Exhaust Blower based on Variable Frequency Drive

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Abstract: Many industrial applications require variable flow control of fluid (air, chemical gases, water and liquid chemicals). An exhaust blower system based on PLC (Programmable Logic Controller) & VFD (Variable Frequency Drive) is proposed. The main aim is to reduce the energy consumption by the implementation of VFD and hence the proper control of exhaust blower. The PLC operates and commands the variable frequency drive (VFD), to drive the induction motor (IM) with required speed by varying the frequency. In this project we are using VFD for controlling two motors for exhaustion of unwanted dust. Here, PLC is controlling suction mechanism of two different machines with set frequency. Whenever suction rate is slower/off, feedback is given to the PLC then, as per the programming, VFD will reduce the frequency of exhaust motor which will ultimately leads to less energy consumption.

Keywords: PLC, VFD, Induction Motor, Energy consumption, Proximity switch, Star–Delta system.

INTRODUCTION

The proposed system is based on variable frequency drive (VFD) using programmable logic controller (PLC) to change the frequency of exhaust blower in order to reduce energy consumption. There are two machines: 1) Short pinion machine 2) Grinding machine. These two machines emit dust and sand particles which are absorbed by exhaust motor via exhaust pipe. The exhaust motor rotates with three phase supply voltage 415 V and frequency 50Hz, when exhaustion from both machines is in ON state or either machine is ON. Thus, we will be implementing VFD system along with PLC so that this will adjust the frequency of exhaust motor considering the exhaustion rate of machines. Hence, energy consumption can be reduced to 40-50% of the previous system.

WORKING OF EXISTING SYSTEM

At present the exhaust blower system works on star delta mechanism. There are three states of Star-Delta starters,

- Star connected state
- Main state
- Delta connected state

During starting time, main and star contactors remain closed. In star connected state, voltage applied is reduced to $1/\sqrt{3}$ of line voltage across each winding. When motor starts it rotates with 90% of full rpm. After few seconds, timer connected in starter disconnects star contactor first and then connects delta contactor. Between these two, star connected and delta connected states, circuit becomes open and motor neither remains in Star nor in Delta state. This is called open transition switching.In Delta connected state voltage applied to windings is equal to line voltage.

PROPOSED SYSTEM

The main supply will be given to SMPS. It provides 24V DC supply to the PLC.PLC has 8 dc inputs and 6 dc outputs. Outputs of solenoid sensors are analog in nature

so, the analog signals feed as input to MSP module which converts analog signals to digital form and further gives it as input to PLC. Through programming of PLC it generates corresponding output and gives to MSP. So, MSP converts incoming digital signal in analog form and gives output to VFD.PLC outputs are relay based, further are given to the contractor to control other module like current transformer, mcb, mccb etc. When both machines are ON, PLC get inputs from sensors and gives command to VFD through communication module. Hence VFD rotates motor with 50Hz frequency. When either or both motors slower down, switches give feedback to PLC and PLC gives command to VFD to rotate exhaust motor with frequency of 35Hz or given set frequency. As frequency is directly proportional to voltage, reduction in frequency leads to reduction in voltage and energy consumption reduced to great extent. Here, in case of failure of the proposed system using the changeover switch we can operate the machines on existing i.e.star delta system.
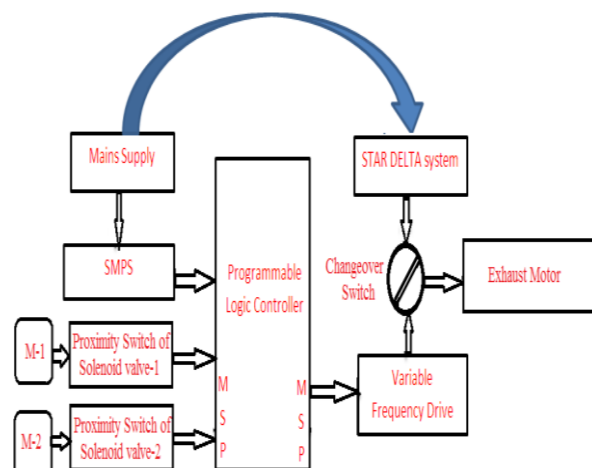

Fig. 1 Block diagram

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Meanwhile, the troubleshooting can be achieved in proposed system.

SOFTWARE IMPLEMENTATION

There may be many software's for implementing ladder diagram depending on the brands of PLC. Here, some basic window of versa pro software is shown which supports coding platform for GE Fanuc Automation North America Inc. With Versa Pro, we can do following things:
1) Create PLC logic and information associated with that logic in a folder
2) Configure PLC Hardware
3) Create and edit variables
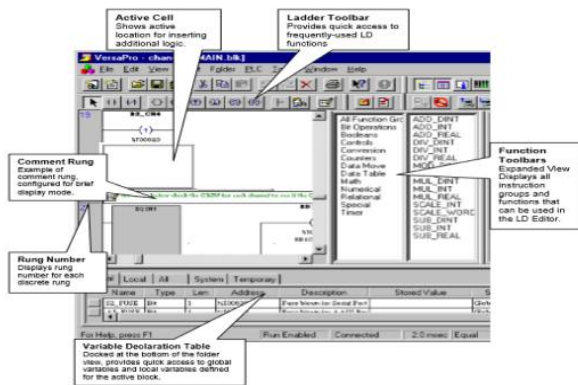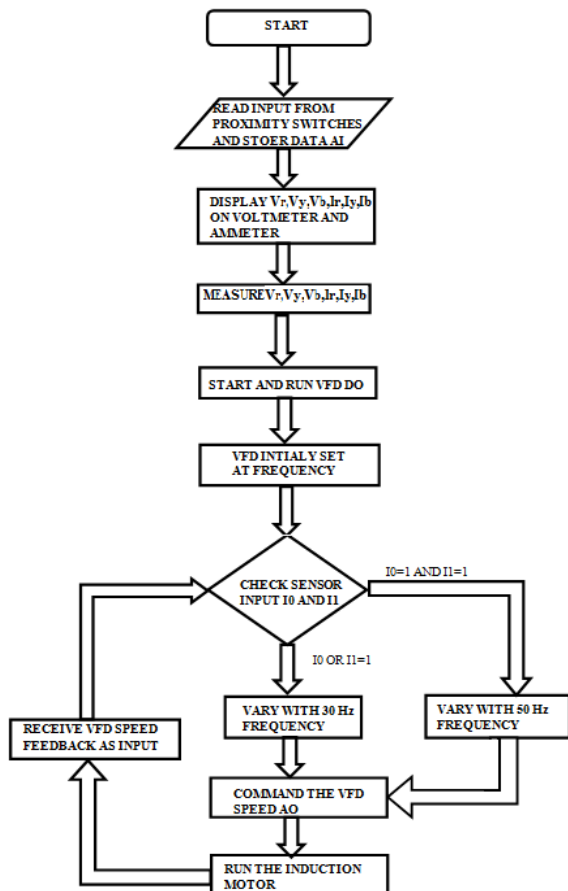4) Create, edit, and monitor the execution of Ladder or Instruction List logic

Fig.2 Versa pro window

FLOWCHART

DO to command the VFD to Run / Stop,
AO to command the VFD speed,
AI for the VFD speed feedback signal to the PLC,
AI as your process input,
DI as a Run/Stop command to the PLC

RESULT

The comparison table shown below tells us the energy consumption of existing system (star-delta system) and theoretical calculation of proposed system (based on vfd). The energy saved due to proposed system calculation is done using formula:

Power consumption in kw
=1.73*current*voltage*power factor/1000

CONDITION	ON STAR-DELTA SUPPLY	ON VFD BASED SUPPLY	% ENERGY SAVED
1.	31.97 KWH	13.85KWH	56.68%
2.	31.97 KWH	10.61KWH	66.81%

Fig4. Comparison between regular (star-delta) supply and VFD based supply

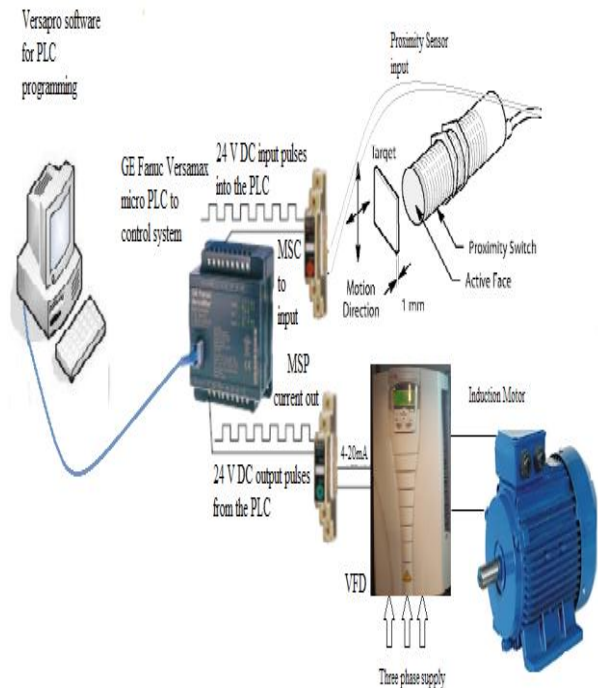The clear idea of the working of proposed system is as shown below:

Fig5. Working of proposed system

ADVANTAGES

- Since, PLC is used it gives us the advantage of reprogramming, flexibility, reliability etc.
- The use of VFD results into lot of energy savings.

APPLICATIONS

- In any automation system, monitoring and control of a exhaust motor with three phase variable frequency drive (VFD) using programmable logic controller (PLC).
- For, energy saving application in any industries plant.

CONCLUSION

Speed control of high power AC motor is achieved and the operation is very reliable, high efficient. With help of VFD as starter we can control energy consumption of AC motor as compare to star delta starter. Also, PLC makes it automatic for change in flow of dust in any of machine connected to input. Thus, by implementing this idea we are able to reduce the energy consumption.

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