MEASUREMENT OF CYLINDRICAL GEAR AIR, GEAR WITH STANDARD SOFTWARE CMM

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Summary

Air gears must meet high performance criteria for accuracy, therefore quality control is necessary for their production. CMM Software determines the capabilities and scope of the measuring machines. The choice of measurement method should be carried out taking into account the accuracy of gear and taking into account the capabilities of the system and measurement needs. Item will present the methodology of measurement of cylindrical gears using a standard CMM software. The results of these diagnostic tests to prevent the need to purchase additional software, the measuring machine and its setup. You should only choose a method of analysis that will be carried out directly in the environment measuring machine, or will be made in the CAD system based on the geometry acquired during the measurement with respect to the virtual model. In the second case export is needed in the appropriate format measurement data to CAD software.

Keywords: economic aspects of diagnosis, diagnostic, gear, cylindrical gear, aircraft gearbox, coordinate measuring technique.

POMIARY KÓŁ ZĘBATYCH WALCOWYCH PRZEKŁADNI LOTNICZYCH Z ZASTOSOWANIEM STANDARDOWEGO OPROGRAMOWANIA CMM

Streszczenie

Koła zębate przekładni lotniczych muszą spełniać wysokie kryteria dokładności wykonania, dlatego niezbędna przy ich produkcji jest kontrola dokładności. Oprogramowanie współrzędnościowych maszyn pomiarowych decyduje o możliwości i zakresie zastosowania maszyn pomiarowych. Dostępne są na rynku specjalistyczne maszyny pomiarowe wyposażone w oprogramowania do pomiaru kół zębatych, które umożliwiają w pełni automatyczne pomiary odchyłek zarysu (ewolwenty), linii zęba, podziałek i bicia promieniowego, topografii boku zęba.

Wybór metody pomiarowej powinien odbywać się z uwzględnieniem dokładności wykonania koła zębatego oraz z uwzględnieniem możliwości sytemu i potrzeb pomiarowych. Artykuł będzie przedstawiał metodykę pomiaru walcowych kół zębatych z zastosowaniem standardowego oprogramowania CMM. Zaletą pomiarów kół zębatych z wykorzystaniem uniwersalnego oprogramowania pomiarowego, jest możliwość pomiaru kół o dowolnej geometrii w odniesieniu do modelu CAD. Wyniki powyższych badań diagnostycznych zapobiegają konieczności zakupu dodatkowego oprogramowania maszyny pomiarowej oraz jej przezbrajania. Analizy przeprowadzać można bezpośrednio w środowisku maszyny pomiarowej, albo w systemie CAD, na podstawie geometrii pozyskanej podczas pomiaru w odniesieniu do modelu wirtualnego. W drugim przypadku niezbędny jest eksport w odpowiednim formacie danych pomiarowych do oprogramowania CAD.

Słowa kluczowe: ekonomiczne aspekty diagnostyki, diagnostyka, koła zębate, koła zębate walcowe, przekładnie lotnicze, współrzędnościowa technika pomiarowa.

1. INTRODUCTION

The fulfillment of complex design requirements found in industry, especially in the aerospace technique and the need to cope with competition forces to ensure the production of a high performance and the quality of products. The effectiveness of the measurement process depends on the accuracy of the measuring equipment of the measuring device, but also to a large extent on the knowledge and skills of the operator. A large impact on the results of measurements of gears have their geometric features.

The course of the measurement process must be planned taking into account the accuracy of the production of gears, wheel type, as well as technology it has been made with. Selection

of measurement strategy enables to shorten the measurement time while at the same time maintaining or even improving the accuracy of measurements.

Currently used measuring devices provide a very versatile range of applications. Software of coordinate measuring machines enable the measurement of regular geometric elements and the possibility of establishing a relationship occurring between these elements, as well as contain the procedures for designating standard deviation of shape, or location.

If you do not have a special software to measure the gear you should have a measurement process prepared based on 3D CAD model of the gear. It is necessary in this case to prepare a strategy based on the measurement of 3D-CAD model and to load points or paths from the CAD model. The results of measurements relate to the 3D-CAD model, treating it as the nominal model.

Gears can be measured by non-contact or contact methods – measurement point or scanning. The choice of method of measurement should be carried out taking into account the precision of production of gear and taking into account the possibility of the system and measurement needs. Another factor influencing the choice of the method of measurement is the time required to execute it and analyze the results. An indisputable advantage of measuring gears using a universal measurement software is the ability to measure the wheel of any geometry with respect to the 3D-CAD model. Starting cylindrical gears, the bevel gears, volute and ending at the gears contoured with involute, it is possible to analyse the deviations of a contour, line of the tooth, as well as the geometry of the lateral surface.

The developed methodology of measuring cylindrical gears (Fig. 1) using standard CMM software is a contribution to the research, in which there have been developed procedures for the gear measurement of any gear tooth profile geometry.

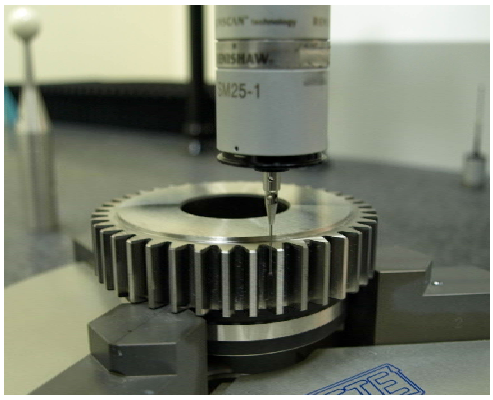

Fig. 1. Model research: cylindrical gear

The measurements were made using a coordinate measuring machine Wenzel. As part of participation in EU-funded projects the analysis of the accuracy of the gears were carried out, not only cylindrical of involute contoured but also non-involute, helical, and bevel but also made with a variety of techniques. This made it possible to develop a methodology for analysis of the accuracy of the gears in relation to the nominal models of the gears [3].

2. METHODOLOGY OF GEAR MEASUREMENT

The developed methodology for measuring gear consisted in comparing of the actual surface of the 3D CAD model. Based on 3D CAD models of gears it is possible to measure the characteristic geometrical quantities describing the gear along with the determination of their deviations. Analysis of deviations of gear i.e. line or tooth profile with respect to the 3D CAD model were performed using a coordinate measuring machine, and based on your software Metrosoft (Fig. 2).

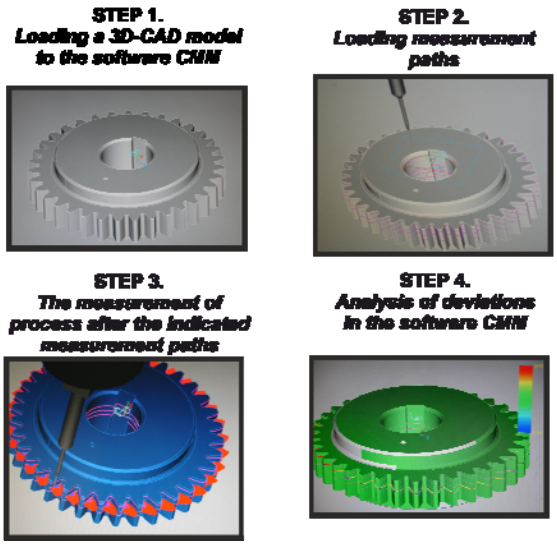

Fig. 2. Measurement of the gear with respect to the virtual model using the CMM

When measurements are performed, the strategy should be consistent with the design documentation and technological of the measured gears. Owing to the developed measurement procedure, standard CMM software was used to measure gears. The developed method allowed to replace expensive specialized software for measuring gear, which further enables measurements of gears contoured with non-involute (e.g. TGear XY).

The essence of measurement is in the importing of standard file to the measuring machine software, and then carrying out the measurement procedure, either in point mode or scanning (Fig. 3).

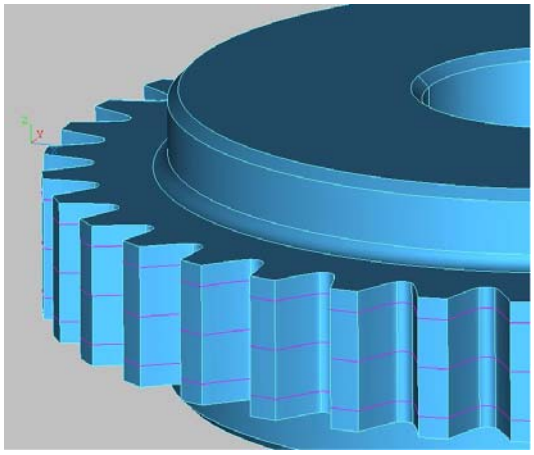

Fig. 3. Model 3D CAD of the gear and the measuring path in the carried out studies

Software during the measurement directly determines the deviation of measured points and checks whether they fall within the tolerance prescribed by the user (Fig. 4).

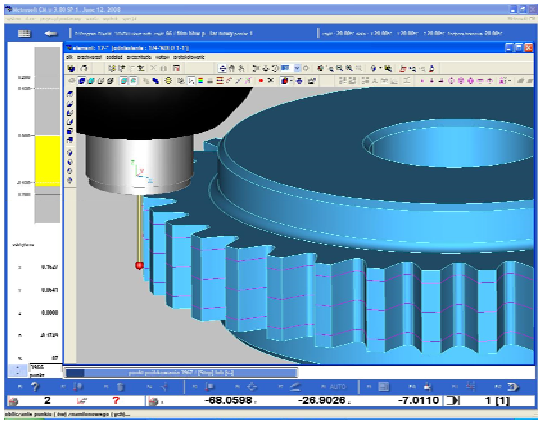

Fig. 4. The dialog box of the software Metrosoft presenting-3D CAD model of the gear and the measuring path in the carried out studies (visualization of deviations of gear outline)

3. ANALYSIS OF GEARS

The results of measurements in the form of measurement protocols are presented: the analysis of the outline of the gear (Fig. 5), analysis of the deviations of the tooth line (Fig. 6). The measurement results are displayed as color maps deviations, where you can also give the numerical values for the selected points (Fig. 7).

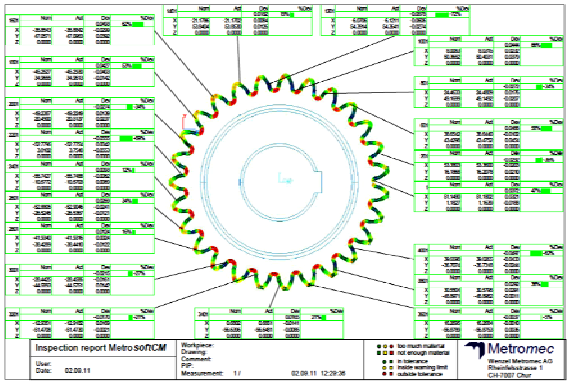

Fig. 5. Measurement of outline involute cylindrical gears - measuring protocol

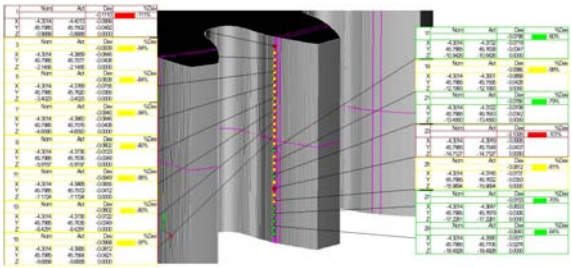

Fig. 6. Measurement of tooth line - measurement protocol

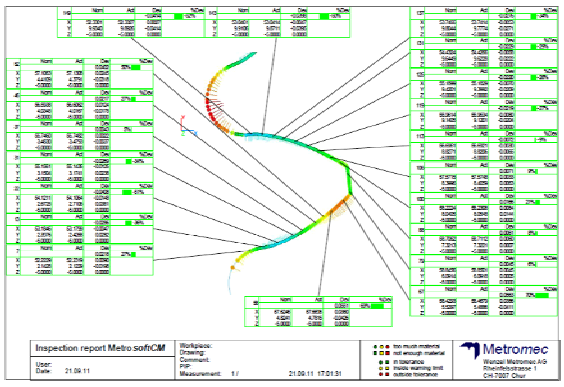

Fig. 7. A detailed analysis of deviations in the outline on the selected tooth at a given tolerance ±0.08 mm

In the developed methodology, the analysis of the results is a little more complicated and time-consuming than with the results obtained from specialized software CMM. In order to obtain comprehensive data on the shape deviations or accuracy class of the performance of gear the need to make use of standards for the gears is inevitable.

CONCLUSIONS

Coordinate measuring systems are widely used in many fields of technology. Most commercial software includes the development of a universal measurement and, depending on the needs of users are complemented by specialized packages to measure such as gears or blades [1,4,5,6]. One of the main advantages of computer-aided measurement methods is the ability to perform measurements with respect to the nominal model of the 3D-CAD at various stages of the manufacturing process. This is particularly important in the manufacture of toothed air gears. On the basis of the 3D CAD models of gears acquired in the research process it is possible to measure the characteristic geometrical quantities describing the gear along with the determination of their deviations. At the same diagnostic tests performed streamline the manufacturing process. The value of the standard uncertainty resulting from the repeatability of measurements, for example, the tooth line was 0.002 [mm][8].

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