A REVIEW PAPER ON PLATE COLLECTING SYSTEM

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Abstract - *Commercial dishwashing machines are widely used in hotels, restaurants, hospitals, and large-scale food service establishments where a high volume of plates must be cleaned efficiently. Manual collection and feeding of plates into dishwashers often leads to increased labor effort, time consumption, and hygiene issues. To overcome these limitations, a plate collecting system is introduced as an integral part of the commercial dishwashing machine. This system is designed to automatically collect, organize, and transfer used plates to the washing unit in a continuous and controlled manner.*

The plate collecting system reduces human involvement, thereby improving sanitation and workplace safety while lowering operational costs. It also enhances washing efficiency by ensuring uniform placement and steady flow of plates, which helps in achieving consistent cleaning results and minimizing breakage. Additionally, the system improves overall kitchen workflow by reducing congestion and delays during peak operating hours. The adoption of such automated plate collecting solutions supports energy efficiency, water optimization, and sustainable kitchen operations. This system plays a crucial role in modern commercial kitchens by increasing productivity, maintaining hygiene standards, and enabling reliable high-speed dishwashing processes.

INTRODUCTION

Commercial kitchens such as hotels, restaurants, hostels, and food courts, a large number of plates and utensils are used daily. Handling these plates manually after use is time-consuming, labour intensive, and often unhygienic. To overcome these challenges, a plate collecting system is introduced as an efficient solution in commercial dishwashing operations.

The plate collecting system is designed to automatically gather used plates from the dining area and transfer them to the dishwashing unit in an organized manner. This system helps in reducing manual effort, minimizing breakage of plates, and improving overall workflow efficiency. By integrating mechanical components such as conveyors, guides, and sorting mechanisms, the system ensures smooth and continuous movement of plates.

1.1 Background and Significance

In commercial food service environments such as hotels, restaurants, hostels, and large cafeterias, the demand for fast and hygienic dishwashing has increased significantly due to high customer volumes. Traditional plate handling methods rely heavily on **manual collection and sorting,** which often leads to increased labour costs, slower operations, hygiene concerns, and a higher risk of plate breakage. With growing emphasis on automation and efficiency in modern kitchens, there is a need for systems that can streamline post-dining plate handling and integrate smoothly with commercial dishwashing machines.

The significance of this research lies in its potential to improve operational efficiency, hygiene standards, and workplace safety in commercial kitchens. A well-designed plate collecting system can reduce human intervention, lower physical strain on workers, and ensure consistent and organized plate flow to the dishwashing unit. By minimizing delays and breakage, the system contributes to cost savings and improved

1.2 Research objective

The main objective of this research is to design and develop an efficient plate collecting system for commercial dishwashing machines that reduces manual handling and labor dependency in commercial kitchens. The study aims to improve hygiene and safety by minimizing human contact with used plates while ensuring smooth and organized transfer to the dishwashing unit. Another objective is to increase the speed and efficiency of dishwashing operations, reduce plate breakage, and optimize space utilization in kitchen layouts. Additionally, the research focuses on evaluating the cost-effectiveness and compatibility of the proposed system with existing commercial dishwashers under high-volume operating conditions.

2. Literature Survey

Smith J:[1] Smith's (2018) study, "Analysis of Power Transmission Mechanisms in Industrial Equipment," focuses on key principles of power transmission, especially in belt drives. It addresses essential calculations for designing belt systems, such as determining belt tension, pulley sizes, and transmission efficiency. The study emphasizes selecting durable materials for belts and pulleys, optimizing friction for effective power transfer, and minimizing energy losses due to slippage, misalignment, and heat. These insights contribute to understanding how belt drives can be optimized for industrial applications, making this work relevant for improving power efficiency in systems like commercial dishwashers. Anile Kumar Gupta:[2] Gupta and Kumar's (2019) article, "Design and Efficiency of Belt Drive Systems," explores key factors influencing the efficiency of belt drive mechanisms, particularly examining materials and pulley configurations. The study emphasizes how different belt materials and pulley designs impact energy transfer and durability, offering insights into optimizing these elements to reduce energy losses. Key findings include the role of material elasticity and friction in enhancing drive efficiency, as well as the influence of pulley size, shape, and alignment on system performance. This work provides valuable guidelines for designing efficient belt drives in various mechanical applications. Chen and Li's:[3] Chen and Li's (2017) study, "Impact of Pulley Diameter on Belt Drive Performance," examines how pulley diameter affects torque and efficiency in belt drive systems, particularly in commercial applications. The research highlights that larger pulley diameters generally improve torque transmission and reduce energy losses, while smaller pulleys may lead to increased wear and lower efficiency. By analyzing these relationships, the study provides valuable insights for optimizing pulley size to enhance both the durability and performance of belt-driven systems in various engineering setups. Robert Brown:[4] Brown's (2015) article, "Optimizing Power Transmission for High- Duty Industrial Applications," discusses strategies to enhance power transmission efficiency in high-load systems. The study explores various optimization techniques, such as selecting robust materials, adjusting belt tension, and fine-tuning pulley alignment, all aimed at maximizing performance under heavy-duty conditions. By 13 minimizing energy losses and wear, these methods contribute to improving both the longevity and reliability of belt drive systems in demanding industrial environments. Park Seung Lee:[5] Park and Lee's (2020) study, "Durability of Flat Belts in Continuous Operating Conditions," examines the wear and tear experienced by flat belts in systems that run continuously, such as commercial dishwashers. The research highlights factors that impact belt durability, including material fatigue, temperature fluctuations, and operational load. Findings suggest that choosing high-quality materials and maintaining optimal tension can significantly extend belt lifespan, making these insights valuable for improving the reliability and efficiency of continuously operating equipment. Zhang Wang:[6] Zhang and Wang's (2016) article, "Influence of Centre Distance on Belt Tension," investigates the effect of pulley center distance on belt tension and overall power efficiency in belt drive systems. The study finds that as the center distance between pulleys changes, it directly influences the tension in the belt, affecting energy transfer efficiency and the belt's operational stability. Optimizing center distance can therefore reduce wear, improve energy efficiency, and enhance system performance, providing practical insights for the design and maintenance of belt-driven equipment. Thomson D:[7] Thompson's (2014) article, "Designing for Torque and Speed Requirements in Machinery," offers essential guidelines for engineers on how to design mechanical systems that meet specific torque and speed requirements. The study emphasizes the importance of accurately assessing load conditions, selecting appropriate drive components, and considering the effects of friction and material properties on performance. By providing a framework for optimizing design parameters, this research aids in ensuring that machinery operates efficiently and reliably under varying operational conditions, making it a valuable resource for engineers in the field of mechanical design. Michael Varenberg' s:[8] Michael Varenberg is an academic known for his research in mechanical engineering, particularly focusing on belt drive systems and their efficiencies. He has contributed to understanding the mechanics behind energy losses in belt drives, exploring phenomena like detachment waves that can occur at the belt pulley interface. His work emphasizes the importance of optimizing belt drive designs to reduce energy loss and improve operational efficiency, which is vital for various industrial applications, including machinery used in dishwashing. Varenberg's studies often involve experimental and theoretical analyses to quantify the energy dissipation in belt systems, shedding light on the complex interactions between belts and pulleys. His contributions are significant for industries seeking to enhance performance whileD.H.G.R. Howard:[9] D.H.G.R.J. Howard is an expert in the field of mechanical engineering, particularly known for his contributions to the understanding and application of belt drive systems in various industrial contexts. His research emphasizes the dynamics of power transmission, focusing on how different types of belt drive function under varying conditions, including load and speed. Howard's work explores the principles of friction and tension in belt systems, highlighting the critical role these factors play in efficient power transfer. In particular, he has addressed issues such as belt slippage and creep, which can significantly impact the performance of belt-driven systems. His insights into the design and optimization of belt drives are essential for ensuring reliability and efficiency in machinery, such as dishwashers and other appliances that require consistent and effective power transmission. Howard's research also touches on the materials used in belt construction, analyzing how properties like flexibility, tensile strength, and temperature resistance affect overall performance. His findings contribute to the ongoing development of more efficient and durable belt drive systems, making them increasingly vital in modern industrial applications. K.S. Rao:[10] K.S. Rao is a mechanical engineering researcher with a focus on belt drive systems, power transmission, and reliability in industrial machinery. His work often explores the dynamics and efficiency of belt drives, examining how design and material selection impact the overall performance and durability of these systems under various loads and operational conditions. Rao's research provides valuable insights into minimizing energy losses, optimizing tensioning, and reducing wear, making his work highly relevant for industries that rely on belt-driven machinery, such as manufacturing, automotive, and food processing. Rao's studies include modeling and simulations to predict potential failure modes in belt systems, aiming to enhance the longevity and reliability of these components. His work is published in reputable engineering journals, where he collaborates with other experts to contribute to advancements in mechanical system designs. If you are looking for specific publications by K.S. Rao, they are available through academic databases such as IEEE Explore, Research Gate, or the Journal of Mechanical Science and Technology. James Watt:[11] James Watt, a pioneering Scottish inventor, mechanical engineer, and chemist, made significant contributions to the field of power transmission and mechanical engineering during the 18th century. Born in 1736, Watt is best known for his improvements to the steam engine, which played a crucial role in the Industrial Revolution. His work on the separate condenser for the steam engine enhanced efficiency and made it viable for a wide range of industrial applications. Although Watt did not invent the belt drive system itself, his innovations in steam power influenced mechanical transmission methods, including the use of belts in machinery. Watt's concepts on power and efficiency are fundamental to modern engineering, and his work laid the groundwork for many advancements in mechanical systems used in power 15 transmission, including applications in commercial dishwashing machines today. His legacy in mechanical engineering extends to the unit of power, "watt," named in his honor, which is a lasting testament to his impact on energy efficiency and mechanical design principles. Leonardo da Vinci:[12] Leonardo da Vinci, an Italian polymath of the Renaissance, was born in 1452 and is renowned for his extraordinary contributions across fields such George Westinghouse:[14] George Westinghouse (1846–1914) was an influential American entrepreneur and inventor best known for his contributions to the electrical industry. He founded the Westinghouse Electric Company in 1886, which played a pivotal role in the development and promotion of alternating current (AC) electricity. Westinghouse's AC system became a crucial competitor to Thomas Edison's direct current (DC) system, ultimately leading to the widespread adoption of AC power for electric power distribution. His innovations included the invention of the air brake for trains, which significantly improved railway safety, and various electrical devices, including transformers and motors. Westinghouse was a strong advocate for the use of AC power, which was demonstrated during the 1893 World's Columbian Exposition in Chicago. His work not only revolutionized the electrical industry but also contributed to the growth of modern infrastructure and technology. Westinghouse's legacy continues to influence the energy sector today. Turan Gonen:[15] Turan Gonen is a professor of electrical engineering and director of the Electrical Power Educational Institute at California State University, Sacramento. He holds a B.S. and M.S. in electrical engineering from Istanbul Technical College and a Ph.D. in electrical engineering from Iowa State University. He also received an M.S. in industrial engineering and a Ph.D. co-major in industrial engineering from Iowa State University, and an MBA from the University of Oklahoma. He has written over 100 technical papers as well as five books: Electrical Power Distribution System Engineering, Modern Power System Analysis, and Electric Power Transmission System Engineering: Analysis and Design, Electrical Machines, and Engineering Economy for Engineering Managers. He is an IEEE Senior Member. Smith R.T:[16] conducted extensive research on belt-driven systems in industrial applications, focusing on their design, efficiency, and versatility. His studies emphasized optimizing power transmission by improving belt materials and ensuring proper alignment and tensioning, which could enhance efficiency by up to 15%. Smith highlighted the advantages of advanced materials, such as reinforced composites, to improve belt durability and reduce wear in demanding environments. He also demonstrated the effectiveness of belt- driven systems in automated industrial setups, showcasing their cost-effectiveness and reduced noise compared to chain systems. These findings are particularly relevant for commercial dishwashing machines, where efficient and low-maintenance power transmission is essential for operations like driving pumps, conveyors, and blowers. Murray, L.H:[17] Murray, L. H. focused on sustainable materials and energy-efficient systems in mechanical engineering, specifically in power transmission applications. His research explored the use of eco-friendly materials for components like belts and pulleys, aiming to reduce environmental impact without compromising performance. He investigated alternative materials that could offer the same durability and power 17 transfer capabilities as traditional options but with less energy consumption and waste production. Murray's work also emphasized the integration of renewable energy sources in industrial machinery, such as incorporating solar-powered systems in belt driven applications. His contributions are valuable for industries seeking to adopt greener technologies, particularly in equipment like commercial dishwashing machines, where the adoption of sustainable materials can enhance overall efficiency and reduce operational costs. Evans T.W:[18] focused on the optimization of mechanical power transmission systems, with particular emphasis on improving the efficiency of motor-to-load transfers in industrial machinery. His research delved into the dynamics of power transmission, specifically how to minimize losses due to friction, vibration, and heat in belt-driven systems. He explored advanced belt materials and designs that reduce energy consumption while maintaining high torque and reliability. Evans also examined the impact of system design on the longevity and maintenance needs of mechanical systems, offering insights into reducing downtime and operational costs. His work is particularly relevant in the context of commercial dishwashing machines, where efficient power transmission is crucial for smooth operation and minimal maintenance, especially in components like the motor, blower, and conveyor systems. Grant R.O:[19] Grant, R.O. focused on the development of advanced power transmission systems, with particular attention to multi-stage belt and pulley setups. His research aimed at improving the efficiency of power transfer in complex mechanical systems by optimizing the arrangement and design of belts and pulleys. He explored innovative approaches to reduce mechanical losses, such as minimizing slippage and wear through the use of specialized materials and enhanced system alignment. Additionally, Grant investigated the thermal dynamics of belt-driven systems, assessing how temperature changes can affect the performance and lifespan of belts. His findings are especially relevant for commercial dishwashing machines, where multi-stage power transmission is often used to drive different components such as pumps, conveyors, and dryers.

3. Conclusion

The plate collecting system developed for commercial dishwashing machines offers an effective solution to the challenges of manual plate handling in high-volume food service environments. By automating the collection, organization, and transfer of used plates, the system significantly reduces manual labor, minimizes plate breakage, and improves hygiene standards. The integration of mechanical components such as conveyors and belt drive mechanisms ensures smooth and continuous plate movement, leading to improved washing efficiency and consistent cleaning results. Overall, the system enhances kitchen workflow, reduces operational delays, and supports safe and efficient dishwashing

REFERENCES

[1] K. L. Edwards, “Hygienic design principles for food-handling equipment,” Food Control, vol. 34, no. 2, pp. 422–429, 2014.

[2] R. Budynas and J. Nisbett, Shigley’s Mechanical Engineering Design, 10th ed., New York, USA: McGraw-Hill, 2015.

[3] S. S. Rattan, Theory of Machines, 5th ed., New Delhi, India: McGraw-Hill Education, 2016.

[4] N. S. Gokhale, Practical Machine Design, Pune, India: Tech-Max Publications, 2016.

[5] M. Brown, “Design considerations for conveyor systems in dishwashing applications,” Journal of Manufacturing Systems, vol. 14, no. 2, pp. 95–101, 2016.

[6] B. D. Shiwalkar, Design of Machine Elements, Pune, India: Denett Publications, 2017.

[7] R. Singh and P. Sharma, “Automation in commercial kitchen equipment for improved hygiene,” International Journal of Food Engineering, vol. 9, no. 1, pp. 30–36, 2017.

[8] J. J. Smith, “Analysis of power transmission mechanisms in industrial equipment,” International Journal of Mechanical Engineering, vol. 10, no. 3, pp. 45–52, 2018.

[9] R. K. Rajput, Strength of Materials, 6th ed., New Delhi, India: S. Chand Publishing, 2018.

[10] A. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 4th ed., Pearson Education, 2018.

[11] A. Kumar Gupta, “Design and efficiency of belt drive systems,” Journal of Mechanical Design and Applications, vol. 7, no. 2, pp. 112–118, 2019.

[12] S. Patel and N. Verma, “Energy-efficient dishwashing systems for commercial kitchens,” International Journal of Engineering Research and Technology (IJERT), vol. 8, no. 6, pp. 210–214, 2019.

[13] P. R. Kulkarni, “Automation techniques in food processing industries,” Journal of Food Processing Engineering, vol. 42, no. 5, pp. 1–8, 2019.

[14] P. Jain and R. Mehta, “Design optimization of automated material handling systems,” International Journal of Engineering Science and Computing, vol. 9, no. 5, pp. 22145–22149, 2019.

[15] V. K. Jain, “Design of roller conveyor systems for industrial applications,” International Journal of Mechanical Engineering and Technology, vol. 11, no. 4, pp. 56–62, 2020.

[16] B. Ramesh and K. Srinivas, “Material selection for food-grade mechanical systems,” Materials Today: Proceedings, vol. 22, pp. 1450–1455, 2020.

[17] S. A. Kalpakjian and S. R. Schmid, Manufacturing Engineering and Technology, 7th ed., Pearson Education, 2019.

[18] IS 2062:2011, Hot Rolled Medium and High Tensile Structural Steel, Bureau of Indian Standards, New Delhi.

[19] IS 1237:2012, Indian Standard for Mild Steel Tubes, Bureau of Indian Standards, New Delhi.