Automation of Security Protocol Setup for Hantzsch Synthesis

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Introduction

After the Industrial Revolution, automation began significantly enhanced manufacturing productivity by substituting human cognitive labor with machines and marking the beginning of mechanization which accelerated after World War II [1].

The potential for remote and continuous reaction testing, even during nighttime using stored light energy, promises higher efficiency and reduced costs. To achieve this, ensuring the integrity of the setup is crucial for the safety of both individuals and the process. Understanding potential risks, implementing robust security protocols, and employing state-of-the-art preventive measures are fundamental.

Materials & Methods

The research advanced by testing the drivers of each automated equipment with methanol and collectively for the Hantzsch reaction. Necessary P&ID adjustments and modifications were implemented along with the partner company, Beartree Automation BV, on the LabVIEW control panel, prioritizing user-friendliness and comprehensive control.

A Hazard and Operability (HAZOP) study validated the system by analyzing risks and defining preventive actions, which were integrated into the Cause-and-Effect Matrix to trigger specific alarms.

Results & Discussion

Figure 1: Connections and tests for each automated device.

Date: 25/04/2024 — Intent: RAMAN and NMR inline analysis
Node 4
P&ID KiloFlow

Ref.	Parameter	Deviation	Cause	Consequence	Safeguards	Action	SIL
20	Signal	No	RAMAN device or software is not working properly Probe is not connected or key is not there Leakage	Transmission will not be accurate or will not occur	None	20.1) Check if there is a way to create a driver for this device on programming environment	-
21	Signal	No	NMR device or software is not working properly Flow cell is not in the correct spot Leakage	Transmission will not be accurate or will not occur	None	Same as 20.1	-
22	Electricity	No	Problems with the electrical grid	In line mechanism doesn't work	None	-	-

Figure 3: Part of the HAZOP tables.

	Tag Name	IO Type	Access	Default	Units	Alarm LL	Alarm L	Alarm H	Alarm HH	Location	Connection	Register
9	PI101	Knauer	read							pressure indic	TCPIP0::192.1	Press
10	TIC-001 Leve	Huber	read					Inf	Inf	vNiv	192.168.2.21	0
11	TIC-001 Wari	Huber	read					Inf	Inf	vWarn	192.168.2.21	6
12	TIC101 Jacke	Huber	read							vPow	192.168.2.21	4
13	TIC101 Jacke	Huber	read					Inf	Inf	vTI	192.168.2.21	1
14	TSA-001	Huber	read							vError	192.168.2.21	5
15	TT101 Maste	Huber	write	1						vTmpMode. 0	192.168.2.21	19
16	TT101 Mediu	Huber	read			10	-Inf	85	88	vTE	192.168.2.21	7
17	TT101 Mediu	Huber	write	20						vSP	192.168.2.21	0

Figure 5: Tag info list on LabVIEW and H alarm.

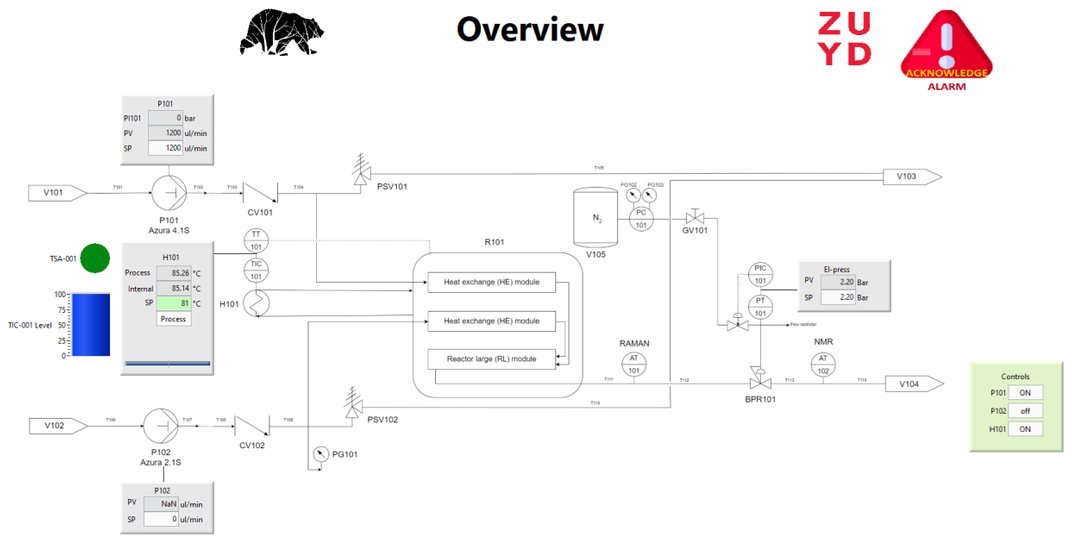

Figure 2: New P&ID inserted into the project interface on LabVIEW.

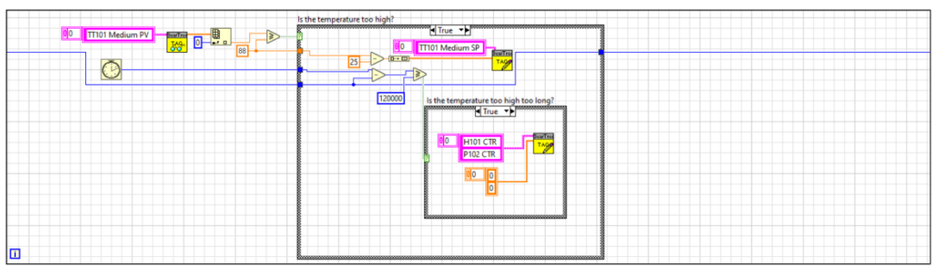

Figure 4: HH alarm on LabVIEW block diagram.

	Cause	Alarm Type	H101 CTR
1	TT101 Mediu	Low Low	Off

Figure 6: C&E Matrix on LabVIEW and LL alarm.

Acknowledgement

We acknowledge financial support from SIA (RAAK-PRO project Light-Up).

References

[1] Hitomi, K. (1994). Automation — its concept and a short history. ***Technovation***, 14(2), 121–128. https://doi.org/10.1016/0166-4972(94)90101-5

Conclusions

- HAZOP actions were suggested: process documentation, new sensors to be added and alarms to be included in the system;
- Temperature HH, H, and LL alarms were set.
- Regular schedule for revisiting the entire HAZOP: 1 year;
- P&ID is now corresponding to the actual setup;
- NMR is connected in-line and El-press is assembled to the system;
- Tests were successfully conducted. For further investigation: El-press deviation (software vs. analogic gauges);
- The equipment automated so far has been consolidated into a user-friendly control panel with access to graphs.