



1960  
1970  
1980  
1990  
2000  
2010  
2020

### Ethylbenzene

- 1960's, Badger assists Union Carbide in improving aluminum chloride EB process
- 1972, Mobil alliance signed for Vapor Phase EB
- 1972-78, EB pilot and semiworks demonstration
- 1980, EB Vapor Phase process commercialized
- 1995, Liquid Phase EBMax<sup>SM</sup> process commercialized
- 1999, commercialized TRANS-4 Liquid-Phase Transalkylation
- 2005, commercialized improved EBMax<sup>SM</sup> catalysts
- 2010, new Reactive Guard Bed catalyst commercialized
- 2020, 30 plants operating with Badger's EBMax<sup>SM</sup> process technology; combined capacity more than 18000 KTA\*
  - 7 licensed plants in various stages of development will add over 4000 KTA of capacity
  - 16 plants operating using Vapor Phase technology (3 utilizing dilute ethylene feed); combined capacity approx 5000 KTA

### Styrene

- 1964, first two reaction stage styrene plant was started up
- 1973, first Vacuum Dehydro unit was started up
- 1980, technology with 8-to-1 steam-to-oil started up
- 1986, high efficient technology introduced
- 1991, Phenylacetylene Reduction Technology (PAR) commercialized
- 1999, Catalyst Stabilization Technology (CST) commercialized
- 2002, 6-to-1 steam-to-oil Badger SM plant startup
- 2007, Multi-Effect Distillation (MED) to significantly reduce energy consumption commercialized
- 2019, commercialized Direct Heating Units (DHU) in two operating SM plants
  - First license of High Efficiency design combining DHU with azeotropic feed vaporization
- 2020, 38 Badger styrene units operating with combined capacity of almost 15000 KTA
  - 5 licensed plants in various stages of development will add 2500 KTA of capacity
  - CST has been licensed for 31 SM units
  - MED has been included in 23 licensed plants
  - PAR has been licensed for 10 SM units

### Cumene

- 1993, Badger introduces zeolite cumene technology
- 1994, first cumene license signed
- 1996, Badger introduces zeolite cumene technology
- 1998, first AlCl<sub>3</sub> based plant revamp and first grassroots facility started up
- 2000, seven licensed plants in commercial operation, installed capacity over 3430 KTA
- 2010, eighteen licensed plants in commercial operation, installed capacity 6835 KTA
- 2018, first non-aromatics purge benzene recovery system licensed
- 2020, Badger has 26 licensed cumene plants in operation, capacity > 9500 KTA
  - Nine licensed plants in various stages of development will add nearly 3148 KTA

### Bisphenol A

- 2004, Badger acquires BPA technology rights
- 2005, first BPA licensed unit startup
- 2010, five licensed plants in commercial operation installed capacity 653 KTA
- 2016, first advanced BPA residue recovery system licensed
  - First license signed for single-train 240 KTA BPA plant.
- 2020, eleven licensed plants in commercial operation; installed capacity 1523 KTA
  - Nine additional licensed plants in various stages of development will add 2020 KTA

### BenzOUT™

- 2006-08, EMRE develops BenzOUT™ process
- 2008-09, first U.S. refinery commercial demonstration
- 2009, Badger-EMRE alliance
- 2010, first BenzOUT™ license signed
- 2011, startup of first commercial unit
- 2016, startup of second commercial unit

### Isopropanol

- 2018, first offered IPA technology to commercial market; two IPA licenses signed
- 2019, signed three additional IPA licenses
- 2020, total IPA licensed capacity of 260 KTA
  - Startup of first commercial unit

\*KTA = kilotons per year