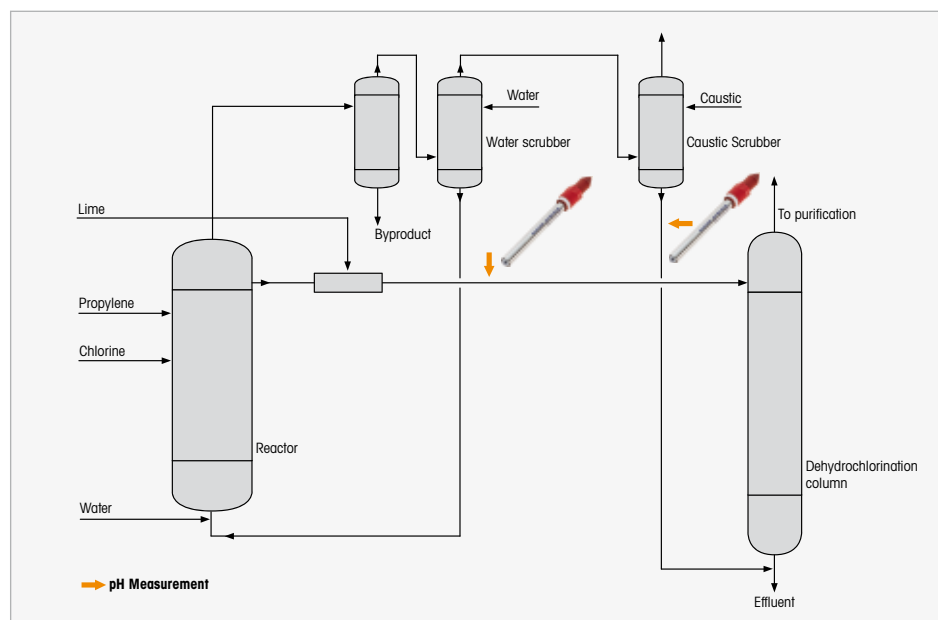


pH Control in Propylene Oxide Production



Background

Propylene oxide ($\text{PO} - \text{CH}_3\text{CHCH}_2\text{O}$) is a large volume intermediate chemical. It is used as a building block in the production of many different chemicals varying from propylene glycol (antifreeze and deicing fluid) to polyurethanes and cosmetics. Currently, the world annual PO capacity is roughly 8 million metric tons and growing. Shortages in propene feedstock have caused manufacturing costs for PO to increase and maintaining margin is a challenge for producers.

Process

Unlike in ethylene oxide production, so far there seems to be no successful way to manufacture propylene oxide by direct oxidation of propene without producing too many byproducts. Several indirect oxidation ways have been found however, with the chlorohydrin process being one of the predominant technologies.

The chlorohydrin process involves the reaction of propene and chlorine in water and is quite a simple process consisting of two reaction steps, chlorohydrination and epoxidation, followed by a purification step.

Step1: chlorohydrination

In a reaction column, propene reacts with an aqueous chlorine solution at 3 bar pressure and approximately 50 °C. In the chlorine solution, hydrochloric acid and hypochlorous acid are in equilibrium. This is necessary as otherwise chlorine will react with the propene to mainly form 1,2-dichloropropane rather than propylene chlorohydrin, which is the desired intermediate.

To optimize the content of hypochlorous acid, the pH of the chlorine solution is brought to a range of 3–6 pH through the addition of an alkali such as caustic soda or lime. Too high or too low a pH will result in undesired byproducts, the waste of chlorine and a low propylene chlorohydrin yield.

Step 2: epoxidation

The effluent of the first process step containing roughly 5% propylene chlorohydrin, is reacted with a 10% excess caustic or lime solution for both the epoxidation (or dehydrochlorination) step and the neutralization of the acid. To maximize yield, the process pH is kept above 12. The formed propylene oxide is quickly steam stripped from the brine solution to avoid further reaction of the oxide to propylene glycol. Further purification of propylene oxide is done by distillation.

Challenges

The presence of chlorine, a large amount of different (chlorinated) hydrocarbons and precipitating salts make in-line pH measurement very problematic. As mentioned above, accurate pH control is vital to the process and to secure profitability. Therefore, most plants running the chlorohydrin propylene oxide process equip their critical control loops with three or four redundant pH measurements. However, the majority of pH sensors have severe difficulties with the process environment and require frequent cleaning and recalibration, placing significant burden on the maintenance department.

METTLER TOLEDO Solution

The InPro® 4800i pH sensor with its annular PTFE diaphragm and extra-long diffusion path, is especially designed for these types of application. It deals particularly well with both oxidants



such as chlorine and hydrocarbons, ensuring the highest possible accuracy and quickest response time for enabling reliable process control. Featuring Intelligent Sensor Management (ISM®) technology, the sensor provides sophisticated diagnostics and allows pre-calibration in the workshop, making maintenance convenient and easy, and reducing maintenance time by up to 85%!

The M400 2-wire transmitter is the ideal instrument to complete the measurement point. Certified for hazardous area use and offering full ISM functionality, the M400 transmitter offers a best-in-class solution for critical pH measurements. ISM diagnostics are communicated via HART protocol and may be accessed remotely with the help of asset management software.

InPro 4800i pH sensor

- Combined pH/ORP/temperature measurement
- High temperature and pressure rating
- Dirt-repelling PTFE annular junction
- Predictive diagnostics

M400 2-wire transmitter

- Multi-parameter ability
- 4 to 20 mA (with HART) or Foundation Fieldbus or Profibus communications
- NEPSI Ex/ATEX/FM approved for hazardous areas
- Full ISM diagnostics

► www.mt.com/InPro4800

► www.mt.com/M400-2wire

► www.mt.com/pro-pHguide

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