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Analysis of Vibration Monitoring in Gear Manufacturing

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ABSTRACT

In order to produce high-quality gears, gear hobbing is the most common method. To remain competitive in the market, manufacturers must produce gears of the highest quality at the lowest possible cost. Unprecedented downtime is caused by catastrophic machine failures. The use of condition monitoring techniques can help to keep these failures at bay. The purpose of this paper is to summarize previous studies on the gear hobbing process and make recommendations for future research.

Keywords : gear hobbing, condition monitoring, vibration, defects.

INTRODUCTION

In order to keep machines, instruments, and equipment running, gears are one of the most important mechanical components. The transmission of motion is accomplished through the use of gears. They can also be used to alter the power source's speed, direction, and torque. A gear manufacturing industry must constantly improve its production with limited tool reliability in order to remain competitive in the market. Gears are typically made of steel, but nonferrous metals like plastic and ceramics can also be used in their construction.

Manufacturing high-quality gears through the art of gear hobbing is a time-tested process. Cutting the teeth on spur gears and helical gears is a common industrial process known as "hobbling." To manufacture bevel and internal gears, Hobbing cannot be used. Using hob tooling has the following advantages:

1. Low tooling costs

2. Precision over a wide range of sizes

3. Workability for materials with a normal-to-higher hardness.

It is possible to generate new gear indefinitely by utilizing the hobbling process. It is common for gear hobbing to use a synchronous rotation between the hob and work piece . All three of these options are available for feeding.

Tolerances of the tool and work piece or clamping displacements can cause deviations in the hobbing

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process [6]. As shown in Fig. 10, there are a variety of possible tool deviations. Pitch and concentricity deviations, also known as flank profile deviations, are what we're dealing with here. Because of manufacturing tolerances or tool wear, the actual flank profile may deviate from the ideal. Several types of pitch deviations can be consolidated into the pitch difference between two teeth of the hob. Two distinct types of deviations can occur during tool clamping. Tumbling and eccentricity deviations are the cause of these anomalies. This eccentricity results in the tool profile having an evenly varying radial run out, while tumbling tilts it to an eccentricity that is dependent on how far away the hob tooth is from the hob axial middle.

LITERATURE REVIEW

An investigation into the vibration patterns of two industrial gear hobbing machines has been conducted by researchers from the University of Texas at Austin (UT Austin), the University of Colorado Boulder, and the University of California, Los Angeles (UCLA)[1]. Accelerometer and impact hammer were used to measure the natural frequencies. Each system's Frequency Response Function is calculated using a dynamic signal analyzer that connects to the sensors. Under the first impact frequency range, the tool's low rotational speed and strong rigidity prevented a resonance condition from forming. This part was cut using the same parameters and the same cutting tool by both machines (A and B). Despite the fact that machine A's efficiency was 25 percent lower than machine B's efficiency due to excessive vibrations, the cracks on the tool surface clearly show.

Libin Zhu and Ying Zhang are coauthors on the paper. [2] Dry hobbing cutting parameter optimization model is presented by the authors. It is the purpose of this experiment to improve hobbing performance. In order to solve this model, an iterative testing method is proposed. The SINUMERIK 840D NC system was also used to develop an online adaptive application system for use in an automated production line. It was found that this model and system can be used to optimize the parameters of five different types of material gear.

Stuckenberga[3]. They studied the appearance of surface defects on a planetary gear, which is a modern dry gear hobbing process. The most common surface defects are weld-on chips and smeared areas. Manufacturing simulation is used to compare defects to typical process values and to determine the root cause of the problem. Defects appear to correlate well with cutting parameters such as cutting length, kinematic clearance angle and the compactness of chips, according to this comparison.

There are three authors: Dong X, Liao C, Yin Y. Gear hobbing tool wear progression is examined in this paper using an experimental-analytical method and tool geometry [4]. A three-dimensional (3D) finite element model is presented in this paper. Modeling the complex motion between hobbing tools and gear work pieces as well as performing a coupled thermo-mechanical analysis on the tools and work pieces during the chip removal process is the primary purpose of this model. Using the model, important cutting parameters, such as cutting forces and torques, as well as the temperature and stress distributions of the hobbing tools and work pieces, can be predicted.

Juan Dai, C. L. Philip Chen, Xiao-Yan Xu, and Peng hu [5] are the authors. A cold press rolling machine in an aluminum factory has been fitted with a vibration theory to help detect problems before they become costly. When combined with voice monitoring, vibration measurement is used to determine the health of the machinery. This system's goal is to establish a link between system vibration response and faults, making it easier to catch problems early on. According to the paper, a cold press machine at an aluminum factory is equipped with three accelerometers and three microphones. This signal is compared to those produced by spectrographs in other working environments to look for potential problems.

Christoper Löpenhaus, Markus Krömera[6].This paper's goal is to simulate non-ideal gear hobbing processes and compute the workpiece's geometry and topography. A continuous gear hobbing simulation was created in order to meet this goal. Markus Piber, Orrin Kleinhenz, Masahiko Mori[7]. There are two milling methods described in this paper, and the paper compares their quality and production times to those

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of traditional gear manufacturing techniques. In addition to enabling new gear design strategies and efficient machining of specialised gear forms, the two new methods discussed in the paper have other advantages. Ultimately, it was found that new methods can produce better gears than traditional methods in pre-heat operations. A. Antoniadis and V.

Dimitriou[8]. A three-dimensional computer-aided design approximation is used to make an accurate and reliable estimate. Direct application of hob kinematics in a single gear gap. In each generating position, the workpiece is bounded by a spatial surface path that defines its penetration volume.

Agoston Katalin[9]. The purpose of vibration and acceleration sensors is examined in this paper by the authors. An acceleration sensor, the ADXL202, was used to build a data acquisition board, which could be connected to a computer and transmit real-time data. Static and dynamic accelerations can be represented separately in the software thanks to its design. LabWindows/CVI virtual instrumentation is used for data visualisation and analysis. The ADXL202 acceleration sensor's great potential is demonstrated by the data acquisition board and software.

Ibtissem.Maria Pietrzak-David, Tan-Hoa Vuong, Akacha Helal, Jacques David, Najib Mrabet Bellaj[10]. A capacitive sensor-based method for detecting electrical motor vibration signatures was presented in this paper. Vibration detection can be improved by using multiple sensors. This method will be used for wireless motor monitoring. Rotational machine vibrations were successfully monitored using this method.

Two industrial gear hobbing machines were examined by, Bouzakis et al. [12] found that tool wear progressed linearly and steadily. The rate of tool wear in this study can therefore be evaluated using the assumption of a uniform wear rate. An extensive range of studies on machining processes have shown that the

Usui wear rate model can accurately predict the wear rate of carbide tools during gear hobbing processes [13].

The enormous advances in condition monitoring techniques especially vibration analysis have not benefited this process as much as turning, milling, and drilling processes have. With regard to both entry and exit strokes in the gear hobbing process, the cutting force is lower in both cases. For this reason, as with many other rolling-principle cutting processes, the gear hobbing process is a highly multi-parametric and complicated gear fabrication method. The fault diagnosis of rotating machines has been aided by a variety of vibration analysis techniques. Research in the past few decades has looked at vibration techniques from an entirely new perspective. It is vital to the health of a machine. There will always be a small amount of vibration, even in the best operating conditions, due to minor defects. Normal levels of vibration can be found in all machines. However, there are times when the machine's vibration level is too high. Most of the time, it's due to some sort of technical difficulty. Unbalance, misalignment, worn gears or bearings, looseness, etc. are all possible causes of excessive vibration. Sensors are used to gauge the machine's trembling frequency. The proximity sensor, velocity transducer, and accelerometer are all parts of a proximity sensor. For vibration analysis, accelerometers are the most common tool. Data collection, feature extraction, and fault detection are the first three steps in rotating machine fault diagnosis. The efficient fault diagnosis system relies heavily on effective feature extraction. Noise often contaminates the vibration signals that sensors collect. These tainted signals can make it difficult to identify the source of a problem. Vibration features or signatures can go unnoticed without the help of certain techniques. To aid in the detection of machine faults, feature extraction techniques can be used to locate specific components in signals .

CONCLUSION

It has been thoroughly researched and extensively discussed in a significant number of research publications about the vibration behaviour of milling tools, notably end milling tools. A gear hobbing machine, on the other hand, has received little attention in terms of research on its vibrational behaviour. It is therefore necessary to conduct additional research into the subject. Among the

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industries that manufacture gear hobs, time-based maintenance (TBM) is the most extensively utilised maintenance method. While hidden failures can be identified and prevented during preventive maintenance (TBM), hidden failures cannot be detected or prevented during continuous preventive maintenance (CBM). The quantity of publicly available research on the development and practicality of Condition Based Maintenance in hobbing machines is also limited, and more study is required to fill in the gaps that have been identified. Also required is specific research on the appropriateness of external measurement devices such as temperature and vibration sensors, as well as acoustic microphones, for use in the field.

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