surface texture standards. They are currently undergoing the twelve-week balloting process that began on February 19, 2020, and will end on May 13, 2020. Once the balloting process for these three draft standards is complete, and assuming they are accepted, it will take an additional eight weeks to publish the official ISO standards. By my mathematics, the new 2D surface texture standards will become official around July 8, 2020.

THE NEW STANDARDS

The new 2D surface texture standards are:

- **ISO/DIS 21920-1:** Geometrical product specifications (GPS) – Surface texture: Profile – Part 1: Indication of surface texture.
- **ISO/DIS 21920-2:** Geometrical product specifications (GPS) – Surface texture: Profile – Part 2: Terms, definitions, and surface texture parameters.
- **ISO/DIS 21920-3:** Geometrical product specifications (GPS) – Surface texture: Profile – Part 3: Specification operators.

Part 1 will incorporate all of ISO 1302 and some additions from other ISO GPS standards such as ISO 1101.

Part 2 will incorporate all the existing profile parameters (i.e. ISO 4287, 4288, ISO 12085, and ISO 13565). It will also include some new parameters, such as *Pvv* (void volume of the valleys on the primary profile) which is adapted from ISO 25178's *Svv* parameter. Note: This might become an interesting parameter for tooth flanks since it is a measure of retained lubricant volume on a surface. Finally, Part 3 will specify additional default values and units of the parameters

related to surface texture. Once published, the following standards will be withdrawn: ISO 1302, 4287, 4288, 12085, 13565-2, and 13565-3.

Regarding contact stylus profilometers, I do not know of any plans to write new standards describing the minimum characteristics of these instruments or their calibration.

Contact stylus profilometers are well-defined already and incorporated in ISO 25178 Parts 6 and 7. I expect ISO 3274 will also eventually be withdrawn.

THE ROUGHNESS CHANGES

The new ISO 21920 standards have a few important changes that relate to gear specifications.

First is that certain roughness parameters such as Ra and Rq are now defined on the entire evaluation length. Remember, Ra and Rq are used to predict tooth fatigue or durability. Previously, ISO 4288 divided the evaluation length into five sampling lengths where parameters were calculated and then averaged together. The new ISO 21920 will calculate Ra and Rq only once on the entire evaluation length. However, Rz will still be calculated by the averaging of five sample lengths to reduce the influence of large outliers.

In addition, the old 16 percent rule will no longer be the default rule in surface roughness measurement. In ISO 4288, the 16 percent rule is the default procedure. It is quite complex and often misunderstood. It allows for multiple roughness measurements to meet a specification. I liken it to hunting around on a surface until you find the number you need. In ISO 21920, the 16 percent rule is replaced with specifying a specific number of measurements on a surface and setting an allowable tolerance range based on a statistical parameter. Alternatively, ISO 21920 states a single maximum or minimum roughness limit shall be specified. Any roughness measurement outside of the limit will result in a rejection.

CONCLUSION

The new ISO 21920 GPS standards can affect the gear industry. The different values of Ra or Rq could be significant when measuring tooth flank roughness using the newer method compared to the old ISO 4288 method. Also, this can be particularly true if the roughness limits are specified to a maximum or minimum, rather than incorporating the old 16 percent rule. Gear designers and manufacturers will need to review and update their tooth flank roughness specifications based on the new ISO 21920 GPS family of standards. These standards should be published in July 2020.

ABOUT THE AUTHOR

Mark Michaud, REM Technical Fellow of REM Surface Engineering, is the inventor and pioneer of REM Surface Engineering's chemically accelerated finishing technology. He has authored numerous patents and technical papers and served a term on the AGMA Board of Directors. He continues to serve as vice chair of the AGMA Aerospace Committee, as a member of the AGMA Wind Turbine Committee and as a shadow delegate on the ISO 61400-4 Wind Turbine Committee. He can be reached at mmichaud@remchem.com.

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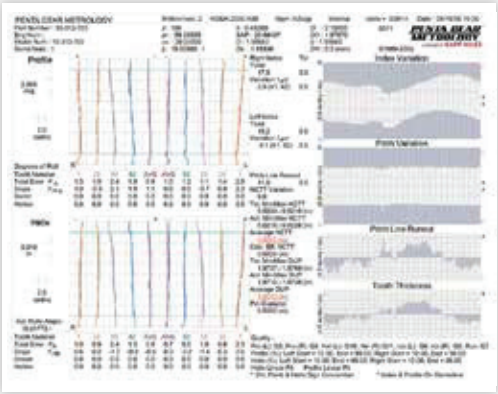

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