Speed Optimization for Fly Ash Brick Machine

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SPEED OPTIMIZATION FOR FLY ASH BRICK MACHINE

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***Abstract*— Over the years, fly ash bricks have evolved significantly from rudimentary production methods to sophisticated manufacturing processes. Initially,simple mixing of fly ash with water and compression was common. However, technological advancements led to the incorporation of additives like lime and sand, resulting in bricks with higher strength and durability. With increasing environmental concerns and a shift towards sustainable construction materials, the demand for fly ash bricks has surged. Their eco-friendliness, costeffectiveness, and compliance with green building standards have propelled their adoption in construction projects worldwide, driving further innovation in their production techniques. The rising demand for fly ash bricks has brought forth critical challenges within the production infrastructure, mainly attributed to the limitations posed by low-speed machinery. This study investigates the root causes of reduced machine speed and proposes solutions to address the identified issues. Analysis reveals that the bottleneck lies in the hydraulic system, where a single valve regulates oil flow to both the hydraulic compressor and the rotating table, leading to decreased machine efficiency. To mitigate this challenge, a double valve system is proposed, offering a solution to enhance machine speed and meet growing demand. Furthermore, the study explores the loading and unloading process, which relies on metal detectors to sense a metallic rod attached to the table rotator. However, with the implementation of the double valve system and subsequent increase in machine speed, the accuracy of metal detection becomes compromised. As an alternative, the study recommends the utilization of inductive proximity sensors, capable of accurately detecting metal at any speed without physical contact, thereby ensuring precise control of the table rotator. The findings of this study provide valuable insights for enhancing production efficiency and meeting the demands of the burgeoning market for sustainable building materials.**

***keywords*—Fly ash brick (FAB),Masonry units,Class C fly ash,Class F fly ash,Industrial waste,Clay brick replacement**

I.INTRODUCTION

Fly ash brick (FAB) is a type of building material which is specifically known as masonry units which consists of Class C or Class F fly ash and water. A fly ash brick is characterized by using industrial waste to replace clay brick, and it does not need to be burned and steamed after moulding processing, it can be used after natural curing. It is compressed at 28Mpa and it is placed in 66° C steam bath for 24 hours for curing. The fly ash brick reduces the dead load on the structures and it also lowers the water penetration. Each fly ash brick consists of fly ash of about 60% of its mass and having a strength of about 7.5MPa - 10Mpa. It has very high tolerance when compared to the other clay bricks. So, it can make full use of waste, save land and does not produce secondary pollution. Moreover, there is very accord with modern environmental protection and building materials industry development policy of emerging technologies[5]. Fly ash brick moulding machine is a new brick making equipment in the brick and tile industry which develop rapidly in recent years and effectively promote the rapid development of national economy. Due to the development of technologies on various field the semiautomatic fly ash brick machine now become fully automated hence it requires some of the features to be added to make it efficiently[3]. The hydraulic fly ash brick machine consists of the hydraulic press and electric motor in order for the movement of the conveyor belt and can able to produce a maximum of 2000 bricks/hour. At present, the demand for fly ash bricks gets increased due to the shortage of raw materials needed for the production mud and red soil bricks. Since the fly ash bricks is fast moving, the machine needs an effective speed optimisation in order to increase the production of the bricks. Also, it needs a proper cut off sensing system for loading raw materials and unloading the brick

II.EXISTING METHOD AND ITS PROBLEMS IDENTIFIED

The surge in demand for fly ash bricks has highlighted critical challenges within the existing production infrastructure, primarily due to the limitations imposed by low-speed machines. Typically, these machines comprise a pan mixer, conveyor belt, and compressing unit. Oil is pumped from the motor to power hydraulic compressors and table rotators within the compressing unit. However, a significant bottleneck arises from the configuration where a single valve from the pump is split to supply oil to both the hydraulic compressor and the rotating table. This design flaw leads to a reduction in machine speed as hydraulic pressure and flow are divided, impacting overall efficiency and production output. To overcome the constraints posed by the single valve setup, a feasible solution involves implementing a double valve system. By incorporating dedicated oil supply lines to each component, such as the hydraulic compressor and rotating table, independent control over hydraulic pressure and flow can be ensured. This modification optimizes the utilization of hydraulic power, significantly increasing the machine's speed[4]. Consequently, production efficiency is enhanced, allowing manufacturers to meet the escalating demand for fly ash bricks efficiently. However, challenges persist concerning the precise positioning of the table rotator, crucial for loading and unloading raw materials and finished bricks. Existing systems rely on metal detectors to sense a metallic rod attached to the table rotator and trigger a cutoff at specific points. Yet, the heightened machine speed resulting from the double valve system implementation compromises the accuracy of metal detection. The increased velocity of the rotating table and metallic rod makes it challenging for conventional metal detectors to reliably detect the rod, leading to inaccuracies in table positioning and affecting production processes. An alternative solution involves replacing traditional metal detectors with inductive proximity sensors. These sensors operate based on the principle of electromagnetic induction, allowing them to detect metal objects without physical contact. Unlike metal detectors, inductive proximity sensors can accurately detect metallic rods at elevated machine speeds, ensuring precise positioning of the table rotator. By adopting advanced sensing technology, manufacturers can mitigate the challenges associated with metal detection and optimize production processes, thereby meeting the rising demand for fly ash bricks efficiently and effectively[12]

III.BLOCKDIAGRAM& METHODOLOGY

1.Block diagram of fly ash brick machine

A typical fly ash brick machine consists of several components, each playing a crucial role in the production process. The components that make up the fly ash brick machine are described in Figure

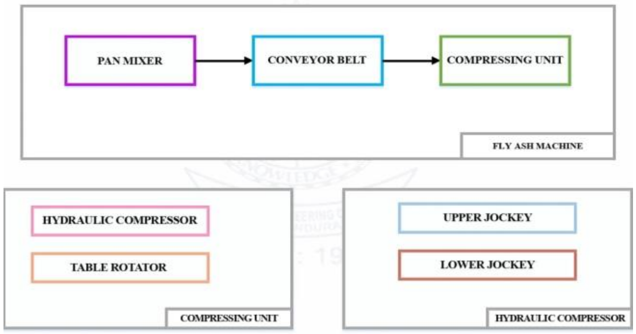

Figure: 3.1 Block diagram of fly ash brick machine

A fly ash brick machine comprises a pan mixer, conveyor belt, compressing unit, and table rotator. In the pan mixer, raw materials such as fly ash, sand, hydrated lime, and water are blended to form a homogeneous mixture. This mixture is then transported to the compressing unit via a conveyor belt. The compressing unit, powered by a hydraulic system, moulds the mixture into brick shapes with controlled pressure, ensuring optimal compaction and density. Meanwhile, the table rotator facilitates the loading and unloading of materials, rotating moulds through various production stages. The compressing unit, driven by hydraulic power, plays a central role in shaping the bricks. Its hydraulic cylinders, valves, and pumps apply pressure to the moulds, compacting the mixture into solid bricks. The hydraulic system, comprising pumps, cylinders, valves, and hoses, pressurizes hydraulic fluid to drive the compressing unit. This fluid is directed to hydraulic cylinders, converting hydraulic pressure into mechanical force for precise brick moulding. Additionally, the table rotator aids in material handling, rotating moulds to facilitate filling, compaction, curing, and ejection of finished bricks. Overall, the fly ash brick machine integrates these components to automate the brick manufacturing process efficiently. From mixing raw materials to moulding and ejecting finished bricks, each component contributes to the production of high-quality fly ash bricks. This cohesive system enables consistent manufacturing, meeting construction demands while maintaining quality standards

2.Block diagram of double valve method

A description of the transition from the current single valve method to the double valve method is provided in Figure.

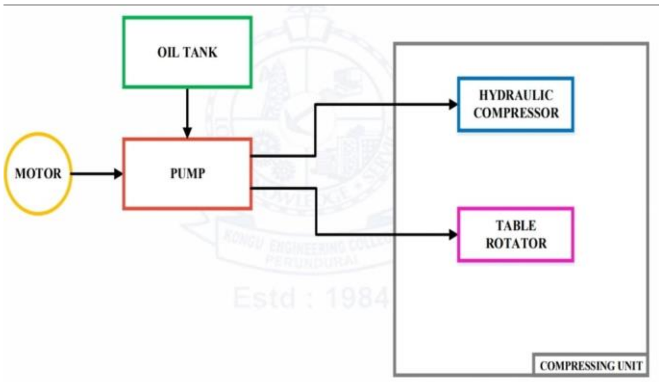

Figure: 3.2 Block diagram of double valve method

In the upgraded configuration, the fly ash brick machine **utilizes** double valve instead of a single valve to supply hydraulic fluid to both the hydraulic compressor and table rotator independently. This enhancement allows for more precise control over each component's operation, optimizing the flow of hydraulic fluid to meet the specific needs of the compressor and rotator. By separately regulating the flow to these critical functions, the machine can achieve higher operational speeds without compromising performance or brick quality. The implementation of double valves enhances efficiency by reducing pressure fluctuations and ensuring consistent operation of both the compressor and rotator. Also, it enhances the time consumed. As a result, the overall productivity of the fly ash brick machine is significantly improved, leading to increased output and faster brick production rates.

3. Block diagram of inductive proximity sensor

The operation of the inductive proximity sensor used in this system is described in Figure. 3.3. An inductive proximity sensor detects metal objects without contact by generating an electromagnetic field. When a metal object enters its sensing range, it disrupts the field, triggering the sensor to produce an output signal. This technology allows for rapid and precise detection of metal objects, making it ideal for applications like sensing the metallic rod attached to the table rotator in fly ash brick machines. Due to its non-contact nature, the sensor experiences minimal wear and tear, ensuring reliable operation in harsh conditions.

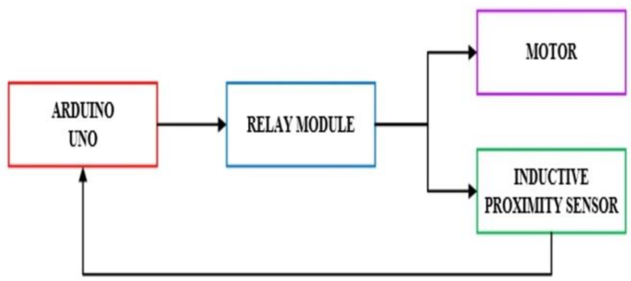

Figure: 3.3 Block diagram of inductive proximity sensor

In this system, the Arduino Uno serves as the central control unit, initiating the operation by sending a signal to the relay, which activates the motor for rotation. Simultaneously, the relay triggers the inductive proximity sensor to monitor for the presence of metal within its detection range. When the sensor detects metal, it sends a signal to the Arduino, prompting it to cut off power to the relay and halt motor rotation. This signal is then relayed back to the relay, ensuring that the motor stops immediately upon metal detection. This integrated setup ensures automated and responsive operation, allowing for efficient metal detection and motor control in the system.

IV.HARDWARE IMPLEMENTATION

1.FLY ASH BRICK MACHINE

The fly ash brick machine, comprising a pan mixer, a conveyor belt, and a compressing unit, is depicted in the field in Figure

Figure 4.1 Fly ash brick machine

In a fly ash machine, several key components work together to efficiently process fly ash, a byproduct of coal combustion. One essential component is the conveyor system, responsible for transporting the fly ash from the collection point to the processing unit. The processing unit typically includes equipment such as crushers, grinders, and classifiers, which work to reduce the size of the fly ash particles and separate them based on their properties. Additionally, a dust collection system is integral for maintaining air quality and capturing any airborne particles during the processing. Finally, control systems, including sensors and monitoring devices, ensure the proper functioning and safety of the machine throughout the operation. Together, these components form a cohesive system that 14 effectively handles and processes fly ash for various industrial applications.

2.DOUBLE VALVE SETUP IN THE FIELD

Figure 4.2 below depicts the hardware configuration of the double valve used in the project's field. The fly ash brick machine's speed and efficiency are limited by the hydraulic system's single valve setup, which splits oil flow and reduces power, and by metal detectors that become inaccurate at higher speeds. The proposed model addresses these issues by introducing a double valve system to separate oil flow, increasing efficiency, and replacing metal detectors with inductive proximity sensors for accurate detection at any speed.

Figure: 4.2 Setup of double valve in the field

Double valves, in contrast to single valves, are now used in the modified fly ash brick machine to precisely control the hydraulic fluid flow to the table rotator and hydraulic compressor separately. With this improvement, operation is optimized and faster speeds are possible without sacrificing brick quality or performance. Pressure variations are reduced, assuring steady operation and increasing efficiency, by controlling flow 15 independently to these vital components. Consequently, there is a notable enhancement in productivity, which results in higher output and quicker brick manufacturing rates[14].

3.Machine specifications

S.no	Range	Specfications
1	Voltage	+-15v to +- 10v
2	Frequency	50+-5
3	Current	15A
4	Power	7.5km
5	Power factor	7.5
6	Speed	1455 rpm
7	IE-CL	152
8	Weight	70kg
9	Temperture	20°c - 50°c

Yes, a sufficient power supply is essential to meet the increased demands of optimized speed operations. If the power supply can provide enough power to support the upgraded components and systems, it will help the machine run at higher speeds and improve overall efficiency. However, if the power supply is not adequate, it may need to be upgraded to handle the increased load and ensure the machine operates smoothly and efficiently. The machine uses To determine if the motors are running at optimal efficiency, we need to ensure they are correctly matched with the power supply and not overloaded. Regular maintenance and proper cooling also help in maintaining optimal efficiency. Heat can make machine parts wear out faster, make the hydraulic fluid less effective, and cause more breakdowns. To reduce heat, we can Add better cooling systems,Use high-quality hydraulic fluids,Do regular maintenance,Redesign the hydraulic system to be more efficient Use better sensors for control.

4.HARDWARE COMPONENTS:

The hardware components required for the project are

S.NO	COMPONENTS NAME	VALUE
1.	DC MOTOR	12V
2.	ARDUINO UNO	5V
3.	INDUCTIVE PROXIMITY SENSOR	1.65Vto5.5V
4.	BATTERY	9V
5.	2-CHANNEL RELAY MODULE	5V

V.HARDWARE SETUP OF INDUCTIVE PROXIMITY SENSOR

The Hardware components setup for the project has shown in Figure 5.1 and Figure 5.2 and also their components are described below. The hardware is placed in the wooden board in order to prevent the damage of electrical equipment by the external factors.

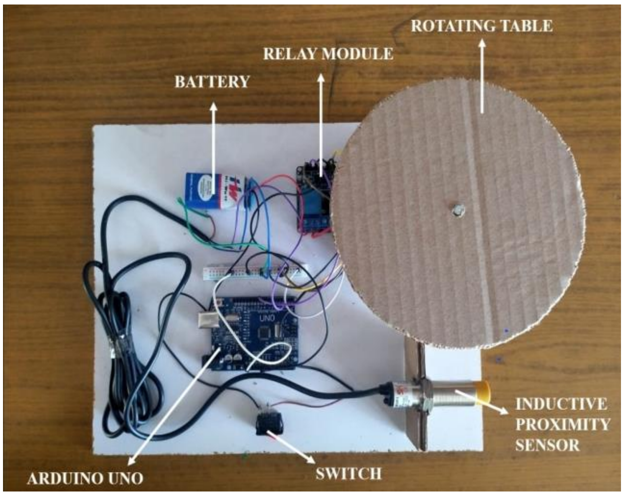

Figure: 5.1 Hardware setup of inductive proximity sensor (Top view)

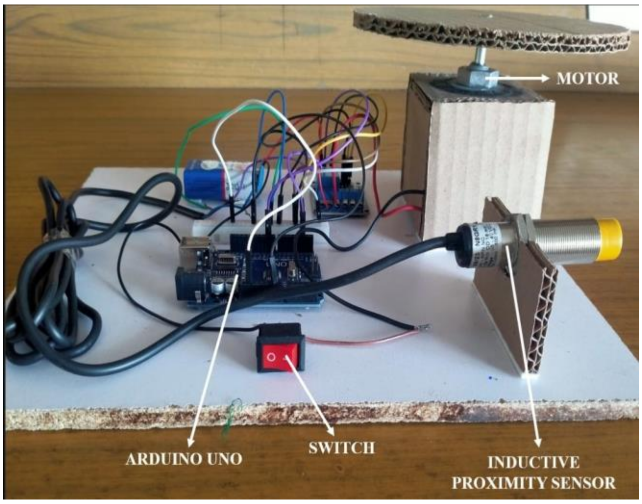

Figure 5.2 Hardware setup of inductive proximity sensor (Side view)

The operation of this integrated setup begins with the Arduino Uno, serving as the system's central control unit. Upon receiving the initial command, the Arduino sends a signal to a relay, a key component acting as an intermediary switch. This signal prompts the relay to engage, permitting electrical current to flow to the motor. Consequently, the motor springs into action, fulfilling its designated task. Simultaneously, the relay triggers an inductive proximity sensor. This sensor, designed to detect metal objects within its range, promptly activates and scans the surrounding area. Upon encountering metal, the sensor promptly relays this information back to the Arduino. In response to the metal detection signal, the Arduino swiftly halts the flow of electricity to the relay, ceasing power to the motor. This instantaneous reaction ensures that the motor stops immediately upon detecting metal, minimizing any potential risks or hazards. The integrated setup operates seamlessly, facilitating the identification of metals and effective

motor control with automated precision.

	SINGLE VALVE	DOUBLE VALVE
1 pallet	110 bricks	110 bricks
1 hour	13 pallets	17 pallets
Bricks (1 hour)	1430	1870
1 shift	100 pallets (8 hours)	100 pallets (6.5 hours)

The comparison between using a single valve and a double valve system in a fly ash brick machine demonstrates substantial enhancements in production output and efficiency with the adoption of the double valve setup. Transitioning from a single valve to a double valve configuration result in a remarkable increase in the number of bricks produced per hour. This improvement stems from the double valve system's ability to handle a higher volume of raw materials and operate at an accelerated pace. Consequently, the machine can produce more pallets per hour, leading to a significant boost in overall brick manufacturing output. Moreover, the double valve system significantly reduces production timeframes, allowing for the generation of a greater quantity of bricks within a shorter period compared to the single valve system. This increased efficiency not only meets manufacturing demands more effectively but also optimizes operational performance by maximizing output capacity. Overall, the implementation of a double valve system in the fly ash brick machine signifies a substantial advancement in production efficiency, offering tangible benefits in meeting production targets and enhancing operational productivity

VI.CONCLUSION

The surge in demand for fly ash bricks has revealed significant challenges in production, notably due to slow machinery. The hydraulic system, with a single valve splitting oil flow between compressor and table, limits machine speed, hindering efficiency. Implementing a double valve system address this, boosting machine speed. Additionally, accuracy issues arise with metal detectors during high-speed loading and unloading. Introducing inductive proximity sensors offers a precise, contactless alternative, ensuring quality amidst growing demand for sustainable building materials. In the modified setup, the fly ash brick machine now utilizes two valves to separately supply hydraulic fluid to the table rotator and compressor. This upgrade allows precise control over each component's operation, optimizing fluid flow and enabling faster operation without compromising brick quality. Double valves stabilize pressure and ensure simultaneous operation, enhancing overall productivity and output. Furthermore, replacing metal detectors with inductive proximity sensors improves loading and unloading efficiency, contributing to increased machine speed and brick production.

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