

The use of multi-gas sensors in the sustainable and economical production of biogas



Introduction

Biogas plays an important role in today's and tomorrow's energy supply. As a renewable energy source, biogas is produced through the anaerobic digestion of organic materials, including agricultural waste, biomass and sewage sludge. This versatility makes biogas a flexible option for energy production.

Currently, biogas serves as a decentralised energy source, especially in rural areas. The use of local resources enables decentralised energy production. Biogas can be used for various purposes, including electricity and heat generation, and as a fuel for vehicles. Reducing greenhouse gas emissions is another important role of biogas, as it helps to reduce dependence on fossil fuels.

In the future, biogas will continue to play an important role, especially in times of increasing integration of renewable energies. As a controllable energy source, biogas can help to overcome the challenges of intermittent energy sources such as solar and wind energy. Biogas will also play an important role across sectors, for example as a climate-friendly fuel for vehicles and as a raw material in the chemical industry.

The coupling of sectors, such as the connection of biogas plants with power-to-gas technologies, opens up new possibilities for the storage and conversion of surplus renewable electricity into hydrogen or methane. This contributes to the flexibility and stability of the energy system. Research and development play a key role in the further development of biogas technologies, and innovative approaches, such as the integration of biogas production with sustainable agricultural practices, can further improve efficiency.

Overall, biogas is expected to play an important role in achieving climate targets and transforming the energy system. However, the integration of biogas into a sustainable energy model requires continuous technological development, political support and economic incentives for biogas plant operators.

What can multi-gas sensors be used for in the biogas value chain?

In order for biogas to fulfil the role described above, it must be produced with high quality, safely and sustainably. Multi-gas sensors make a decisive contribution to this in the application scenarios discussed below.

Substrate monitoring

Organic materials are converted into biogas by anaerobic microorganisms in fermenters. Multi-gas sensors monitor the concentrations of methane (CH₄), carbon dioxide (CO₂), carbon monoxide (CO), oxygen (O₂), hydrogen sulphide (H₂S) and other gases to ensure that fermentation proceeds efficiently. An optimal gas composition promotes the activity of the microorganisms and maximises the biogas yield.

Fermentation control

When optimising process conditions, multi-gas sensors enable real-time monitoring of the gas composition in the fermenters. This allows operators to adjust process conditions such as temperature, pH value and nutrient supply to maximise the efficiency of biogas production.

Gas purification

Multi-gas sensors play an important role in monitoring the hydrogen sulphide concentration. Hydrogen sulphide is an undesirable gas that can be produced during the fermentation process. Detection of H₂S is crucial for controlling gas purification processes, such as desulphurisation units, to ensure that the biogas meets the required quality standards.

End product monitoring

Multi-gas sensors are used to check the quality of the biogas produced before it is fed into the gas grid or used for other purposes. This includes monitoring methane content, CO₂ content and other gases to ensure that the biogas meets the specified standards.

Precise monitoring of the gas composition throughout the process helps to increase the efficiency of biogas production, improve process stability, and ensure that the biogas produced meets the required quality standards. Multi-gas sensors therefore enable comprehensive control of biogas production and contribute to sustainability and profitability in the biogas value chain

What can be the consequences if the gas composition is not adequately monitored?

Monitoring the gas composition in biogas plants is crucial, as inadequate control can have a significant negative impact on various aspects of biogas production. Some of the consequences that can occur if the gas composition is not carefully monitored are described below.

Low biogas yield

Without precise monitoring of the gas composition, sub-optimal conditions can occur in the fermenters. This can lead to reduced activity of the anaerobic microorganisms, which impairs biogas production. Inefficient fermentation leads to a lower yield of methane, the main component of biogas.

Process instability

Fluctuations in gas composition can indicate irregularities in the fermentation process. Insufficient monitoring makes it difficult to react to changes in good time. Process instability can lead to operational interruptions, production losses and additional maintenance costs that affect the overall efficiency of the plant. Repairing equipment and restoring operations can be expensive.

As a rule, restarting a biogas plant can take anywhere from a few hours to several days. During this time, various parameters such as temperature, pH value and gas composition must be carefully monitored and controlled to ensure optimal conditions for the microorganisms. A slow and controlled restart is important to ensure process stability and avoid damage to the plant.

Quality problems of the biogas

If critical gases such as hydrogen sulphide (H₂S) are not adequately monitored, this can lead to quality problems with the biogas produced. High H₂S concentrations can not only impair the efficiency of downstream purification processes, but also reduce the service life of plant components such as motors and generators.

Environmental impact

Unmonitored biogas production can lead to increased emissions of greenhouse gases, especially if methane and CO₂ are not produced in the desired proportions. Methane, if not captured and utilised, is a major contributor to global warming. Careful monitoring is therefore crucial to minimise the environmental impact of biogas production. If biogas plants do not comply with emission standards and uncontrolled emissions of methane or other gases occur, penalties and additional environmental compliance costs may be incurred.

Increases in operating costs

Lack of gas monitoring often leads to inefficient operation and higher operating costs. For example, if gas cleaning processes are not optimally controlled, this can lead to higher consumption of cleaning chemicals and energy, which increases operating costs. Higher energy costs are a direct financial burden for the plant operator.

Non-compliance with standards

Many countries have set specific quality standards for biogas, especially if it is to be fed into the gas grid. Insufficient monitoring can result in the biogas produced not meeting the prescribed standards, which can lead to legal problems and possible penalties.

Conclusion

Accurate monitoring of gas composition in biogas plants is crucial to ensure efficient, reliable and environmentally friendly biogas production. Inadequate monitoring can lead to significant economic losses, environmental impacts and quality issues that affect the sustainability of the plant.

The exact costs vary depending on plant size, local environmental regulations, energy prices and other factors. However, it is clear that investing in adequate gas monitoring technology and infrastructure is a worthwhile endeavour compared to the potential costs of process upsets and quality issues. Preventing problems through effective monitoring helps to minimise long-term operating costs and improve the profitability of the biogas plant.