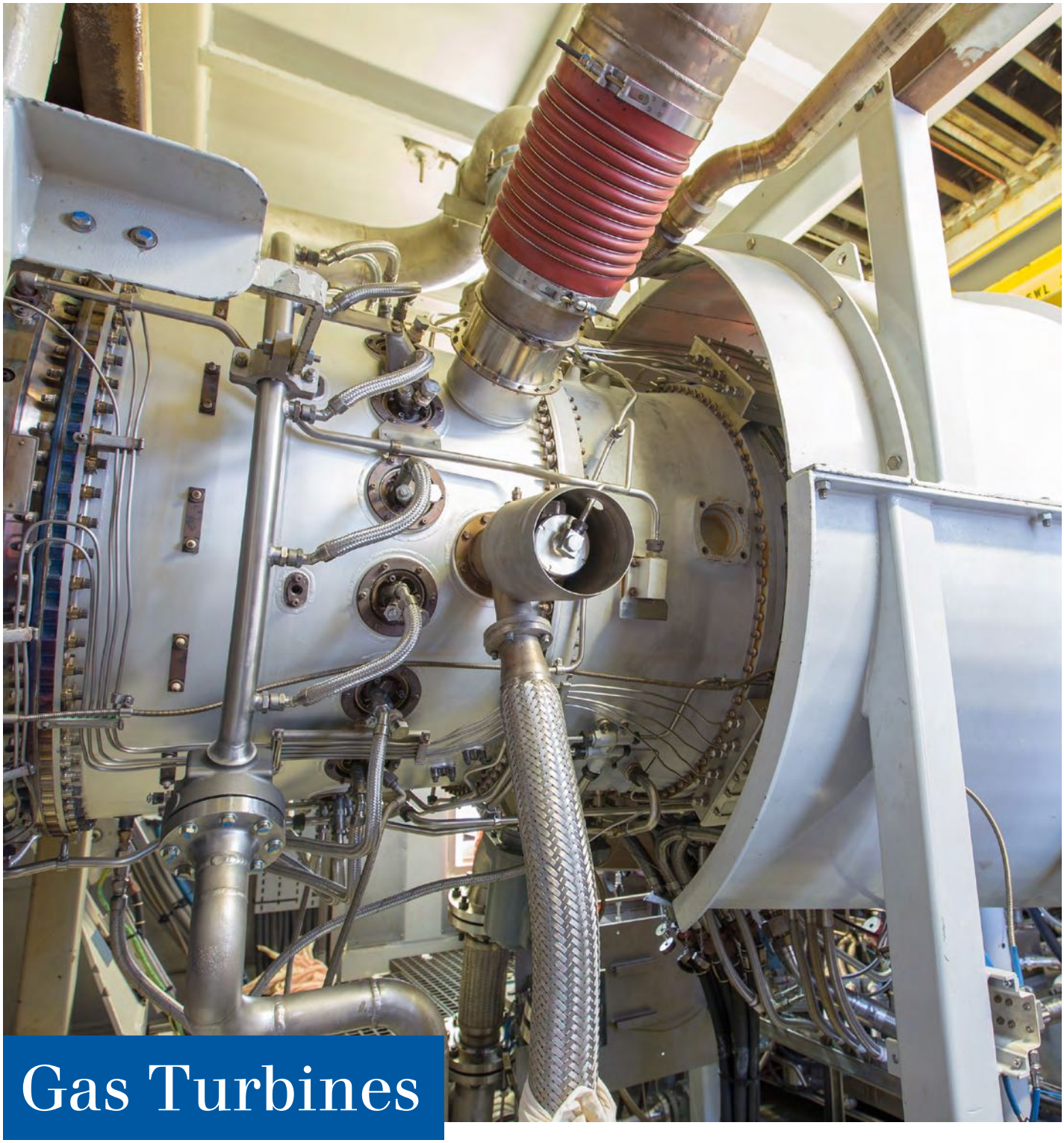
Dräger



Gas Turbines

Application Note

Introduction

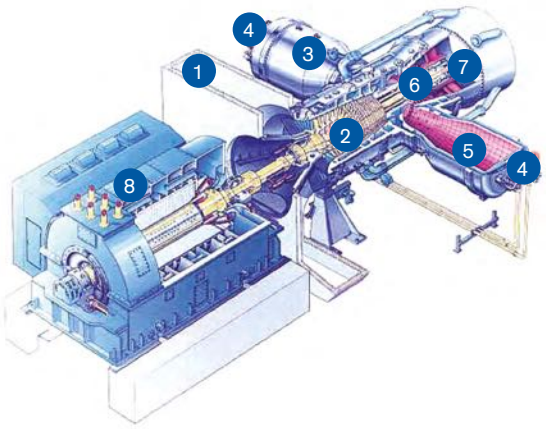
Beside aircraft there are a wide range of industrial applications for gas turbine devices. They are used to drive rotating equipment such as compressors at gas pipelines or electrical generators for energy production. Continuous output ratings of more than 30 Megawatts per unit are possible.

Modern gas turbines are designed to burn light oils (Naphtha) or natural gas. But not only can the fuels be dangerous the lubricating oils and cooling agents like hydrogen add-up to a high degree of hazard potential. For this reasons a multiple line of defense has to be established to guaranty protection against fire and explosion risks. Gas detection instruments are the central element in the protection systems.

Market Segments

The total market of gas turbines is about 1000 units a year, representing up to 8000-10000 gas detection points.

Common applications:
- Compressor Stations on Gas Pipelines
- Oil Production
- Power Generation
- Water & Sewage Pumping Stations
- Oil & Gas Wellhead Re-injection



1) Fresh Air
2) Compressor
3) Combustion chamber
4) Burriers
5) Flame cylinder
6) Turbine
7) Exhaust
8) Generator

Description of the Challenge

There are three main areas of risk assessment related to gas detection systems. All different segments require specially matched systems with features optimised for each application.

1. Turbine Air Intake

Gas turbines are typically located in areas where large amounts of combustible gases or liquids are stored. They are either used as fuels to feed the turbine or they are part of the application itself as in gas pipeline compressor stations. Leaks in this area can have disastrous consequences when the supply air of the turbines is already loaded with combustible gases or vapours. There is a genuine risk of pre-ignition of the air/ gas mixture in the compressor stage of the turbine or the excess of fuel can result in an uncontrolled over-speed of the turbine. Both situations require immediate shut down of the turbine.

To generate an early warning the intake air has to be controlled for any build-up of hazardous combustible gas concentrations. Infrared optical measurement techniques have proven to be reliable and fast detection systems for these applications. The best place to position the detector is just outside or inside the air intake hoods. Positioning is critical with regard to the high air speed in the ducts. Special care has to be taken to avoid misreading of gas concentrations related to different modes of operation.

2. Acoustic Turbine Enclosure

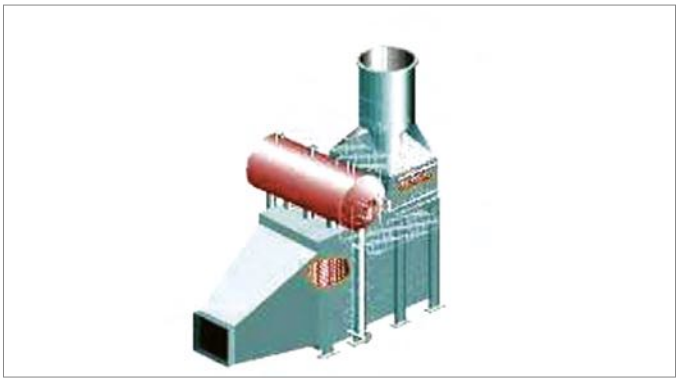
The significant noise levels of gas turbines often require an acoustic enclosure. They have to be ventilated to ensure an optimum temperature range of the turbine. Typical operating conditions are 40 - 60 °C. However, under hot environments, near the combustion chamber or under equipment failure conditions the internal temperatures can reach values up to 100 °C.

The turbine is fed with high pressure (700 p.s.i./ 50 bar) combustion fuel. Hundreds of connections and the complex distribution system are always a source of potential leakages inside the enclosure. Also the lubrication oil system can spill into the acoustic chamber in case of malfunctions. To prevent the system from a build-up of high concentrations of flammable gases under these conditions a gas detection system has to be installed.

Most infrared combustible gas detectors are restricted to upper limits of around 170°F. Operating temperatures around the turbine often require positioning the detectors outside the enclosure using extractive sampling systems to draw the sample to the detector, often with additional gas conditioning.

Open path measurement systems are located outside the acoustic chamber but overlooking the inner part of the chamber through IR transparent windows or special duct mountings. They are known to guarantee fast response and increased coverage of explosion hazards.

As an alternative, high temperature catalytic bead detectors with operational temperatures up to 120°C can be used. They sometimes can be located directly in the enclosure near the turbine avoiding special extractive sampling systems.



Acoustic Turbine Enclosure

3. Hydrogen Cooling System

Power output rating of all combustion turbines is based on the inlet air temperature. Output capacity of the turbines decreases with increase in ambient air temperature. Therefore, in hot weather climates or on hot days, cooling of turbine inlet air has been found to be cost effective for many users to help boost power output. Hydrogen driven heat exchangers are frequently the best choice for removing heat from the high power generators in this application. Hydrogen has a high heat capacity and, therefore, removes excess heat efficiently. Hydrogen also has a very low viscosity (or windage), thus allowing higher capacity operation of the generators while maintaining efficient cooling.

On the other hand Hydrogen is known to be a highly combustible gas. Leaks in the closed cooling system cycles can be an additional source of a potential hazard while operating a gas turbine. Catalytic bead detectors or electrochemical sensors are highly sensitive in detecting H_2 and can pick up this risk.

Solutions from Dräger

Dräger offers a complete range of solutions for all safety applications around gas turbines. Catalytic and infrared sensors for combustible gases and electrochemical gas sensors for monitoring of toxic gases and hydrogen are available.

Infrared Point and Open Path Gas Detectors

An installed base of more than 100,000 transmitters shows the experience and proves the unrivalled technology of Dräger infrared gas detectors. The fast speed of response of Dräger PIR 7000 of less than 1 second, maintenance free operation and self test functions guarantee reliable warning and a low cost of ownership of the safety equipment.

Duct mount installations at the air intake points as well as in exhaust ducts of the acoustic chambers are part of the standard portfolio of Dräger gas detection equipment. When temperatures above 170°F restrict the direct measurement at the point of hazard with infrared instruments a complete sampling system including sample gas conditioning can be offered.

At pipeline compressor stations a set of multiple turbines is common. Open path gas detection offers the possibility to monitor a possible build up of combustible gases across a wide area. A system of Pulsar 7000 open path IR beams oriented at right angles with criss crossing beams can create a virtual monitoring blanket over the entire area and further increases the probability of detection. Also at the air intake hoods open path detectors are a valuable addition to pure point detection systems.

Ultrasonic Gas Leak Detectors

The Polytron® 8900 UGLD contains an ultrasonic sensor that detects gas leaks regardless of environmental influences, even before a gas detection sensor detects a critical concentration. An acoustic gas leak detector detects any gas leaks springing from pressurized lines and vessels. It hears gas leaks instead of smelling them. They are ideal for reliably detecting gas leaks > 50 Bar up to 20 meters away indoors and outdoors. They provide a great early warning system to complement an existing gas detection system.

Catalytic Bead Detectors

In the internal area of the acoustic chambers very high temperatures are possible. It is often difficult to place a detector in this area directly. To avoid an aspirator system and the related

delay of response it is possible to use catalytic bead detectors for flammable gases specified for temperature up to 300°F. They can be placed remote from the transmitter directly at the point of hazard. Catalytic bead detectors are also the only possibility to detect Hydrogen leaks in the LEL range. While IR detectors are not sensitive to Hydrogen catalytic bead sensors are known to give reliable warnings in the 0-100% LEL range.

Electrochemical Gas Detectors

Even small, ppm level leaks of Hydrogen can be detected by electrochemical sensors. This guaranties the earliest warning and the possibility of controlled actions of safety measures to avoid a build up of hazardous concentrations. Measurement ranges down to 0-500 ppm and even lower alarm settings are possible when using Polytron® 8100H_2 transmitters.

Another source of hazard risks can be an accumulation of toxic gases generated via leaks in the exhaust systems of the turbines. In such cases toxic Carbon Monoxide concentrations and Oxygen depletion can be measured by electrochemical sensors.

For detailed description of the technical features of all Dräger gas detection transmitters visit our homepage under www.draeger.com

Restrictions

As mentioned above the temperature limit for IR detectors is 170°F. In cases where higher temperature ranges are required the use of HT-catalytic bead detectors is strongly recommended.

ADVANTAGES OF THE DRÄGER SOLUTION

Catalytic bead detectors:
- Low capital cost
- High temperature versions available
- Detection of hydrogen

IR detectors:
- Lower cost of ownership due to lower maintenance and longer operating life
- Open path offer increased coverage
- IR detectors have the fastest response time
- Fail-safe operation due to self-test features

Ultrasonic detectors:
- Fast warning of pressurized gas leaks in a large area
- Very low maintenance
- Larger coverage than point gas detectors
- Augment to reliable point gas detectors

Appendix

In this note only gas detection around the gas turbine itself has been considered. The purpose for which the engine is being used may also be important. For example in many pumping stations for the transmission of natural gas the compressors are driven by gas turbines. In this case more gas detection is required to cover safe operation of the compressor itself.

Relevant Norms:

USA NFPA37 / API 616 / ANSI B133

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