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Oxo Alcohols

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Dipti Dave
Senior Analyst II

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Abstract

This report consolidates and updates the IHS Process Economics Program (PEP) technical and economic analyses of oxo alcohols manufacturing technologies from 1995 to the present. The term "oxo" is the generic name for the chemicals manufactured from "oxo synthesis" chemistry, which is the hydroformylation of olefins by using syngas, carbon monoxide, and hydrogen. The oxo process or hydroformylation of olefins with synthesis gas (or syngas) is the principal route to C_3–C_{15} aldehydes, which are converted to alcohols, acids, or other derivatives. By far the most important oxo chemical is n-butyraldehyde, followed by C_6–C_{13} aldehydes for plasticizer alcohols, isobutyraldehyde, valeraldehyde, and C_{12}–C_{18} aldehydes for detergent alcohols. Nearly all oxo aldehydes are converted to derivatives in plants adjacent to the hydroformylation unit; very small volumes of oxo aldehydes are transported.

Technical descriptions and economic analyses are provided herein for the eleven technologies listed below, four of which produce the intermediate aldehydes—three processes for n-butyraldehyde and one process for n-valeraldehyde—as feedstocks to be converted to oxo alcohol products. The other seven technologies covered produce a range of C_4–C_{15} oxo alcohols.

- Dow-Davy's low-pressure (LP) Oxo^{SM} SELECTOR^{SM} process for n-butyraldehyde by propylene.
- The Union Carbide, Davy McKee, and Johnson Matthey LP oxo process with liquid recycle for n-butyraldehyde by propylene. (Union Carbide Corporation is a subsidiary of Dow Chemical Company, and Davy Process Technology Limited is a subsidiary of Johnson Matthey.)
- The Ruhrchemie/Rhône-Poulenc process for n-butyraldehyde by propylene. (Rhône Poulenc/Ruhrchemie is a subsidiary of Sanofi.)
- The BASF process for n-valeraldehyde by raffinate II C_4 olefins (2-butene).
- The BASF process for n-butanol by n-butyraldehyde.
- The hydrogenation to amyl alcohol by n-valeraldehyde.
- The Mitsubishi process for 2-ethylhexanol by n-butyraldehyde.
- The Exxon process for isononyl alcohol by isooctane.
- The Exxon process for isodecyl (isodecanol) alcohol by nonenes.
- The BASF process for 2-propylheptanol by n-valeraldehyde.
- The Shell process for primary linear C_{12}–C_{15} alcohols by linear olefins.

These and other technologies (past, present, and emerging) for oxo alcohol production are reviewed with a bibliography and abstracts for relevant patents since the mid-1990s. The industry status is updated, and the modern oxo alcohol processes are summarized in terms of economics and the key process indicators (KPI) of capital intensity and carbon intensity. Lastly, the iPEP Navigator interactive module is attached to the electronic version of this report. iPEP Navigator provides an economic snapshot for each process, allowing the user to select and compare the processes, units, and regions of interest.

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IHS Customer Care:

Americas: +1 800 IHS CARE (+1 800 447 2273); CustomerCare@ihs.com
Europe, Middle East, and Africa: +44 (0) 1344 328 300; Customer.Support@ihs.com
Asia and the Pacific Rim: +604 291 3600; SupportAPAC@ihs.com