Mobile natural gas quality measuring systems

by **Achim Zajc and Michael Friedchen**

With this paper, concepts and solutions for mobile gas quality measurement systems are presented and described. Mobile gas quality measurement for natural gas is becoming increasingly important in the recent years, as the gas compositions are changing because of different effects such as biogas injection or 100% hydrogen supply to the natural gas network, or the transition from "L" to "H" gas in certain areas of Germany. A mobile gas composition measurement system can be very helpful to support these adaptations.

1. INTRODUCTION

Natural gas composition has changed in recent years due for instance to biomethane injection. Moreover, additional new "sources" such as the injection of 100% hydrogen (power-to-gas) and the injection of regasified liquefied natural gas (LNG) are added [1].

Germany is supplied with two basic qualities of natural gas: "L" and "H" gas. The Wobbe index and calorific value of these two qualities differ. "L" gas originates from domestic and Dutch production. In contrast to this, "H" gas comes from Russia and Norway. Domestic and Dutch production is already declining and will decline even more steeply in coming years.

The area in Germany supplied with "L" gas is located primarily in the north-western [2, 3]. A conversion from "L" to "H" gas must occur here. This conversion can occur for instance by conditioning the "H" gas into "L" gas with nitrogen. However it must be ensured that the functioning of millions of gas devices is not impaired in this connection.

It is easy to see that the issue of gas quality and the topics associated with it is a very complex matter. Flexible new pathways must be taken in the area of gas quality measurement – especially in the area of custody gas quality measurement [4]. Thus the calorific value was determined in distribution networks during calorific value tracking with the help of mobile gas quality measurement during nine months of field trial to validate a novel correction algorithm in combination with standard load profiles (SLP) and using additional input information for each network node [5, 6]. A mobile process gas chromatograph also helped during the validation of a new calculation engine for the SmartSim software for calorific value tracking [7].

2. MOBILE GAS QUALITY MEASUREMENT

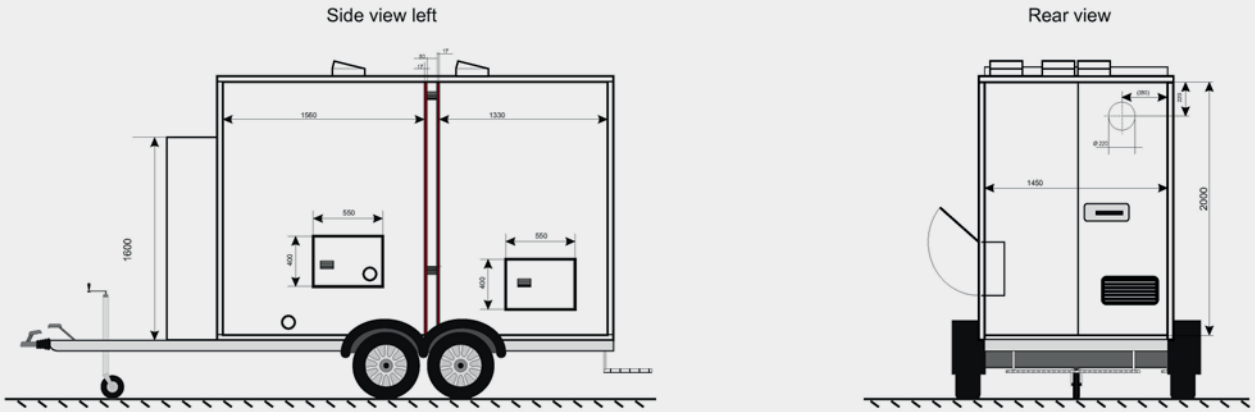
A mobile gas quality system's core assignment is to deliver gas quality measurement values within the shortest possible time whether as a substitute for an existing gas quality measurement (such as after report of a system failure or for measured-value retension during a station's retooling or renovation) or at network nodes that are not usually equipped with gas quality measurement.

Mobile gas quality measurement's application areas are manifold:

- field trials,
- calibration purposes (reconstruction systems/transport),
- as a back-up system within transport networks,
- calorific value tracking (SmartSim/distribution networks) [5 to 7],
- emergency supply,
- special compressor measurements,
- substitute measurement and
- quality assurance.

The mobile gas quality system consists primarily of a trailer the load space of which is divided into two spaces. The trailer with the division into and ex space and in non-ex space is shown in **Figure 1**.

Gas quality systems such as process gas chromatograph, dew-point measurement, humidity measurement, and the like are integrated into the first space, which is declared to be an ex space. Peripheral devices such as pressure-reduction levels and gas supply unit with test gases are also installed in the ex space. The switch cabinet with analysis and remote data transfer units is installed in the second, non-ex-protected space.



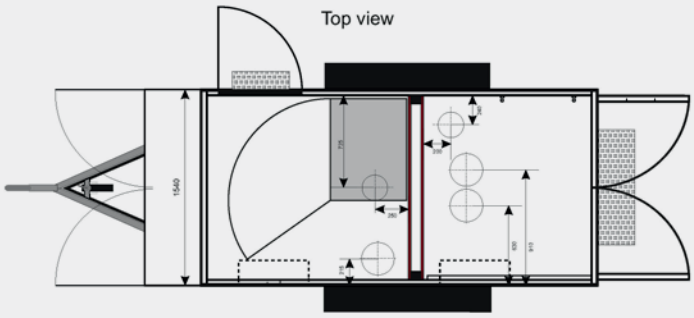


Figure 1: A mobile gas quality measurement set-up

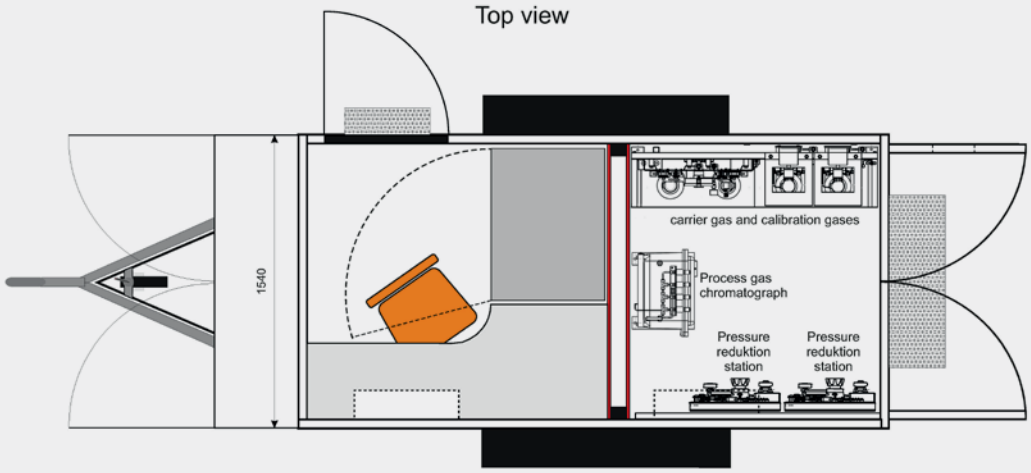


Figure 2: The mobile gas quality measurement trailer's set-up

In principle, the system solution can be subdivided into three parts:

- trailer,
- gas quality measurement (ex area) and
- analysis electronics (non-ex area).

Ultimately the challenge with mobile gas quality measurement consists of generating a measuring system that enables delivery of the quickest, most mobile actual measured values possible in case of malfunction or revision in order to keep downtimes as short as possible.

Moreover the following must be considered during planning and special attention should be paid in contrast to a standard, stationary gas quality measurement:

- switch cabinet and racks supported with special damping and mounted swinging (to avoid vibrations);
- maximum trailer loading;
- planning and arrangement of ex-zones in the most varied situations;
- weight distribution within the trailer;
- the trailer's insurance-related aspects (property insurance for instance in case of a traffic accident);

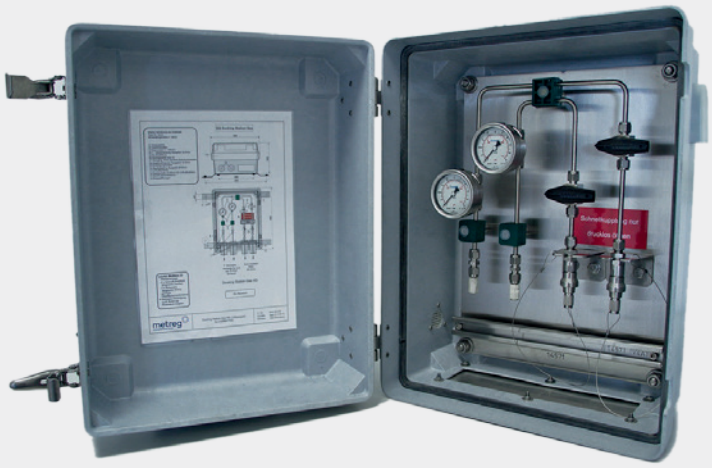


Figure 3: GQ docking station GAS for two sample streams

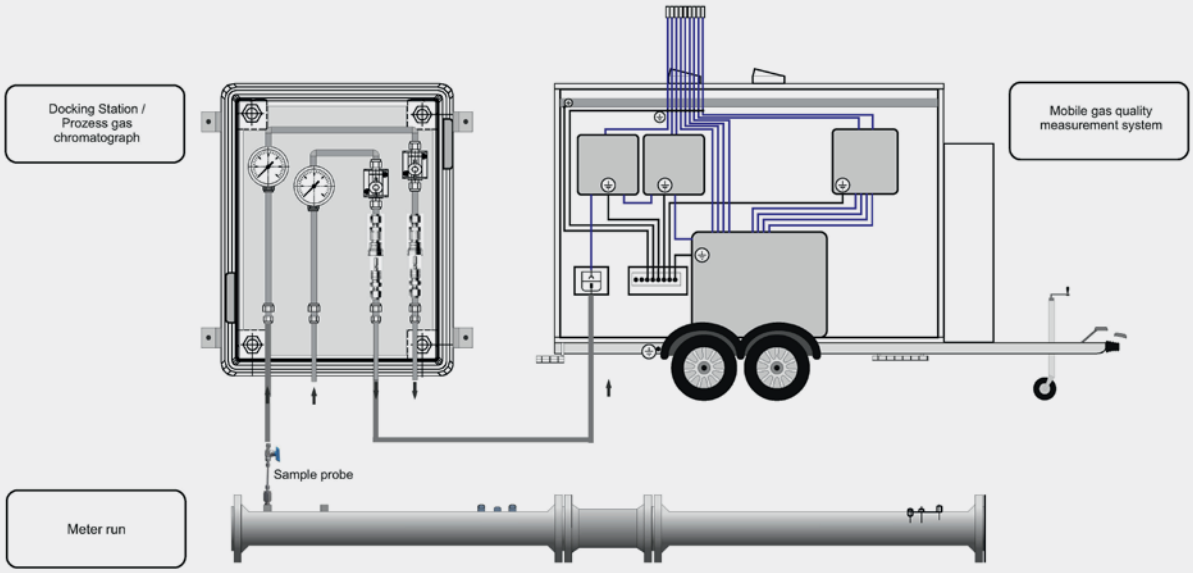


Figure 4: Standardized connection unit (docking station) supplies the mobile quality measurement with the natural gas to be measured

- air conditioning, heating, and lighting;
- emergency power supply;
- fire protection measures;
- overvoltage/lightening protection and
- integrated industrial PC.

2.1. Structural set-up

The trailer's structural set-up is presented in **Figure 2**. The way the process gas chromatograph, high pressure reduction, and fixed bottle rack for carrier and calibration gases are installed in the ex space should be noticed here. The space-saving arrangement of all the elements can be clearly seen. Moreover it can be easily seen that all of the elements are optimally arranged vis-à-vis weight distribution.

Figure 2 also shows the switch cabinet with analysis units such as flow computer, industrial PC, and data communications modules in the non-ex-protected space. The exact placement of switch cabinets for mobile gas quality measurement can be seen in **Figure 5** and **Figure 6**.

2.2. Standardized connection units for mobile gas quality measurement [8, 9]

Practice has shown that the infrastructure prerequisites encountered in various gas stations or plants varies widely. This often impacts the initial start-up of mobile gas quality measurement within the plant in very complex (logistics, connections, where the mobile gas quality measurement should be situated, etc.) and time-consuming (manual installation of the electrical connections and sample gas lines) ways.

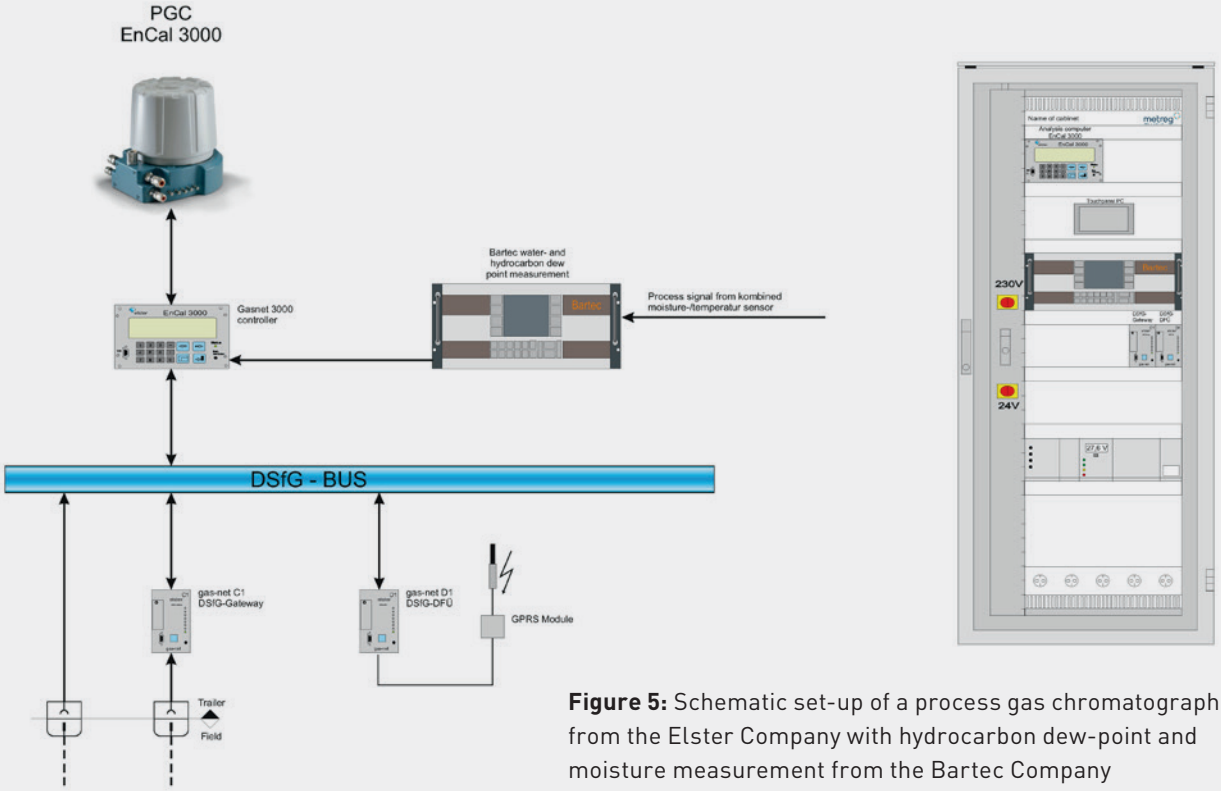


Figure 5: Schematic set-up of a process gas chromatograph from the Elster Company with hydrocarbon dew-point and moisture measurement from the Bartec Company

The GAS and ELEKTRO docking stations **(Figure 3** shows the GAS docking station) are permanently installed in gas stations and are permanently connected both mechanically and electrically. It is thus ensured that mobile gas quality measurement is always connected in the same way. The trailer with the mobile gas quality measurement can now be parked in a marked area at the plant. Thus an ex area can be unambiguously defined.

Connection of the process gas or process gases (in the case of a multistream station) is done from the GAS docking station via flexible connection lines, which are part of the trailer's equipment, to the trailer's plug couplings. The same principle applies to the electrical lines. Here a connection is made from the ELEKTRO docking station to the electrical plug couplings on the trailer side.

The entire system is visualized in **Figure 4**. A trailer with a process gas chromatograph is connected to the measured section using a standard connection through a docking station. Installation and start-up times are thus considerably reduced.

2.3. Metering design concept

The metering design concept is presented in **Figure 5** with a process gas chromatograph from the Elster Company and a hydrocarbon dew-point and moisture measurement from the Bartec Company by way of example. Moreover the switch cabinet installed in the non-ex space is presented.

Only process gas chromatographs which are approved for custody transfer measurements are used for the gas quality measurement as such. Data communication is done via a serial interface using the digital interface for gas measurement equipment (DSfG) protocol.

Figure 6 shows the version in which the process gas chromatograph from the RMG Company by Honeywell was used instead of that from the Elster Company. An instrument from the Michell Company is used here for the hydrocarbon dew-point and moisture measurement.

In addition to the DSfG bus, an Ethernet connection is set up in parallel. An industrial PC can be connected via this Ethernet connection and exchange data with the process gas chromatograph.

3. SUMMARY AND OUTLOOK

Demonstrating that designs for mobile gas quality measurements could be developed based on years of experience was possible with this article. These designs possess a high degree of standardization and can nonetheless be adapted flexibly to the corresponding requirements and applications.

Mobile gas quality systems are gaining significance due to changing gas qualities. Various gas transport com-

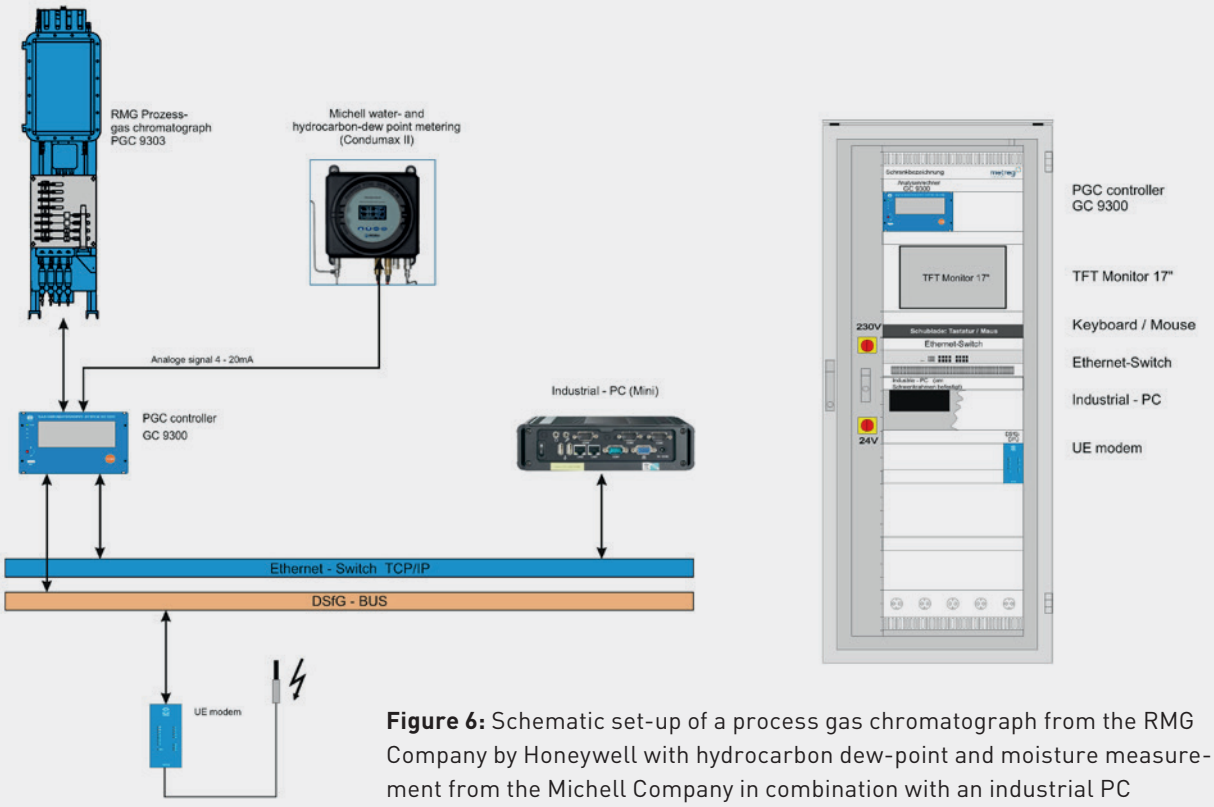


Figure 6: Schematic set-up of a process gas chromatograph from the RMG Company by Honeywell with hydrocarbon dew-point and moisture measurement from the Michell Company in combination with an industrial PC

panies already use gas quality measurements and will conduct them more diligently in future due to positive experiences in different situations.

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AUTHORS

Dr **Achim Zajc**
Managing Director
Metreg Solutions GmbH
Fürstenwalde
Phone: +49 6403 9298 223
E-mail: achim.zajc@metreg-solutions.de

Michael Friedchen
Managing Director
Metreg Solutions GmbH
Hüttenberg
Phone: +49 6403 9298 184
E-mail: michael.friedchen@metreg-solutions.de
Internet: www.metreg-solutions.de