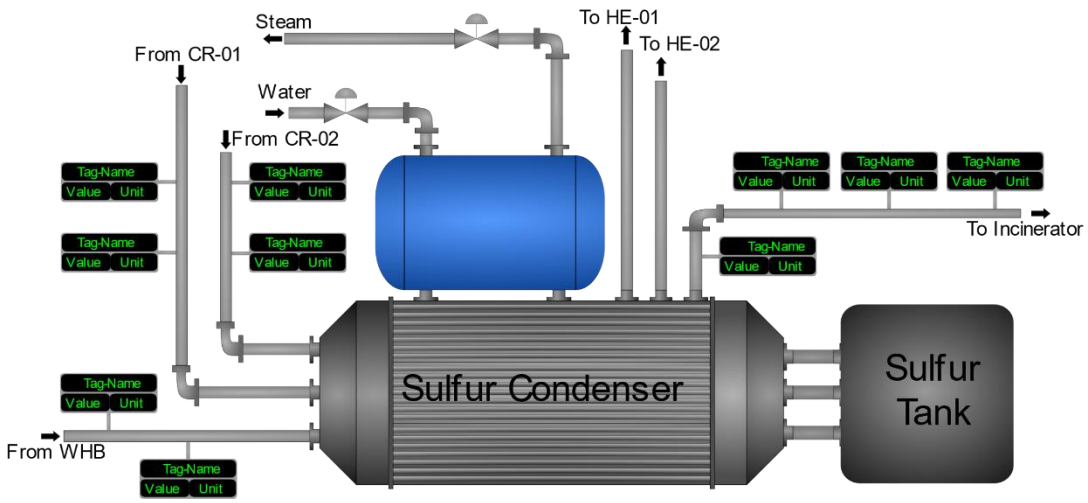
MCL CONTROL



TailGasVASentinel™

Using a Virtual Tail Gas Analyzer, in a Claus plant, to increase its performance

Resume

TailGasVASentinel is a real-time computer system based on machine learning algorithms to monitor the performance of sulfur recovery plants. The system infers the compositions of hydrogen sulfide, sulfur dioxide, and air demand using redundant measurements with very high availability.

TailGasVASentinel it is designed with modern technology and has a web interface to monitor said plant from anywhere in it.

Justification for Monitoring of Sulfur Recovery Units

Environmental concerns have been increasing in recent years in society, which is why refineries and gas industries must comply with government laws and strict standards on product specification and the emission of pollutants into the atmosphere, leading them to the implementation of increasingly efficient control and measurement policies to monitor process variables. One of the units within a refinery and gas plant for environmental purposes is the sulfur recovery unit. Generally, many sulfur recovery units present problems in the monitoring and control of the concentrations of gases that are emitted into the atmosphere. Unstable feeds and poor or no control can result in significant losses of 10% or more of sulfur recovery.

Monitoring and control systems require reliable measurements of the exhaust gas concentrations at an adequate frequency, however, the physical analyzers of these currents represent a challenge for the industry since their implementation and maintenance is expensive. Currently there are commercial alternatives for the monitoring, control and optimization of this type of plants and they are based on software called virtual analyzers and these allow inferring the emissions.

The objectives of the virtual analyzer are:

- Infer the H2S/SO2 ratio in the tail gas from the Claus plant.
- Determine the air demand of the process.

Tail gas analyzer and feedback control account for 2-4% of recovery efficiency and contribute more to overall sulfur recovery unit performance than the third catalytic converter.

Development of the Sulfur Recovery Unit Monitoring Application

In order to develop a virtual analyzer, it is necessary to have enough data from the process to retrain the AI models that represent the system.

The following diagram shows the process of developing a computational system for the inference of process variables.

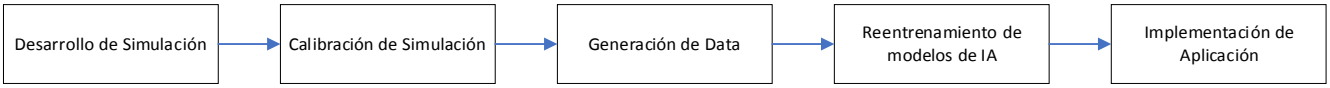


Figure 1. Virtual Analyzer Commissioning Process

From experimental plant data, the calibration of a simulation of the process is carried out for the generation of sufficient data, necessary for the design of the analyzer.

Case Study

A typical sulfur recovery unit is shown in Figure 2.

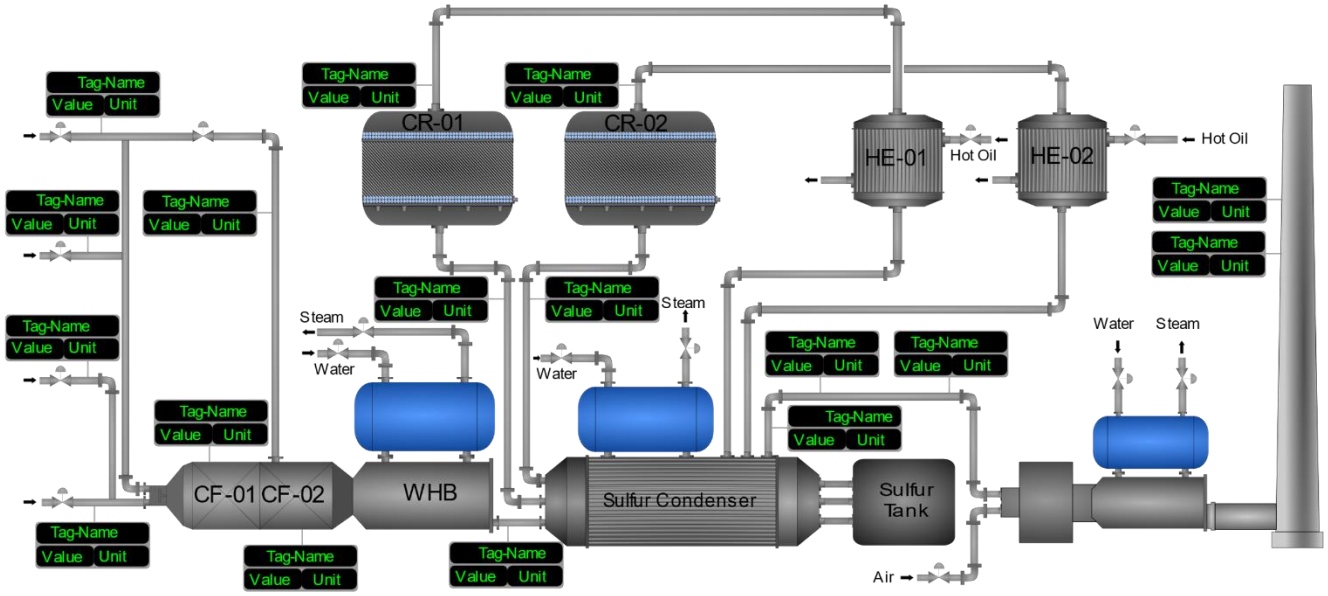


Figure 2. Sulfur Recovery Unit HMI

A stream of amine acid gas (AAG) is mixed with a stream of acid gas (SWS) and fed to the Claus furnace (CF-01), combining with the amount of air necessary for sulfur production. Another part of AAG feeds a second chamber (CF-02) of the Claus oven. The process gas leaving the furnace enters the waste heat generator (WHB) to cool down and generate steam. The process gas enters the sulfur condenser where liquid sulfur is recovered, and the process gas is sent to the first catalytic reactor (CR-01). This sulfur recovery and catalytic reaction process is carried out in 2 stages, obtaining the so-called tail gas from the sulfur recovery unit.

TailGasVASentinel, infers the composition in the tail gas and also determines the air demand necessary for optimal sulfur recovery.

Results of the Study

The implementation of **TailGasVASentinel** allowed monitoring of the sulfur recovery unit through a modern web browser accessible from anywhere in the plant that has access to the local network.

Below are a series of figures of the screens that can be seen from **TailGasVASentinel**.

Figure 3 allows monitoring the air demand (red line) on the left graph, and the comparison of the H2S/SO2 prediction (black line) with the field measurement (blue line) as well as the temperature difference of the catalytic reactors. (graph on the right). In turn, the summary of the **TailGasVASentinel** systems is shown, where the status, description and criticality are observed. In addition, you can have a summary of the system alarms at the top.

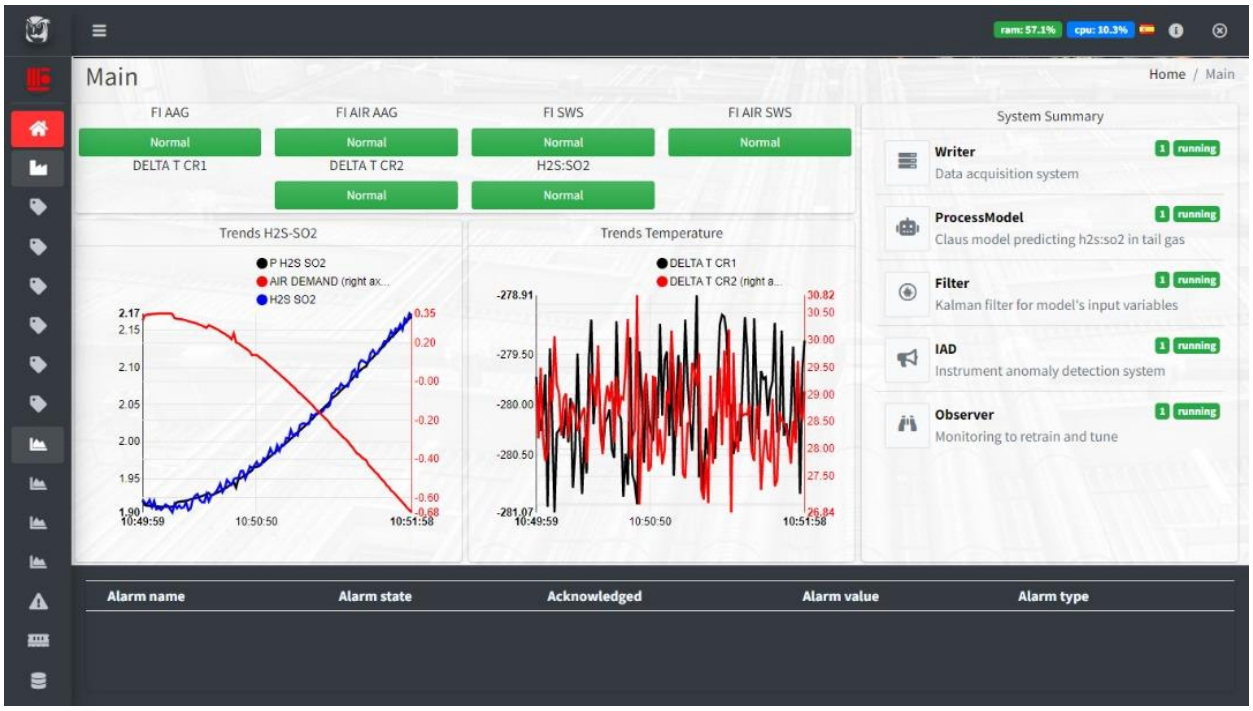


Figure 3. TailGasVASentinel HMI Main Section

The application has systems that provide intelligence to **TailGasVASentinel**, in Figure 4 the detail of the subsystems, such as:

- Data Acquisition System.
- Process Models.
- Filter of Field variables.
- Instrument anomaly detection system.
- Observer System.

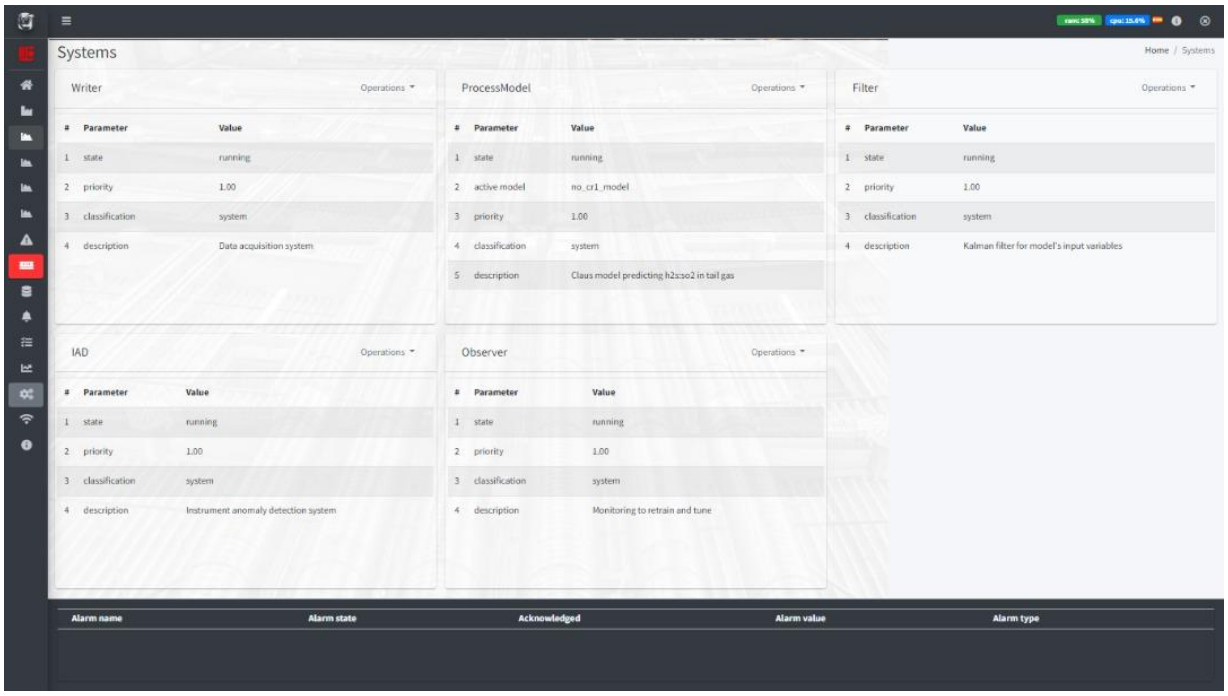


Figure 4. TailGasVASentinel Systems Section

Figure 5 shows the real-time trends of important **TailGasVASentinel** variables.

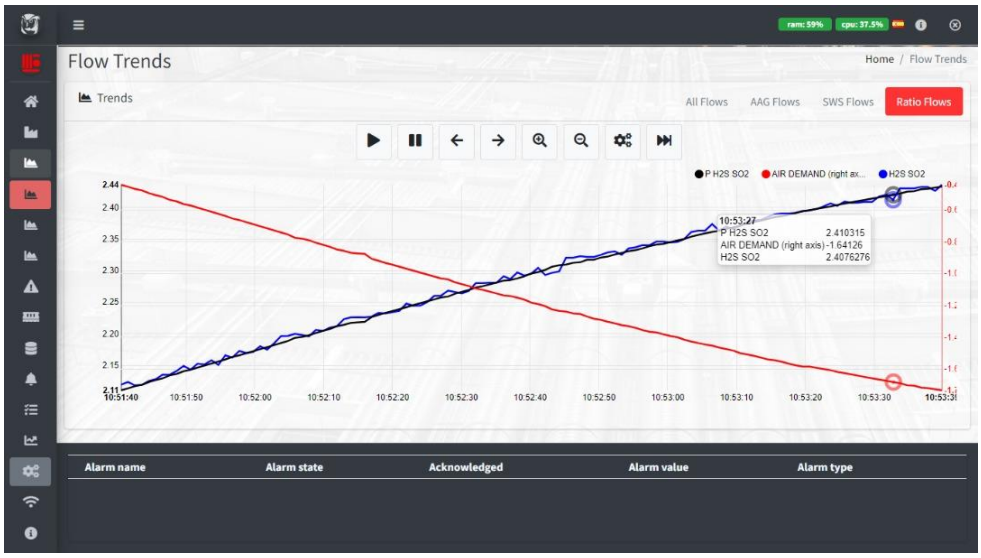


Figure 5. HMI TailGasVASentinel Trends Section

On the other hand, the performance section shown in Figure 6 allows monitoring the capacity of the hardware where the **TailGasVASentinel** is run, as well as the performance of the inference of the tail gas ratio.

Figure 6. TailGasVASentinel Performance Section

Finally, Figure 7 shows the **TailGasVASentinel** alarms section that allows, based on the ISA 18.2 standard, to manage an alarm system specific to the application.

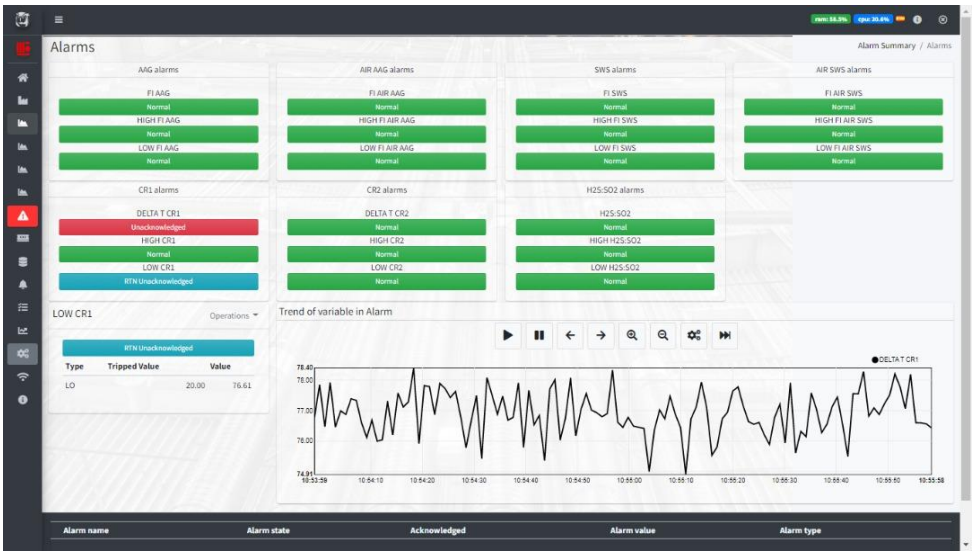


Figure 7. HMI TailGasVASentinel Alarms Section

Conclusions

- **TailGasVA** allowed to infer the composition of H2S and SO2 online with a mean error of 2%.
- **TailGasVA** based on ISA-18.2, allowed alarm management correctly giving additional support to the plant operator.
- **TailGasVA's** modern web interface enabled quick and easy operator training.

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