Mitsubishi Chemical OXO Alcohol ‘M-Process’
(for the production of Normal Butanol and 2-Ethylhexanol)

The Mitsubishi Chemical OXO Alcohol ‘M-Process’ technology produces the highest product quality of Normal Butanol (NBA) and 2-Ethylhexanol (2EH) from Syngas and Propylene using a unique ligand catalyst. The resulting N/I isomer ratio is very high while reducing propane and heavy end products. The relative capacities of the NBA and 2EH production can be designed to satisfy client requirements.

**OXO Reaction Section**
In this section, normal-Butyraldehyde (NBD) is produced from Propylene and Syngas in a liquid phase reactor using a homogenous Rhodium/Ligand catalyst complex dissolved in NBD. A small amount of propane and a very small amount of iso-Butyraldehyde (IBD) are produced by side reactions. The gas and liquid purge streams containing these byproducts are ultimately used as fuel. Catalyst and ligand are recovered from a small hydroformylation purge stream.

The OXO section contains three steps: (1) OXO reaction; (2) aldehyde separation; and (3) catalyst recovery.

**Normal Butanol (NBA) Section**
In the NBA section, the NBD intermediate is converted to Normal Butanol. This process is divided into two steps: (1) NBD hydrogenation and (2) NBA distillation.

**2-Ethylhexanol (2EH) Section**
In the 2EH section, the NBD intermediate is converted to 2-Ethylhexanol. This process occurs in three steps:
1. NBD aldole condensation and dehydration
2. Hydrogenation of 2-Ethylhexenal
3. 2EH distillation

**OXO Alcohols process scheme**

```
Oxo Reaction -- Distillation
              |                  |       
              v                  v      
Oxo Section  -- Catalyst recovery -- Spent catalyst heavy ends
              |                                    |
              v                                    v
IBD          -- Hydrogen                -- NBA
              |                                    |
              v                                    v
Normal Butyraldehyde (NBD)  -- Distillation

2EH Section

2EH Section

2EH
```
Mitsubishi Chemical OXO Alcohol ‘M-Process’ technology highlights

OXO Reaction Section

High N/I Isomer Ratio
The Mitsubishi Chemical OXO ‘M-Process’ technology achieves a significantly higher N/I isomer ratio than any other competing C3 OXO process. This eliminates the need for purification of the less valuable iso-Butyraldehyde (IBD), resulting in both investment and operating cost savings.

High Catalyst Utilization and Reduced Catalyst Management Requirements
Unlike other processes, the Mitsubishi Chemical OXO ‘M-Process’ uses a precisely designed distillation column to recover the catalyst from the reactor effluent. The vast majority of the catalyst is recovered and returned to the reactor using a technology MCC co-developed with Technip Energies.

Simple Operation
The required catalyst concentration is low due to the very high activity of the hydroformylation catalyst, and therefore is fully dissolved in NBD. There is no need for an external solvent and the risk of plugging is eliminated.

Alcohol Section

Low Operating Cost
The process uses the vapor-phase hydrogenation method, which has excellent reaction selectivity and low UTT requirement. This makes it possible to reduce operating costs.

High Product Purity
The distillation section is designed for efficient removal of minor product impurities, producing an ultra-high purity alcohol. The final product exceeds the purity requirements for production of OXO Alcohol derivatives such as solvents and acrylates.

Licensors
The Mitsubishi Chemical OXO Alcohol ‘M-Process’ is available for licensing from Technip Energies and Mitsubishi Chemical Corporation.