Comparison of Strength Rating of Plastic Gears by VDI 2736 and JIS B 1759 - In Vision of Building a New International Standard | VDI Wissensforum

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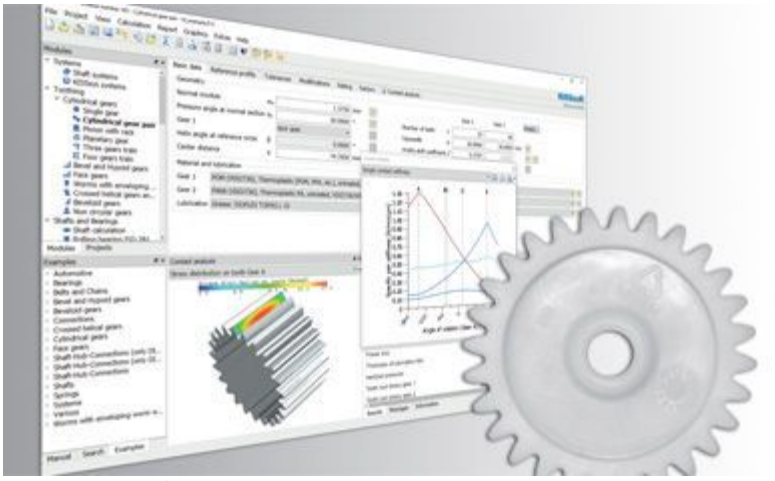

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The applications of plastic gears are greatly expanding in modern industry as alternatives to metal gears. Plastic gears have various benefits in terms of weight, noise, vibration, lubrication, and in design and production when injection molded. At the same time, there are several drawbacks such as lower accuracy, lower strength and higher sensitivity to the operation environment such as temperature and humidity. Both the benefits and drawbacks are mainly caused by its material properties. Thus, the strength rating considering the special material properties of the plastics is inevitable for the reliable design of plastic gears. However, no international standard is available for the calculation, but only domestic level or in-house standards are in use; one could say essentially every major plastic gear supplier has its own calculation method.

This situation is a big obstacle for plastic gear industry because it hinders easy exchange of the design knowledge and information. It is common that the design and the production of plastic gear drives are made on global level; for instance, an automotive company has multiple suppliers from different countries for the plastic gear drives that are used in their cars. How can the engineers guarantee that all the drives have the same level of safeties and life expectancies if they are designed by different calculation methods?

In western countries, the only widely accepted strength rating method for plastic gears had been the German guideline VDI 2545 which was withdrawn in 1996. After almost 20 years of hibernation period, the VDI published a new guideline VDI 2736 in 2014 as the successor of the old guideline. On the other hand, a Japanese standard JIS B 1759 was newly published in 2013 for the calculation of bending load capacity of plastic gears. Both standards are quite similar in a sense that the VDI 2736 is based on DIN 3990 and the JIS B 1759 on ISO 6336 which is essentially equivalent to DIN 3990. However, both DIN 3990 and ISO 6336 are intended to be applied only for metal gears, and thus several adaptations has been made in VDI 2736 and JIS B 1759 respectively to consider the special characteristics of plastic gear geometry and materials. This leads to differences in several points. For instance, VDI uses nominal load applied on reference diameter while JIS assumes the load applied on operating pitch diameter. VDI applies the load increasing factors (K factors) while JIS does not. In addition, there are differences in the geometry related factors such as the tooth form factor and the stress correction factor. VDI assumes that the load is applied at the tooth tip when calculating the geometry factors while JIS takes the load applied at the highest point of single tooth contact. The VDI's approach gives more conservative result to consider lower quality and dimensional variation of plastic gears. However, this approach is questionable as new materials with better mechanical properties have been developed in recent years and the advances in design and manufacturing technologies has been achieved. On the other hand, JIS B 1759 has the limitation that it doesn't provide any material data for allowable bending stress. Once the user defines the allowable stress, JIS introduced operation related factors such as the temperature factor,

the temperature rise factor, the lubrication factor, and the material factor to obtain permissible bending stress. Another limitation of JIS is that it provides only the bending load capacity without treating other important failure modes such as pitting and wear resistance.

The authors' objective is to initiate a discussion for a global consensus on the strength rating method for plastic gears in near future. This paper clarifies the differences of VDI 2736 and JIS B 1759 in detail and presents the comparison of the calculation results to provide a foundation for the discussion. It cannot be emphasized enough that a well-established international standard is most important for the rapid evolution of plastic gear technology.

Authors

Dr. Inho Bae
is the head of technical support for KISSsoft and KISSsys software suites of KISSsoft AG in Switzerland. Dr. Bae obtained his Ph.D. degree in 2002 from Hanyang University in Korea for the research on the design of multi-stage gearboxes. After three years of work as a post-doctoral research fellow at Kyoto University in Japan, he started his work for KISSsoft AG in Korea in 2005. Dr. Bae moved to KISSsoft AG head quarter in Switzerland in 2008 as a software developer for various topics on gear design and analysis.

Dr. Ulrich Kissling
studied mechanical engineering at the Swiss Federal Institute of Zurich (ETH). From 1981 to 2001, he worked as a calculation engineer, technical director, and then as managing director of Kissling Co., a Swiss gearbox company located in Zurich, focusing on planetary, turbo, and bevel-helical gearboxes for industrial applications and in the ski lift business. In 1998, he founded KISSsoft AG and has been acting as the president. He is the chairman of the gear committee of the Swiss Standards Association (SNV) and the voting member of Switzerland in the ISO TC 60 committee. He has been involved in numerous engineering projects ranging from micro plastic gears to large open gears. He has published over 70 publications on the calculation for machine design and has presented numerous papers at the major international gearing conferences.