International Journal of Interdisciplinary Innovative Research &Development (IJIIRD)
ISSN: 2456-236X
Vol. **08** Special Issue **01 | 2023**

Surface Characteristics of Finish Hobbed Gear- A Review

Govind Shantaram Dhage[1, 2], Dr Ramkisan S Pawar[3, 4], Mr Jotiba Patil[5]

[1] *Phd Research Scholar,Dr Babasaheb Ambedkar Marathwada Univeristy,Aurangabad,Maharashtra,India*
[2] *Assistant Professor, Mechanical Engineering,Hi-Tech Institute of Technology, Aurangabad, Maharashtra,India*
[3]*Research Guide, Dr Babasaheb Ambedkar Marathwada Univeristy,Aurangabad,Maharashtra,India*
[4] *Principal, Padmabhooshan Vasantdada Patil Institute of Technology, Bavdhan, Pune,Maharashtra,India*
[5] *Managing Director,Sarvesh Engineering, MIDC Waluj,Aurangabad, Maharashtra,India*

ABSTRACT

Design and manufacturing methodologies are already decided in the manufacturing industry. In order to transmit power and motion, gear is a crucial component. It should be error-free. For effective power transmission, the teeth's surface properties should be optimal. Grinding is eliminated by CNC finish hobbing machines, making it simpler to make the gear with the necessary surface qualities. Analysing process-wide variations can be used to evaluate the quality of machined gears. Process parameter optimisation enhances gear hobbing. Treatment and research on cutting tools, cutting fluid, cutting parameters, and workpiece parameters can enhance the quality of hobbed gear. According to the study, giving the hob cutter a cryogenic treatment will improve gear hobbing. Comparative investigations should be conducted both before and after cryogenic treatment on the hob. Finding the ideal cutting conditions for Pfauter Gear Hobbing is essential for achieving optimal productivity, quality, and tool life. The gear hobbing machines studied in the past have improved productivity by enabling quicker cutting rates and longer tool lifetimes. The American Gear Manufacturing Association (AGMA), the Deutsches Institut für Normung (DIN), and the Japanese Industrial Standards (JIS) have established the most widely used standards for describing gear quality. Microgeometric deviations are used to measure gear accuracy and quality. Runout error, which determines the form and location of the gear teeth, as well as pitch errors related to the actual positioning of the gear teeth are examples of microgeometric deviations.

***Keyword** - Gear hobbing, CNC Finish hobbing, DIN, Gear Quality, Gear teeth*

1. INTRODUCTION

Manufacturing methods for gears for transmissions include hobbing, milling, and shaping forged stock. Utilising a spinning cutter known as a hob, gear hobbing creates gear teeth. It is used to make splines, helical, spur, and worm gears. A high surface quality is required for the gear tooth flank. Gear hobbing enables the production of gears with various module configurations, weights, and diameters. The blank is first dragged inward towards the hob during gear hobbing until the correct depth is obtained. Once the depth is reached, both the gear and the hob are fed across the face of the gear until the teeth are finished.

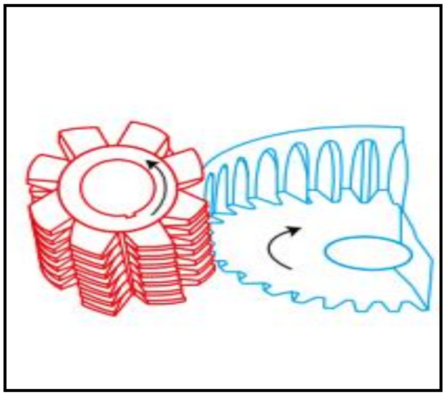

Figure-1. Gear Hobbing[1]

Traditionally, hobbing and then grinding are used to create gears. The gear can only be produced using two manufacturing procedures. The CNC completed hobbing machine has replaced grinding in modern times. On a CNC finished hobber, it is simple to make the gear with the desired surface characteristics. In CNC hobbing, a range of process parameters can be modified, allowing for easy study of their effects. Determine the precision of gear cutting and lower the cost of production are very significant. Thermally generated geometrical defects are usually insignificant because the gears are frequently subjected to a subsequent, intensive machining procedure. The quality of machined gears is impacted by a number of factors, including the tool's accuracy, how it is clamped to the workpiece, and the hobbing machine's kinematic errors. The quality of the gear can be assessed through analysis of the overall deviations in the process.

Regarding gear hobbing, a few more recent breakthroughs have been made, namely, advancements in substrate materials and coating systems, which have increased productivity by allowing for faster cutting rates and longer tool lives. The influence on the tool investment as well as the subsequent cost per piece must be investigated, though, as we all know that higher performance results in higher tool prices. Simplifying the process chain is an additional strategy for increasing productivity. Finally, the potential for cost reductions through process substitution is covered, with examples of finish hobbing as the main focus. In order to replace shaving as the conventional soft-finishing technique, novel tool concepts that aim to improve process performance in terms of tool life and workpiece quality are introduced. Equally crucial is the possibility that new applications could emerge if the natural twist of finish hobbing could be reduced or controlled. [9]

Fine machining is the last step in many gear manufacturing process chains. Therefore, precision machining is primarily used as the quality-defining stage in the production of gears. Both hard and soft workpieces can be used to finely manufacture gears. Gear honing and gear grinding are the most widely used techniques for rigorous finishing. Soft finishing technologies are an alternative to harsh finishing techniques for fine machining. The two most popular soft-finishing methods are gear shaving and gear finish hobbing. Gear finish hobbing has a higher potential to develop into an economical and environmentally friendly way of finishing gears than gear shaving.[10] By using a dry-cutting approach in finish hobbing, a totally dry production chain can be achieved. If the gear finish hobbing process and the related component qualities are under your control, you might be able to cut the production chain in half. The construction of the external shape and functioning surfaces is the prerequisite for manufacturing. During the subsequent hobbing technique, only minor shape modifications are permitted. Furthermore, the surface after hobbing has to meet strict requirements because the tooth does not go through additional processing where faults could be corrected. The component has undergone heat treatment and is now ready for gearbox installation. Gear finish hobbing has considerable economic potential since it can avoid expensive hard finishing. A basic need of the gear finish hobbing process is to maintain the fewest possible shape deviations. Hobbing is always based on process-related form imperfections. These are the generating-cut deviations (δy) and the feedmark deviations (δx).

Gear finish hobbing is typified by high-speed machining of the stock to create gears with the fewest shape variations and the best surface properties. Compared to other finishing methods used in the manufacture of gears, gear finish hobbing provides benefits for the environment. The quality of a piece of gear can be assessed by comparing the microgeometry deviations to those demanded by a number of international standards. The American Gear Manufacturing Association (AGMA), Deutsches Institut für Normung (DIN), and Japanese Industrial Standards (JIS) have all established standards for describing gear quality that are most frequently utilised. The cylindrical gear quality standard DIN 3961/62 is broken down into 12 numbers, with lower DIN numbers denoting higher quality and vice versa. [10]

1.1 Types of Errors in Gear:

Gear precision and quality are assessed by microgeometric deviations. Runout error, which affects the shape and placement of the gear teeth, and pitch variations, which have to do with the actual positioning of the gear teeth, are examples of these deviations. Form deviations, also referred to as deviations in lead and deviations in profile; refer to changes in the gear teeth's shape and slope, respectively. While location deviations, or cumulative pitch deviations, refer to the difference between the accumulation of theoretical pitches and actual pitches throughout the gear teeth, radial runout refers to the largest variance in the radial positioning of gear teeth assessed with respect to the nominal position. A gear's functional performance qualities are controlled by the degree of accuracy in these factors. While mistakes or deviations in total pitch (Fp) and radial runout (Fr) are responsible for a gear's capacity to transfer motion and maintain gearbox precision, respectively, errors or deviations in total lead ($F\beta$) and total profile (Fa) have a significant impact on a gear's ability to generate noise and its ability to bear loads. Surface roughness factors like average roughness (Ra) and maximum roughness (Rmax) influence both the service life of a gear and, to some extent, its functional performance. [10] It is important to understand the reasons behind manufacturing defects in spur gears. These mistakes have a negative impact on how well the gear works. Consequently, it is essential to produce high-quality gears. To improve the gearbox of power, torque, and speed without any loss, it must have perfect geometry. flaws in position and form are used to categorise flaws in the micro geometry of gears. The features of gear's load carrying capacity and noise generation are caused by form errors. On the effectiveness of the gearbox and the gear's ability to transfer motion, location mistakes have a negative impact.

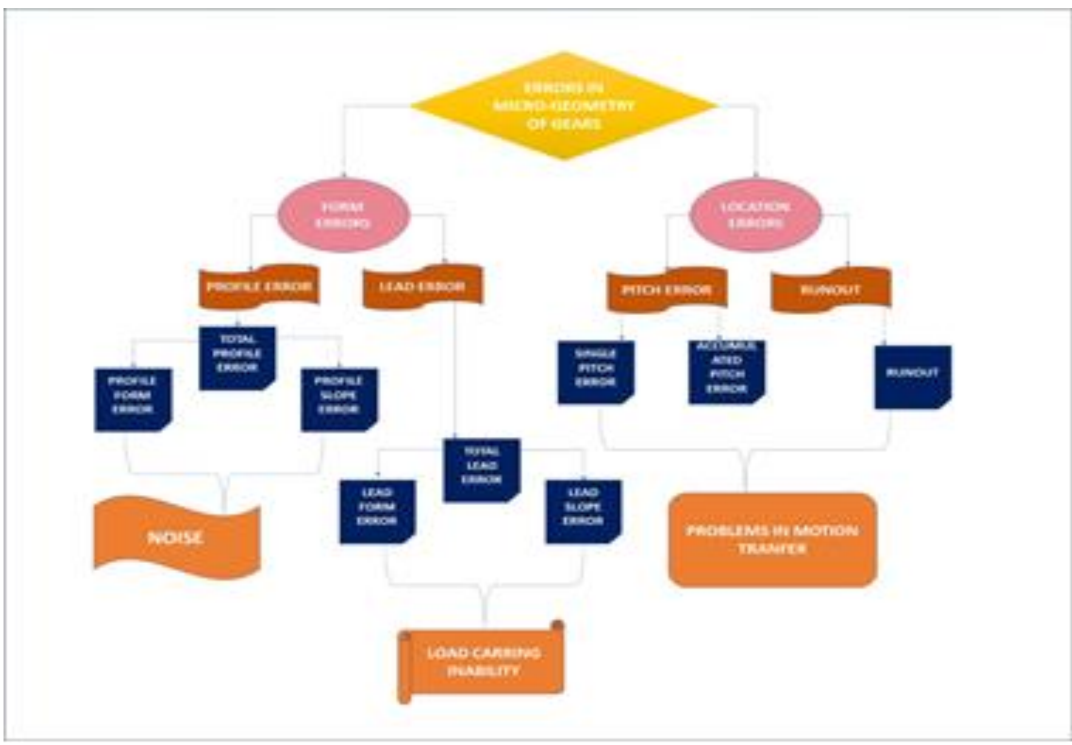

Fig-2. Errors in Gear

The aim of this paper is to review past studies conducted on gear hobbing machines. The rest of the paper is organized as follows: Section II summarizes the past researches in the mentioned domain. The obtained results are discussed in Section III. Section IV concludes the paper and Section V suggests possible research direction or future scope.

2. LITERATURE SURVEY

W. D. Cao[3] presented the suggested IBPNN/DE technique, which offers a fresh concept for constantly optimising the process parameters throughout the high-speed gear hobbing process. The IBPNN/DE method is less flexible for dealing with the small sample problem in gear hobbing than the suggested SVM/ALO/GH approach. Keche and Gajhas [2] proved that Al-SiC spur gear experiences fewer stresses than 20MnCr5 spur gear and that applying nodal force at the pitch line gives more exact results in ANSYS. The study by Naoual Sabkh[5] employed an orthogonal cutting model to predict the cutting forces and thermomechanical parameters (contact length, pressure, frictional stress, and temperature) at the tool-chip interface for the final gear hobbing process. F. Klocke et al.[6] investigated tool wear behaviour in relation to chip forming properties. It has been demonstrated that the software aids the engineer to develop gear hobbing processes that consider wear behaviour and productivity. Naser Amini et al [7] outlined the principles of RZP-grinding, Fissler honing, and Hurth green-shaving in order to manufacture noise-free gears. Neelesh Kumar Jain et al [8] investigated the effects of finishing time and AFF medium viscosity on the reduction of microgeometry parameters, including total profile deviation (Fa), total lead deviation (Fp), total pitch deviation (Fp), runout deviation (Fr) and average surface roughness (Ra), of the spur gears finished by the Abrasive Flow Finishing process. According to Oliver Winkel [9], future productivity gains are predicted as substrates and coatings continue to be developed. The introduction of novel tool designs and enhanced tool quality may lead to increased use of finish hobbing.

3. INFERENCES DRAWN FROM LITERATURE

Hobbing with an HSS hob cutter has been researched to enhance tool life and the surface roughness of gear. Diverse lubrication methods, including dry, flood, and MQL, have been employed to improve the condition of various types of gears. Numerous coatings with monolayer coating structures, including TiN, TiCN, and AlCrN, have been employed. According to a review of past work, there is a scarcity of published studies comparing the productivity resulting from the spur gear hobbing process and gear quality under cryogenic treatments on the hobbing tool. According to the findings of a novel study that compared hobbing with cryogenically treated hobs to hobbing without treatment in terms of sustainability and performance indicators, hobbing with cryogenically treated hobs is the most environmentally friendly option for increasing spur gear productivity and quality at the same time.
This study will serve as a motivation for future research on the optimisation of process parameters of a hobbing machine manufacturing spur gears in order to minimise profile error, lead error, and pitch error.

4. SUMMARY

In this study, the performance of hobbing is evaluated in terms of error reduction for various combinations of hob speed, feed, hob material, and hob treatment. Controlling lubrication, modifying tool geometry, treating the tool, and optimising cutting settings can all help optimise the gear hobbing process. There has been a lot of research done on hob geometry adjustment, managing the lubricating environment, and optimising process parameters. However, there has been little investigation into the influence of hob treatment on gear microgeometry deviations and surface roughness. Coating or cryogenic treatment can extend the life of the hob. Cryogenic therapy is less expensive than coating. The overall deviations in the process can be used to measure the quality of the gear. Advances in substrate materials and coating systems have enhanced productivity by allowing for quicker cutting rates and longer tool lifetimes. Fine machining is the final machining stage in many gear manufacturing processes. Gear finish hobbing has the potential to become a more cost-effective and ecologically friendly method of finishing gears.

5. FUTURE RESEARCH

The investigation will indicate that:
- The influence of the factors on the tool will be examined before and after cryogenic treatment.
- The behaviour of tool life, surface properties, and error minimization will be compared before and after cryogenic treatment on the tool.
- An economic analysis will be performed by comparing cycle time and process costs.

6. ACKNOWLEDGEMENT

I'd like to add that I'm grateful to support by Research Center,Department of Mechanical Engineering,Maharashtra Institute of Technology,Aurangabad and Dr Babasaheb Ambedkar Marathwada University, Aurangabad.

7. REFERENCES

1. Shewale, S. V., & Suryawanshi, S. R. (2016). Analysis of Process Parameters in Hobbing using Optimization Technique. International Advanced Research Journal in Science, Engineering and Technology, 3(1), 273-276.

2. Keche, A. J., & Gajhas, M. S. (2019). Design Analysis of Conventional and Composite Spur Gear Using Finite Element Method. In Smart Technologies for Energy, Environment and Sustainable Development (pp. 715-723). Springer Nature Singapore Pte Ltd. https://doi.org/10.1007/978-981-13-6148-7_68.

3.Cao, W. D., Yan, C. P., Wu, D. J., & Tuo, J. B. (2017). A novel multi-objective optimization approach of machining parameters with small sample problem in gear hobbing. International Journal of Advanced Manufacturing Technology, 93(9-12), 4099-4110. https://doi.org/10.1007/s00170-017-0823-y

4.Cao, W. D., Yan, C. P., Ding, L., & Ma, Y. F. (2016). A continuous optimization decision making of process parameters in high-speed gear hobbing using IBPNN/DE algorithm. International Journal of Advanced Manufacturing Technology, 85(9-12), 2657-2667.

5.Sabkhi, N., Moufki, A., Nouari, M., & Ginting, A. (2020). A thermomechanical modeling and experimental validation of the gear finish hobbing process. International Journal of Precision Engineering and Manufacturing, 21, 347-362. https://doi.org/10.1007/s12541-019-00258-y.

6.Klocke, F., Gorgels, C., Schalaster, R., & Stuckenberg, A. (2010, October). An innovative way of designing gear hobbing processes. In International Conference on Gears (pp. 393-404).

7.Amini, N., & Rosrn, B. G. (1998). Optimization of Gear Tooth Surfaces. International Journal of Machining Tools & Manufacture, 38(6), 425-435.

8.Petare, A. C., & Jain, N. K. (2017). Improving Spur Gear Microgeometry and Surface Finish by AFF Process. Materials and Manufacturing Processes. Taylor & Francis. ISSN: 1042-6914 (Print) 1532-2475.

9.Winkel, O. (2010). New Developments in Gear Hobbing. Gear Technology, 45-52.

10.Kharka, V., Jain, N. K., & Gupta, K. (2020). Predictive modelling and parametric optimization of minimum quantity lubrication assisted hobbing process. International Journal of Advanced Manufacturing Technology, 109(5), 1681-1694. https://doi.org/10.1007/s00170-020-05757

11.Kharka, V., Jain, N. K., & Gupta, K. (2022). Sustainability and performance assessment of gear hobbing under different lubrication environments for manufacturing of 20MnCr5 spur gears. Sustainable Materials and Technologies, 1-10. https://doi.org/10.1016/j.susmat.2022.e00388.

12.Kohlscheen, J., Knoche, H. J., Hipke, M., & Lümkemann, A. (2010). Coating development for gear cutting tools. In Key Engineering Materials (Vol. 438, pp. 35-40), Trans Tech Publications Ltd. https://doi.org/10.4028/www.scientific.net/KEM.438.35.

BIOGRAPHIES (Not Essential)

Author Photo-1 	Description about the author1 Govind S Dhage He is assistant Professor at Hi-Tech Institute of Technology, Aurangabad. He is working in teaching field more than 15 years.He is research Scholar (Phd Student) at Dr Babasaheb Ambedkar Marathwada University, Aurangabad
Author Photo-2 	Description about the author2 Dr R S Pawar He is Principal at Padmashri Vasantdada Patil Institute of Technology, Bowdhan,Pune.He is working in teaching field more than 25 Years. He is Research Guide, Dr Babasaheb Ambedkar Mar athwada University, Aurangabad.
Author Photo-3 	Description about the author3 Mr Jotiba Patil He is Industrial expert and working with Gear Hobbing more than 25 years. He is owner and managing director of Sarvesh Engineering, situated,in ,Waluj MIDC, Aurangabad.