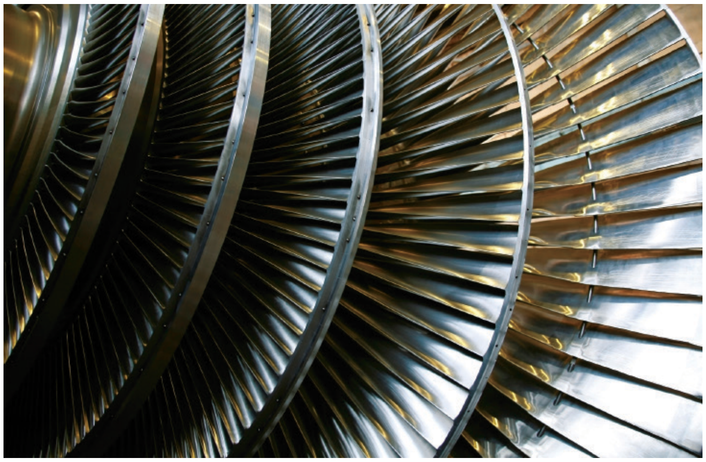
C2+ Measurement Solutions for Turbine Control Using an X-STREAM *Enhanced* Analyzer

Background

Industrial power markets covering multiple energy sources require rapid control in order to optimize plant performance and prevent costly turbine damage. Lower emission requirements and varying fuel sources due to the increase in unconventional natural gas sources, such as shale, have created a higher priority on maintaining turbine efficiency. Although the plants gas sources are predominantly made up of methane, extensive variations in higher hydrocarbons (C2+) typically exist. In fact, in some cases, over 18 % variation has been recorded with fluctuations from 10% to 16 % within one minute. In addition, turbines have to be more flexible and need to present the above criteria over a wide range of loads because gas turbine power plants are often used only for peak loads.



Typical Power Plant Turbine

Application

Methane and higher hydrocarbons like ethane and propane behave differently during combustion. Particularly for combined cycle turbines with lower emissions, variability of fuel sources presents challenges for control and optimization. Although a gas chromatograph can provide all needed measurements, speed of response is sometimes not sufficient for such control.

A process gas analyzer (PGA) with a specific configuration of optical benches and filters provides continuous measurement and the rapid response necessary. In addition, an approximate calorific value (BTU) can be provided as long as the higher hydrocarbons are low in content. If this is not the case, the BTU value will be underestimated but never overestimated. Such values cannot be used for custody transfer but may be adequate to prevent turbine damage and optimize performance. If the variation of C2+ in the fuel sources are known, the error can be greatly minimized.

Table 1 - Typical Gas Composition in Natural Gas Power Plants

Component	Formula	Concentration
Methane	CH_4	70–90 %
Ethane	C_2H_6	0–20 %
Propane	C_3H_8	
Butane	C_4H_{10}	
Carbon Dioxide	CO_2	0–8 %
Oxygen	O2	0–0.2 %
Nitrogen	N_2	0–5 %
Hydrogen Sulphide	H_2S	0–5 %
Rare Gases	Ar, He, Ne, Xe	Trace

Solution

With a 0–100 % CH_4 NDIR bench measuring 7.85 µm, and a 0–25 % C_2H_6 NDIR bench measuring 6.6 µm, we designed a solution which provides a high selectivity for CH_4 against C_2H_6, C_3H_8 and C_4H_{10} as well as CO_2.

The C_2H_6 bench measures C_2H_6, C_3H_8 and C_4H_{10} with response factors of 1.0, 1.0, 1.1 and gives a low response from CH_4, internally corrected by cross compensation. Best accuracy is achieved in Natural Gas mixtures with CH_4 as a major component, C2+ up to 20 %, and low water content.

Combination with Other Measurements

Since CO_2 content also varies in fuel sources, this measurement may be combined with the hydrocarbon values for better control and calorific value calculations. Carbon dioxide measurement utilizing optical non-dispersive infrared (NDIR) technology can also be added to the X-STREAM *Enhanced* analyzer configuration.

A calculation of the Wobbe Index is also possible utilizing a calculated relative density from the concentration values or by utilizing an external density signal. Calorific value calculations might require integration of additional channels. As with the BTU calculation, this is not for custody transfer but aids in rapid adjustments to operations if fluctuations occur.

System Configuration

Methane (C1) and Ethane plus (C2+) measurements for natural gas power applications often take place in hazardous areas. Therefore an X-STREAM *Enhanced* flameproof analyzer by Rosemount Analytical (Figure 1) is recommended.

Sample Conditioning

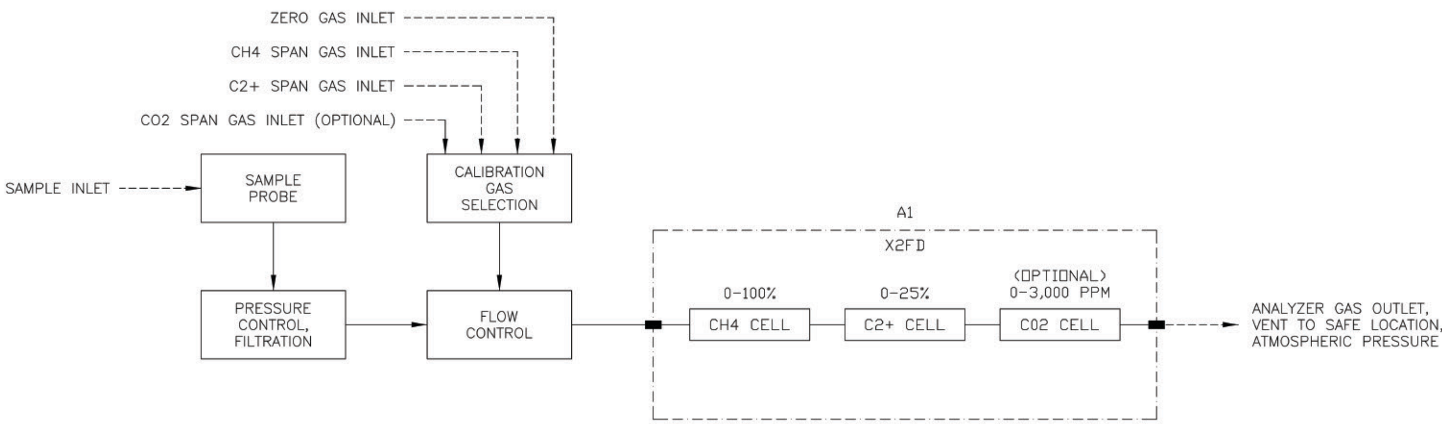
Figure 2 below shows a flow diagram of the recommended analyzer system. Sample extraction, transport, and conditioning occurs using Rosemount Analytical Sample System Modules which include a flanged sample probe, heated pressure reduction station, sample filtration, and sample flow control.

Analyzer Calibration

Zeroing and Spanning calibration of all X-STREAM *Enhanced* analyzer measurement cells execute manually or automatically through calibration solenoid valves.

Figure 1 - X-STREAM *Enhanced* Flameproof Gas Analyzer

Figure 2 - Sample System Flow Diagram



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