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AN OVERVIEW ON DESIGN AND OPTIMIZATION OF MAGNETIC COOLANT FILTER

KRISHNA KUMAR. R, Asst Professor, SNS College of Engineering Coimbatore - - 641107.

ABHILASH. B, ABISHEK. D, **ASWIN. A**, **LOGESH. N** UG, Department of Mechanical Engineering,

SNS College of Engineering Coimbatore - 641107

Abstract

The machinability of workpiece materials, which refers to their ability to respond to chip removal during machining processes. Superior machinable materials exhibit low levels of tool loading, clogging, cutting forces, temperatures, and tool wear, and allow for the creation of finely polished surfaces while preventing heat damage to sub-surfaces. The machinability of a material depends on the machining method, process variables, and coolant lubricant used. The two main categories of workpiece materials are metals and nonmetals, each with its key elements of machinability. One advanced technique for removing chips from a lathe is the magnetic chip conveyor, which uses a magnetic field to attract and remove chips from the machine. This method is highly efficient and can handle large volumes of chips, but it requires a more sophisticated system and can be more expensive than other techniques. Nonetheless, it is an excellent option for high-volume applications that require a high level of efficiency. Understanding the machinability of workpiece materials is essential for optimizing machining processes. The choice of machining method, process variables, and coolant lubricant should be carefully considered to achieve superior machinability. The magnetic chip conveyor is a highly efficient technique for removing chips from a lathe, but its advanced nature may increase its cost and limit its practicality for some applications

Keywords:Magnetic collant filter, pneumatic setup, conventional machines, CNC

I. Introduction

The conventional machines experience reduced working time due to the maintenance time required for them. Although filtering processes are carried out manually, they take a lot of time, which increases maintenance time and manpower requirements. However, using a magnet and pneumatic setup in the coolant tank can significantly reduce maintenance time and manpower. The conventional method involves metal chips and coolants flowing into the tank after machining. Normal-sized chips can be removed by the conveyor, but tiny chips remain in the coolant tank. This can cause problems during repumping of coolant and can lead to maintenance taking 2 to 3 hours. On the other hand, using a magnet for attracting and a pneumatic setup for clearing the tiny chips can be done automatically and only takes seconds. This approach reduces the time taken for maintenance and the manpower required. A magnetic filter in a coolant tank is a sort of filtering device used to remove metallic particles from a machine's coolant system. This is crucial because metallic debris has the potential to harm the equipment and lower its performance. The utilization of a magnetic field to draw and hold metallic particles suspended in the coolant is the foundation of the magnetic filter's operation. One or more strong magnets are present in the magnetic filter, which the coolant passes through. Metallic particles suspended in the coolant, such as iron or steel, are drawn to the magnetic field produced by these magnets. The metallic particles are caught on the filter's surface or in the magnetic field as the coolant passes past it. Now a day's use of coolants in industry has become dominant because of high production demands. Coolants not only help in speeding up the production but also provide many advantages in the metal working operation. As the consumption of coolants is very high a system is badly in need, so as to recirculate the used coolant. Also the amount of hazardous waste generated by industrial plants has become an increasingly costly problem for the manufactures and an additional stress on the environment. Since the purchase and disposal of the spent cutting fluids is becoming increasingly expensive, fluid recycling is a viable option for minimizing the cost. Separation of metallic chips from

the coolants by using magnetic coolant separation has proven a good management and maintenance of the cutting fluid. By removing the metallic chips, the coolant life is greatly extended, increases the machining quality and reduces downtime. Above being the case, a magnetic coolant filter is developed which utilizes high energy permanent magnets to develop a dense magnetic field along a narrow flow path into which the contaminated coolant is directed. The ferromagnetic particles are captured and aligned by the dense magnetic field, from the efficient filter medium. This enables the unit to remove ferromagnetic particles from the coolant. Magnetic coolant filters use the principle of magnetic separation to purify the used coolant. The developed magnetic coolant separation has the capability of purifying 40 liters per minute of coolant with the size of the contaminants ranging from 1 µm to 30 µm. The filter will be helpful in saving the production cost as the cost associated with the proposed design is well justified by the cost savings in production. The magnetic field produced by permanent magnets will be throughout the area underneath the reservoir. This produces a magnetic field 30mm above the coolant reservoir. Very fine particles are arrested without slip. The magnetic material used will not lose its strength even for a number of years of use. Dirty coolant is fed from the machines into the reservoir of the coolant filter either by a pump or taken by gravity and flows under the tray. This attracts the ferrous particles and builds up a cake of ferrous material and finally taken away by the scraper. The moving permanent magnets mounted on the shaft attract ferrous chips and slide them on to plate and then to the discharge end or sludge bin. The coolant separated from chips flows back to the coolant tank. Well in this fast-changing growth of metal working operation the recycling of cutting fluids become very important for the management of coolant. With the help of this developed model of magnetic coolant separator we can get a highly efficient way of filtration guaranteeing fine finish, dimensional accuracy and increased tool life. The most significant role of this filter is that it will reduce the waste disposal of coolant and a net profit for the production industries.

1.1 Experimental work.

Magnetic filters are extensively employed in industrial applications where metalworking fluids, cutting oils, and coolants are used to lubricate, cool, and remove debris from machines during machining operations. The coolant may become contaminated and lose its effectiveness as a result of metal chips, wear particles, and other metallic debris. This will increase machine wear and tear and decrease production efficiency. There are many advantages to using magnetic filters in coolant tanks. First, it lowers the concentration of metallic particles in the coolant, increasing the system's overall effectiveness. As a result, the coolant will last longer and require fewer changes overall. Second, it lessens the incidence of metallic particle-related machine failures, which results in cost savings for A magnetic coolant tank, also known as a magnetic separator or coolant filter, is a device used to remove ferrous particles, such as iron and steel, from cutting fluids and coolants used in metalworking operations. The working principle of a magnetic coolant tank is based on the fact that ferrous particles in a liquid can be attracted to a magnet. The coolant tank consists of a drum or cylinder made of stainless steel or some other non-magnetic material, and a magnetic system that is positioned inside or outside the drum. The magnetic system comprises a series of permanent magnets arranged in a specific pattern, and the strength and orientation of these magnets determine the efficiency of the magnetic coolant tank. When the contaminated coolant flows through the tank, the ferrous particles are attracted to the magnetic system and are held on the surface of the drum. The non-magnetic particles, such as dirt and chips, continue to flow with the coolant and are collected in a separate chamber or disposed of separately. To ensure optimal performance, the magnetic coolant tank should be sized appropriately for the specific application and the expected flow rate of the coolant. The strength and orientation of the magnets should also be selected to match the size and type of particles to be removed Maintenance of the magnetic coolant tank is important to prevent clogging and loss of efficiency. The tank should be inspected regularly, and the collected particles should be removed and disposed of properly. The magnets should also be cleaned periodically to prevent buildup of debris. Magnetic coolant tank

involves the use of a magnetic system to attract and remove ferrous particles from cutting fluids and coolants used in metalworking operations. Proper sizing, selection, and maintenance of the tank and magnets are important to ensure optimal performance and efficiency. The manufacturing sector is essential for the production of goods, and subtractive manufacturing has been a primary method used for centuries to bring designs to life. However, this method results in wastage, which is evident in conventional machining, where chips are cut from the workpiece. While normal-sized chips can be easily removed, tiny chips mix with the coolant and end up in the coolant tank. This mixture creates sedimentation, and the industry must clean the coolant tank regularly, usually once a week. our project has designed a coolant filter that uses a magnetic chuck and pneumatic wiping system to remove tiny chips from the coolant. This innovative filter will reduce the ideal time for cleansing the coolant tank. We believe that our filter will be highly beneficial and easily adaptable for conventional machining industries. The manufacturing sector is crucial to the production of goods, as it takes designs and turns them into tangible products. One of the primary methods used in manufacturing is subtractive manufacturing, which involves cutting away material from a workpiece. However, this method often leads to wastage, which is especially prevalent in conventional machining. During conventional machining, chips are cut from the workpiece, and while larger chips are easily removed, tiny chips mix with the coolant and accumulate in the coolant tank. This mixture of tiny chips and coolant creates sedimentation, which is a significant problem for the industry. As a result, the industry must clean the coolant tank regularly, usually once a week. This process is time-consuming and can lead to a halt in production, which can negatively impact the manufacturing process. our project has designed a coolant filter that uses a magnetic chuck and pneumatic wiping system. This innovative filter can easily remove tiny chips from the coolant, reducing the ideal time for cleansing the coolant tank. Our filter is highly adaptable and will be beneficial for conventional machining industries, reducing the downtime associated with cleaning the coolant tank. The manufacturing sector is essential to the production of goods, and subtractive manufacturing is a primary method used in the industry. However, conventional machining, a form of subtractive manufacturing, often results in wastage, specifically tiny chips that mix with the coolant and end up in the coolant tank. This creates sedimentation, leading to time-consuming weekly cleaning of the coolant tank. Our project has designed a coolant filter that uses a magnetic chuck and pneumatic wiping system to easily remove tiny chips from the coolant. This innovative filter will reduce the ideal time for cleansing the coolant tank and is highly adaptable and useful for conventional machining industries.

II. Literature

Prashanth, B. N. - Now a day's use of coolants in industry has become dominant because of high production demands. Coolants not only help in speeding up the production but also provide many advantages in the metal working operation. As the consumption of coolants is very high a system is badly in need, so as to recirculate the used coolant. Also the amount of hazardous waste generated by industrial plants has become an increasingly costly problem for the manufactures and an additional stress on the environment[1].

Vaithianathan, N., - In recent days the usage of coolants has increased because of today's high production demands, the usage of coolants in industry has become normal. Coolants not only serve to speed up production, but they also have a number of other benefits in metalworking. Fluid recycling is a potential solution for lowering costs because the acquisition and disposal of used cutting fluids is getting increasingly expensive. Separation of metal chips from coolants the magnetic coolant filters are designed for filtering coolant oil contaminated with ferrous particles[2].

Hao, Xiaohong, et al. - The International Technology Roadmap for Semiconductors (ITRS) forecasts that high-performance microprocessors will exhibit feature sizes as small as 15 nm and transistor densities approaching ten billion transistors per square centimeter by the end of the 2019, With decreasing feature size and increasing clock speed, the thermal management of chips is becoming increasingly challenging, and obvious facts are that the total power consumption is increasing and power distribution over the whole chip area is highly non uniform.[3]. Yeh, Po-Len - The programme was concerned with the effects of processing variables on the structure and properties of coolant reservoir tanks. The work was concentrated on the extrusion blow molding process and on propylene polymers, following an earlier similar research in the Institute on high density polyethylene. We have worked with a company which specializes in technical blow moldings; the work has dealt with coolant tanks which are required for high temperature, high pressure service in the presence of antifreeze.[4].M.V. Wilkes ; W. Renwick - The function of the control unit of an electronic digital computer is to provide the sequences of pulses, which, when applied to the store, arithmetic unit and other units of the machine, cause the orders of the programme to be executed. The paper discusses a number of related ways in which a systematic and flexible design for a control unit may be achieved. In one group of systems the order code is determined by the arrangement of diodes in a diode matrix, and in another by the appropriate threading of wires through a matrix of ferrite cores.[5]Prashant Sinha - At present aluminum-magnesium alloys are widely used in various engineering applications due to its light weight and superior properties. Joining is considered as one of the most complex phenomenon in various precision industries like aerospace, railway, automotive and marine structures because inflexible tolerances are required during different product assembly. The friction stir welding (FSW) of aluminum-magnesium of various grades has incited substantial scientific and industrial importance since it has a potency to transform the product with a good quality joint. The fabrication of such alloys is a challenging task through conventional fusion welding due to its various metallurgical concerns[6].Parag G Shewane - Neodymium (NdFeB) magnets have become widely available in recent years and have replaced other types of magnet in many applications in modern products that require strong permanent magnets, such as motors in cordless tools, hard disk drives and magnetic fasteners. These magnets can be used to invent a new method of energy generation by using the magnetic field of a magnet and converting the magnetic energy into kinetic energy without using any kind of fuel and overcoming the energy generation problem such as building a magnetic turbine. The main objective of the study was to study the advantages of using NdFeB magnets over other magnets, the nature of different types of neodymium magnets and how it can be used to convert magnetic energy into kinetic energy[7].Meng, Deyuan - In this paper, a detailed model was developed for a rodless pneumatic cylinder controlled by a proportional directional control valve. The dynamic of the valve spool was firstly investigated and an equation was introduced to describe the mass flow through the valve's variable orifice. The thermodynamics in cylinder chambers was carefully considered and the heat transfer coefficient between the air in the chamber and the inside of the barrel was identified experimentally. In addition, the friction force of the pneumatic cylinder seals was described using the LuGre model, and several experiments were conducted to estimate the friction parameters. The proposed system model was validated by comparing experimental and simulated open loop step input responses, and can be used to develop a controller for high accuracy positioning[8].Reddy, Araveeti C. Sekhara, et al. - CNC manufacturing has evolved into the modern multi-process and multi-axis machining operation. The advances in hardware design increased productivity. This development brought an advanced feature for CNC machines such as automatic lubrication systems, automatic tool length setters, and coolant-fed tooling systems. A large amount of heat can be liberated from CNC machining operation due to friction developed at the tool–work interface[9]. Yan, Xinming, Muriel Primot, and Franck Plestan - In this paper, various type of differentiators are studied. In the context of velocity and acceleration estimations of a pneumatic system, a comparison is made between numerical methods, based on classical or algebraic approaches, and a high order sliding mode differentiator[10].

FÖLDI, László, Zoltán BÉRES - This paper presents a novel control design, developed to realize fast and accurate position control of a pneumatic actuator using inexpensive on/off solenoid valves. In contrast to conventional control methods, the proposed control method operates chatter free, based on air compression. The control principle was developed by investigating the dynamics of a pneumatic actuator with an identified mathematical model.[11].Dragan, Cristian, et al. - This paper presents aspects related to use of cylinders with two piston rods. Besides that, in this article are presented four schemes for a double acting cylinder with in and out piston rod compressed air supply, air filter, 4/2 way valve, two throttles valves and a double acting cylinder (Cylin 1-1). The second pneumatic scheme comprises following devices: compressed air supply, start-up valve with filter control valve, 5/2 way valve, two throttles check valve and two double acting cylinders (Cylin 2-1 and Cylin 2-2). Furthermore, the first electro-pneumatic system comprises the following devices: compressed air supply, air service unit, 5/2 way solenoid valve, two throttle check valves, two double acting cylinders (Cylin 3-1), two relays, two valves solenoid and two lamps.[12].Nyamekye, Patricia, et al - Laser additive manufacturing (LAM), known also as 3D printing, is a powder bed fusion (PBF) type of additive manufacturing (AM) technology used to fabricate metal parts out of metal powder. The development of the technology from building prototype parts to functional parts has increased remarkably in the 2000s. LAM of metals is a promising technology that offers new opportunities to manufacturing and to resource efficiency. However, there are only few published articles about its sustainability.[13]. Kim, Hongseok, et al - For wireless charging of electric vehicle (EV) batteries, high-frequency magnetic fields are generated from magnetically coupled coils. The large air-gap between two coils may cause high leakage of magnetic fields and it may also lower the power transfer efficiency (PTE). For the first time, in this paper, we propose a new set of coil design formulas for high-efficiency and low harmonic currents and a new design procedure for low leakage of magnetic fields for high-power wireless power transfer (WPT) systems.[14]. Ostroukh, Andrey, et al - The article researches the problem of automating the mobile crushing and screening plant as a complex multi-level system. The analysis of the characteristics of the technological equipment and individual aggregates of the mobile crushing and screening plant is performed.A software for automated cone crusher control system, that allows to integrate a set of interconnected technological units in the control of one hardware, controller and human-machine interface on the touch panel in the operator station.[15].

III. METHODOLOGY

Machining process in conventional machine used coolants made as a mixture of fluids and metals normal sized chips removed by conveyors tiny chips will attracted by the permanent magnet fixed under the tray the pneumatic setup will control the compressed air by control valves and works the piston, the magnetic and pneumatic setup will connect in single line(on-off) alt g in pneumatic setup piston is connected with the brush by that the sludge will be cleared in some seconds.

3.1 Chip conveyor

A chip conveyor is a type of equipment used in the manufacturing industry for the automated removal of metal chips and debris from machine tools. These metal chips are a byproduct of the machining process, and they can cause damage to the machine tool and affect the quality of the finished product if left unchecked. Machine tools are equipped with a coolant system that uses a combination of coolant and oil to lubricate the machining process and help remove the metal chips. The coolant system works by spraying the coolant and oil mixture onto the machining area, which helps to reduce the heat generated by the machining process and lubricate the tool. The metal chips and debris accumulate in the coolant system, they can clog the filters and reduce the efficiency of the coolant system. This is where a chip conveyor for coolant filters comes in. A chip conveyor for coolant filters is a specialized piece of equipment that is designed to remove the metal chips and debris from the coolant system and

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transport them to a collection bin or disposal area. The conveyor system works by using a series of conveyor belts, chains, or augers to transport the metal chips and debris away from the machining area and into a collection bin. The chip conveyor for coolant filters is typically installed in the coolant system, either above or below the filter. The conveyor system can be integrated with the machine tool's control system, allowing for automated operation and monitoring of the coolant system's performance. There are several different types of chip conveyors for coolant filters available on the market. The most common type is a hinged steel belt conveyor, which uses a series of steel plates to transport the metal chips and debris away from the machining area. Another type is the magnetic conveyor, which uses a magnetic head pulley to remove the metal chips and debris from the coolant system. Overall, a chip conveyor for coolant filters is an essential piece of equipment for any manufacturing facility that uses machine tools with coolant systems. By removing the metal chips and debris from the coolant system, the chip conveyor helps to improve the efficiency and reliability of the machining process and prolong the life of the magnet.

IV. DESIGN

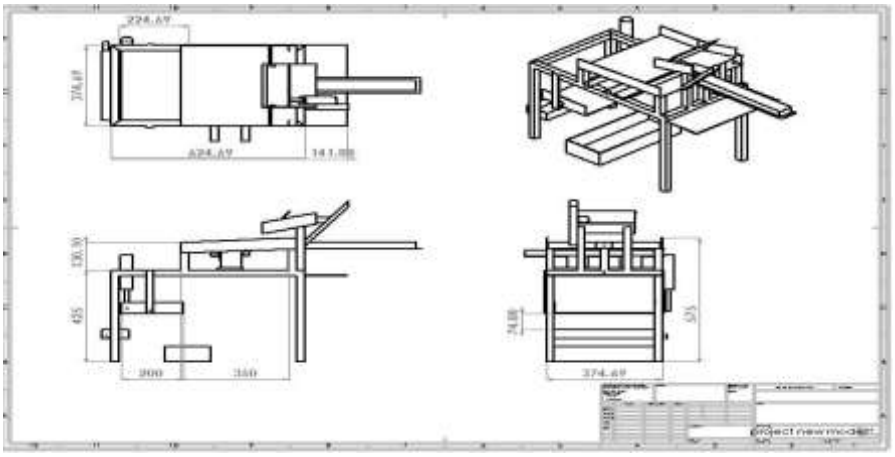

Fig.4.1 - DESIGN WITH DIMENSIONS

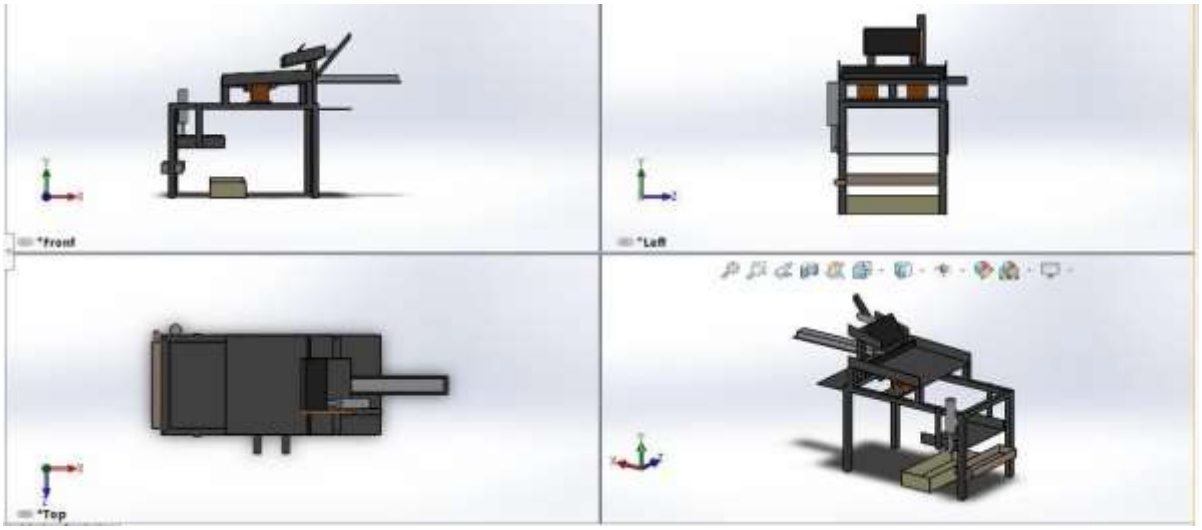

Fig.4.2 – PRODUCT DESIGN

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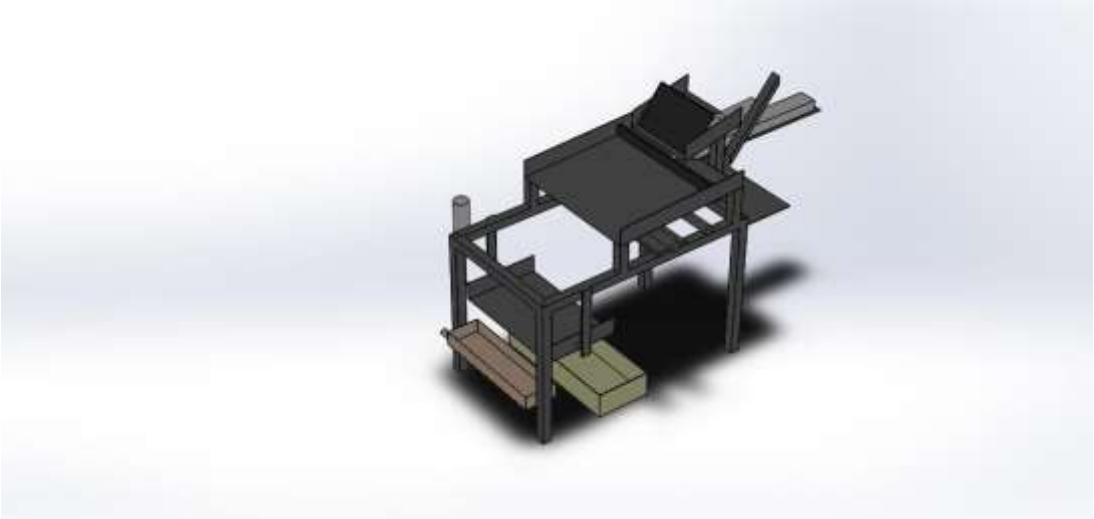

Fig.4.3 – ISOMETRIC VIEW

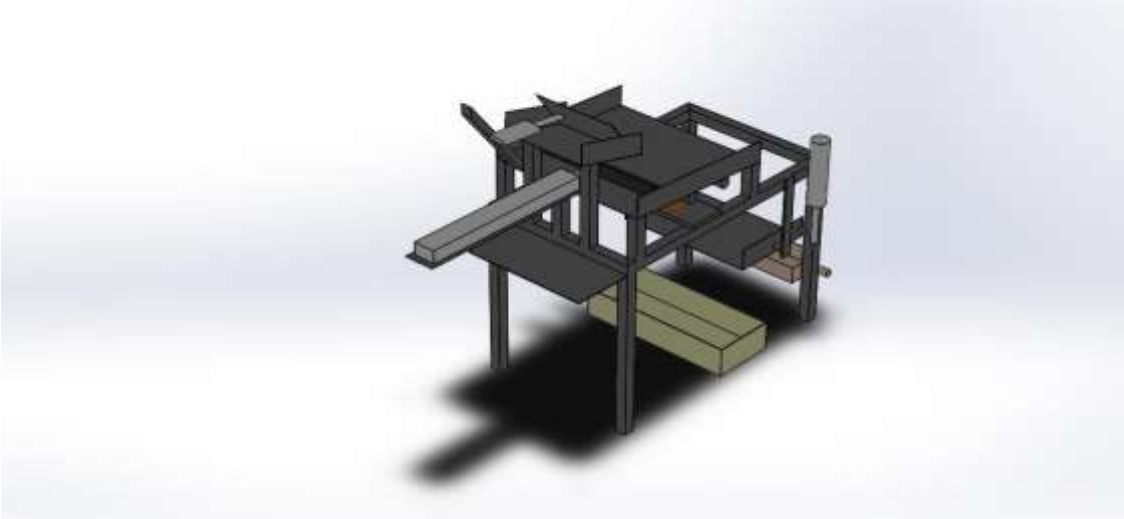

Fig.4.4 – ISOMETRIC VIEW

V. RESULT

- Capacity of absorbing chips from coolant - 100 g
- Time taken for absorption -30 sec
- Time taken for despatch chips -5 sec
- Gauss value of magnet - 19 GS
- Coolant inlet cut off - 15 sec
- Magnet cutoff -10 sec
- Magnet on time -30 sec

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GAUSS VALUE OF ELECTRO MAGNET

VI. Conclusion

In manufacturing sector conventional machining process uses subtractive manufacturing and in this excess of heat and huge amounts of wastage is created and to cool the workpiece and tool a constant flow of coolant is used in this process even though normal sized chips is expelled by the conveyor, tiny chips is mixed with coolant and flow to the coolant tank which makes it necessary to clean the tank at least once a week in most of the industries. our project will address this problem and reduce the ideal time of the current coolant filtration method thus becoming an unavoidable product for conventional industries. The conventional manufacturing process utilizes subtractive techniques that generate wastage and excess heat. To manage this heat and extend the life of the tool and workpiece, a constant flow of coolant is used. Despite the use of a conveyor to expel normal-sized chips, tiny chips still mix with the coolant and flow to the coolant tank. This requires frequent cleaning of the tank, typically at least once a week in most industries. Our project aims to address this problem by developing a product that will reduce the time required for the current coolant filtration process. This product will become essential for conventional industries, making it an indispensable tool in their operations. Our project focuses on solving this problem by developing a product that will reduce the time required for the current coolant filtration process. This solution is necessary for conventional industries, making our product essential for their operations.

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