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RECENT DISTRIBUTED CONTROL SYSTEMS IN CHEMICAL PLANTS

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1. FOREWORD

In recent years, the use of DCS (Distributed Control System) to replace conventional instrument has increased. Recently, however, it has been aimed at plant or company-wide unification and rationalization, in addition to simple replacement of instrument.

The purpose, system configuration and features, and result of installation of a DCS in modern chemical plants based on an example of a large chemical plant with an explosive reaction process are introduced.

2. INSTRUMENTATION SYSTEM AND PURPOSE OF DCS

2.1 Conventional instrumentation system

The conventional instrumentation system at the plant in which a DCS was installed this time is panel operation with instruments, MIMIC-panel, and annunicator installed on an approximately 20m board. Three plants of the same system were monitored and operated at individual instrument rooms. The operator performs board instruments indication check and shift log and daily report data recording, etc. The maintenance personnel check for faulty indication and faulty moving parts and perform calibration and repair, as required.

2.2 Problems with conventional instrumentation

The main problems with such conventional instrumentation are:

(1) The operator load is large and labor-saving is difficult.

Since the status of many instruments and devices must be grasped, the operator load is large. Especially, transient states, such as plant starting and stopping, are dealt with by increasing the number of operators.

(2) Aging and lack of operators

Recently, since there has been almost no replenishment of operators, the lack of experienced operators and the aging of existing operators has become noticeable. Therefore, coping with emergencies and plant transient states and training of young operator cannot be said to be sufficient.

(3) Rise of maintenance cost

The number of maintenance personnel cannot be reduced substantially because of the increase of the number of repairs due to aging of board instrument and the large number of instruments.

2.3 Purpose of DCS

Conventional instrumentation is generally replaced by a DCS for the following four purposes, in addition to simple replacement of instruments:

(1) Solution of conventional instrumentation problems

(2) Automation of irregular operation

Operability and plant safety are improved by automating plant starting and stopping, emergency stopping, and other irregular operations, centered about the sequencer.

(3) Improvement of facility efficiency

A system which can connect to a host-system is built so that the plant can be operated on the factory or company-wide production plant. Optimum plant operation is possible by downloading the various set values based on the production plan from the host-system to the DCS.

(4) Unification of instrument room

The man-machine interface (MMI) of each plant is installed in the same instrument room or the instrument room is unified by incorporating multiple plants into one DCS to save labor and to unify the data of plants of the same system for the operator.

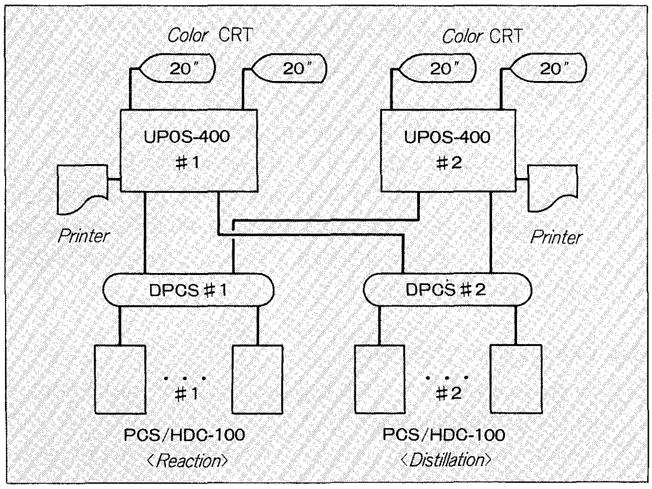
3. DCS EXAMPLE

3.1 Objective plant

The objective plant of the system introduced here as a DCS example consists of a reaction process and distillation process. The reaction process is mainly a high temperature, high pressure reaction process using an explosive raw material and demands extremely safe control and operability.

The DCS has approximately 1300 registered TAG per plant. Approximately 120 of these points are a PID control loop. The plant system is shown on 36 CRT screens (plant-panel).

Fig. 1 System configuration



3.2 System configuration

The system configuration per plant is shown in *Fig. 1.*

Two 32-bit super microcomputer based UPOS-400 are used as the operator stations. A total of four MMI are installed, one for each of the two color VDU at each UPOS. A total of 21 PCS-100 PID control and analog processing stations and HDC-100 high-speed sequencers are installed as the controller.

The UPOS-PCS-HDC are connected by DPCS-E high speed dataway.

3.3 System features

(1) The UPOS operator stations are made a parallel redundancy system by connecting both stations to the reaction process and distillation process dataway loop and also using the same software.

The UPOS internal processing load is reduced and response to operation from the VDU is improved, compared to the 4 VDU/1 UPOS system, by building a four VDU system by making the 2 CRT/1 UPOS system parallel redundant.

System upgrading, etc. allows plant operation with the remaining UPOS when the UPOS are maintenanced and when one system is stopped and improves working ratio as a system.

(2) Speeding up of screen display

Complete display of the screen on the VDU, that is, screen switching, is performed within one second after the operator calls the screen from the keyboard. Speeding up of screen switching is achieved by improving the UPOS and VDU hardware and firmware.

At the plant panel, the data on the screen is refreshed within 1 or 2 seconds.

(3) Speeding up of important alarms

Pump trouble and other alarms which are especially important to plant operation are reported on the VDU within 0.5 second after the alarm is generated at the site. Conventional annunciator functions are realized by displaying alarms on a dedicated alarm screen, in addition to message display to the top line of the VDU.

To report an alarm within 0.5 second, PCS → UPOS signal transmission uses dataway message transmission, and UPOS internal processing is assigned to the highest priority level.

(4) Duplexing of important loops

The loop units working ratio is improved by duplexing the common parts (MPU, memory, transmission, power supply) of the PCS-100 stations including especially important control loops of the reaction process.

3.4 System functions

(1) Operation

In normal plant operation, all supervision and control is possible at the VDU plant panel only. The group panel and loop panel are for supplementary use for detailed data reference. Operation from the panel is performed by selecting the control loop or device symbol with the cursor and pressing the function switch corresponding to the set data input and operation.

During automatic sequence execution, its progress can be checked at a dedicated screen. The screen is the time chart made at the sequence function design stage and arranged for VDU. The time chart and interlock acknowledgment symbols are switched to match the progress of the sequence.

(2) Analog control

Introduction of a DCS is taken as a opportunity for improvement study and simulation of controllability as a plant by the user and the control loop is reconfigured and the control characteristics are improved based on the result. Many loop configuration changes from the conventional cascade control to feedforward control are made, especially at the distillation process.

For the control loops related to the automatic sequence, SV and MV changes and SV lamp shape changes are made by command from the sequencer HDC.

(3) Sequence control

Automatic sequences called as process automatic start and stop and not seen in the past, are implemented around the HDC sequencer. The sequence menu is shown below.

(a) Automatic start sequence of reaction process and distillation process
(b) Reaction process automatic stop sequence
(c) Distillation process batch sequence

Taking the danger of the process into account, the reaction process automatic sequence adopts safety measures combined with the following external hardware circuit.

External: Interlock (plant emergency stop)
1st stop sequence (DCS preprocessing)
DCS: Stop pattern selection by source
Operator intervention at important points
Sequence congestion alarm generation

3.5 System engineering method

Engineering work for system construction is performed by sharing the load with the user as shown in *Table 1.* Especially in UPOS detailed design, not only document

Table 1 Engineering work distribution

Work item	User	Fuji Electric
Entire system configuration	○	○
Function design and function distribution	○	△
Engineering schedule	○	○
Detailed design by device: UPOS	○	△
:PCS	○	△
:HDC	△	○
Factory test	○	○
Field adjustment site test	○	△

Note) ○ : Overall
△ : Support

level, but also up to system generation is performed by the user. The assist function, an interactive type engineering function of the UPOS, is used in this.

The user engineering team is made up of those in charge of instrumentation and experienced operators. Participation of the operators in these works ensures that reflection of the operations conventionally performed by experience and other detailed parts are incorporated into the system and improves the completeness of the various software.

4. RESULTS OF INTRODUCTION

The results of introduction of a DCS are shown below. The purpose of DCS introduction described in paragraph 2 is achieved.

4.1 Economic effect

(1) The number of operators was reduced by improving operability.
(2) Maintenance cost was reduced by eliminating the board instruments.
(3) Product quality was stabilized by improving the control loop configuration.

4.2 Improvement of operability

(1) Operator load was reduced by making operation VDU operation.
(2) Start/stop operations were automated by sequencer.
(3) Three plants were unified at the same instrument room.
(4) Daily report and other data processing was automated.
(5) Learning of the operation method at DCS switching was made easy by participation of the operators in system construction.

4.3 Expandable equipment

(1) Host transmission was implemented by connecting a gateway to a dataway.
(2) System horizontal/vertical development centered about the gateway was made possible.

4.4 Improvement of user internal consciousness

(1) Operator concern with the system construction was improved.
(2) Since those responsibility for instrumentation and the operators constructed the same target system, cooperation among the departments in the company was improved.

5. CONCLUSION

The results of the recent introduction of a DCS into a chemical plant was introduced above with a DCS built cooperatively by the user and Fuji Electric were introduced above.

The introduced system a fast VDU display speed, fast operation response, and a 100% working ratio and is highly evaluated by the user and is operating favorably. The introduction of an artificial intelligence use optimization control and expert system is being planned with the user and future system expansion and improvements are scheduled.