

Design, Simulation and Implementation Monitoring System for System Control C4 Feeding Pump for Feed Vaporization in the Butadiene Plant

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Abstract—This study implements the auto start control system on an electric motor 3 phase C4 Feeding pump when the discharge pressure is low-low (4.3 kg/cm^2). The C4 feeding pump motor was initially manually operated from the local control station, this was very ineffective and inefficient because it still relied on the field operator to operate the pump motor and when the plant was in normal operating it is very risk if the field operator late to operate motor then it will impact to quality of the product, and if the delay time to operate motor is too long then plant have to shut down, therefore improvement is needed in the C4 feeding pump motor control system. In this paper, various types of 3-phase motor control are explained which allow it to be applied to the C4 feeding pump motor that are on-off, inverter, and variable speed drive and efficient selection of the three systems control of the motor. Software and hardware used in this work are DCS CENTUM VP Yokogawa.

Keywords: Thing speak, SMS, engine temperature, arduino mega 2560, SIM900A

I. INTRODUCTION

Mixed C4 is a gaseous of different C4 olefins and is used in various industries. Mixed C4 is a produced by cracking naphtha in the steam cracker. Characteristic of mixed C4 is flammable, Mixed C4 is the raw material for the Butadiene plant which is an important component in the manufacture of synthetic rubber. Method of shipping with a pipeline or vessel. The derivative product is in the form of Butadiene. Butadiene, C₄H₆ - also known as 1,3-Butadiene, is a simple conjugated one. Butadiene is mostly obtained using the extractive distillation process from Crude C4. Most Butadiene is polymerized for Styrene Butadiene Rubber (SBR) products used in the manufacture of car tires, in addition to their use in producing adhesives, sealants, coatings and rubber products such as shoe soles.

C4 feeding pump is a pump that serves to transfer C4 which is used as a vaporization feed in the butadiene plant, the pump is currently still manually operated through the local control station located near the C4 pump, this is very risky due to a drop pressure then the operator must immediately go to the pump location to turn on the standby pump so that the pressure is maintained, this is very inefficient because if it is too late

to turn on the standby pump there will be cavitation on the running pump resulting in a damaged pump, the second will cause a bad impact with quality of the butadiene product, and the third one it will make the butadiene plant shutdown due to supply C4 to feed vaporization at the butadiene plant is not fulfilled, with this problem one of the solution to solve those problem are make improvement to this pump to make it auto start system.

This pump using a 3 phase induction motor where the voltage source is 380VAC which is supplied from the Motor Control Center.

II. MOTOR INDUCTION 3 PHASE

An induction motor is an electric machine that converts electrical energy into mechanical energy or motion. 3 phase induction motor consists of 2 parts namely the rotor or the rotating part and the stator part that is stationary. 3-phase induction motors are operated in 3-phase power systems and are widely used in various industrial fields with large capacities.

A. Types of 3 Phase Electric Motor Controls

On/Off. Using control on off by not using an analysis of motor speed fluctuations, that is by adjusting the valve opening to increase and decrease pressure. Component On / off control is using contactor or relay, local control station. The price is cheap.

Inverter. Using adjustment of motor cycle speed up and down the frequency so that the motor spinning speed can be maintained. This kind of System control need bigger cost to material procurement. The inverter component consists of inverter, contactor or relay, MCB, ELCB

Variable Speed Drive. VSD that control the speed of either the motor or the equipment driven by the motor (fan, pump, compressor). this device can be electrical or mechanical. the majority of the motor operate only at 100% speed for short periods of time. Consequently, there are significant energy losses during the operation time. System loss reduction can be achievable by installing VSD systems to match the speed

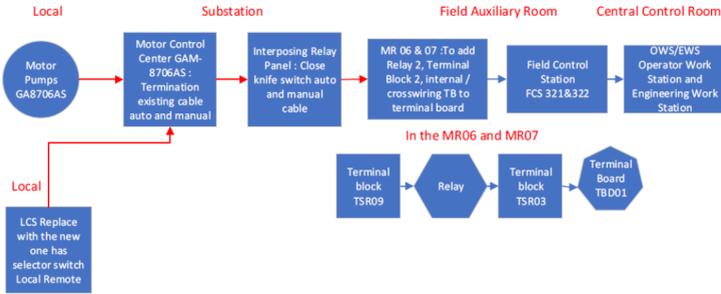


Fig. 1. Diagram Block Modification System

of the motor with the related load. By using VSD the speed of a motor or generator can be controlled and adjusted to any desired speed. Besides adjusting the speed of an electric motor, VSD can also keep an electric motor speed at constant level where the load is variable

Of the three control systems described above, the author uses an on / off control system to operate the C4 Feeding pump motor for consideration of the installation price of equipment and the desired requirements of the process. Modification software is using DCS Yokogawa Centum VP.

III. DIAGRAM BLOCK MODIFICATION WORK

The block diagram (Fig.1) explains the modification activities carried out by replacing the old LCS with the new LCS which is equipped with a switch selector for the selection of auto and manual modes so that the operator can operate the motor by selecting the manual mode from local and from DCS by selecting auto mode. Termination of the existing auto and manual cable at MCC then closed the knife cable switch from MCC. on MR06 and MR07 there is an activity of adding relay logic to start stop motors from DCS, adding terminal blocks and internal wiring.

The stages of modification check spare I/O module at this stage I/O module is checked from IOM builder (DCS software that is connected to IO module) does it still have a spare for modification activities if still then go to the next stage if not then provide new I / O module, do I / O assignment at IOM builder, check the railway for relay spare if there is still a spare if you don't provide new relay if you still install the relay, check spare terminal block and terminal board if there is spare install internal wiring from terminal relay to terminal block from terminal block, continuity internal wiring from terminal block to terminal board, from terminal block to relay, from terminal block to interposing relay panel, do modification logic, internal loop test or relay logic test (simulate digital output signal) and ensure the relay works in accordance with the logic made, replace LCS with the new one with new selector switch for local remote mode, Loop

test from LCS to DCS, dry function test (do testing directly on the motor).

IV. FLOWCHART PROGRAM

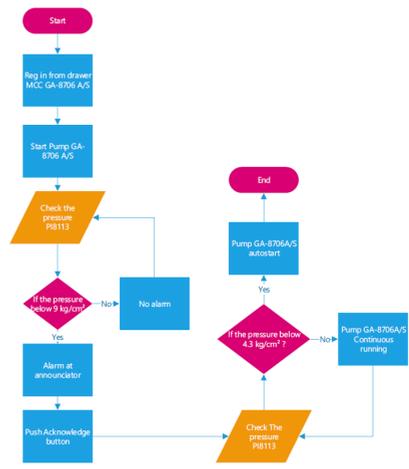


Fig. 2. Flowchart New Program

The program flow (Fig.2) explains about the new program modification sequence which is started by reg in MCC GAM8706AS drawer. This activity aims to activate 380VAC supply power to the motor pump then start the pump motor from local or CCR then check discharge pressure P18113 if the pressure is below 9 kg/cm^2 then annunciator will active and giving alarm sounding, after that push acknowledgment button on the DCS console after that check the discharge pressure P18113 if the pressure below 4.3 kg/cm^2 standby pump will start automatically. The difference between the old program

and the new one located at the discharge pressure when the pressure low-low (4.3 kg / cm^2) of the new system is equipped with the auto start facility which means that the standby motor pump will start when the pressure is low-low.

V. MODIFICATION HARDWARE

Material (Fig.3) and equipment that use are centrifugal pump GA-8706A and GA-8706S, motor control center GAM-8706A and GAM-8706S location in the substation building, marshalling rack MR06 and MR07 the location in the field auxiliary room, interposing relay panel the location in the substation, internal wiring, terminal block, terminal board, relay, EWS (Engineering Workstation) and HIS (Human Interface System) for software modification. Modification hardware consist of change local control station with the new one this equipment is used to start stop motor before motor just only be able to start and stop from local but now it can be remoted from CCR also due to already facilitate with selector switch to choose operation mode, wiring in the MCC GAM8706AS using existing cable, to add terminal block in the MR07 and MR06 it is used to digital output terminal, to add relay in the MR07 for GA8706AS for start stop motor and auto start logic, to add cross wiring / internal wiring from terminal block to terminal board.

| No | Hardware | Picture | Specification | Position Installation |
|----|---------------------------|---|---|-----------------------|
| 1 | Relay |  | Omron MY4N-GS 24V DC 14 Pin | MR07 |
| | Mounting Socket |  | Omron P1F14A-E | MR07 |
| 2 | Terminal Block Weldmuller |  | Knife switch | MR07 |
| | |  | Fuse switch | MR06 |
| 3 | Internal wiring |  | NVAF Black 1x2 mm ² , NVAF White 1x1 mm ² , Tube Marker | MR06 to MR07 |
| 4 | Local Control Station |  | LCS Appleton 220VAC with the selector switch | Local |

Fig. 3. Material Specification

The specification of relay that will be installed are model MY4N-GS with contact configuration 4PDT and rated voltage use 24VDC (Fig.4). Because it uses dry contact and MCC using wet contact. The terminal arrangement is like drawing above it has 14 pins as we know relay has pin and need to be connected to the socket, the socket is provided based on how many pins that relay has, below mounting socket that will install. This relay mounting socket is a terminal cable from and to terminal block, terminal block is a terminal that

receive and send a current. Condition after new relay install, tag number for new relay are RY16 for GAM8706S and RY17 for GAM8706A. There are two kind of terminal block that use in this modification, terminal block with knife switch and terminal block with the fuse. Terminal block knife switch type is used in the marshalling rack 7 Terminal slot right TSR09 terminal number 1-4 that received 220 V AC from interposing relay panel and then go to the relay to reduce the voltage to be 24 VDC. Terminal block with fuse is install in the marshalling rack 6 Terminal Slot Right TSR03 terminal number 1-4 before go to terminal board to protect short circuit.

| IRP | MR07 | GAM8706AR | GAM8706SR | MR06 | TBD01 |
|--------------|-----------|------------|------------|-----------|-------------------|
| GA8706AR 1.2 | TSR09 1.2 | RY17 14.13 | | TSR03 1.2 | TBD01-TM1-18B,18A |
| GA8706SR 3.4 | TSR09 3.4 | | RY16 14.13 | TSR03 3.4 | TBD01-TM1-17B,18A |

Fig. 4. Wiring Connection for Relay Installation

From the wiring connection, the cable from the interposing relay panel GA8706AR terminals 1 and 2 enter the MR07 terminal cabinet racking block TSR09 no terminal 1 and 2 then from the terminal block to the RY17 terminal socket mounting relay terminal pin no. 14 and 13, from socket mounting relay terminal enter the MR06 terminal marshalling rack block TSR03 terminal number 1 and 2, then head to the TBD01 terminal board channel number 18A and 18B.

The cable from the interposing relay panel GA8706SR terminals 3 and 4 goes to the MR07 terminal cabinet racking block TSR09 terminal number 3 and 4 then from terminal block to socket mounting relay terminal RY16 terminal pin 14 and 13, from socket mounting relay terminal goes to marshalling rack terminal MR06 cabinet blocks TSR03 terminal number 3 and 4, then goes to TBD01 terminal board channel number 18A and 18B.

VI. MODIFICATION SOFTWARE

modification software to add io assignment in the IOM builder is for digital output GA-8706AR and GA-8706SR, modification loop control builder is main program, modification logic chart is used to make auto start system, to add sequence table it is used to sequence of auto start system means that it is consist of step must be fulfilled to make motor start automatically, online download is used to download program from engineering workstation to human interface system and to the central processing unit of the controller.

A. New IO assignment

IOM builder functions for input output assignments, this builder informs about Nodes, Slots and Channels. The node is the addressing rack used to install the module in this case the digital output module. While the slot is the number of modules calculated from the leftmost module to the right module. While the channel is the terminal number used for digital output cable in this case GA- 8706AR and GA-8706SR are used to start stop motor from DCS (Fig.5). From IOM builder above, information is obtained as follows: the module used is at FCS322 Node: 5 slots: 7 Channel number 22 and 23. The

pump GA-8706A/S Start and the pressure PI-8113 below 4.3 kg/cm².

VIII. RESULT

By new installation of local control station with local remote facility, operator can operate motor C4 feeding pump locally or remote it automatically from control room. By adding alarm low and alarm low-low in pump discharge pressure, operator will get early warning by annunciator. By adding relay and logic auto start in control system C4 feeding pump, then: Pump will be started automatically when the pressure lo-lo (below set point 4.3 kg/cm²) so the operator doesn't need to operate it manually, pretend the pump cavitation due to the stability of discharge pressure. Moreover, the pump will be running in its operating pressure. Pressure discharge can be easily maintained in order to operate as its operating pressure, Product quality is controlled because the C4 supply into Butadiene Plant feed vaporization is maintained well, Make possible to implement many innovation or improvement in the system. For the example is the adding interlock system, the adding of trigger for auto start system, etc.

IX. CONCLUSION

After the modification, C4 feeding pump can be operated automatically from DCS, The C4 feeding pump not only to be back up for the pump during maintenance but also to be back up for discharge pressure to supply C4 when the discharge pressure low-low (below set point 4.3 kg/cm²). When discharge pressure C4 feeding pump below set point 9 kg/cm² announcer will active to inform alarm low. By the implementation of auto start system then the discharge pressure can be maintained, so it can eliminate the probability of unfulfilled C4 supply and shutdown in the Butadiene Plant. Standby pump will start automatically when the discharge pressure below set point 4.3 kg/cm².

X. RECOMMENDATION

The recommendation is to add interlock system when the pressure is high-high (pressure above set point 12 kg/cm²). To add auto start for standby pump when power failure (source power from MCC off).

REFERENCES

- [1] Kocurek, M. J., *Mill Wide Process Control and Information System*, Vol 10, 3rd edn (The joint test book comitee of the paper industry TAPPI, CPPA, Montreal, Que, Canada) 1993, 256-57
- [2] Liptak, B. G., *Instrumentation Engineer's Handbook: Process Control (Chilton Book Company I Radnor, Pennsylvania)*, 1999, 705-750.
- [3] VFD. *Variable frequency drive*, 2010. Available online at: <http://www.energy.ca.gov> [retrieved on 4th November 2010].
- [4] Saidur, R. A., *Review on Electrical Motors Energy Use and Energy Savings*. Renewable and Sustainable Energy Reviews 2009;14:87798.
- [5] Seifer, M. J., *Wizard, the Life and Times of Nikola Tesla*, 1998. ISBN (HC), ISBN (SC) Suharto, Pompa Sentrifugal, 2016. Yogyakarta : Ray Press.
- [6] www.chandra-asri.com