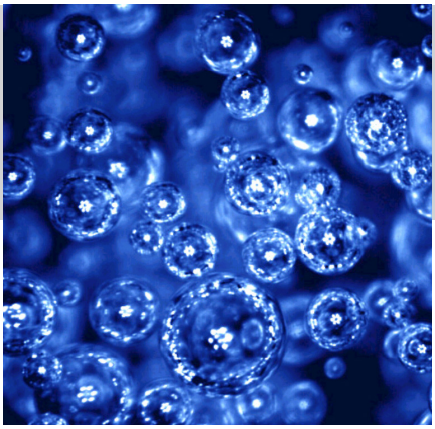


ALKOXYLATION

Buss ChemTech is the worldwide leading supplier of alkoxylation technology.

Our technology is especially known for its:
- **operational safety**
- **performance reliability**
- **excellent product quality**

Our experience with unique speciality products, combined with our comprehensive R&D services (including in-house lab and pilot-plant facilities), enable Buss ChemTech to provide our clients with optimised process designs resulting in cost-effective and high performance solutions.

Naturally, our ethoxylation and propoxylation technology is based on the proven performance characteristics of the Buss Loop® Reactor, which achieves the highest efficiency in these, as well as other gas/liquid reactions, as compared to other alternatives. In the case of alkoxylations, however, we have focused even more on the most important design aspect which does not allow compromise: safety!

SAFETY

Ethylene oxide (EO) is an extremely flammable liquid. It can also form explosive mixtures when it comes into contact with air. Unfortunately, the dangers of EO are often not recognized until after an accident actually takes place. And despite the occurance of many serious incidents, there are technologies on the market which do not adequately address the dangers. At Buss ChemTech, we insist on and incorporate the following minimum safety requirements in our process design:

- No explosive gas phase!

When an ignitable gas phase is present, the potential for an explosion exists. We do not gamble. We add a nitrogen (N_2) blanket and tightly control the pressure of the N_2/EO mixture ensuring an inert (non-ignitable) atmosphere at all times.

- No liquid droplets in the gas phase!

"Flying" liquid droplets are to be avoided because they can cause an electrostatic build-up and deflagration.

- Shock resistant design!

To protect personnel as well as the environment, our standard plant design pressure is 45 barg. In the very unlikely worst-case scenario, our "shock resistance" design means no release of product or chemicals, no danger for the environment and no damaged equipment.

ALKOXYLATION PROCESS

The alkoxylation process consists of three major steps:

- Pre-treatment:

The initiator and catalyst are metered and dehydrated under vacuum according to the product recipe.

- Reaction:

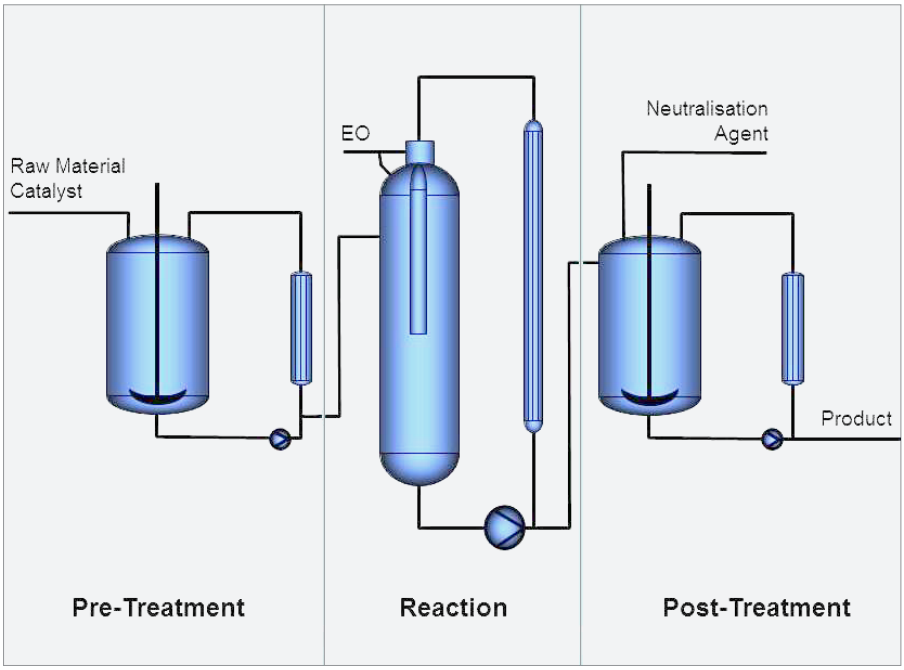
The EO and/or PO feed begins and is controlled by monitoring reactor conditions to ensure a safe and fast reaction. When the reaction is completed, residual oxide is cooked down to 1 ppm and 100 ppm for EO and PO, respectively.

- Post-treatment

The product is neutralized and, if necessary, blended, bleached and stripped.

All three steps can be performed in one reactor (a "one-pot system"). But the most economical design in terms of space-time-yield is the "three-pot system", where each step is performed in a dedicated section (see illustration).

Each of these sections is operated in batch mode and all sections can operate independently so three batches can be processed in the plant simultaneously.



PRODUCTIVITY/ECONOMY

- Very high EO dosing rates (not heat transfer capacity limited)
- Elegant process control algorithms result in stable reaction conditions
- Very short cook-down times
- High throughput
- Constant efficiency from beginning (low reactor liquid level) to the end of reaction (full reactor)
- Low energy consumption due to lower discharge head in comparison to spray head technology

PRODUCT PORTFOLIO

Extensive production technologies are available for derivatives of fatty alcohols, -acids, -amines and -esters, alkyl phenols, castor oil, sorbitan esters, methanol, allyl alcohol, butanol, MEG, BPA, glycerine and other polyols.

The design of the Buss Loop® Reactor allows the handling of low boiling or high melting starters as well as the production of high viscous products like high molecuar weight PEG and mPEG.

PRODUCT QUALITY

Raw material handling under inert conditions, effective temperature control and accurate EO dosing lead to optimized reaction conditions with a minimum of side product formation (dioxane, coloured impurities).

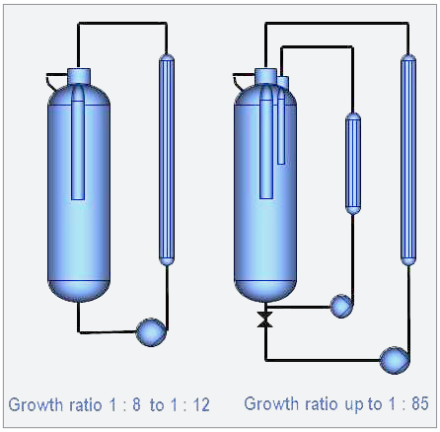
By recirculating the gas in the head space during cook down, extremely low concentrations of residual EO in the gas and liquid phase can be achieved within a very short period.

PRODUCT QUALITY (without stripping)	
Residual EO	< 1 ppm for most products
Dioxane	< 4 ppm for most alcohol and alkyl phenol derivatives
Colour	< 20 APHA for alcohol and alkyl phenol derivatives

HIGH GROWTH RATIO DESIGN

(growth ratio = end volume : minimum starting volume)

For the production of high molecular weight products, our design incorporates a small loop. This allows us to achieve growth ratios of up to 85:1 without the need for a second reactor, intermediate storage or a loss of efficiency.



BUSS ChemTech

www.buss-ct.com

RT/020/1-17

BUSS ChemTech AG | Hohenrainstrasse 12A | 4133 Pratteln 1 | Switzerland | Tel. +41 61 825 64 62 | Fax +41 61 825 67 37 | info@buss-ct.com