SUPERIOR PLANT EFFICIENCY THROUGH SEAMLESS SYSTEM INTEGRATION OF PROCESS GAS CHROMATOGRAPHS

Typical distillation towers - A significant application field for process gas chromatographs

Process analytics, in conjunction with sophisticated system integration, plays an important role in the efficient operation of chemical production plants. A practical example of a distillation process provides insights into important aspects of planning and implementation.

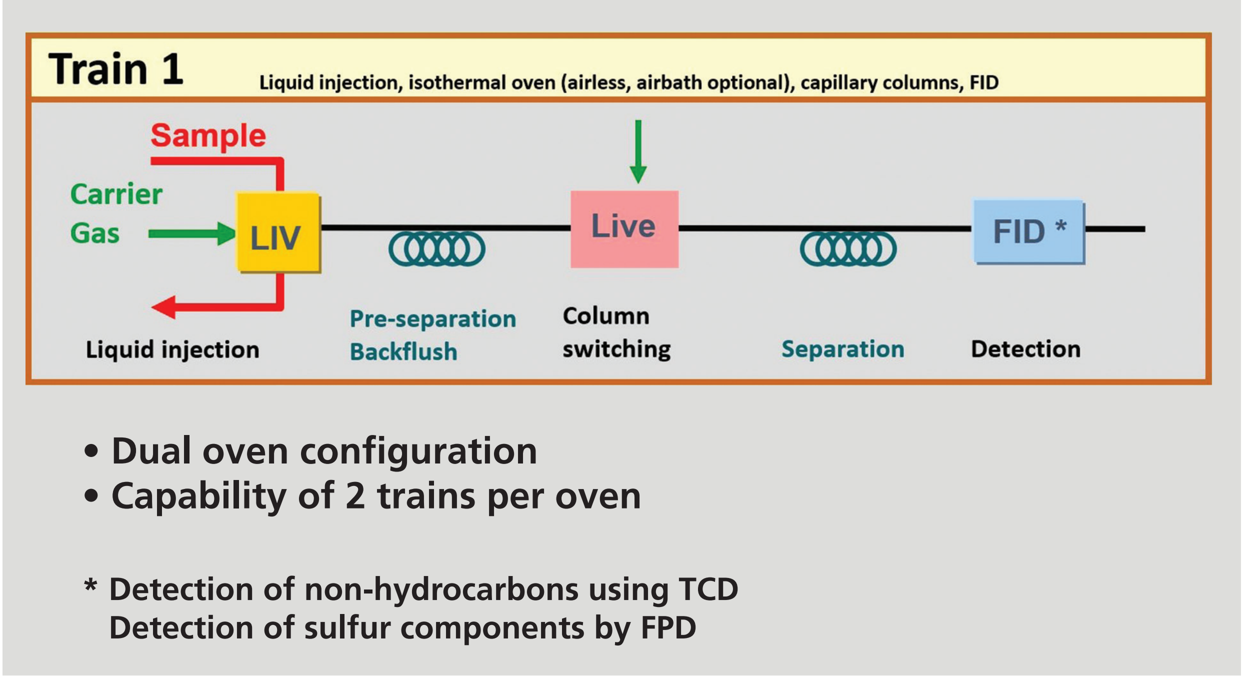
Process optimization by using process analytics

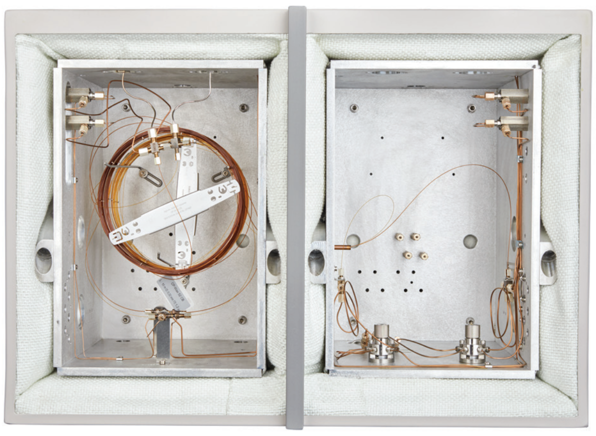
What is the motivation to implement additional costly equipment in a process plant? Nowadays, the market pressure is enormous – for suppliers of process analyzers, but also for operators of chemical production plants. Energy is increasingly expensive and need to be saved whenever possible. An excellent tool is advance process control (APC) and optimization. To implement APC, data must also be provided by the analyzer in such a way that the operator can react to process changes in time to prevent plant degradation. Sometimes even small traces of a process poison are sufficient to destroy the catalyst material. The analysis of trace components is becoming increasingly important to meet quality standards. A good example is the measurement of ammonia traces in C2 products or arsine traces in C3 products. The producers want to avoid out-of-specification product batches, which means that in worst case a significant amount of sample has to be reprocessed. The solution is an efficient process optimization through the use of online analytics.

An excellent application for the analyzer is the fractionating tower, which helps customers to better control their plant. Various control elements such as flow or temperature are needed for plant optimization. In addition also analytical control is important to measure the purification that's occurring in a distillation tower. Are the chemicals leaving the top or the bottom the correct purity? A significant value for the user when implementing process gaschromatographs (process GC) is specifically getting closer to maximum allowed purity levels of samples and therefore closer to any product specification. Without process GCs operators have to use a much more conservative set-point for the reflux rate with much smaller fluctuation. Unfortunately, by refluxing or recycling so much, energy costs increase because more heating and cooling is required than needed. Additionally, the high recycling rate reduces also the through-put. Ultimately, the GC allows the operator to know exactly what the reflux rate would be, even as the different conditions change over time. Energy costs are minimized with maximum production rate. A process GC integrated into a distillation tower can provide tremendous user benefits. It could increase through-put of the distillation tower and energy consumption in the range of 5 to 15%. It is crucial that process control is supported by the use of process analytics in such a way that it operates the process at an economic optimum. Therefore, the payback time is often less than one year and one analysis per day can already be profitable! Strong arguments for process analytics!

Process analyzer technology

Process gas chromatographs has been established in the process industry since decades specifically for applications to optimize distillation towers. Users appreciate this technology, even if it sometimes seems complex, because





Picture 2a and 2b:

Typical GC configuration for liquid samples with key analytical componets (above) and standard GC design (right), options to integrate multiple analytical trains.

- the measurement is proven in use and the analyzer system can be easily automated.
- plenty of components can be simultaneously measured and
- the analysis is typically interference free because the principle of chromatography is based on a physical separation of any substance - either a gas or a liquid, as long as it can be evaporated without leaving any residue.

There are multiple options to implement the required measurements for a specific application. For complex liquid sample streams, analytical separation trains are often combined with a liquid injection valve, capillary separation columns preferably with valveless column switching and, depending on the measuring task, a flame ionization (FID), thermal conductivity (TCD) or flame photometer detector (FPD). Due to the high analytical flexibility, several separation trains can even be integrated in one GC (in the use case below using 4 analytical trains). For the injection valve also inert versions are available. The combination of capillary columns with a valveless switching device provides a superior separation power compared to packed columns and valves. The Siemens FID offers the advantage that the detector is placed outside the analytical oven and is heated separately. This supports the high availability of the GC by avoiding detector corrosion due to condensation effects.

The following arguments speak for this technology:

- Process chromatography is a powerful analytical technique to measure beside vapor samples also liquid matrices over a wide range of boiling points.
- Method development and application know-how is crucial for demanding applications especially for liquid process streams.
- MAXUM Ed. II gas chromatograph offers flexible analysis tools, such as various injection valves or separation techniques for the analysis of simple to complex sample mixtures.

Picture 3: System integration: Analyzer house with 2 process GCs - Optimized for best reliability using liquid sample streams

Process GCs optimize the distillation process of the Kuraray polyvinyl alcohol plant in Frankfurt

The following use case addresses the specifics of integrating a process analyzer system into a chemical production plant. Due to the high flexibility of application usage of a process GC, the design, the plan, and the manufacturing of a sample preparation system is a key for a proper GC operation.

In terms of the possibility to measure different sample streams with just one process GC, the different samples often need to overcome large distances from the tapping point to the final installation of the GC. For this reason, it is crucial to build up a fast loop system, that considers T90 time, the pressure and temperature levels at the sample tapping and the sample return point to secure an appropriate and fast flow of the sample over the fast loop. This is necessary to secure that the sample itself is actual and representative when it is injected to the GC.

Statement Kuraray: "By using the additional GCs as control element, improved process stability, distillate qualities and energy consumption have been the major outcome of this project!

Next to the fast and reliable transport (considering also back-purge possibilities and barriers) of the sample, transporting just a small and needed amount of sample to the GC is also crucial. It is often mandatory to decrease the flow to the injection valve because you do not want to have that big amount of gas going over the valve to the atmosphere, or - when we talk about liquid injection - not that big amount of liquid sample going to the slop. In the described use case, it is possible to integrate the sample which is going over Liquid injection Valves for high and low boiling components, directly to the fastloop system with an intelligent flow-controlled sample preparation system. The complete sample is with this solution 100% recovered and there is no waste of sample and energy.

Industrial samples are often complex, flammable, explosive and/or they tend to polymerization. Considering health, fire and explosion issues, a fast loop system is often installed directly in the field, so that the high amount of sample stays in the field, and that just the necessary amount of sample is going to the analyzer room and to the GC. By consindering an appropriate air exchange concept with integrated flow monitoring and additional safety measures like monitoring potential leakages with LEL (Lower Explosive Limit) and toxic gas (Tox) sensors and using a Sample Shut off valve as safety valve for the analyzer room the solution provider AGT-PSG has realized a fast, safe, and reliable installation to secure a perfect operation of the process GC.

In regard to the use case a good and real partnership between the process experts from the operator Kuraray, the GC experts from Siemens, and the system integration experts from AGT-PSG was essential for the successful implementation of the GC project. While Kuraray identifies the optimal sampling and return points, and also specifying the real need of what to measure, a feasibility study with the Siemens MAXUM Ed. II process GC gave conviction that the use of airless GCs gave stable values and also that the needed accuracy was reached. With the design, the layout and the installation of the complete analyzer arrangement, AGT-PSG delivered an appropriate sample conditioning system, equipped the complete analyzer room and installed the MAXUM Ed. II process GC to secure a precise measurement. By enjoying this excellent collaboration, the Kuraray production plant was able to reach a next level of efficiency.

Picture 4: Sampling system design variants for liquid samples – heated in cabinet (right) and unheated on SS plates (left)

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