

# Badger Ethylbenzene technology

The Badger Ethylbenzene technology (EBMax<sup>SM</sup>) has gained acceptance as the worldwide standard for EB production. The Badger technology is a high yield and highly energy efficient process. Capital investment and operating costs are low and the EBMax process is easy to operate and maintain.

**ExxonMobil and Badger have a 40-year history of cooperation in the development of catalysts and processes for the production of ethylbenzene from polymer grade ethylene, chemical grade ethylene, and ethylene recovered from refinery off-gas.** Since its commercialization in 1995, the EBMax technology has been licensed 40 times, both for new plants and the expansion and conversion of plants based on earlier technologies to EBMax technology. The exceptional properties of ExxonMobil's EBMax catalysts allow operation with a minimal excess of benzene in the alkylation and transalkylation reactor feeds, reducing capital investment and energy consumption in the reaction and distillation sections of the EB plant.

## Alkylation

An alkylation reactor system converts benzene and ethylene to ethylbenzene in the liquid phase. ExxonMobil's specialized Reactive Guard Bed technology helps achieve long catalyst life.

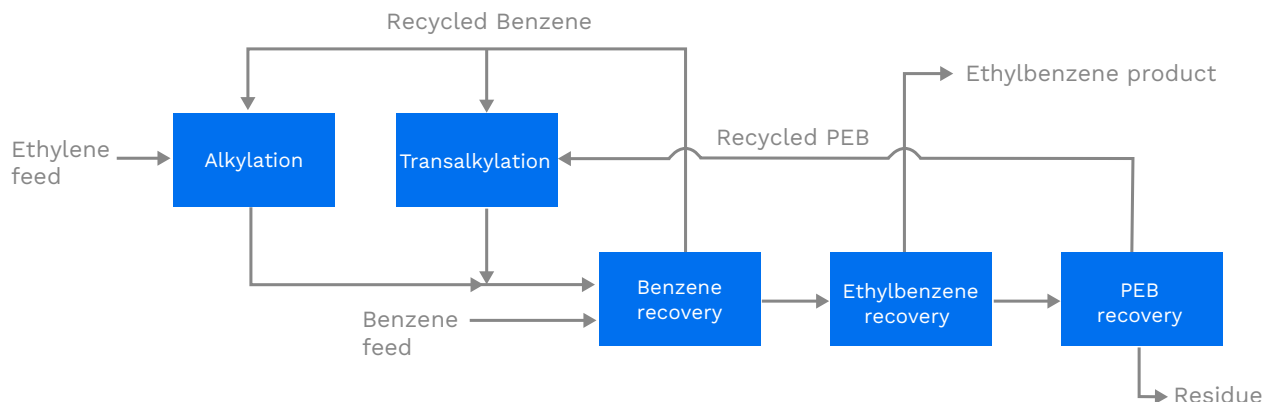
## Transalkylation

A transalkylation reactor converts the small amount of polyalkylbenzenes (PEB) formed in the alkylator to additional ethylbenzene by reaction with benzene in the liquid phase.

## Purification

A simple energy efficient distillation train is used to return unreacted benzene to the reactors, recover ethylbenzene product, and recover PEB for conversion to EB in transalkylation.

## EBMax process scheme





# Ethylbenzene technology highlights

## LOW VARIABLE OPERATING COST

- Ultra-high (nearly stoichiometric) yields minimize raw material consumptions
- Low benzene to ethylene ratio reduces capital investment and consumption of HP steam
- High energy efficiency and seamless integration with downstream styrene units

## LOW INITIAL CAPITAL INVESTMENT

- Smaller benzene recovery equipment
- Small reactors and catalyst volumes
- Optimized equipment layout and plot plan

## COMMERCIAL EXPERIENCE

- As of early 2021, plants using Badger Ethylbenzene technologies produce over half of the world's ethylbenzene capacity having a total installed capacity of more than 25 million metric tons per year.
- Single trains as large as 1.4 million MTA have been demonstrated.
- Technip Energies and ExxonMobil assist producers with troubleshooting, plant monitoring, and potential plant expansions.

## Our Catalyst Provider: ExxonMobil

ExxonMobil Catalysts and Licensing LLC zeolite catalyst research and development capabilities are unsurpassed within the industry. Supported by basic research activities at its R&D facilities and pilot plant facilities used to screen new catalysts, ExxonMobil is a recognized leader in the development and commercialization of new zeolite catalytic materials. ExxonMobil's commercial catalyst production plants maintain the highest quality control standards. The exceptional characteristics of the EBMax catalysts benefit the process as follows:

- ExxonMobil's proprietary zeolite alkylation catalyst does not age due to coking caused by ethylene oligomerization, resulting in long, uninterrupted EBMax unit operation.
- The alkylation catalyst is highly selective to monoalkylation, which has allowed operation at design benzene-to-ethylene molar feed ratios as low as 1.6-to-1 for plant expansion projects.
- The reaction system produces extremely low levels of impurities boiling in the range of EB, resulting in EB product purities in excess of 99.97 wt%.
- ExxonMobil's proprietary guard bed catalyst removes traces of nitrogen-containing compounds which would otherwise poison the process catalysts, minimizing the frequency of catalyst regeneration.



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