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RESEARCH ARTICLE OPEN ACCESS

Integration of Linear Displacement Encoder and Servo Motor for 180 Ton Powder Compacting Press

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Abstract:

Industries are grown drastically in now a days without influence of human beings, this is achieved only through automation. In this project we are going to design a press for powder compacting by integrating the linear displacement encoder and servo motor. The main advantage of using servo motor is to save the power consumption up to 30%. LVDT is mainly used to control the position of moving bolster. The total setup is controlled by the ladder logic which is framed by PLC. The PLC program is written through total integrated automation. The PLC used in this project is SIMATIC S71200 PLC, which is manufactured by Siemens company, it is used to control the operation also it will indicate when the fault or overload is occur. The control panel designed and monitoring for 180 ton powder compacting press. The power panel consists of PLC kit, Transformers, SMPS, protection and safety circuit. The panel board wiring reduces the complexity of the system hardware. The servo motor is controlled by the VFD driver circuit. The output terminal from the PLC is connected to valves and motor, alarm etc.

Keywords — **LVDT, Servo Motor, PLC,HMI, E-PLAN.**

I INTRODUCTION

The industry does not run without machines which are invented by the man for reducing his work time and increase the production. In the starting point, the controlling the process of machine is done by the isolator which trip the circuit totally when the fault is occurs. This will stop the production and involve the manual operation to retain the normal condition in later this is overcome by the placing relay and the other protective device. This will increase the complexity and the identification of the fault is difficult, usage of relay is high because its operation is either open or close. This will increase the cost and need more maintenance. To overcome this, we use the PLC and relay for reducing the cost and increase the production. The main advantage of using the PLC is the fault is easily identified and it can be easily modified the logics for the required

specification. Power consumption is very less and operating frequency is high and the program is executed very fast.

1.1 Previous Method

In the previous setup Induction motor is used for the same process. It will consume the power in the curing time and also speed controlling is very complex. This will reduce the production of the product. LVDT is absent due to the presence of proximity sensor. This setup consumes high amount of power. It is difficult to turn ON and OFF in operating condition. The main disadvantage of the setup it consumes lot of power comparing to the other motor in one point of view the induction motor having the high efficiency but having this as an major consideration we can't achieve our desired production at specific time.

1.2 Proposed Method

Comparing the past method we can use servo motor instead of induction motor. The main advantage of the motor is it can operate any supply. It can operate in both the supply AC and DC but we use only AC servo motor. The servo motor is works on the servo mechanism. Position is

send as feedback for the motor operation. This is controlled by VFD driver circuit. It can turn off when the curing time of the material is takes place, at this time the energy is saved up to 30%. It will reduce the power consumption and electricity bill. Proximity sensor is replaced by LVDT. It is easy to identify the movement of the bolster. The main advantage of the LVDT is it can control the production of the product and cost is low comparing to the previous setup. There is no need for the additional pump setup.

1.3 Architecture

The architecture for the setup is shown in Fig 1.0. Power wiring circuit contains Moulded case circuit breaker, Miniature circuit breaker, Current transformer, Single phase preventer. The purpose of current transformer is to sense the current rating of each phase. Single phase preventer is used to prevent the circuit from the fault when over voltage is occur.

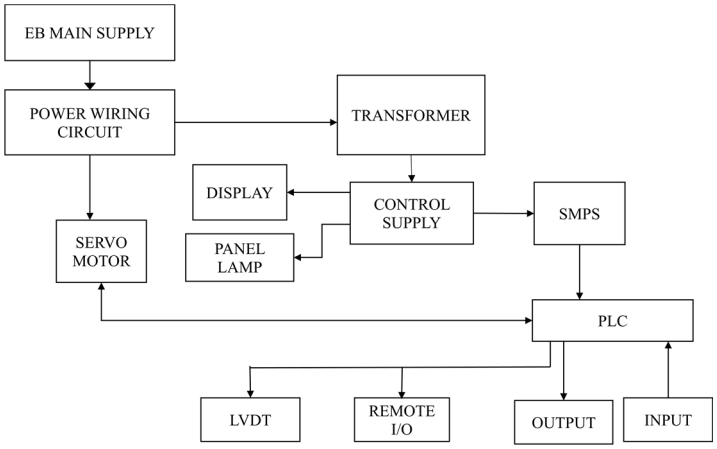

Fig 1.3.1 Architecture of the system

II OPERATION TOOL

2.1 Servo Motor

A Servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. The term servomotor is suitable for use in a closed-loop control system. A Servomotor is a closed-loop servomechanism that uses position feedback to control. The input to its control is a analog signal or digital signal representing the position commanded for the output shaft. The motor is paired with some type of encoder to provide position and speed feedback. The device is controlled by a feedback signal generated by comparing output signal and reference input signal. Servo motor can be rotated from 0 to 180 degree, but it can go up to 210 degree, depending on the manufacturing. The servo motor is mainly classified in to two types.

- AC Servo motor
- DC Servo motor

In this project we use only AC Servo motor it is easy to control and required less maintenance.The Star Delta starter is used to start the motor in smooth manner.The speed is contolled by VFD driver circuit.Operating current and voltage rating of the servo motor is 3.2A,440V.The speed of motor from 1 RPM to 2200 RPM. Power rating of the motor is 8KW.

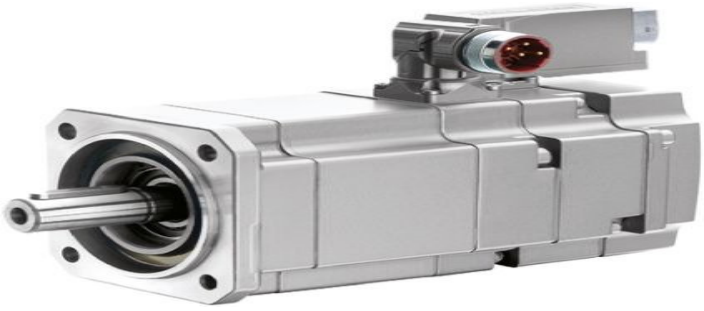

Fig 2.1.1 Servo Motor

2.2 VFD Driver Circuit

The driver circuit is shown in Fig 2.1B which is position is send as feedback, the AC supply is given to the bridge rectifier. The capacitor and inductor is act as filter circuit to eliminate the harmonics. And the output voltage is fed to the inverter which is used to invert the power supply to the motor the voltage and the frequency is controlled according to the operation. The efficiency of the driver circuit is about 92% - 98%, the remaining 2% is loss due to heat dissipated by the circuit.

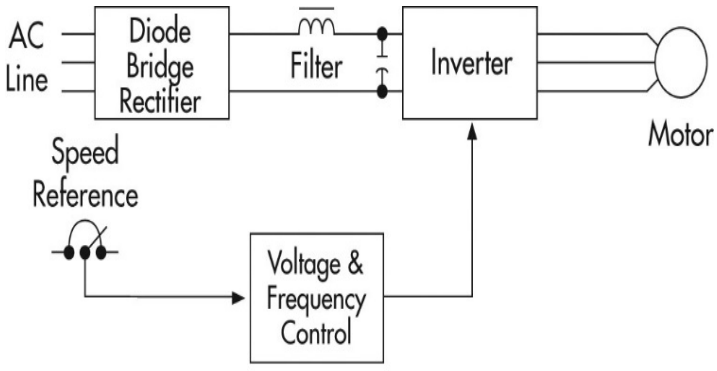

Fig 2.2.1 VFD circuit

2.3 LVDT

The LVDT is used to monitor the position of the moving bolster. It consists of three solenoid coils which are faced opposite to each other. The core is placed between the coils. The movement of the core which causes induced voltage to change. The change in voltage will cause the changes in movement of bolster. It can operate up to high temperature of 1200^0 F. The operating voltage for the LVDT is 24 V DC. It is mainly used in the servo motor for the position feedback control. We use BALLUFF LVDT for this operation. It can withstand up to 85^0F.The over voltage protection is possible and also it will record the default reading when it is turned off suddenly. The LVDT is connected with help of the 8 pin female connector.

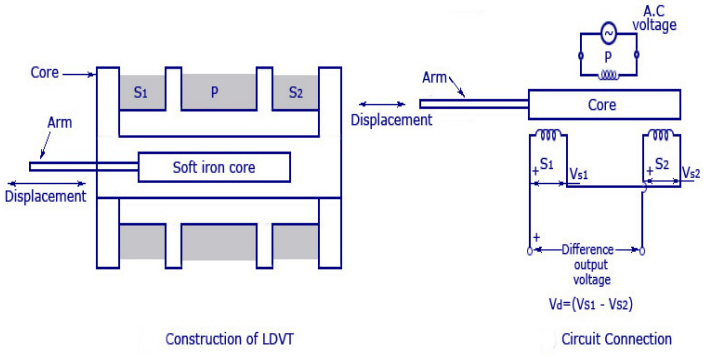

Fig 2.3.1 LVDT Setup

2.4 Relay

The relay is mainly used for the protective purpose either it may turn ON or turn OFF. In this we use the transistor module relay for the operation. The transistor relay consists of 8 individual relay which is called as set. The relay is available in open condition when the supply flows the switch is closed by the energisation of the coil.

2.5 SMPS

SMPS stands for Switched Mode Power Supply. Its operated frequency is 50/60 HZ. The current rating of the SMPS is 10A. The input supply voltage is AC up to 240V. The output voltage is constant 24V DC for the PLC inputs.

2.6 HMI

Human Machine Interface which is used for communication between the user and the CPU. It is operated on the 24V DC supply. The lower limit of the operating voltage is 19.2 V and the maximum operating limit of the voltage is about 28.8V DC. The current consumption of the HMI is about 0.5A. It can support the HTTP, HTML, CSS, XML, and JAVA Script. The CAN bus protocol is not supported here. Ethernet and MODBUS is suited for the communication. It contains the library files.

2.7 Solenoid Valve

The solenoid valve is an electromechanically operated device. It consists of large number of copper wire turns. The valve is operated based on PLC ladder logic. The power consumption of the valve is about 1.3A to 1.8 A, which is decide based on the load.

2.8 PLC

The PLC stands for Programming Logic Controller here we use Master as CPU SIMATIC S7-1200 PLC. This PLC consists of 14 pins input and 10 pins as output operating voltage is 24V DC supply and maximum permissible operating voltage (upper limit) is 28.8 V DC. The minimum permissible operating voltage (lower limit) is 20.4V DC. The rated current when the CPU alone is operated is 500mA. The maximum amount of current consumption is about 1500mA, when all the expansion modules are operated or connected. There is no expandable memory only 100 KB is used for the program. Here we used only two analog modules as an output. If we want more than two slave bits, we must use the additional CPU.

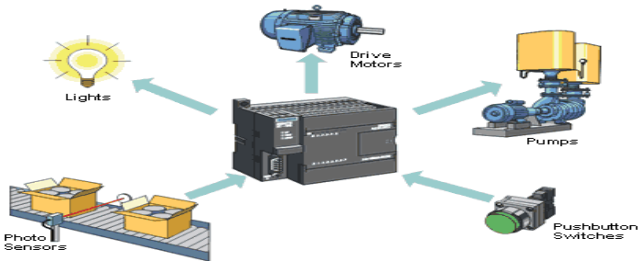

Fig 2.8.1 Architecture of PLC

III DRAWING TOOL

E-PLAN is the essential software used for drawing the circuits. It consists of planning, documentation and managing the automation projects. This involves wiring diagrams and connection diagram and also commission and verification of the diagram before the starting process of

wiring. The main disadvantage of this software is there is no simulation model. The usage components must be in the form of higher level function.

3.1 Main power supply circuit

The main power supply circuit consists of MCCB which is used to protect the device from the over current or over voltage the Amps rating of the MCCB is 32A, which is placed according to the connection of the load. CT is placed on every phase of the supply voltage to monitoring the current rating of incoming buses. The CB0 is provided for protection of energy meter another circuit breaker CB9 is connected for the protection for single phase preventer.

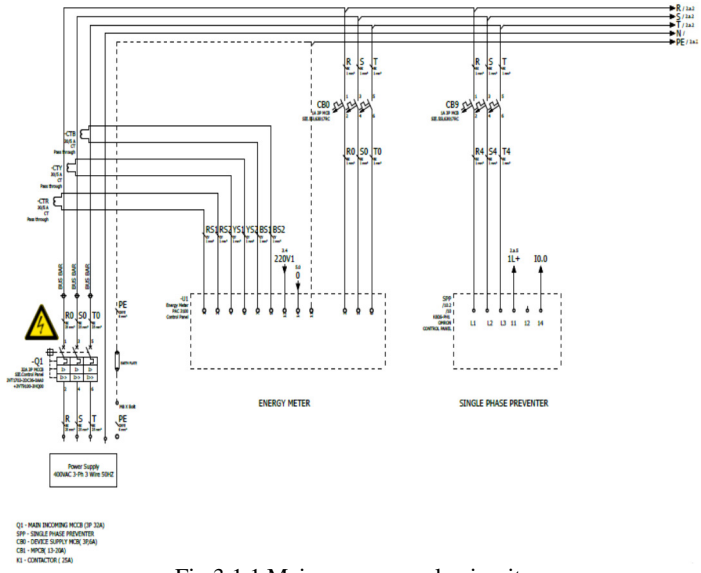

Fig 3.1.1 Main power supply circuit

3.2 Motor control circuit

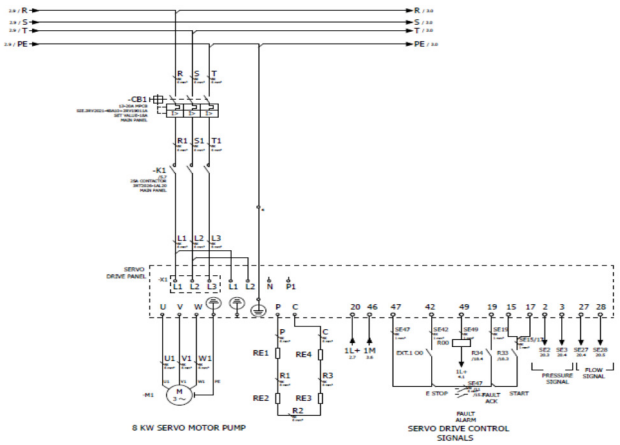

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Fig 3.2.1 Motor power supply circuit

The motor is connected with driver circuit and device is protected with MPCB. Supply is fed for the servo motor through circuit breaker 1 and contactor through star delta starter. The position of the motor is feed back through servo driver circuit signaling by LVDT. The fault alarm is connected to driver circuit.

3.3 SMPS and PLC input circuit

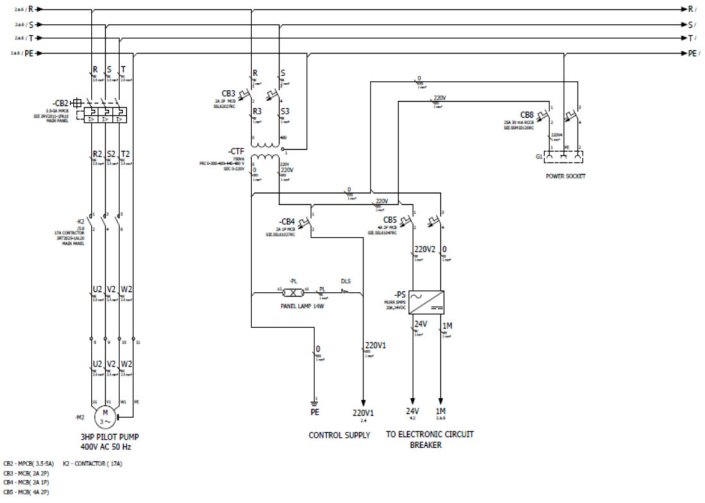

Fig 3.3.1PLC input supply and transformer arrangements

IV PLC PROGRAM AND TIA

4.1 TIA

The software used for the system is **TIA –TOTAL INTEGRATED AUTOMATION.** It is whole controlled operating tool (which can control all the equipment which is mounted on the system which includes HMI, SCADA etc.). This is user friendly and innovative capability and efficient working steps or algorithm for TIA is below

Step 1: Start.

Step 2: Create a new project.

Step 3: Add devices.

Step 4: Add Device configuration.

Step 5: Communication through Ethernet.

Step 6: Program downloading.

Step 7: Program execution in machine

Step 8: Stop.

The flow path of Auto cycle is shown in below

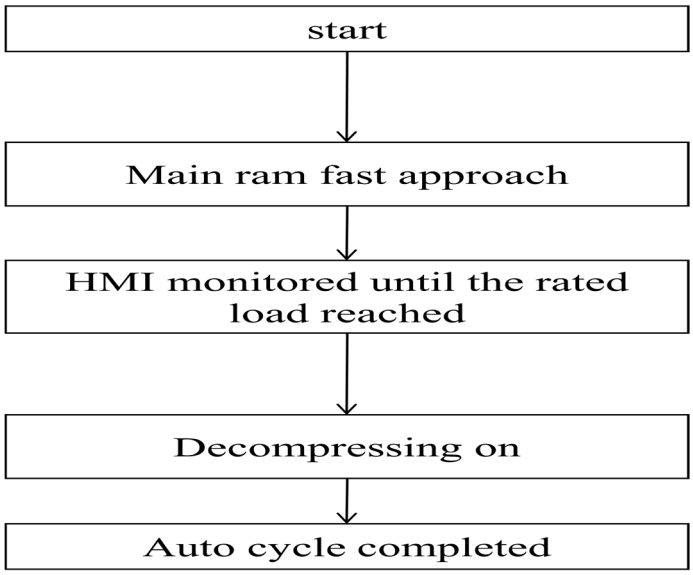

Fig 4.1.1 Flow chart for auto cycle

4.2 PLC PROGRAM

Fig 4.2.1 Ladder logic for auto ready

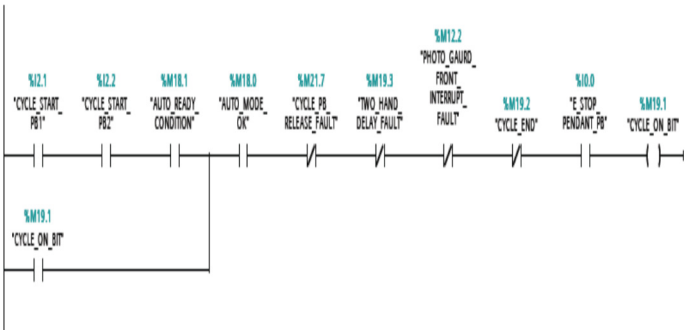

Fig 4.2.2 Ladder logic for Auto cycle on

V CONCLUSION

Thus in all the industries the product manufacturing operation is done by manual which cause the accident due to his lack of concentration. To overcome this machines are introduced to perform the operation automatically. Here the machines are monitor by the way of PLC program. The PLC operation involves the operation with SCADA which is very easy to operate from the PC itself. Thus the operating time is get reduced with high production and saving of electricity up to 30% by using servo motor in the place of induction motor. The wiring complexity is reduced by connecting the relay. PLC program was designed for controlling the machine either automatic or manual. It is undergone to stress relief process. Designed frame is under gone to the floor boring section .After floor boring it is taken for the painting and assembled in the assemble section. The final inspection is performed in the assembly and production is checked according to the load arrangement. The machine is dismantled for repainting and ready for dispatch.

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