AUTOMATED CONTROL OF PERIODIC DELAYED COKING PROCESS

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Abstract
The challenge facing the refining industry in the medium term will be to remain economically viable in the face of rising process costs (heavier, higher sulphur crude oils and emissions restrictions on their end products).

Keywords: Processing, control, efficiency, safety, automation, process optimization.

Introduction

The process of delayed coking (DC) is one of the high-temperature periodic processes of processing residual oil fractions. Due to its duration, multi-section nature and fire hazard, it requires strict control and management of process parameters. In the conditions of a modern oil refining enterprise, the introduction of automated control systems (ACS) allows to significantly increase the efficiency, safety and economic return of the process.
Given the multiplicity of stages, the diversity of equipment and the need to coordinate the actions of operators, automation is a critically important aspect.

Architecture of the automated system

Modern control systems are based on a multi-link hierarchical structure:
1. Lower level(level of sensors and actuators):
– Pressure, temperature, flow and level sensors.
– Electric drives, valves, pumps, gate valves.
– Local controllers and frequency converters.

2. Average level(programmable logic controllers - PLC):
– Collection and processing of signals from sensors.
– Coking cycle control algorithms.
– Logic for switching flows and controlling heat exchangers.

3. Upper level(ACS, SCADA systems):
Graphical representation of the process flow diagram (operator interface).
– Data historiization and accident registration.
– Reporting and archiving.
– Possibility of remote access and diagnostics.

Automated control of the delayed coking process allows to transfer a complex and dangerous periodic process into a controlled and stable mode. This ensures both high production efficiency and reliable protection of personnel and equipment. The constant development of digital technologies opens up new horizons for further optimization of the process and increasing the depth of oil refining.

Figure 2 shows a typical flow chart condition execution required at one stage of a level to enter that stage of a periodic control sequence. Although this flow chart is shown as a sequence of logical stages, a true continuous periodic control system can explore the logical chart in other sequences or parallel control conditions that require confirmation before entering that stage. For the purpose of simplicity of illustration, these conditions are shown in the wrong sequence in the block diagram shown in Fig. 2.

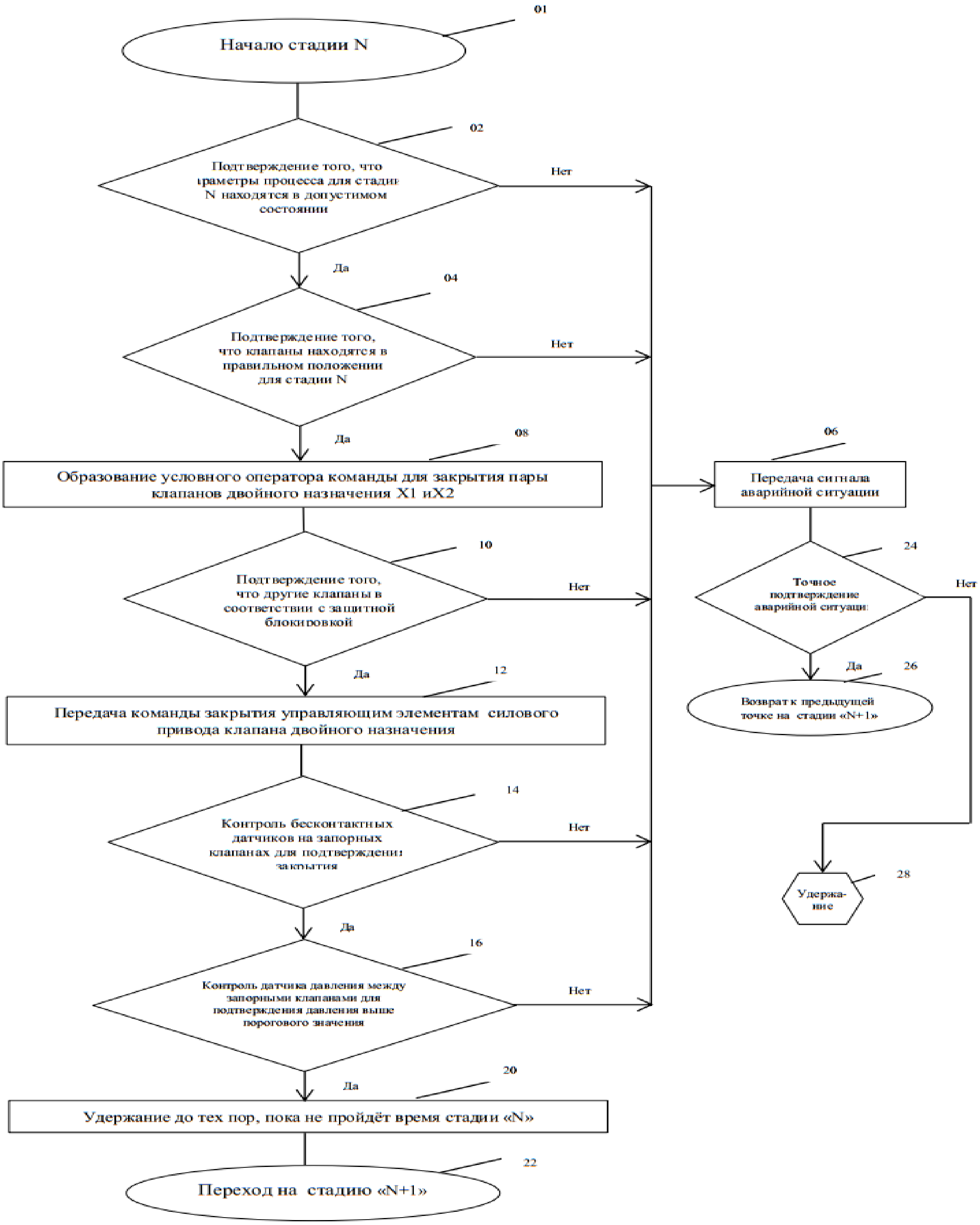

Fig. 2 - Typical logic block diagram for one typical stage of the coke drum operating cycle in an automated controller

This block diagram may not coincide with the actual assumptions that can be obtained from the selected configuration hardware and software platform management system.

At the beginning of stage "N" of the batch control sequence, stage 01, the batch control system may confirm that the selected process parameters being monitored for stage "N" are within a predetermined range, or above or below a threshold value, which satisfies the control system logic node, stage 02. The batch control system may also confirm that the selected valves being controlled as required by the control system logic node for stage "N", are in the correct position, stage 04. Some or all of the process input data in the control system and automated valves can be selected as controlled for a given stage, depending on the level of safety requirements. If neither the process parameters being monitored nor the operating valves being monitored are in the correct state, then the control system may transmit an alarm signal to the control system display, stage 06. If the selected process parameters are satisfied and the selected valves are in the correct position, the sequence controller creates a conditional statement that commands the dual-purpose valve pair X1 and X2 to close, stage 08. The control system confirms that everything is other selected valves are in the correct position as required by the safety interlock system to allow closing of the specified valves X1 and X2, stage 10. If it is confirmed that the selected valves are in the correct positions, then the control system transmits a closing command to the actuator control element of the double-acting valve, stage 12. If the selected valves are not in the correct position in accordance with the safety interlock, then the control system transmits an alarm signal to the system screen management, stage 06.

As a primary check of the valve position, the control system monitors the proximity switches on the shut-off valves that have been commanded to close to confirm that the shut-off valves have moved to the closed position, step 14. As a secondary check, the control system also monitors the pressure sensors between the shut-off valves to confirm that the pressure in the piping system between the shut-off valves has increased above a predetermined threshold, step 16. If neither the primary check nor the secondary check, then the control system transmits an alarm signal to the control system display, stage 10. For stages that may need to be held in this state for an extended period of time, the periodic control system may hold the stage until a timer expires, stage 20. After this time has elapsed, the periodic sequence controller may move to the next stage, stage 22. Re-acknowledgment may be desirable process parameters and valve positions, stages 302 and 304, before moving on to the next stage. After the alarm condition has been positively confirmed, either by automatic detection or by operator intervention, stage 24, the control system may return to the previous point in the stage "N" logical operation where the controller was last turned on before the alarm condition occurred, stage 26. If the alarm condition is not corrected, then the sequence controller will move to an undefined position.

In the articleThe article presents the features of automation and control of the delayed coking process, information on coking of heavy oil residues, the process of coking in a fluidized bed and automated control of the periodic process of delayed coking.

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