Heavy-Duty Industrial Chromatography

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Non-laboratory applications for gas chromatography in industry have certainly been growing in recent years. That growth has in part been fueled by demand for measurement of indoor air quality in the workplace, outdoor air quality in field environments, mud logging and specialty gas. While diverse in need, all of these measurement applications lend themselves to gas chromatography. The design of one instrument to have practical application in all of these fields requires that no aspect of the product design be glossed over.

Interior air quality measurements are often made in a fairly benign environment, applications in the oil and gas field can be rather hostile. Mud logging is a good example. Geologists involved in energy exploration may be situated at drill sights virtually anywhere in the world, under the most variable conditions imaginable.

During the drilling process, geological samples are retrieved for analysis at different depth levels. The samples are analyzed by a geologist, who uses a variety of analytical tools to search for trace amounts of gas and other markers that indicate the likelihood of that drill site being economically viable. One of the instruments used is a gas chromatograph. Accuracy, speed, sensitivity and reliability are all critical for decision-making in oil and gas exploration. Therefore an instrument with the selectivity of gas chromatography with the sensitivity and broad dynamic range of a flame ionization detector (FID) is an asset.

Even though gas chromatographs used in oil and gas exploration are located inside of a trailer or vehicle, the operating environment and available power quality can be a challenge. An

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instrument intended to perform measurements in a controlled laboratory may not be able to maintain its performance in the field on a consistent basis.

This article takes an instrument-designer's perspective, and looks at why coping with the variables of the operating environment is important and what solution was used in the design of one instrument.

It is not at all surprising that gas chromatographs must be designed for reliable specs to provide the functionality that users demand. What may be surprising to many, though, is some of the less analytical functionality that must be designed into the instrument. Indeed, there is a good deal of extra thought that goes into areas that are virtually invisible to the chromatographer. One of those areas is system power, which will be discussed later in this article. But having a better understanding of the instrument designer's perspective can benefit those who are end users or may need to specify instrument requirements. To this end, Baseline-MOCON designs and manufactures gas analyzers based on several principals of analysis, including gas chromatography, continuous analyzers with component selective detectors and sensors. By necessity, these products are designed for accuracy, reliability, compactness and operational simplicity.

A look inside

Before discussing the power challenges for the instrument, it is worth taking a look at the core technology that allows the instrument to perform its job.

The Series 8900 gas chromatograph is microprocessor-based, which, along with a variety of detector and gas-train options, gives the instrument the required flexibility and precision to perform its intended applications. It is accurate and specific to a wide variety of gases and is designed for continuous unattended operation. It also features automatic baseline correction for long-term stability and analog, digital and logic outputs.

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Because the instrument is designed for industrial and environmental applications in particular, it is available in a variety of configurations and built to meet individualized user specifications. All variations use pressurized gases and a flame ionization detector (FID) to perform analyses, which uses a flame produced by the combustion of a fuel gas and air. When an organic compound enters the flame, the compound becomes ionized, resulting in the production of electrons and positive ions. The stream of freed electrons is directed to a measuring circuit by a polarizing electrode within the detector. The measurement circuit senses this electron stream as a current that is proportional to the amount of organic compound in the flame. Therefore, the current measurement can be reported as a concentration by the analyzer.

Used specifically for the analysis of many organic compounds and some inorganic compounds, the chromatograph uses a single-valve, two-column analytical arrangement (Figure 1). In the inject position, the two columns are in series with each other; the carrier stream enters column 1 (stripper Column - CI) and then column 2 (analytical column - C2). For the load position, the carrier stream is split into two streams. One leg reverses direction through column 1 to vent, while the other continues through column 2 to the detector.

At sample injection, a fixed-volume sample is carried to the stripper column. The volume of the fixed-volume sample loop is specific to the intended application. Back flush of the stripper column is timed from sample injection, so that only the analytes of interest are eluted from the stripper column to the analytical column. The analytes of interest elute through the analytical column to the FID, while the other compounds are flushed to vent.

Software considerations

The instrument's platform allows for method development and instrument control through the communications port. An external personal computer can acquire the analytical information from the analyzer using proprietary SkyChrom™ software or a user-supplied integration

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software package. When the instrument is controlled by SkyChrom, the communications port is used for binary communication between the software and the 8900.

Five standard relays (others are optional) are powered by the power supply distribution module. Relays have three attributes: the relay event mapping, the normal energy configuration and the latch configuration. All relay attributes are assigned with the SkyChrom software.

More to power than meets the eye

Our 8900 GC is designed to run off standard 90-260 VAC, at 50-60 Hz, but reading this spec alone greatly oversimplifies what makes that capability and other power distribution issues possible.

Our engineers prefer to concentrate on core competencies of gas and chemical analysis. The circuitry developed to perform those functions, like other electronic systems, requires various types of power that is distributed in different ways. From a conceptual standpoint, the engineers hit on the concept of “distributed power” providing the best solution for reliability, versatility and energy savings. In this approach, an efficient low-wattage supply would handle housekeeping power requirements and “standby power” that would suffice when the instrument was switched off. Conventional switching power supplies do not function efficiently when operating at power levels that are well below their ratings. All of this takes place within the power supply/distribution module.

While the supply/distribution module is a proprietary design, the engineers chose not to design and build either of the required power supply themselves. So, to supply housekeeping and standby power, a rather unique modular AC-to-DC switching power supply was selected from a third-party source, Bias Power.

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Operating environments drive power module design

Because these GCs are used throughout the world, both the main and standby power supplies needed to offer a universal power input without the need for model changes, thus precluding the use of a linear low-power supply. And as gas chromatographs are often used where power quality is prone to be poor, the supply needed to tolerate sudden variations in power quality, severe noise on the line and even transient spikes, as is often encountered in the oil and gas service industries. Such environments can cause computer data corruption or system failures. We chose the Bias Power supply for its ability to function worldwide without changes or jumpers, and for its capacities within volatile environments.

The chosen power supply also responds to two basic needs in our GC. First, it provides a low-voltage, small-current AC-to-DC power source for the touch-sensitive membrane key pads. Secondly, it functions as a standby power source. So, when the instrument is switched off, the supply maintains such housekeeping functions as powering the internal clock circuit, memory and front panel on-off switching.

Figure 2 portrays the power supply distribution module. The power unit is the black module surface shown mounted to the board; note that it is entirely potted. This makes it more shock resistant and environmentally stable. Another unusual aspect of this small power supply is that it requires no external EMI filtering, further simplifying circuit design of the board.

In terms of application within the oil and gas services industry, there were other issues that had to be considered as well. While local power quality (if available at all) or generator power may be poor, the analytical circuitry of the instrument needs to see clean power. Power filtration circuitry can add to circuit board space, perhaps necessitating a larger enclosure. Because the instrument is often used in very tight quarters, crammed with other instruments, overall size and power consumption can also be an issue.

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Conclusion

In summary, even in an instrument as purpose-built as a gas chromatograph, it is possible to incorporate the flexibility needed to handle a wide range of applications and operating environments. Through the application of versatile software, a modular architecture and the distributed power approach outlined, we are able to offer instruments that are energy efficient, perform well on virtually any AC line voltage worldwide and are tolerant of noisy AC power sources. Furthermore, by utilizing off-the-shelf power supplies, our engineers can concentrate on areas of core competency, speeding time to market for new models.

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