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MAXUM II

Perfect on-line gasoline analysis using the MAXUM II process gas chromatograph

Case Study · September 2008

Gasoline is a petroleum-derived liquid and primarily used as fuel in combustion engines. The analysis of gasoline for its chemical composition is extremely important as e. g. the concentration of individual hydrocarbons determines the octane number as well as the emission characteristics of gasoline.

Therefore, great efforts are made to serve producers of gasoline with an efficient tool for process suitable on-line gasoline analysis.

Siemens Sensors and Communication, a leader in process analytics, has proven worldwide competence to manufacture, apply and service on-line gasoline analyzer systems.

The MAXUM edition II process gas chromatograph is very likely the best suited process-suitable gasoline analyzer for this application on the market.

This Case Study reports details.

Gasoline analysis

Gasoline is a petroleum-derived liquid mixture consisting mostly of aliphatic hydrocarbons and enhanced with aromatic hydrocarbons to increase octane number. It is primarily used as fuel in combustion engines.

The analysis of gasoline for its chemical composition is essential to optimize gasoline quality, evaluate raw materials, control refining processes and ensure compliance with given specifications. The concentration of individual hydrocarbons is extremely important as they determine the octane number which needs to be between 86 and 100.

Isooctane is considered to have an octane number of 100. Isoparaffines, olefins, naphtenes and aromnatics increase the octane number whereas paraffins reduce it.

New gasoline blends can be more valuable by using innovative formulations which reduce vehicle emissions or increase mileage. For refineries and car manufacturers worried about stringent new restrictions on the amount of emissions, a formula leading to clean-burning gasoline would be of highest advantage.

Gas chromatography is the ideal technique for gasoline analysis. It is this type of multicomponent mixtures containing very similar compounds, that need the high efficiencies available from a GC for a successful analysis.

Process Analytics

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Gasoline composition and analysis requirements

Challenges

Gasoline composition and analysis

Commercial gasoline typically consists of a complex mixture of at least 23 hydrocarbons (fig. 1) in varying concentration ranges from 1 to 70 %. The mixture comprises paraffines, isoparaffines, naphtenes and aromatics. Concentration analysis of the individual gasoline components is important for evaluating raw materials, optimizing production processes and ensuring product quality.

Gasoline analysis is a very challenging task. Different types of gasoline analyzers are available at the market but they are restricted either to off-line (laboratory) operation or - in case of on-line analyzers - to a limited number of components that can be determined with one analyzer.

User requirements

Users increasingly demand a gasoline analyzer that overcomes the known restrictions offering the following features:

- On-line analysis performed directly at the process with short analysis times
- Analysis of all 23 components in just one analysis run and using only one analyzer
- High resolution performance to perform even the most ambitious separation of 2-Methylpentane and 2,3 Dimethylbutan
- Simple and clear arrangement of the analytical components
- Flexibility in analyzer configuration in order to adapt analyzer set-up (and thus investment costs) to the actual analysis requirements
- Representative and reproducible results, easy operation and low maintenance efforts
- Suitability of the analyzer to be used also for other than gasoline analysis

Solution

The solution to the ambitionous user requirements comes from the Siemens MAXUM edition II Process Gas Chromatograph. With its unique flexibility, modularity and analytical performance MAXUM II offers exactly what the market needs:

- a high performance gasoline analyzer in standard and advanced version,
- using standard components from liquid injection and double oven concept to valveless column switching and detection
- combined with the outstanding application know how of Siemens Process Analytics.

1	C4	i-Butane	14	C7	2,2-Dimethylpentane
2	C4	n-Butane	15	C7	2,4-Dimethylpentane
3	C5	i-Pentane	16	C7	2,2,3-Trimethylbutane
4	C5	n-Pentane	17	C7	3,3-Dimethylpentane
5	C5	Cyclopentane	18	C7	2-Methylhexane
6	C6	2,2-Dimethylbutane	19	C7	2,3-Dimethylpentane
7	C6	2,3-Dimethylbutane	20	C7	3-Methylhexane
8	C6	2-Methypentane	21	C7	n-Heptane
9	C6	3-Methylpentane	22	C7	Methylcyclohexane
10	C6	n-Hexane	23	C7	Sum C7
11	C6	Methylcyclopentane			
12	C6	Cyclohexane			
13	C6	Benzene			

Fig. 1: List of major components of gasoline

MAXUM edition II

MAXUM edition II is a universal process gas chromatograph offering an outstanding broad variety of analytical possiblities. Main application field is process monitoring and control for gases and vaporable liquids in rough industrial environments. MAXUM II performs a wide range of duties in refineries and chemical/petrochemical industries. MAXUM II features e. g. a flexible, energy saving single or dual oven concept, valveless sampling and column switching, and parallel chromatography using muliple single trains as well as a wide range of detectors such as TCD, FID, FPD, PDH ID, PDECD and PDPID.

Important user benefits include

- Flexible range of oven capabilities
- Multiple detector and valve options
- Local panel and remote workstation
- Powerful software
- Extensive local and remote I/O's and serial links
- Multiple network capabilities
- Large, experienced support team

Fig. 2: MAXUM II process GC

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MAXUM II, the solution provider for gasoline analysis

MAXUM II based Gasoline Analyzers

Standard Gasoline Analyzer

The Standard Gasoline Analyzer (fig. 3, setup A, and fig. 6) uses one airless oven, one liquid injection valve and an 8-cell TCD for detection. A total of 22 C4-C7 compnents are separated. The C8+ components are backflushed. Cycle time is 15 min.

A typical Standard Gasoline Analyzer analysis detail is shown in fig. 5.

The throughput of setup A may be doubled just by using oven 2 in parallel with identical analytical configuration.

Advanced Gasoline Analyzer

The Advanced Gasoline Analyzer (fig. 3, setup B) uses a split airbath oven, two liquid injection valves and two FIDs for detection.

A total of 23 C4-C7 components is separated including 2,3-Dimethylbutane and 2-Methypentane, see fig. 4. The other components are backflushed. Cycle time is 15 min.

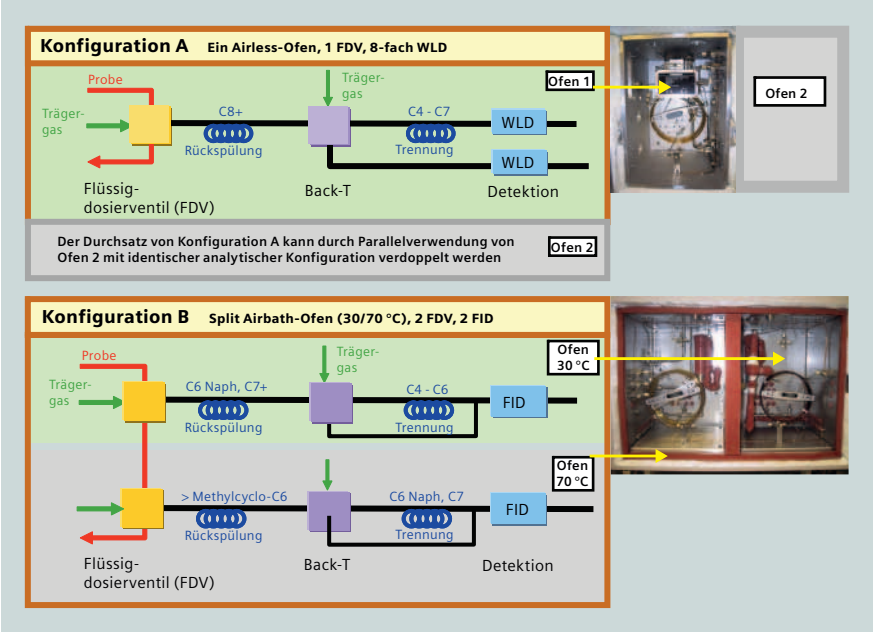

Fig. 3: MAXUM II set-ups for gasoline analysis, flow charts and oven front views

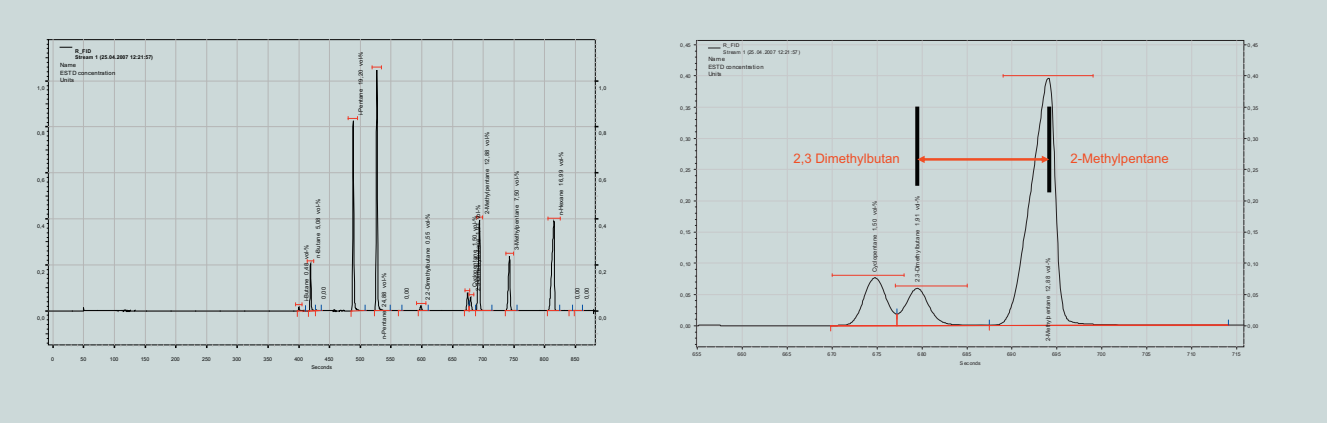

Fig. 4: Gasoline analysis using the MAXUM Advanced Gasoline Analyzer with separation of 2,3 Dimethylbutan and 2-Methylpentan

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User Benefits

User Benefits

- All of the 23 components of a typical total gasoline analysis, including 2,3-Dimethylbutane and 2-Methylpentane, can be analysed using just one analyzer. This essentially improves analysis significance and ensures best possible process control.
- The Gasoline Analyzer is a standard process gas chromatograph (type MAXUM II) that is especially configured to meet the demanding requirements of gasoline analysis. Analysis is performed on-line directly at the process with short analysis times. No time consuming sample transport to the laboratory is needed.

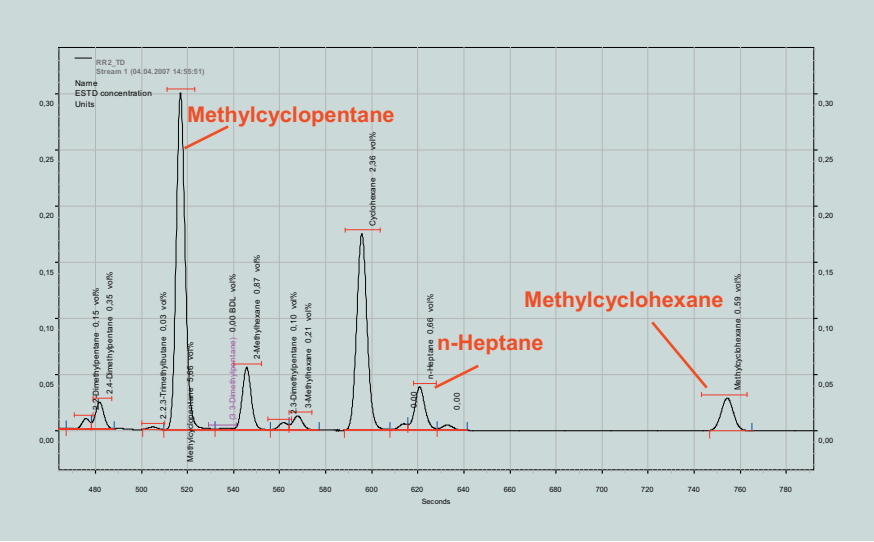

Fig. 5: Detail of a gasoline analysis using the Standard Gasoline Analyzer

- The Gasoline Analyzer requires a remarkable low number of analytical components and transitions. In case of a reduced number of analysis components, the analyzer configuration can be reduced even more. This will minimize the investment costs.

Fig. 6: Standard Gasoline Analyzer, oven configuration

- The Gasoline Analyzer setups can be used for similar applications as well

- MAXUM edition II is able to control the sample conditioning system, which also allows for analysis of more than one sample stream.

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Siemens Process Analytics - Answers for industry

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