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Analytical Products and Solutions

Styrene monomers in high quality

Process analytics optimizes styrene monomer production

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Challenge

Styrene is one of the most important monomers for the polymer industry. Today the total annual production of styrene is around 25 million tons and is estimated to increase to 40 million tons by 2020, so that the production of styrene is one of the most important industrial processes.

The colorless oily liquid is an aromatic olefin with the chemical formula $C_6H_5CH=CH_2$. It is easy to be polymerized due to the presence of a carbon double bond. It is a main monomer block for the production of polystyrene and other polymer derivatives.

Polystyrene is a hard, stiff, brilliantly transparent synthetic resin. It is widely employed in the food-service industry as rigid trays and containers, disposable eating utensils, and foamed cups, plates, and bowls. Polystyrene is also copolymerized, or blended with other polymers, lending hardness and rigidity to a number of important plastic and rubber products.

There are three types of processes generally used – suspension, solution and mass (bulk) polymerization.

Solution

Styrene plants are equipped with comprehensive measuring and control instrumentation in order to comply with the requirements of quality, safety and energy efficiency control. Field instrumentation includes process analyzers and analyzer systems to monitor in detail the production steps by analyzing the process flow streams for their composition and communicate the measured data to the central control system. For that, Siemens process analytics offers well proven analyzer and analyzer systems together with specific application knowledge. Process gas chromatographs (PGC) and gas analyzers are part of field instrumentation in styrene monomer production plants.

Customer's benefit from PGC

- Multiple analytical tools for adapting the hardware perfectly to the analytical needs
- Liquid injection modules optimize the vaporization of liquid samples
- Broad range of column types and columns switching technologies
- Sensitive detectors to determine trace components
- Airless oven minimizes utility costs

Siemens PGC in a plant.

Let's have a deeper look into the details

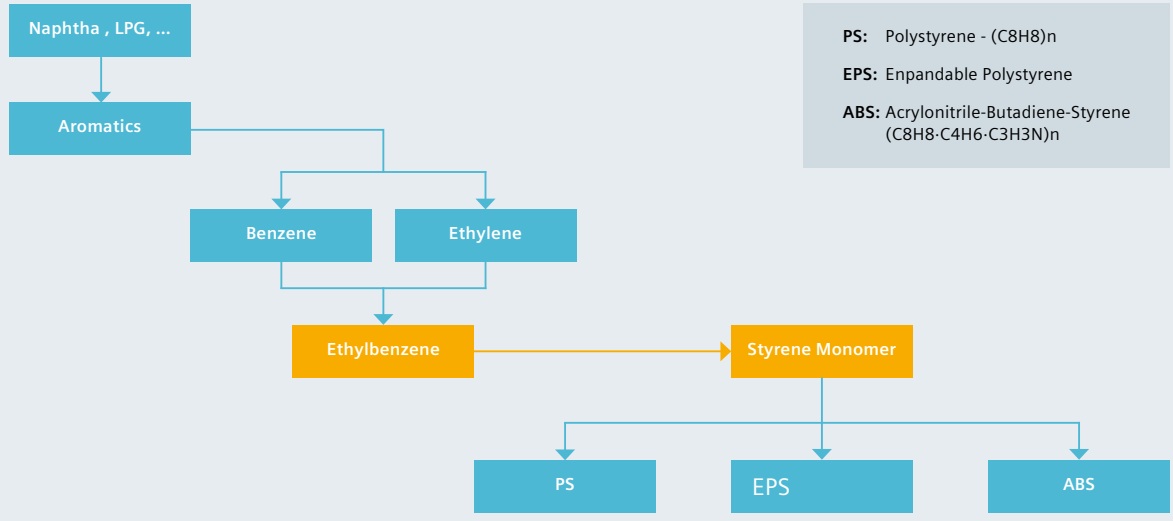
The most common technology for manufacturing styrene monomer is the dehydrogenation of ethylbenzene. Most of the world's actual styrene production is carried out using this technology. Licenser like CB&I/Lummus, Badger/Total or Versalis use alkylation of benzene with ethylene to produce ethylbenzene (EB) as intermediate. In a second step superheated steam is used to produce styrene monomer (SM) from ethylbenzene by dehydrogenation.

The ethylbenzene (EB) process as first production step uses a fixed-bed zeolite catalyst, which provides a run duration of several years. To get a mixture of alkylated benzenes and excess benzene the alkylation of benzene with ethylene is involved in the EB process. The mixture is then distilled to recover EB, and to recycle benzene and higher ethylated benzenes. The latter are trans-alkylated with benzene to form additional EB. The recycle benzene is sent back to the alkylator and transalkylation reactor vessels and the EB product to the dehydrogenation section of the styrene unit. Sampling points for measuring are the O_2-concentration at the outlet of the alkylation reactor and chemical byproducts at the ethylbenzene reactor.

During the styrene monomer process as the second production step the dehydrogenation of EB to SM and by-products is the major reaction. This catalytic reaction is endothermic. The reaction heat will be supplied by steam from a super heater. The steam is the source of heat and it removes coke that tends to form on the iron oxide catalyst. On the other hand the reactor effluent is cooled by generating steam.
The dehydrogenated mixture is distilled to recover SM product, recycle EB, as well as benzene and toluene by-products. Inhibitors are added to prevent styrene polymerization.
The measuring task in this production step are: O_2-, N_2, CO- and CO_2 concentrations in fuel gas to compressor, various by-products during distillation and fractionation processes.

For the third production step to polymerize styrene to polystyrene there are three types of processes generally used – suspension, solution and mass (bulk) polymerization.

Styrene monomer production process



Siemens Product Description

In order to comply with the requirements of quality, safety and energy efficiency control styrene plants are equipped with comprehensive measuring and control instrumentation.

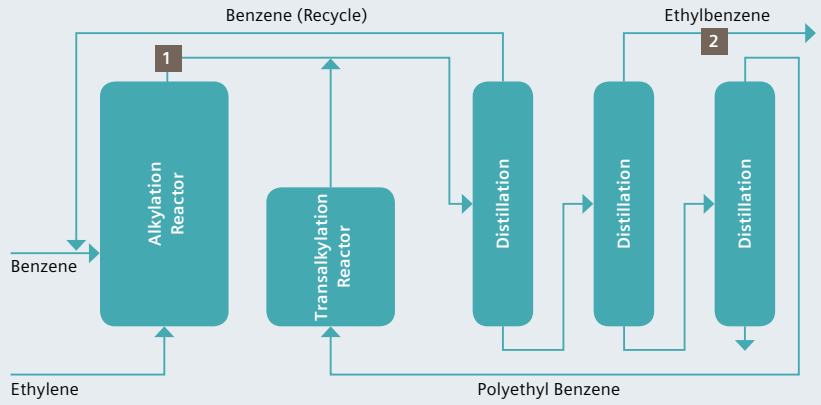
Field instrumentation includes process analyzers and analyzer systems to monitor in detail the production steps by analyzing the process flow streams for their composition and communicate the measured data to the central control system.

Siemens process analytics supports with its high performance PGC MAXUM edition II, the Continuous Gas Analyzers (Series 6 and SIPROCESS GA700) and the in-situ gas analyzers SITRANS SL and LDS 6 together with specific application knowledge.

Process gas chromatograph (PGC) MAXUM edition II represents the top technology in process gas chromatography for analyzing liquids and vapor process samples.

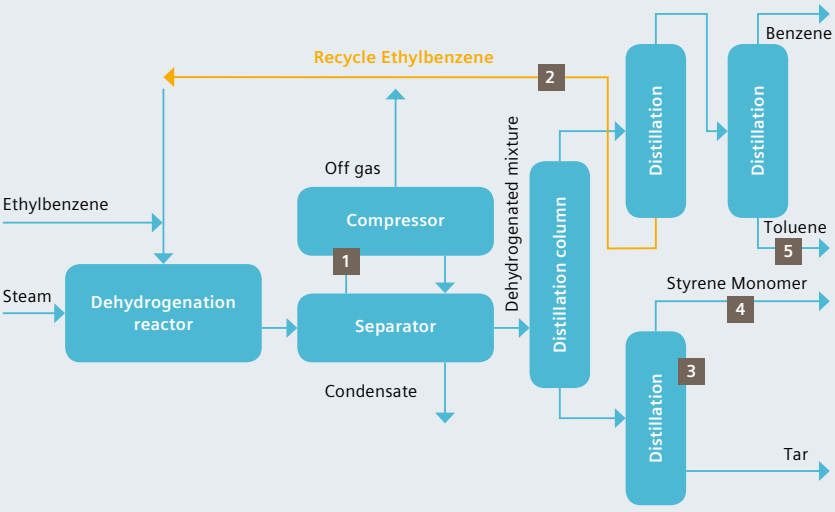
Siemens process analytics offers a comprehensive portfolio of continuous extractive and in-situ measuring gas analyzers. The analyzers can be easily integrated into the Totally Integrated Automation (TIA) concept and are programmed using SIMATIC PDM software a PROFIBUS DP/PA interfaces.

Ethylbenzene production process



Sampling point	Location and application	Measuring component	Measuring range	Siemens Analyzer
1	Alcylation reactor outlet	02	0 – 5 %	OXYMAT 7 or SITRANS SL
2	Ethylbenzene purity	o-Xylene, m-Xylene, p-Xylene, Benzene, Toluene, Cumene, Styrene	High ppm to low % level	Maxum edition II

Styrene monomer production process



Sampling point	Location and application	Measuring component	Measuring range	Siemens Analyzer
1	Fuel gas to compressor	O_2	0 – 2 %	OXYMAT 7 SITRANS SL
		N_2, O_2, CO, CO_2	Low to medium % level	Maxum edition II
2	Recycle ethylbenzene	Nonaromatics Benzene, Toluene Styrene	Low to medium % level	Maxum edition II
3	Styrene distillation – plateau	Styrene Nonaromatics Ethylbenzene m-/p-Xylene	Medium to high % level	Maxum edition II
4	Fractionation overhead – SM purity	Ethylbenzene m-Xylene p-Xylene Phenylacetylene Alpha-Methylstyrene Cumene	Medium to low ppm level	Maxum edition II
5	Toluene fractionation bottom	Benzene	0 - 2 %	Maxum edition II

Process gas chromatograph (PGC) MAXUM edition II

MAXUM edition II represents the top technology in process gas chromatography for analyzing liquids and vapor process samples. The multiple analytical tools such as injectors, ovens, sensitive detectors or columns adapt the hardware perfectly to the analytical needs. The airless oven reduces utility costs as well as the use of corrosion-resistant materials when required for the application.

When the chromatographs are installed on an Ethernet network, the "Gas Chromatograph Portal" software provides real-time analysis and maintenance information for reliable monitoring and control.

SITRANS SL

The measuring principle of the diode laser gas analyzer SITRANS SL is based on the specific light absorption of different gas components. SITRANS SL with its extremely rugged design and minimum maintenance requirements is suitable for fast and non-contact measurement of gas concentrations in process or flue gases. The sensors (transmitter and receiver) are meant to be mounted directly on the process with no need of sampling systems. The hardware for processing the measurement signal into a concentration value as well as monitoring, control and serving of the communication means are also integrated into two main modules.

SIPROCESS GA700 OXYMAT 7

With its long service life, the SIPROCESS GA700 OXYMAT 7 is an exceptionally reliable measuring device and can even handle small measuring ranges (0 to 0.5% O_2). With its vibration compensation and physically suppressed zero point (99.5 to 100% O_2) it delivers highly precise measurements. The module can be operated in either a rack or wall-mounted housing. Furthermore, the operating concept is based on a clearly laid-out menu structure. The advantages offered by the OXYMAT 7 make it indispensable for many applications in incineration plants, in environmental protection, or in quality assurance monitoring purity, and many more areas.

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