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Functional description Styrene filter installation version 2.

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1 FOREWORD

This document describes the control functions and operator interface with the PLC, SCADA system
The function of the PLC , SCADA system is to serve and assist the operator to start-up, shut down and operate/control the Styrene filter installation and auxiliary systems.

The objective of this document is to provide the basic engineering for the detail design of the control system for the Styrene filter installation.

This document should be read in conjunction with the following project drawings/documents:

XXXXXX_Automatiseringsschema_009

XXXXXX2_ISL_009

XXXXXX_SCADA_002

XXXXXX2_PID_014

2 CONTROL LOOPS AND CONTROL LOGICS

2.1 Tank T001 level control loop (LICZA003)

Objective:

To supply water to tank T001 and keep tank level on setpoint.

Principle:

Control the pump P003 by means of level controller and speed controller SC003. For level control input: $LT003 - PT003 = P_{static}(T001) + H(\text{level}) - P_{static}(T001) = H(\text{level})$; this is tank static pressure corrected level.

Pump pressure PT083 shall be reached in 10s. If not, stop pump.

Implementation:

Input:

Level T001 reading	LT003
Pressure reading	PT010
Level PID controller	LC003
Output: speed controller	SC003

Motor thermal feedback ok (from MCC)	EM003
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Logic

Output: pump motor start (to MCC)	P003
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Input: pressure reading	PT083
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Operation:

Automatically enable/disable by sequence see ch.3.

Automatically depending on the difference between reading and set point.

Manually by operator intervention on the controller output signal.

The operator can NOT adjust the loop set point.

Valve HV098 shall be locked with padlock in the open position.

Note:

Alarms and interlocks:

LZHH003	: shut down regeneration by stopping boiler to standby, stop pump P021 and close XV002 and XV023.
LAH003	: alarm
LAL003	: alarm
LZLL003	: shut down boiler , regeneration start disabled
PZL083	: alarm
PZLL083	: stop pump P003A.

2.2 Tank T020 level control loop (LICA021)

Objective:

To supply water for tank T020 and keep tank level on setpoint.

Principle:

Control the water supply valve XV011. For level control input: $LT021 - PT084 = P_{static}(T020) + H(\text{level}) - P_{static}(T020) = H(\text{level})$; this is tank static pressure corrected level.
At $LT021 < SP$: open XV011
At $LT021 \geq SP$: close XV011
Switching hysteresis +/- 5 cm towards setpoint SP

Implementation:

Input:

Level T020 reading	LT021
Pressure reading	PT084
Level on/off controller	LC021
Output: level on/off valve	XV011

Operation:

Automatically enable/disable by sequence see ch.3.
Automatically depending on the difference between reading and set point.
Manually by operator intervention on the controller output signal.
The operator can NOT adjust the loop set point.

Note:

Alarms and interlocks:

LAH021 : Alarm
LAL021 : Alarm
LZLL021 : stop pump P003

2.3 Tank T020 temperature control loop (TIC020)

Objective:

To keep tank T020 water on temperature setpoint by means of cooling the tank.

Principle:

Control the cooling water supply valve TCV020.

Implementation:

Input: water temperature reading	TT020
Temperature on/off controller	TIC020
Output: level control on/off valve	XV020

Operation:

Automatically enable/disable by sequence see ch.3.

Automatically depending on the difference between reading and set point.

NOT manually by operator intervention on the controller output signal.

The operator can NOT adjust the loop set point.

Note:

Alarms and interlocks:

TZHH021 : shut down regeneration by stopping boiler to standby, stop pump P021 and close XV002 and XV023. (HHSP=30 deg.C)

TAH021 : alarm

2.4 Heat Exchanger EX003 temperature control loop (TICA017)

Objective:

To keep EX003 process fluid on temperature set point by means of cooling EX003 with cooling water.

Principle:

Control the cooling water supply valve TCV017

Implementation:

Input: water temperature reading	TT017
Temperature on/off controller	TIC017
Output: level control on/off valve	XV017

Operation:

Automatically enable/disable by sequence see ch.3.

Automatically depending on the difference between reading and set point.

Manually by operator intervention or by sequence intervention (ch.3) on the controller output signal.

The operator can NOT adjust the loop set point.

Note:

Alarms and interlocks:

TZHH017	: shut down regeneration by stopping boiler to standby, stop pump P021 and close XV002 and XV023. (HHSP=30 deg.C)
TAH017	: alarm

2.5 Weighing scale control loop (WICA001)

Objective:

To prevent styrene drum weight exceeding 50 kg

Principle:

Control the styrene supply valve XV001

At WT001 < 50kg : open XV001

At WT001 ≥ 50 kg : close XV001

Switching hysteresis +/- 0,1 kg set point SP

At WIA = ok OR at XV001 open control signal=1 -> XI001O=1 , then warning lamp shall be steady green colour.

Implementation:

Input:

Weight reading

WT001

Valve position open

XI001O

Weight controller

WICA001

Output: weight control on/off valve

XV001

Operation:

Automatically enable/disable by sequence see ch.3.

Automatically depending on the difference between reading and set point.

Not manually by operator intervention on the controller output signal.

The operator can NOT adjust the loop set point.

Note:

Alarms and interlocks:

WAHH : warning lamp blink orange colour. Weight ≥ 50 kg

WAH : alarm (on PC screen)

WAL : alarm (on PC screen)

WALL : warning lamp blink red colour. This means no drum on weighing scale

XI001O : At XV001 open control signal=1 AND after max. travelling time -> ZS=0 : alarm and warning lamp will blink red colour. This means valve control failure.

2.6 Pump P001 on/off control logic

Objective:

To supply cooling water for condenser EX001 by keeping pump P001 on constant speed.

Principle:

On/off control pump motor.

Pump pressure PT070 shall be reached in 10s. If not stop pump.

Implementation:

Input:

Pump start HC001-1

Motor thermal feedback ok (from MCC) EM021

Logic

Output: pump motor start (to MCC) P021

Input:

Pressure reading PT070

Operation:

Automatically start by sequence see ch.3.

Valve HV072 shall be locked with padlock in the open position.

Note:

Alarms and interlocks:

PZL070 : alarm

PZLL070 : stop pump P001.

2.7 Pump P002 control loop (LIC002)

Objective:

To supply feed water for steam boiler

Principle:

On/off control pump motor by measuring boiler water level.
Control is integrated in boiler control system.

Implementation:

By boiler control system

Operation:

By boiler control system
Valve HV032 shall be locked with padlock in the open position.

Note:

Alarms and interlocks:

By boiler control system

2.8 Fan FD001-2 on/off control logic

Objective:

To supply cooling air for cooler C001-2 by keeping EM001-2 on constant speed.

Principle:

On/off control fan.

Implementation:

Input:

Fan start HC001-2

Motor thermal feedback ok (from MCC) EM001-2

Logic

Output: fan motor start (to MCC) FD001-2

Operation:

Automatically enable/disable by sequence see ch.3.

Note:

Alarms and interlocks:

2.9 Fan FD001-3 on/off control logic

Objective:

To supply cooling air for cooler C001-2 by keeping EM001-3 on constant speed.

Principle:

On/off control fan.

Implementation:

Input:

Fan start

HC001-3

Motor thermal feedback ok (from MCC)

EM001-3

Logic

Output: pump motor start (to MCC)

FD001-3

Operation:

Automatically enable/disable by sequence see ch.3.

Note:

Alarms and interlocks:

2.10 Fan FD025 flow control loop (FIC025)

Objective:

To supply waste gas from client stack to Styrene filter. Filter is placed in suction line of fan.

Principle:

Control the fan by varying fan speed by means of a frequency converter.

Fan airflow FS002 set point shall be reached in 20s. If not generate alarm.

Implementation:

Input: flow reading	FT025
Flow PID controller	FC025
Output: speed controller	SC025

Motor thermal feedback ok (from MCC)	EM025
Logic	
Output: pump motor start (to MCC)	FD025

Input: flow reading	FA002
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Operation:

Automatically enable/disable by sequence see ch.3.

Automatically depending on the difference between reading and set point.

Not manually by operator intervention on the controller output signal.

The operator can NOT adjust the loop set point.

Note:

Alarms and interlocks:

FAL002 : alarm

2.11 Fan FD027 on/off control logic

Objective:

To supply cooling air to XXXXXX filter by keeping EM027 on constant speed .

Principle:

On/off control the fan motor.

Fan airflow FS003 set point be reached in 20s. If not generate alarm.

Implementation:

Input:

Fan start HC027

Motor thermal feedback ok(from MCC) EM027

Logic

Output: pump motor start (to MCC) FD027

Input:

Flow reading FS003

Operation:

Automatically enable/disable by sequence see ch.3.

Note:

Alarms and interlocks:

FAL003 : Alarm

2.12 Fan FD030 on/off control logic

Objective:

To extract Styrene polluted air from drum room by keeping EM030 on selectable (HOLD) constant speed. In this way drum room will be a non-hazardous safe area.

Principle:

On/off and speed selectable (HOLD) control of fan.
At no flow FAL001 generate alarm.

Implementation:

Input:

Select speed (HOLD)

Fan start

HC030

Motor thermal feedback ok (from MCC)

EM030

Logic

Output: fan motor start (to MCC)

FD030

Input: flow reading

FS001

Operation:

Automatically enable/disable by sequence see ch.3.

Note:

Operator shall check flow alarm as soon as possible to maintain a safe container room area.

Alarms and interlocks:

FAL001 : alarm

2.13 On/off valve open-close monitoring

Objective:

To check proper functioning of valve motor by checking valve travel time.

Principle:

Monitor travelling time between control on/off signal start and position feedback open/close signal generation.

When travelling time is longer than maximum travel time, alarm shall be generated.

Implementation:

Input:

Valve control signal (start)	HC
Open/close valve position signal (feedback)	XI O , XI C

Logic

Output: OK or alarm

Operation:

Automatically enable/disable by control loop or by sequence see ch.3.

Note:

Alarms and interlocks:

XI-O Valve open travelling time too long:alarm

XI-C Valve close travelling time too long:alarm

2.14 Miscellaneous monitoring

Objective:

To monitor miscellaneous process conditions, the measurements listed below are not involved in the control loops or control logics.

Principle:

Remote reading in PLC via 4-20 mA signal.(analog signals)

Implementation:

XXXXXX filter temperature	TI001, TI003
Water temperature T001	TI010
Cooling water temperature EX001 in	TI011
Cooling water temperature EX001 out	TI012
Condensate temperature EX001 in	TI013
Condensate temperature EX001 out	TI014
Water temperature EX002 out	TI015
Condensate temperature EX003 in	TI016
PID analyser	QIR001
PID analyser	QIR002

3 CONTROL SEQUENCES

The complete sequence consists of starting up the adsorbing process followed by a regenerating process to clean the active styrene filter.

3.1 Adsorbing process

Objective:

To filter styrene gas from waste gas during 10 hours.

Principle:

This program controls the sequential on control of the Styrene adsorbing process.

It consists of manual actions which have to be taken, starting up of auxiliary equipment and starting of specific adsorbing sequences, control loops and control logics.

When a sequence step generates an alarm then stop sequence, operator shall take actions to resolve alarm and to enable step through. At L or H alarm after start-up, operator shall investigate and resolve problem. At instrument air unit trip PZA051LL after start up, disable FIC025

Implementation:

1. Preparation of manual actions
 - Open all process and instrumentation hand valves
 - Close all drain valves.
 - Power up control cabinet/MCC (incl. all LV-equipment)
 - Put styrene drum on weighing scale.
2. Preparation of auxiliary equipment. Automatic controlled by sequence.
 - Start fan FD030 (HC030)
 - Start-up boiler (to stand by)
 - Boiler ready.
 - FA001 ok (not L)
 - PZA051 ok (not LL).
 - PIA061 ok (not L)
 - Enable weighing scale control loop WICA0001
 - WA001 ok (not LL)
 - Enable T020 temperature control loop TIC020.
 - Enable T020 level control loop LICA021
 - When LICA021 is at setpoint SP then proceed with following step
 - Enable T001 level control loop LICZA003A
 - When LICZA003A is at setpoint SP then proceed with following step
3. Adsorbing control loops and control logics. Automatic controlled by sequence.
 - Open XV021 (HC021) plus XV021 open-close monitoring (2.13)
 - AND open XV022 (HC022) plus XV022 open-close monitoring (2.13)
 - Enable FD025 control loop FIC025.
 - Run adsorbing process for 10 hours.

3.2 Regenerating process

This process step consists of: heating up the absorber and expel air and finally the regenerating process itself with steam.

3.2.1 Heating up absorber plus expel air

Objective:

To heat up the absorber and expel air during 30 to 60 minutes.

Principle:

This program controls the sequential on control of the first step of the regenerating process. It consists of manual actions which have to be taken, starting up auxiliary equipment and control specific regenerating sequences, loops and logics. At instrument air unit trip PZA051LL after start-up, stop boiler to stand by. At TIA012H after start-up, generate alarm. At boiler trip, stop regenerating process by closing XV023 and XV002 . At PIZA001HH close XV023 and stop boiler to stand by.

Implementation:

1. Preparation of auxiliary equipment. Automatic controlled by sequence.
 - Additional to the steps taken at 3.1 step 2, the following steps will be executed.
 - Start fan FD001-2 (HC001-2)
AND start fan FD001-3 (HC001-3)
 - Start pump P001 (HC001-1)
 - TIA012 ok (not H)
 - Boiler start
 - Open XV002 (HC002) plus XV002 open-close monitoring (2.13)
2. Control loops and control logics. Automatic controlled by sequence.
 - Disable FD025 control loop FIC025
Close XV021 (HC021) plus XV021 open-close monitoring (2.13)
AND close XV022 (HC022) plus XV022 open-close monitoring (2.13)
 - Disable T020 level control loop LICA021
 - WA001=ok (not HH)
 - XV001 ok (= not close)
 - Open XV024 (HC024) plus XV024 open-close monitoring (2.13), when valve is open proceed with following step:
 - Open XV023 (HC023) plus XV023 open-close monitoring (2.13)
AND open XV026 (HC026) plus XV026 open-close monitoring (2.13)
 - Enable EX003 temperature control loop TICA017.
 - IF TI005 = 98 deg.C THEN close XV026 (HC026) plus XV026 open-close monitoring (2.13)
 - Run heating up process for 30 – 60 minutes.

3.2.2 Regenerate absorber with steam

Objective:

To regenerate the absorber with steam during 3 to 4 hours.

Principle:

See 3.2.1.

Implementation:

3. See 3.2.1. At boiler trip go to 3.2.1.
 - Continue (heating) regenerating process for 3 – 4 hours.

3.3 Cool down process

This process step consists of: expel steam from the absorber and cool down the process.

3.3.1 Expel steam from absorber

Objective:

To expel steam from the absorber during 1 hour.

Principle:

This program controls the sequential on control of the expelling steam process.

It consists of manual actions which have to be taken, starting up auxiliary equipment and control specific regenerating sequences, loops and logics. At instrument air unit trip PZA051LL, stop FD027.

Implementation:

4. Auxiliary equipment. Automatic controlled by sequence.
 - Boiler stop to stand by (= ready).
 - Close XV023 (HC023) plus XV023 open-close monitoring (2.13)
AND close XV026(HC026) plus XV026 open-close monitoring (2.13)
 - Close XV002 (HC002) plus XV002 open-close monitoring (2.13)
 - Open XV025 (HC025) plus XV025 open-close monitoring (2.13)
 - Start fan FD027 (HC027)
5. Control loops and control logics. Automatic controlled by sequence.
 - Output TIC017 forced close (to close XV017)
 - Run expelling steam process for 1 hour.

3.3.2 Cool installation

Objective:

To cool down the installation for 2 hours. Then shut down process or resume adsorbing.

Principle:

This program controls the sequential on and off control of the cooling down process.

It consists of manual actions which have to be taken, starting up auxiliary equipment and control specific regenerating sequences, loops and logics. At instrument air unit trip PZA051LL, stop FD027.

Implementation:

6. Control loops and control logics

See 3.3.1. No further actions

7. After cooling down for 2 hours, shut down process or go to stand by position

To shut down process

- Go to 3.4

Stand by position consists of: (Automatic controlled by sequence.)

- Stop fan FD027 (HC027)
- Close XV025 (HC025) plus XV025 open-close monitoring (2.13)
AND close XV024 (HC024) plus XV024 open-close monitoring (2.13)
- Stop fan FD001-2 (HC001-2)
AND stop fan FD001-3 (HC001-3)
- Stop pump P001 (HC001-1)

If needed adsorbing process (3.1) can now be started.

3.4 Shut down process

Objective:

To shut down the process –if needed- after absorbing and regenerating steps.

Principle:

This program controls the shut down sequential control of the Styrene adsorbing and regenerating process. It consists of manual actions which have to be taken, stopping auxiliary equipment and disabling of specific regenerating sequences, control loops and control logics.

Implementation:

1. Auxiliary equipment. Automatic controlled by sequence.
 - Stop fan FD027 (HC027)
 - Close XV025 (HC025) plus XV025 open-close monitoring (2.13)
AND close XV024 (HC024) plus XV024 open-close monitoring (2.13)
 - Stop boiler from stand by to off.
 - Stop fan FD001-2 (HC001-2)
AND stop fan FD001-3 (HC001-3)
 - Stop pump P001 (HC001-1)
 - Stop instrument air unit
 - PZA051 ok (= LL).
 - Stop fan FD030 (HC030)
 - FAL001 ok (=L)
2. Control loops. Automatic controlled by sequence
 - Disable T020 temperature control loop TIC020.
 - Disable T001 level control loop LICZA003A
 - Disable EX003 temperature control loop TICA017
3. Manual actions
 - Close IF NEEDED all instrumentation and process hand valves
 - Open IF NEEDED all drain valves.
 - Remove Styrene drum.
 - WIA001 ok (=LL)
 - PIA061 ok (=L)
 - Disable weighing scale control loop WICA001.
 - Power down control cabinet/MCC (incl. all LV-equipment) .