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Design And Fabrication Of Roller Based Centrifugal Balls De-Rusting Machine For Ball Bearing Recycling

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Abstract: Ball bearings are very common part of most of the machines that we use for domestic as well as industrial purposes. Ball bearings are used in automobiles, fans, motors, pumps, elevators, pulleys, grinders, turbines, lathe machines, drilling machines, milling machines, cutting machines, heavy trucks, etc., everyday millions of ball bearings fail across the globe and gets replaced by a new ball bearing. 90% of the bearing failures are due to seal failure and entering of water in to the bearing. Water causes rusting of balls, increases in friction between inner & outer race and finally results in bearing failure. Only in rear cases few balls get failed due to heavy or shock loads, that means most of the balls of the bearings don't crack even after bearing failure. Recycling of these balls will help reduction in waste generation as well as save money. But there is no machine available in market for de-rusting ofballs of ball bearings. As a part of our project dissertation, we are performing design and fabrication of roller based centrifugal balls de-dusting machine that helps in ball bearing recycling. The machine mainly consists of a collar shell, rollers, drive motor and support structure.

Key words: De-rusting, Recycle, Ball bearings, AC Motor, Centrifugal drum.

I. INTRODUCTION

Steel balls are commonly used in various applications, including machinery, automotive components, and industrial equipment. The rusting of bearing steel ballscan indeed present significant problems and result in waste. Rust formation on these steel balls can compromise their functionality, leading to decreased performance, increased friction, and potential equipment failure. Additionally, the presence of rust can contaminate lubricants and affect the overall efficiency of the machinery. When these steel balls become rusted and ineffective, they are often considered waste and need to be replaced, resulting in additional costs and environmental impact.

Rusting not only affects the performance and lifespan of the bearing steel balls but also poses challenges for their de-rusting. Removing rust from steel balls can be a time-consuming and complex process. Traditional methods of rust removal, such as manual scraping, wire brushing or abrasive blasting, require significant manual labor and can be inefficient, especially when dealing with large quantities of steel balls. Moreover, these methods can potentially damage the surface of the steel balls, compromising their integrity and leading to further waste.

Chemical de-rusting processes are often employed to remove rust from bearing steel balls. Acid-based solutions, such as phosphoric acid or hydrochloric acid, are commonly used to dissolve the rust. However, these chemicals can be hazardous to handle and require careful disposal to prevent environmental contamination. Furthermore, the de-rusting process may need to be repeated several times to completely remove the rust, which can result in increased chemical usage and waste generation.

To address these challenges, alternative methods for de-rusting bearing steel balls have been developed. One such method is the use of electrolysis, which involves immersing the steel balls in an electrolyte solution and applying an electric current. This process can effectively remove rust from the surface of the steel balls without causing damage or generating harmful waste. However, electrolysis de-rustingsystems can be costly to implement, requiring specialized equipment and skilled operators.

Another approach is the use of advanced surface coatings or treatments toprevent rust formation on bearing steel balls. Various protective coatings, such as zinc plating, chrome plating, or ceramic coatings, can be applied to the steel balls to createa barrier against corrosion. These coatings significantly extend the lifespan of thesteel balls and reduce the frequency of de-rusting requirements. However, the application of such coatings adds an additional step to the manufacturing process,increasing production costs and potentially impacting the performance characteristics of the steel balls.

In conclusion, the rusting of bearing steel balls presents challenges in terms of performance degradation, equipment failure, and waste generation. The de-rusting process can be time-consuming, labor-intensive, and require the use of chemicals that need proper handling and disposal. Developing preventive measures, such asimproved storage and handling practices, appropriate lubrication, and advanced surface coatings, can help mitigate rusting issues. Additionally, exploring alternative de-rusting methods, such as electrolysis, could offer more efficient and environmentally friendly solutions. By addressing the rusting problems associated with bearing steel balls, we can enhance their longevity, reduce waste, and improve the overall efficiency and sustainability of various industries that rely on these components.

1.1. Roller Based Centrifugal Balls De-Rusting Machine

The centrifugal roller based de-rusting machine mainly consists of centrifugal collar drum, rollers with shafts, support structure / frame, pillow block bearings, drive pulley, driven pulley and drive motor.

Centrifugal Collar Drum: In this machine rusted steel balls gets rubbed against abrasive material surface with the help of centrifugal force acting on steel balls due to the rotation of the centrifugal collar drum. Centrifugal collar drum rotation is achieved by using drive roller, pulleys and motor.

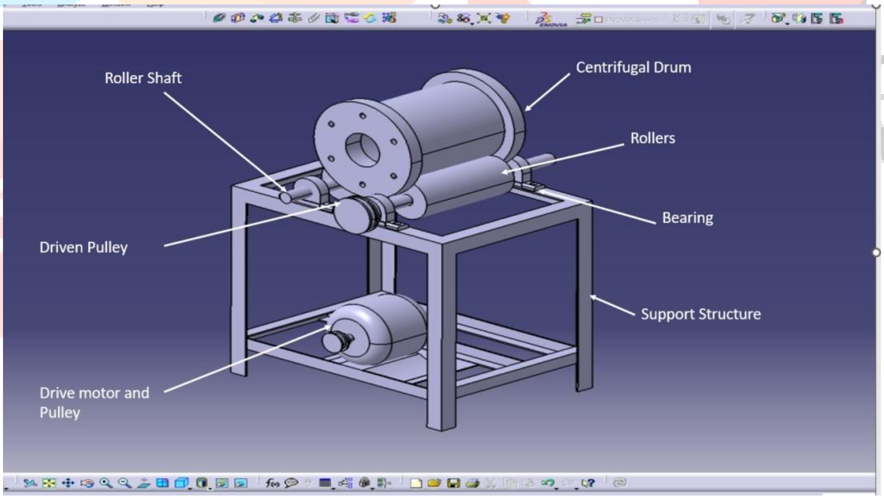

Fig. 1.1. Project image

Rollers: Rollers carries the weight of the centrifugal collar drum and also allows the rotation of drum. In this project we have used 2 rollers out of which one is normal roller and the other is drive roller

Drive Roller: drive roller supports the centrifugal collar drum and also transfers rotary motion to drum

Bearings: in this project we have used pillow block bearings to support load of rollers, drum and material inside the drum and transfers load to the support structure while allowing rotary motion with least friction

Drive motor and Pulley: we have used drive motor of ¾ HP and 230V single phaseto drive the pulley to make the drum rotate along with the material

II. LITERATURE SURVEY

2.1. Acid-Based De-Rusting

The use of acid-based solutions, such as phosphoric acid or hydrochloric acid, can effectively dissolve rust from the surface of steel balls. However, these chemicals are hazardous to handle and require proper safety precautions and disposal methods to prevent environmental contamination. Additionally, the de-rusting process may need to be repeated multiple times to completely remove all the rust, resulting in increased chemical usage and potential waste generation.

2.2. Electrolysis De-Rusting

Electrolysis involves immersing the steel balls in an electrolyte solution and applying an electric current to remove rust. While this method offers a non-toxic and environmentally friendly approach, it requires specialized equipment and skilled operators, making it a costly solution to implement. The initial investment and maintenance of the electrolysis system may pose challenges for smaller operations or those with limited resources.

2.3. Protective Coatings

Applying protective coatings, such as zinc plating, chrome plating, or ceramic coatings, can prevent rust formation on bearing steel balls, significantly extendingtheir lifespan. However, this method adds an additional step to the manufacturingprocess, increasing production costs. Moreover, the application of coatings may impact the performance characteristics of the steel balls, such as their friction coefficient or surface roughness, which could influence their functionality in certain applications.

It is important to consider these drawbacks when selecting a de-rusting method for bearing steel balls. Factors such as cost, safety, environmental impact, and desired performance characteristics should be evaluated to determine the most suitable approach. Additionally, ongoing maintenance and monitoring are crucial to ensure the effectiveness and longevity of the de-rusting method chosen.

In conclusion, while chemical de-rusting, electrolysis, and protective coatings offer viable solutions for removing rust from bearing steel balls, they all have their limitations. It is essential to weigh the advantages and disadvantages of each method and select the one that aligns with specific requirements and constraints. Continuous research and development in the field of rust prevention and removal may yield evenmore effective and sustainable alternatives in the future.

III. DE-RUSTING METHODOLOGY

3.1. De-rusting methodology

We are planning to use centrifugal drum for cleaning rusted bearing steel balls. The process begins by placing the rusted bearing steel balls inside a specially designed centrifugal collar drum. The internal surface of the drum is coated with an abrasive material, such as sand or fine-grit particles. As the drum rotates at high speed, the centrifugal force generated by the spinning motion causes the steel balls to come into contact with the abrasive-coated shell.

During rotation, the abrasive particles on the drum's internal surface act as a mechanical scrubbing agent, effectively removing rust from the surface of the steel balls. The centrifugal force enhances the scrubbing action, allowing for the removal of rust from multiple balls simultaneously. This method enables the treatment of a large mass of bearing steel balls at a time, significantly increasing the efficiency and productivity of the rust removal process.

The use of the abrasive-coated drum also minimizes the need for manual labor and reduces the risk of damage to the steel balls. Unlike manual scraping or wire brushing methods, which require individual handling and can potentially cause surface scratches or deformation, the centrifugal effect method treats the steel balls uniformly, ensuring consistent results without compromising their integrity.

Furthermore, this solution reduces waste generation compared to traditionalde-rusting methods. As the rust is mechanically removed from the steel balls, there isno need for chemical agents or abrasive blasting that can generate hazardous waste or by products. This aspect contributes to a more environmentally friendly approach to rust removal, aligning with sustainable practices and reducing the overall impact on the environment.

To enhance the efficiency and effectiveness of this centrifugal rust removal process, the drum can be designed with adjustable rotation speed and duration. This flexibility allows for the optimization of parameters based on the specific rust condition and the type of bearing steel balls being treated. By adjusting the rotational speed, the level of abrasiveness, and the treatment duration, the process can be fine- tuned to achieve optimal rust removal results while preserving the integrity of thesteel balls.

3.2. Design and major parts

3.2.1. Part Design Structure

Modeling of components is performed in Catia V5 software. We have drawn a rectangle using line command for length 465mm and width 340mmas shown in figure (3.1.)

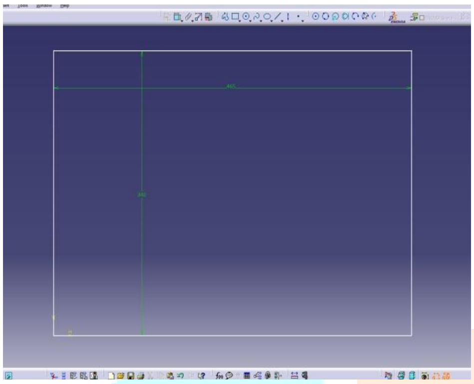

Fig. 3.1. Rectangle sketch for frame

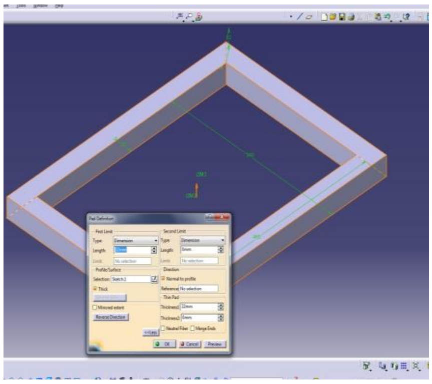

Fig. 3.2. Base frame sketch

We have used pad command to generate 3D of the given sketch and obtained 32mmwidth and 400mm length frame legs as shown in figure (3.3).

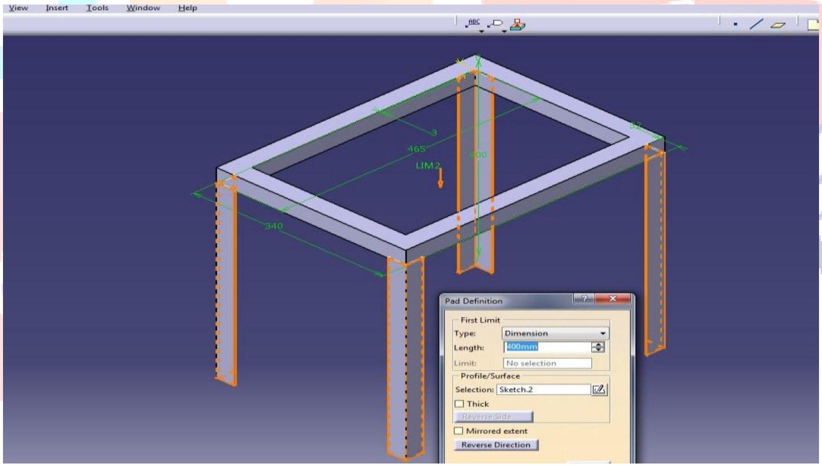

Fig. 3.3. Frame legs

We have obtained structure by following above mentioned process and structure is asshown in figure (3.4).

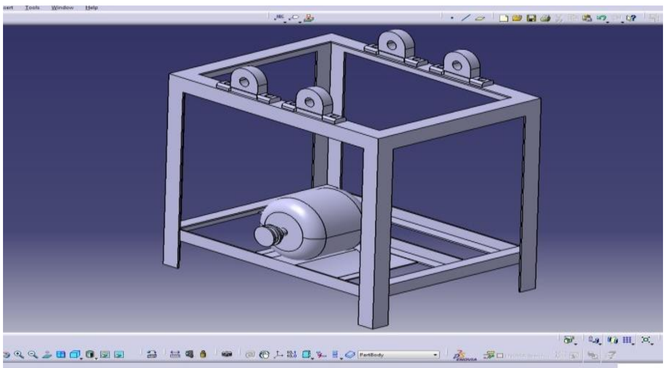

Fig. 3.4. Structure

Final image of the project after full assembly is as shown in figure (3.5).

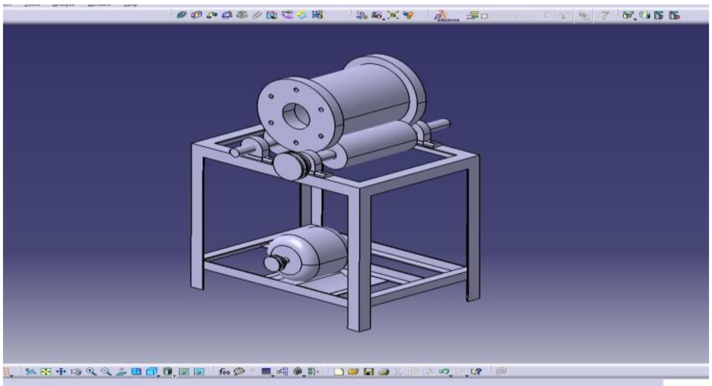

Fig. 3.5. Project image

IV. METHODOLOGY

We have taken our roller of diameter of 75mm along with 20mm diameter pipe of SA106 carbon steel pipe is welded is welded with end caps of diameter 65mm and5mm thick with a bore of 20mm and then a MS rod of 20mm diameter is inserted in to the end caps bore and welded to form a roller and the process is repeated to make 2 numbers of rollers.

4.1. Parts Assembly

We have fixed motor onto the structure using bolt and nuts of diameter 8mm asshown in figure (4.1).

Fig. 4.1. Mounting of motor

the centrifugal drum after assembling it using Allen bolts and key ware fitted. We have placed centrifugal drum onto the rollers carefully as per the requirements and performed wiring of the speed controller using screw driver and poured abrasive de-rusting material inside the centrifugal drum.

V. Results and Discussion

- While testing rusted balls of bearings are placed inside the machine along withthe abrasive material and the machine is run and the test results are presented below.

Table 7.3. Result

Test	Test Duration	Result
Steel Balls + Sand with Moisture	30min	40% of rust removed
Steel Balls + Sand with Moisture	45min	50% of rust removed
Steel Balls + Sand with Moisture	60 min	60% of rust removed
Steel Balls + Dry Sand	30min	50% of rust removed
Steel Balls + Dry Sand	45min	62% of rust removed
Steel Balls + Dry Sand	60 min	68% of rust removed
Petrol Soaking of Steel Balls + DrySand	30 min	60% of rust removed
Petrol Soaking of Steel Balls + DrySand	45min	67% of rust removed
Petrol Soaking of Steel Balls + DrySand	60 min	75% of rust removed

VI. CONCLUSIONS

- From the test results it can be clearly understood that the machine is quite very effective in de-rusting of steel balls of ball bearings and helps recycling of rusted steel balls of ball bearings. This machine is able to clear 50% to 68% of the rust collectedon surface of the steel balls, just by suing sand as cleaning agent. Sand is cheaper and one of the most available abrasive materials for de-rusting of steel surfaces. If we use this machine in addition to petrol soaking, the results are much better.
- This machine will be best choice for recycling of steel balls of ball bearings which otherwise get converted in to normal scrap. As the machines' cost is very low, its possibility of market reach will be very high. Sand being de-rusting agent, the users of this machine doesn't need to spend much on working capital.
- We have considered thick metal shell and collars to make rotating centrifugal collar shell heavy due to fallowing reasons;

i. Heavy rotating centrifugal collar shell will not run-away during rotation
ii. Vibrations due to un balanced mass of bearings while in rotation will be less
iii. Shell do not get compromised due to abrasive nature of sand / cleaning agent
iv. Shell will always be in contact with drive, which avoids slip

- Large collars will reduce chance of shell run away due to unbalanced bearing masseson shell during rotation
- Carbon steel material is used for fabrication of shell, pulleys and collars due to its lowcost, availability, machinability and high strength (241 MPa).

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