Application Note AN-PAN-1007

Online analysis of peroxide in the HP-PO process

Propylene oxide (PO) is a colorless yet extremely flammable liquid derived from crude oil. PO is used in several industrial applications. It is mostly used to produce polyols, which are the building blocks for polyether polyols (e.g., foams, coatings, adhesives) and propylene glycol (e.g., PET bottles, fibers, furniture).

Several production processes are currently available to manufacture PO. Some of these processes create co-products (e.g., chlorohydrin «CH-PO», styrene «SM-PO», and methyl *tert*-butyl ether «MTBE-PO») and others are derivative-free (e.g., hydrogen peroxide «HP-PO» and cumene «CU-PO»). Out of these processes, HP-PO is considered to have the smallest environmental footprint.

This Process Application Note focuses on HP-PO process monitoring of hydrogen peroxide (H_2O_2) online. This process requires an explosion-proof process analyzer due to the hazardous production environment. Online analysis facilitates a high propylene oxide production yield while reducing costs with low feedstock consumption. It also ensures a safe working environment for operators working in this highly hazardous process.

INTRODUCTION

Propylene oxide (PO) is an important intermediate product for several markets because of its wide range of applications predominantly used in the polyurethane and solvent industries.

The global production of PO accounts for more than 10 million tons of PO per year [1]. This market is still growing, and so is the need for a more cost-efficient and environmentally friendly production process. PO production methods are available both with and without byproduct materials (Table 1). Depending on the condition of the market for these byproducts, one or more of these processes may dominate the global market at any time.

Table 1. List of propylene oxide production processes categorized by whether they produce co-products or not.

Processes with co-products	Derivative-free processes
Chlorohydrin «CH-PO»	Cumene «CU-PO»
Styrene «SM-PO»	Hydrogen peroxide «HP-PO»
Methyl *tert*-butyl ether «MTBE-PO»	

The hydrogen peroxide to propylene oxide («HP-PO») process creates PO from propene (C_3H_6) and hydrogen peroxide (H_2O_2) using a titanium silicate catalyst (Reaction 1). This process is preferred over others since it has the smallest environmental footprint compared to all other existing technologies. Additionally, it is proven to guarantee high yields of PO with only water as a byproduct.

Reaction 1. Overall reaction for the epoxidation of propylene with hydrogen peroxide (HP-PO).

H_2O_2 present in a methanol solvent is used as the *sole oxidizing agent*. It is also the critical feedstock and key parameter to measure the complete conversion rate to PO. Thus, there is a high demand for accurate and robust online process monitoring throughout the whole HP-PO reaction process.

Considering the dangerous nature of this process, online measurement techniques are vital to ensure safe operation. H_2O_2 can be monitored accurately in the effluent of the primary reactor using an online analysis solution designed for extremely hazardous areas (Figure 1).

Additionally, analyzing the residual H_2O_2 concentrations in finishing reactor overheads, upstream of the propene recovery section, ensures that unreacted hydrogen peroxide is closely monitored for control measures after the epoxidation reactor (Figure 1).

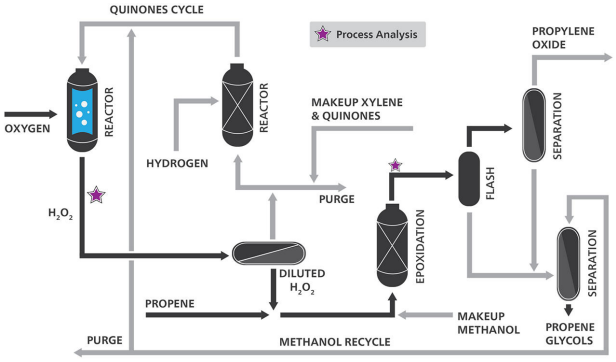

Figure 1. Schematic process diagram outlining the hydrogen peroxide-propylene oxide (HP-PO) method for byproduct-free PO production. Stars note where online process analysis can be integrated for safer, more efficient operations.

APPLICATION

Due to the hazardous environment at these production plants, strict safety precautions must be implemented with all production and process equipment. The 2060 TI Ex Proof Process Analyzer from Metrohm Process Analytics (Figure 2) complies with all electrical safety requirements and is specifically designed for high-throughput processing in hazardous locations.

Hydrogen peroxide is analyzed by using a complexing agent, followed by a colorimetric measurement with a dipping probe.

Figure 2. The Metrohm Process Analytics 2060 TI Ex Proof Process Analyzer.

Table 2. Key parameters to monitor in HP-PO effluent streams.

Analyte	Effluent of the primary reactor (%)	Effluent of the finishing reactor (%)
H_2O_2	0–2	0–0.25

CONCLUSION

HP-PO process monitoring of hydrogen peroxide requires an explosion-proof process analyzer due to the hazardous production environment. The **2060 TI Ex Proof Process Analyzer** is specifically designed for this. Its online analysis capabilities facilitate a high propylene oxide production yield while reducing costs. It also ensures a safe working environment for operators working in this highly hazardous process.

RELATED DOCUMENTS

White Paper: Utilizing online chemical analysis to optimize propylene oxide production

AN-PAN-1008 Online determination of sulfuric acid in acetone and phenol

AN-PAN-1027 Online monitoring of TBC in styrene storage tanks according to ASTM D4590

AN-PAN-1051 Inline process monitoring of the moisture content in propylene oxide

BENEFITS FOR ONLINE ANALYSIS IN PROCESS

- **Protection of company assets** with built-in alarms at specified warning limits.
- **Accurate moisture analysis** in hygroscopic sample matrices.
- **Safer working environment** for employees (high temperature and pressures, autopolymerization, ATEX).
- **Increased product yield** with an optimized production process, which leads to better profitability.

REFERENCE

1. Kawabata, T.; Yamamoto, J.; Koike, H.; et al. *Trends and Views in the Development of Technologies for Propylene Oxide Production*; SUMITOMO KAGAKU (English Edition) 2019, Report 1; Sumitomo Chemical Co., Ltd., 2019; pp 1–9.

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CONFIGURATION

2060 TI Ex Proof Process Analyzer

The **2060 TI Ex Proof Process Analyzer** is an intrinsically safe wet chemistry process analyzer for process monitoring in gas or dust zoned hazardous environments rated as zone 0, 1 and 2, or 20, 21, and 22. It complies with EU Directives 94/9/EC (ATEX95) and is certified for Zone 1 and Zone 2 areas. Its design combines a purge and pressurization system with intrinsically safe electronic devices. The air purging phase and permanent overpressure prevent potentially explosive atmospheres from entering the analyzer enclosure.

The analyzer's design eliminates the need for purging large analyzer shelters, allowing for direct installation at the production line within hazardous zones. It supports various kinds of techniques, including titration, Karl Fischer titration, photometry, ion-selective electrode measurements, and direct measurements.