CROWCON
Detecting Gas Saving Lives

Power

An Introduction

September 2020

1. Introduction

The energy industry is the very backbone of our industrial and domestic worlds, supplying essential energy to industrial, manufacturing, commercial and residential customers around the globe. The sector includes fossil fuel industries (petroleum, coal, LNG); electricity generation, distribution and sales; nuclear energy and renewable energy.

The energy industry attracts very substantial investment worldwide. This is because developed countries are looking to upgrade their aged fleets and transition to different fuel sources. Meanwhile, expansion continues in developing countries to meet growing demand fuelled by population growth.

Power plants can be divided in to 3 major groups:

Fossil fuel power plants

Nuclear power plants

Renewables including solar, wind, geothermal, hydroelectric, biogas, etc.

All of these generate their own gas-related hazards and demand high quality, accurate gas monitoring in various contexts.

2. Fossil Fuel Thermal Power Plants

Typical processes and associated gas detection issues

The production of electricity begins with the loading of fuel into a power plant. The fuel is burned in a giant furnace, and heat energy is released. In the boiler, heat from the furnace flows around pipes that are full of cold water. The heat boils the water and turns it into high-pressure steam. The heated steam flows at high pressure around a turbine wheel, the blades of which start turning as the steam flows past.

The turbine is linked by an axle to a generator, so the generator spins around with the turbine blades. As it spins, the generator uses the kinetic energy from the turbine to make electricity. Boiling hot water from the steam turbine is cooled in a condenser (which is a form of heat exchanger) then sprayed into giant cooling towers and pumped back for reuse.

Once electricity is generated, transformers 'step up' the electric power to a higher voltage, so that it can travel long distances with minimal energy loss. It then travels along power cables to its destination, where transformers subsequently 'step down' the electric power to voltages that are safe for houses and utilities.

Fuel handling and storage

Power plants run on all types of fuel including coal, fuel oil, natural gas and methane gas from decomposing rubbish. However, the types of fuel most commonly used in thermal power plants are coal and natural gas.

Within coal-fired power plants, coal bunkering and storage take up a lot of space. Prior to transport from storage to the processing area, rough coal is crushed to smaller pieces before transporting to the in-plant storage silos by conveyor belts.

In a gas-fired power plant, CH_4 is monitored around the LNG terminal, storage tanks and vaporiser.

Gas detection in fuel handling and storage

The transport and pulverisation of coal poses a high risk of combustion. Fine coal dust becomes suspended in air and highly explosive. The smallest spark, for example from plant equipment, can ignite the dust cloud and cause an explosion that sweeps up more dust, which explodes in turn, and so on in a chain reaction. Coal power plants now require combustible dust certification, in addition to hazardous gas certification.

Single point gas/flame and open path detectors are commonly used to monitor flammable gas, along with CO and O_2. A controller is also required to alarm, initiate shut-down functions or activate a fire suppression system that includes a manual call point and smoke/heat detector.

Crowcon's Xgard Bright is rated II 2 D Ex tb IIIC T80^{c} Db. Find out **more here.**

An infrared-type detector is usually specified, as it provides fast response and long-term stability (it does not require frequent calibration). Thus, Crowcon's IRmax – which has fast response (<4s) and small size – is well suited for this application. Further details are on **our website.**

Coal pulveriser and boiler mill

If coal is to combust efficiently in boilers, it must be pulverized into fine particles (100µm) before being placed in the boiler. A coal pulveriser is used to break pieces of coal down in this way.

Pulverised coal is fed into the boiler furnace, where it is burned to generate heat. This heat converts water, which is within steam piping, into high-pressure and high-temperature steam. This makes the boiler mill a key component of any power plant. Large boilers can reach 80m in height and weigh more than 130 tonnes.

Figure 1 shows a sampling system installed in a coal pulveriser within a Chinese power plant.

Gas detection in coal pulverising and boiler mill

Coal power plants generate large volumes of carbon monoxide (CO) which is both highly toxic and flammable and must be accurately monitored. A toxic component of incomplete combustion, CO comes from boiler casing leaks and smouldering coal. It is vital to monitor CO in coal tunnels, bunkers, hoppers and tipper rooms, along with infrared-type flammable gas detection to detect pre-fire conditions.

Crowcon's CO detection system provides early warning of any fire within coal pulverisers and silos. The system uses pumps to extract air samples from the coal mill via hardened sample probes. The use of moisture and dust filters within the sampling system helps to prolong sensor life. **Crowcon's GM64 control system** allows the user to remotely monitor detector readings, through web access.

Figure 2 shows a sampling panel with Gasmonitor control panel.

Turbine and generator

The steam flows at high-pressure around a wheel made of tightly-packed metal blades known as a steam turbine. The steam turbine blades start turning as the steam flows past, thus converting steam's energy into kinetic energy. The turbine is linked by an axle to a generator, so the generator spins around with the turbine blades. As it spins, the generator uses the kinetic energy from the turbine to make electricity.

The generator produces large amounts of heat and must be cooled to maintain efficiency. Air, water and oil can all be used for cooling. Hydrogen is commonly used, because its low density, high specific heat and thermal conductivity make it a superior coolant. Hydrogen is also readily available and relatively inexpensive. However, hydrogen, when mixed with air, becomes combustible. The explosive range of hydrogen in air is wide, from 4% to 74%, and the gas can easily ignite. Hydrogen is also very light, so leaks are virtually unavoidable.

Gas detection in Turbine and generators

Hydrogen must be monitored, to prevent seal-oil system fires, unscheduled shutdowns and to protect personnel from fire. Hydrogen burns with a pale blue, almost invisible, flame that can cause serious injuries and severe equipment damage.

In addition, power plants must have back-up batteries, to ensure the continued functioning of critical control systems in cases of power outage. Battery rooms generate considerable hydrogen, and monitoring is often carried out in conjunction with ventilation.

Crowcon's XgardIQ with remote sensor option (up to 15m) is well suited for hydrogen measurement, because the sensor can be mounted at height on the ceiling with a collector cone, while display and output are installed at eye level for easy operation. XgardIQ also comes with relay output to trigger ventilation, if required. Find out more **here.**

Cooling tower

Boiling hot water from the steam turbine is cooled in a heat exchanger (condenser). Then, it is sprayed down cooling towers, where an updraught of air through water droplets cools the water before it is pumped back for reuse. Most of the water condenses on the walls of the towers and drips back down again. About 3 to 5% is lost through mechanical carry-over, so water must be continually replaced. To maintain water quality, disinfectants – like chlorine, ozone or ammonia – are routinely put into the cooling tower reservoir.

Gas detection in cooling towers

The addition of disinfectant chemicals to the cooling tower reservoir is to prevent the build-up of micro-organisms. Ammonia is also dosed to maintain optimal pH in the system. Chlorine, ozone and ammonia are strong toxic gases and should be monitored in case of leaks. Leak monitoring is required in the chemical storage and dosing areas.

Xgard Bright is a compact detector that has a local display and relay output that allows users to see the gas concentration and to link output to ventilation, if required. The Xgard Bright's addressable offers cost savings via reduced cable run to the central control room. Find out more from our **website.**

Power transmission

Once electricity is generated, transformers ‘step-up’ the electric power to a higher voltage, so the power can travel long distances with minimal energy loss. It then travels along overhead power cables to its destination, where transformers subsequently ‘step-down’ the electric power to voltages that are safe for houses and utilities. Within the transformer room is gas-insulated high-voltage switchgear (GIS), a compact, metal-encapsulated switchgear that comprises high voltage components, including circuit-breakers and disconnectors.

Sulphur hexafluoride (SF_6) is an inorganic, colourless, odourless, non-flammable, heavy gas that has exceptional electrical insulation performance. It is commonly used in high voltage circuit breakers, substations and electrical equipment within the power industry.

Gas detection in power transmissions

Although non-toxic, SF_6 is considered the worst greenhouse gas, having an atmospheric lifetime above 1,000 years. The use and storage of SF_6 (and other fluorinated greenhouse gases, often called F-gases) are regulated in the US and EU. SF_6 is also costly, so any leakage generates operational inefficiencies and higher operating costs.

Crowcon’s F-gas detector enables gas suppliers and users to comply with the mandatory European F-Gas regulations. Crowcon’s F-gas detector uses an IR sensor, which provides long term stability as it is not affected by temperature and humidity. This SF_6 detector also requires no maintenance or calibration. For more details on the F-gas detector, please visit our **website.**

Personal gas detection requirements

It is important to monitor O_2 in enclosed or poorly ventilated spaces that might deplete or displace oxygen, e.g. chemical sheds, boilers, generator rooms and air ducts. The use of a personal gas monitor is recommended when entering an enclosed space or when working around coal piles/conveyors. Crowcon’s range of personal detectors protects users from gas hazards, with single gas and multi-gas monitors available for personal monitoring and portable safety applications. Visit our website for more information.

3. Summary

Crowcon has more than 50 years of experience in supplying gas detection equipment to power plants around the world. A reference list is available upon request.

For more information, please visit our website www.crowcon.com

4. Summary of Crowcon detectors suitable for use in the power industry

			Crowcon Products									
Gas	**Overview**	**Areas**	**Clip SGD**	**Gasman**	**T3**	**Gas-Pro**	**T4**	**Xgard**	**IRmax**	**Xgard Bright**	**XgardIQ**	**SF6 detector**
Carbon monoxide	Smouldering coal	Coal tunnels, bunkers, hoppers and tipper rooms	✓	✓	✓	✓	✓	✓		✓	✓	
	Boiler casing leaks / incomplete combustion	Boiler room										
Methane	Majority component of coal seam gas	Coal bunkering, storage and pulveriser		✓	✓	✓	✓	✓	✓	✓	✓	
	Main component in natural gas	LNG terminal, storage tank & vapouriser										
Oxygen	Displacement by carbon monoxide and/or methane	Confined spaces	✓	✓	✓	✓	✓	✓		✓	✓	
Chlorine	Used during cooling water disinfecting	Storage and dosing		✓		✓		✓		✓	✓	
Ammonia	Used during cooling water disinfecting	Storage and dosing		✓	✓	✓		✓		✓	✓	
Hydrogen	Coolant for generator, leakage from Li-ion battery	Generator, back-up battery room		✓	✓	✓		✓		✓	✓	
Sulphur Hexafluoride	Cooling medium for switchgear in transformer	Transformer room										✓

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ABOUT CROWCON

For over 50 years, Crowcon has been developing and manufacturing high-quality gas detection products, securing a reputation for reliability and technical innovation that continuously improves efficiency and safety. Globally respected, and part of FTSE 100 Halma, today, over 500,000 Crowcon devices are in use around the world.

Our vision is to grow a safer, cleaner, healthier future for everyone, every day, by providing best in class gas sensing solutions. The Crowcon range offers both fixed and portable gas detection equipment enhanced with Crowcon Connect, our digital solution, which protects people and places in industries including petrochemical, oil and gas, water, industrial manufacturing and food production. In every case, we combine our expertise with emerging technologies to develop process insights and protection for our customers, improving their operational efficiency and creating safer, cleaner and healthier workplaces.

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