USAGE OF FESTO SIMULATOR FOR MARINE SYSTEMS

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***Abstract**: Two simulators of ship automation systems are realized by means of FESTO didactic elements and software. They are applied into syllabus for marine students and naval cadets. The analysis and advantages will be discussed between real and simulated systems.*
***Key words**: FESTO simulator, ship's systems, automation, algorithms.*

I.Introduction

The modern vessels are equipped with unattended machinery spaces and high automation level. In the same time educational requirements and maintenance skills for operational staff going up. Lately computer-based simulators with different types of ships, engines and systems are used for training of marine officers. But the question for practical skills with real techniques stayed open. And the current price for it is impossible for a lot of educational structures. Therefore the solution could be usage of real didactic element simulators with adaptive algorithm regards to the system presented. The FESTO simulator is a good example for such a system.

II. Models done

The FESTO simulator consists of few main systems – pneumatically, hydraulically, electrically and programmed logically controllers(PLC). The different algorithms are implemented by PLC software. Input signal are coming from sensors, push-buttons and transmitters. Output signals are going to distributors, cylinders, hydromotors, signal lamps and buzzers. Final target is creating of simulating model which demonstrates normal work mode, different malfunctions and timer readjusting for separate operational steps.

The following order for simulation could be applied:

- Collecting and researching of original system documentation.
- Projecting of operational algorithm with all steps needed.
- Elements choice maximum closed to real system like type and numbers.
- Program source code making through FESTO PLC software.
- Working scheme preparation by training software FluidSim, developed by FESTO.
- Program test with test device.
- System assembling with didactic elements and final test in action.

2.1 „Mitsubishi"purifier simulator

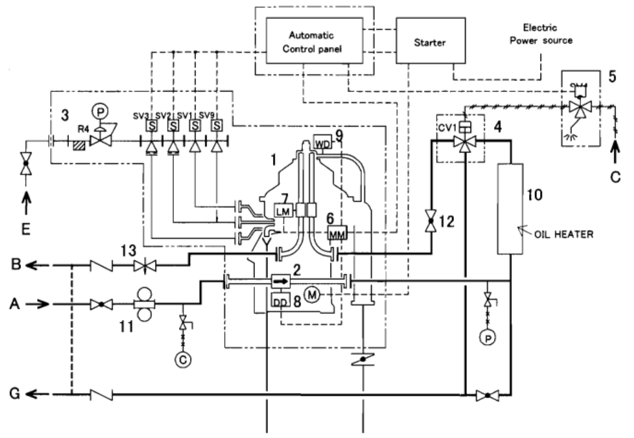

Fig.1

Fig.1 shows typical working diagram on purifier Selfjector subtype GSH-1.

The main components related with automation are:

Automatic Control Panel- the block contained PLC

3- control water supply unit with solenoid valves

4- three-way valve for fuel admission (pneumatically controlled)

5- three-way solenoid valve controlled 4.

6- Multi-Monitor(MM) unit

7- Cleaned fluid pressure sensor

8- RPM sensor

9- Circulation line pressure sensor

Fig.2 presents the main algorithm repeats with the HIDENS mode.

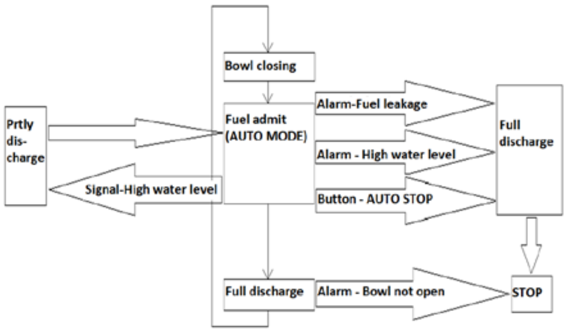

Fig.2

The water and/or sludge discharge and separation processes are repeated by determined time interval with normal automatic operation.

Two PLC units are connected in "Master-Slave" scheme due to numbers of I/O signal are too much for one.

The program source code is the same independent of work mode – HIDENS or PURIFIER. Readjusting of time intervals T002 and T003 needs only.

Diagram of connected elements on the simulator (Fig.3).

Specification:

1 – air compressor(6-8 bars).

2 – compressed air bottle.

3 – hand drain air filter.

4 – pressure reduction valve.

5 – pressure gauge.

6 – 5/2 distributor with electrical control for pilot and supply air to 10 and 16.

7 – 3/2 distributor with hand controlled switch.

9,11 – 3/2 distributor with mechanical roller control for supply air to 12.

10 – double acting cylinder with reciprocating piston simulating bowl rotation.

12 – 5/2 distributor with pilot air control actuating 10.

13,14,15 - 5/2 distributor with hand switch control actuating elements 17,18 and 19.

16 – pneumatic cylinder with single action.

17,18,19 – double-acting pneumatic cylinder.

20, 21, 22, 23 – capacitive sensors instead of revolution sensor, pressure sensor at circulating line, revolution sensor and pressure sensor at clean fluid outlet.

24,25,26 – 5/3 distributor with electrical control and spring for air supply of 27,28,29,30 and 31.

27,28,29,30,31 – pneumatic cylinders with single action instead of electromagnetic valves SV1, SV2, SV3, SV4, and SV9.

32 – buzzer activated with introducing alarm signal.

33 – lamp for electromotor stop signal.

34 – lamp for "High water contamination" alarm.

35 – lamp for "Bowl not open" alarm.

36 – lamp for "Fuel leakage" alarm.

37 – lamp for "Discharge" indication from main PLC.
38 – lamp for "Fuel admit" indication from main PLC.
39 – Push button „Automatic operation".
40 – Push button „Discharge test".
41 – Push button „Emergency stop".
42 – Push button „Automatic STOP"
43 – Push button „Alarm reset".
44 – Push button „Sound alarm reset".

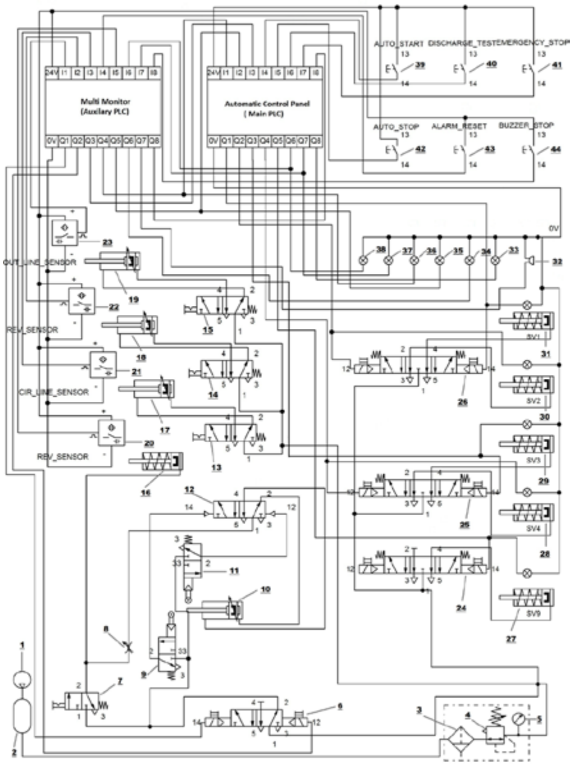

Fig.3

2.2 Simulator of remote control(RC) system of ship main engine(ME).

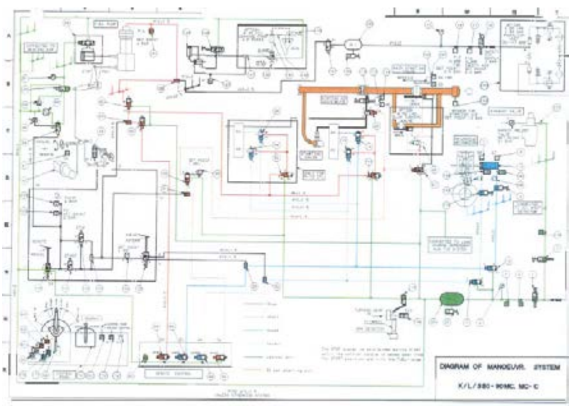

Fig.4. ME RC system for MAN B&W S80-90MC engine

Stand assembling requires a proper choice of pneumatic, hydraulic and electric elements to be created more realistic scheme.
The main elements used for are:
- Pneumatic cylinders – single and double acting.
- Distributors 3/2 and 5/2 type.
- Logic function valves „AND" and „OR".
- Non-return valves.
- lamps and buzzers for alarm signals.

The diagram is divided at five main units:
1. Turning gear.
2. Remote control.
3. Reversing mechanism.
4. Air starting mechanism.
5. Simulating of output power – ship propeller shaft.

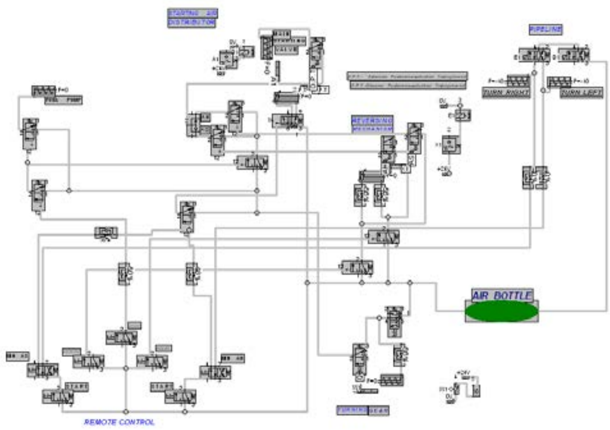

***Fig.5.** ME RC system in FluidSim-Pneumatics*

IV. Results analysis

4.1. Differences between simulator and real separator. Main difference coming from PLC's applied in the simulator. The presence of discrete(digital) inputs only is disadvantage in this case. It is impossible to be connected analogue sensor with this PLC type, i.e. values like pressure, temperature and revolutions are unable. Also the main PLC number of input/output ports is insufficient.
For timers or counters readjusting it needs PLC to be connected with computer with installed program interface. At the real purifier this activity could be done directly through display situated on control panel.
• The centrifugal bowl rotation could be simulated with real drum instead of pneumatic cylinder and smoothly rpm increasing would be shown. So the centrifugal clutch will be expressed.
• The diagram and element connections could be exchanged so that alarm resetting without distributor 7 comes back in initial condition and the cylinder 10 not to be activated again.
4.2 The drawing presents RC system in realistic and well-introduced manner.
- Each trainee is able to control the system processes which are very closed to the real and on board are difficult for simulation.
- The scheme solution consists enough alarms activated when improper steps or activities are detected. The visual and sound signals are included.
- Possibilities for simulation and education with software comes before real diagram assembling.
Disadvantages:
- This project follows operational algorithm of real one but the didactic elements are not equal with real valves.

- Control console is missing like "Emergency" but also "Bridge" and "Control room" units.
- The propeller rotation is simulated by hydraulic motor.

V. CONCLUSION

These two simulators have established already their possibilities in the education trainings with students and cadets. They have been used for post-graduated courses with ship engineers and also for specialized pneumatic and hydraulic trainings. The simulators were good scope from collaboration between lecturers, students and naval cadets.

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