Development of Roller Conveyor Design for Reducing Energy Consumption Review

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Abstract: In the realm of bulk materials handling, roller conveyors are one of the most used technologies. Bulk products such as coal, cement, ores, and grains are often transported using these systems across processing plants or to storage or shipping facilities. With a maximum standard roller width of 275 cm, roller conveyor systems may stretch for tens of kilometres (108 inches). Driving such systems requires a lot of energy and, as a result, releases a lot of toxins into the environment. The study's goal is to examine the most important aspects that influence power consumption in such systems and to come up with solutions that can reduce power consumption during the design process. The most relevant elements on roller conveyor power demand were researched and summarized as a first stage, based on a literature review. System design characteristics (such as idler roll material, trough angle, idler spacing, idler roll diameter, and idler roll bearing type), operating circumstances (such as roller speed), and environmental conditions are all elements to consider (as ambient temperature). Calculations of a roller conveyor system's power requirement are made under various working situations using typical inputs used in the mining sector. To study the relevance of these parameters and their interaction effects on power demand, the estimated values were analyzed in a factorial design.

Key Words: —*Roller conveyor, optimization in conveyor, material saving, Variable belt speed, weight optimization.*

I. INTRODUCTION

Although the roller conveyor is not subjected to a complex condition of loading, we discovered that it is constructed with a greater safety factor. It is feasible to reduce the total weight of the assembly by redesigning crucial sections such as the roller, shaft, bearing, and frame. When compared to roller conveyors, powered belt conveyors are much longer (9000 to 10000 metres). So, if we apply the previous roller conveyor research to this belt conveyor, we may save a significant quantity of material. The stress analysis is carried out using the 'Finite Element Method,' which is a mathematical approach. The solid representation of the component is fragmented into smaller components using this procedure. At certain points on the model, constraints and loads are imposed.

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The model is given various attributes like as material, thickness, and so on. After that, the model is examined using FE solver. In the post processor, the findings are plotted. The scalar plot depicts the stresses and deformations throughout the whole length of the span.

Conveyors are a useful tool for moving materials. They can help a production or distribution operation increase efficiency, reduce product handling and damage, and cut labour costs. Unit Load Conveyors are meant to handle certain uniform units such as cartons or pallets, whereas Process Conveyors are designed to handle loose goods such as sand, gravel, coffee, cookies, and other items that are fed to machines for additional processing or mixing. Manufacturing firms frequently employ both Process and Unit Load conveyors in their operations.

II. LITERATURE REVIEW

2.1 Survey of research in modelling conveyor-based automated material handling systems in wafer fibs

This research reviews the literature on conveyor system models in semiconductor fabrication. A thorough examination of simulation-based models is offered. In the design and

control of closed-loop conveyors, we also identify and analyses unique research challenges and demands. To understand the behavior of conveyor systems and bridge the gap between theoretical research and industry concerns, new analytical and simulation models of conveyor systems must be created.

2.2 Availability modelling of powered roller conveyers

The dependability and availability of two popular line-shaft roller conveyor configurations are examined in this research. The first is a conventional configuration in which each roller is belted directly to the conveyor's rotating line shaft. The second is a novel design in which just one top roller is belted to the line shaft, and all other rollers in a series arrangement are belted to the one powered roller. The fundamental justification for this design is because upper belts are easier to repair than line shaft belts, resulting in higher system availability. The latter arrangement, on the other hand, is less dependable since a single belt failure might result in several roller failures.

2.3 An investigation into design and manufacturing of mechanical Conveyors Systems for food processing.

Several essential conveyor parts were studied for their functionality, material appropriateness, strength criteria, cost, and simplicity of assembly in the entire conveyor system using the idea of concurrent engineering and the concepts of design for manufacturing and design for assembly [4, 5]. The crucial parts were rebuilt with new shape and geometry, as well as new materials in some cases. On a new test conveyor system created, manufactured, and built utilizing the new enhanced components, the better design processes and functioning of new conveyor parts were validated and tested. The enhanced conveyor component design and manufacturing approach is based on the reduction of materials, parts, and costs while employing design for manufacture and design for assembly principles. The benefits of employing the enhanced approaches are confirmed by results obtained on a test conveyor system. When compared to traditional methods, the overall material cost was lowered by 19% and the overall assembly cost was reduced by 20%.

2.4 Modelling power & free roller conveyor system

This research lays the framework for utilizing Auto MOD II simulation software to model power and free conveyor systems. A technique is being developed to identify and model system characteristics, control and routing logic, and product mix sequencing. There is an explanation of the problems, workarounds, and other concerns to be aware of while using Auto MOD to represent power and free systems. The report concludes with recommendations for future improvements and a comparison of power and free systems with state-of-the-art movement systems.

2.5 Design Optimization, Analysis and Remedies over Failure of Charging Belt Conveyor System

The goal of this article is to help you choose the correct belt conveyor and system components. Yash Enterprises, Khamgaon, and Buldhana participated in the funded project. The difficulties of various components in the system were investigated, and the appropriate remedy was provided to extend component life. The ultimate goal was to develop a redesigned design that would allow for larger-scale idler manufacture while increasing efficiency and output. This report provided solutions to a variety of issues.

2.6 Experimental Tests of Selected Constituents of Movement Resistance of the Belt Conveyors Used in the Underground Mining

The goal of this article was to lower the resistance of a belt conveyor in order to reduce its energy consumption. Belt rolling conveyor, conveyor sliding resistance, bending resistance, idlers rotating resistance, and bulk material flexure resistance are some of the many resistances. The most energy savings are predicted in the selection of belts and idlers, as well as in some circumstances, innovative route options. The test rig was used to evaluate various idler and belt resistances. Reduced resistance resulted in a 34% reduction in energy use. The belt conveyor, which is utilized in mining, was investigated.

2.7 Modelling and energy efficiency optimization of belt conveyors

The goal of this study is to save energy by improving the operating efficiency of the belt conveyor system, which is why optimization is used. We'll start with the energy model for belt conveyors, which will serve as the foundation for optimization. After reviewing the current energy models, an analytic model was devised that lumped all of the parameters into four coefficients. The four coefficients of the new model can be determined through field trials or deduced from the design parameters. The latter ensures increased model accuracy and, as a result, the feasibility of belt conveyor energy optimization. The identification of this energy model was proposed using off-line parameter estimate based on least square (LSQ) and on-line parameter estimation based on recursive least square (RLSQ). For belt conveyors without permanent instrumentation for electrical power, belt speed,

and feed rate, off-line parameter estimate can be used. On the other hand, if a belt conveyor has permanent instrumentation, on-line parameter estimation is used to automatically update the energy model coefficients. The suggested off-line and on-line parameter estimation of the energy model are provided with simulation results to demonstrate its applicability.

2.8 Modelling and Analysis of Industrial Belt Conveyor System Using Cero Parametric and Ansys Software

The research of structural analysis was done in this work. The modelling is done using Cero Software, and the FEA is done with ANSYS software to get variation of stress at crucial locations of the system, as well as applying boundary conditions to assess total deformation, equivalent stress, and shear stress. For system and belt rollers, ASTM A-36 hot rolled steel bar and nylon 66 materials were investigated.

2.9 Development of concept design CAD system

Three dimensions in a CAD/CAE system are required to save product development time and increase product quality. It is vital to create a system that leverages concept design data at an early stage throughout the whole product development process. The goal of this project is to increase product quality by doing a sufficient design study iteration early in the design process. It is necessary to create a CAD system that can be utilised for concept design as well as an acceptable CAD environment. Another goal is to reduce the time it takes to build a product at the end of the design process.

2.10 A Parametric Energy Model for Energy Management of Long Belt Conveyors

The aim of this paper was to propose a generic energy model based on belt resistance for long belt conveyor. Here they have used two parameter power equation and also partial differential equation through the belt for calculating the variability of the material mass per unit length on the belt in order to give a more accurate representation of the transported bulk material throughout the belt. Here they have achieved with the error of less than 4 % the power consumption calculation of newly proposed simpler model is consistent with those of known non-linear model.

2.11 Analysis and Optimization of Gravity Roller Conveyor Using Ansys

The main objective of this paper was to analysis the gravity Roller Conveyor, the detail study of existing gravity roller and optimizing its parts by using composite material, so weight reduction of system is achieved.

A finite element model was generated of existing system by using Pro-E software. In this paper only roller is optimized by using composite material.

2.12 Design and Optimization of Roller Conveyor System

In this study, we looked at an existing conveyor system and improved important sections of a roller conveyor system, such as the roller, C-channels for the chassis, and support, to reduce total assembly weight and save money. Geometrical and finite element modelling of existing and optimized designs are included in the paper. CATIA V5 was used for geometrical modelling, while ANSYS software was used for finite modelling. The results suggest that the improved design is safe. Optimization yields the best design for the same loading situation while saving a significant amount of weight. Weight loss of 39.26% is achieved utilizing an optimal approach and a feasible accessible structure.

2.13 Design and Optimization of Roller in Belt Conveyor System for Weight Reduction

The goal of this article is to examine an existing Belt conveyor system and optimize important sections such as the roller, Lchannels, and support to reduce total assembly weight. Geometrical and finite element modelling of existing and optimized designs are also included in the paper. Catia V5R20 was used for geometrical modelling, while ANSYS14.0 was used for finite modelling. To verify that the design is safe, the results of linear static, modal, and transient analysis of the present and optimized designs are compared. We focus on roller design and optimization in this research.

2.14 A knowledge-based system for conveyor equipment selection

This paper Conveyor equipment selection is a complex, and sometimes, tedious task since there are literally hundreds of equipment types and manufacturers to choose from. The expert system approach to conveyor selection provides advantages of unbiased decision making, greater availability, faster response, and reduced cost as compared to human experts. This paper discusses the development of a prototype expert system for industrial conveyor selection. The system, which was developed on Level V Object, provides the user with a list of conveyor solutions for their material handling needs along with a list of suppliers for the suggested conveyor devices. Conveyor types are selected on the basis of a suitability score, which is a measure of the fulfilment of the material handling requirements by the characteristics of the conveyor.

The computation of the score is performed through the Weighted Evaluation Method, and the Expected Value Criterion for decision making under risk.

The prototype system was successfully validated through two industrial case studies.

2.15 Design and Analysis of a Roller Conveyor System for Weight Optimization and Material Saving

The current trend is to provide weight/cost effective products which meet the stringent requirements. The aim of this paper is to study existing conveyor system and optimize the critical parts like roller, shafts, C-channels for chassis and support, to minimize the overall weight of assembly and material saving. Critical parameter which reduces the weight is C channels, roller outer diameter and roller thickness. Though value of deflection, stress is more in case of Optimized design, but it is allowable. 30.931 % of weight reduction due to Optimized design.

III. PROBLEM STATEMENT

The existing belt conveyor design is heavyweight, containing important pieces such as rollers, belts, roller shafts, supporting brackets, and a C channel base frame, all of which have a direct impact on excessive material usage and increased prices, as well as increased power consumption and maintenance. To address these issues, a redesign of the present system as well as an analysis and optimization will be carried out.

Gravity roller conveyor assemblies often require hefty channels, rollers, and shafts due to their structure and the steel used in their construction.

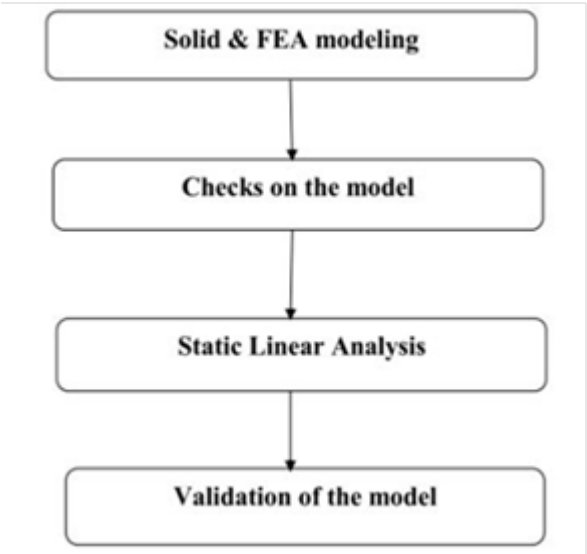
Based on all of the prior research, the Foundry's belt conveyors appear to be hardly used. In my project work, I mostly focus on providing suggestions for reducing the weight of all major conveyor system components and conducting a crate evaluation.

3.1 Suggestion Provide

The mechanical elements of the Roller Conveyor need to be designed individually and tested in the assembly environment. The structure needs to be tested for external forces acting on the entire assembly.

If suppose force is apply on roller conveyor with help of ansys software so study S-N Cover and analysis result its help to manipulate the value of deformation and stress also strain.

3.2 Proposed Flow of Work and Methodology



To carry out the linear analysis to study the behavior.

- To generate a surface model suitable for linear static analysis
- To validate the model for the permissible load
- To generate a finite element model of the same

IV. CONCLUSION

The authors of most research studies attempted to reduce the weight of the conveyor assembly by lowering the diameter of the roller since the roller is a critical component of the conveyor assembly and its weight is greater than that of other components. Here, an attempt is made to reduce the weight of the conveyor system by employing composite materials, such as carbon fibre for the roller and C-channel frame, which has never been done before.

The mechanical components of the Roller Conveyed must be developed and tested separately in the assembly environment. External forces acting on the entire assembly must be tested on the structure.

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