



Application Note AN-PAN-1007

HP-PO 工艺中过氧化物的在线分析

环氧丙烷 (PO) 是一种从原油中提取的无色但极易燃的液体。环氧丙烷有多种工业用途,但大部分用于生产多元醇,而多元醇是聚醚多元醇(如泡沫、涂料、粘合剂)和丙二醇(如 PET 瓶、纤维、家具)的基本成分。

目前有多种生产工艺可用于制造 PO。其中一些工艺会产生副产品(如氯海德林“CH-PO”、苯乙烯“SM-PO”和甲基叔丁基醚“MTBE-PO”),而另一些工艺则不产生衍生物(如过氧化氢“HP-PO”和积炭“CU-

PO”)。在这些工艺中,HP-PO 被认为对环境的影响非常小。

由于生产环境的危险性,本工艺应用说明重点介绍使用防爆工艺分析仪在线监测过氧化氢 (H_2O_2) 的 HP-PO 工艺。在线分析有助于提高环氧丙烷的产量,同时以较低的原料消耗降低成本,并确保在这一高度危险工艺中工作的操作人员有一个安全的工作环境。

INTRODUCTION

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

The global production of PO is more than 10 million tons per year [1]. This market is still growing and with it 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 market for these byproducts, one or more of these processes may be in major use globally 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 has been proven to guarantee high yields of PO with only water as a byproduct.

H_2O_2 present in a methanol solvent is used as the *sole oxidizing agent* and is 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.



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

Considering the dangerous nature of this process, online measurement techniques are key for safety reasons. H_2O_2 can be accurately monitored in the effluent of the **primary reactor** using an online analysis solution designed for extremely hazardous areas (**Figure 1**).

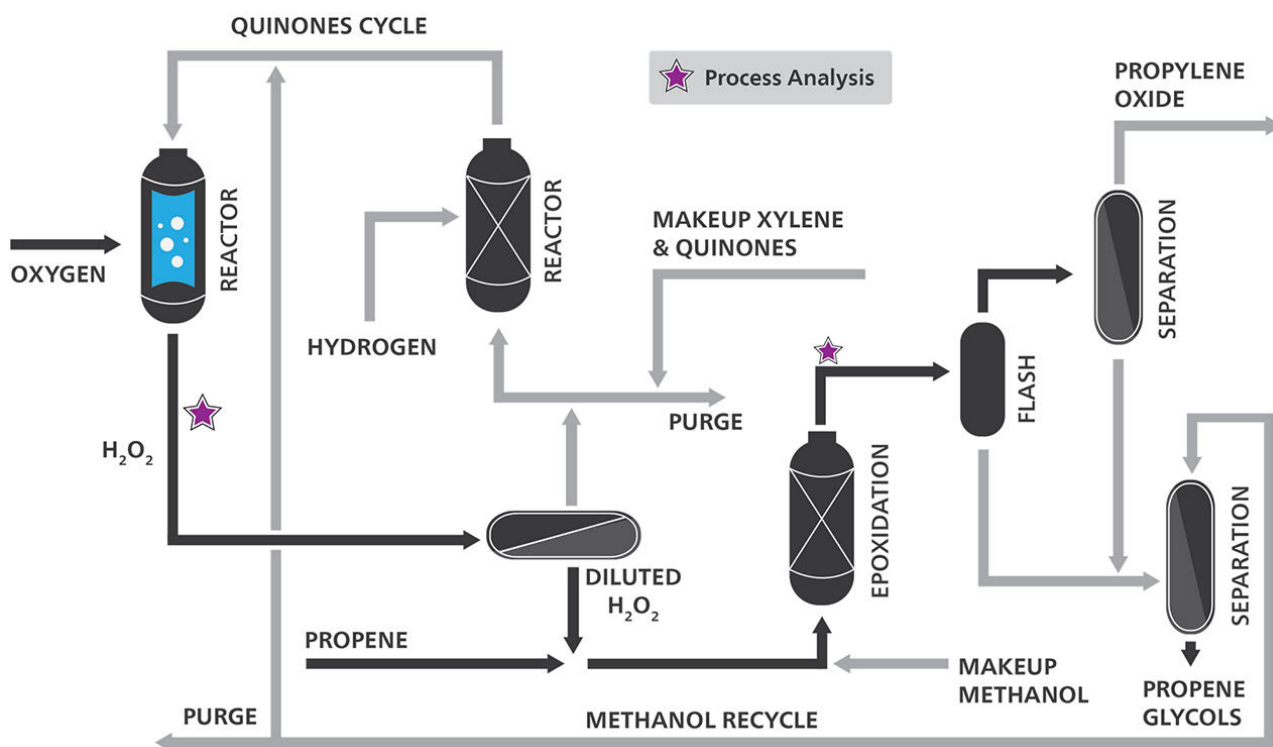


Figure 1. Schematic process diagram outlining the hydrogen peroxide-propylene oxide (HP-PO) method for byproduct-free PO production. Stars note where online process analysis can be integrated for safer, more efficient operations.

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**).

Due to the hazardous environment at these production plants, strict safety precautions have

to be implemented with all production and process equipment. The **ADI 2045TI Ex proof (ATEX) Process Analyzer** from Metrohm Process Analytics (**Figure 2**) complies to all electrical safety requirements and is specifically designed for high throughput processing in hazardous locations.

APPLICATION

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



Figure 2. The Metrohm Process Analytics ADI 2045TI Ex proof (ATEX) 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 ₂ O ₂	0–2	0–0.25

FURTHER READING

[White Paper: Utilizing online chemical analysis to optimize propylene oxide production](#)
[Determination of sulfuric acid in acetone and phenol](#)

[Monitoring of 4-tert-butylcatechol in styrene in accordance with ASTM D4590](#)
[Inline process monitoring of 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 matrix
- Safer working environment for employees (high temperature and pressures, autopolymerization, ATEX)
- Increased product yield with an optimized production process: more profitability



REFERENCES

1. Kawabata, T.; Yamamoto, J.; Koike, H.; Yoshida, S. *Trends and Views in the Development of Technologies for Propylene Oxide Production*; Sumitomo Kagaku, 2019; pp 4–11.

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