

Chapter 1

Catalysis in Alkylation of Benzene With Ethene and Propene to Produce Ethylbenzene and Isopropylbenzene

Mohammed C. Al-Kinany

*National Center for Petrochemical
Technology (KACST), Saudi Arabia*

Khawla M. Almalahi

*National Center for Petrochemical
Technology (KACST), Saudi Arabia*

Saeed M. Alshihri

*National Center for Petrochemical
Technology (KACST), Saudi Arabia*

Norah H. Almousa

*National Center for Petrochemical
Technology (KACST), Saudi Arabia*

Saud A. Aldrees

*National Center for Petrochemical
Technology (KACST), Saudi Arabia*

Faisal M. Alotaibi

*National Center for Petrochemical
Technology (KACST), Saudi Arabia*

Eyad A. Alghilan

*National Center for Petrochemical
Technology (KACST), Saudi Arabia*

Yousef I. Al-Rashed

*National Center for Petrochemical
Technology (KACST), Saudi Arabia*

Sami D. Aldrees

*National Center for Petrochemical
Technology (KACST), Saudi Arabia*

Feras A. A. Alshehri

*National Center for Petrochemical
Technology (KACST), Saudi Arabia*

ABSTRACT

The alkylation of benzene with ethylene or propylene to form ethylbenzene (EB) or cumene is an industrially significant transformation. EB is used as an intermediate in the manufacture of styrene, which in turn is an important in the manufacture of many kinds of polymers. The primary use of cumene is in the co-production of phenol and acetone, which in turn are important in the manufacture of many kinds of chemicals and polymers. In industry, EB and cumene are mainly manufactured by the alkylation of benzene with ethene or propene via two methods, the gas and the liquid phase in the presence of Lewis and Brønsted acids. The development of efficient solid catalysts has gained much attention over the last decades. The objective of this chapter is to provide an overview of the history of the alkylation of benzene with ethene and propene, the development of homogeneous and heterogeneous Lewis and Brønsted acids and zeolite catalysts, the liquid and gas phase alkylation processes, and the industrial technologies for EB and cumene production.

INTRODUCTION

Alkylation of aromatics: Alkylation is the transfer of an alkyl substituent from one molecule to another via an alkyl carbocation or carbonium ion, a carbanion, a free radical, or a carbene, which are generated from electrophilic alkylating agents such as olefin or alkyl halide in the presence of catalyst, such as Brønsted acid, Lewis acid or zeolite.

The ethylene (ethene) feed used for ethylation of benzene is produced from the cracking of fractions obtained from distillation of natural gas and oil. The processes are:

- (a) the steam cracking of ethane and propane (from natural gas and from crude oil),
- (b) the steam cracking of naphtha from crude oil,
- (c) the steam cracking of gas oil from crude oil.

The choice of feedstock depends on availability, price and what other products from cracking are needed for other chemical processes.

The alkylation of benzene with ethylene or propylene to form ethylbenzene or isopropylbenzene (cumene) over acid catalyst is an industrially significant and the main commercial route for the production of important petrochemical intermediates, such as ethylbenzene (EB) as the key building block for manufacture polystyrene and isopropylbenzene (IPB - cumene), a precursor to solvents and chemical intermediates

45 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/chapter/catalysis-in-alkylation-of-benzene-with-ethene-and-propene-to-produce-ethylbenzene-and-isopropylbenzene/238682

Related Content

Preparation, Characterization and Desulfurization of the Supported Nickel Phosphide Catalysts

Zhoujun Wang, Pingyi Wu, Ling Lan and Shengfu Ji (2016). *Petrochemical Catalyst Materials, Processes, and Emerging Technologies* (pp. 431-458).

www.irma-international.org/chapter/preparation-characterization-and-desulfurization-of-the-supported-nickel-phosphide-catalysts/146335

Catalysis in Alkylation of Benzene With Ethene and Propene to Produce Ethylbenzene and Isopropylbenzene

Mohammed C. Al-Kinany, Saeed M. Alshihri, Saud A. Aldrees, Eyad A. Alghilan, Sami D. Aldrees, Khawla M. Almalahi, Norah H. Almousa, Faisal M. Alotaibi, Yousef I. Al-Rashed and Feras A. A. Alshehri (2020). *Advanced Catalysis Processes in Petrochemicals and Petroleum Refining: Emerging Research and Opportunities* (pp. 1-47).

www.irma-international.org/chapter/catalysis-in-alkylation-of-benzene-with-ethene-and-propene-to-produce-ethylbenzene-and-isopropylbenzene/238682

Production of Ethylene and its Commercial Importance in the Global Market

Ahmad Alshammari, Venkata Narayana Kalevaru, Abdulaziz Bagabas and Andreas Martin (2016). *Petrochemical Catalyst Materials, Processes, and Emerging Technologies* (pp. 82-115).

www.irma-international.org/chapter/production-of-ethylene-and-its-commercial-importance-in-the-global-market/146324

Advances in Catalytic Conversion of Syngas to Ethanol and Higher Alcohols

Jie Sun, Shaolong Wan, Jingdong Lin and Yong Wang (2016). *Petrochemical Catalyst Materials, Processes, and Emerging Technologies* (pp. 177-215).

www.irma-international.org/chapter/advances-in-catalytic-conversion-of-syngas-to-ethanol-and-higher-alcohols/146328

Palladium in Heterogeneous Oxidation Catalysis

Andreas Martin, Venkata Narayana Kalevaru and Jörg Radnik (2016). *Petrochemical Catalyst Materials, Processes, and Emerging Technologies* (pp. 53-81).

www.irma-international.org/chapter/palladium-in-heterogeneous-oxidation-catalysis/146323