Abstract

Process Economics Program Report 35D

BUTADIENE AS A CHEMICAL RAW MATERIAL

(September 1998)

The dominant technology for producing butadiene (BD) is the cracking of naphtha to produce ethylene. BD is obtained as a coproduct. As the growth of ethylene production outpaced the growth of BD demand, an oversupply of BD has been created. This situation provides the incentive for developing technologies with BD as the starting material. The objective of this report is to evaluate the economics of BD-based routes and to compare the economics with those of currently commercial technologies. In addition, this report addresses commercial aspects of the butadiene industry such as supply/demand, BD surplus, price projections, pricing history, and BD value in nonchemical applications.

We present process economics for two technologies:

- Cyclodimerization of BD leading to ethylbenzene (DSM-Chiyoda)
- Hydrocyanation of BD leading to caprolactam (BASF).

Furthermore, we present updated economics for technologies evaluated earlier by PEP:

- Cyclodimerization of BD leading to styrene (Dow)
- Carboalkoxylation of BD leading to caprolactam and to adipic acid
- Hydrocyanation of BD leading to hexamethylenediamine.

We also present a comparison of the DSM-Chiyoda and Dow technologies for producing styrene. The Dow technology produces styrene directly and is limited in terms of capacity by the BD available from a world-scale naphtha cracker. The 250 million lb/yr (113,000 t/yr) capacity selected for the Dow technology requires the BD output of two world-scale naphtha crackers. The DSM-Chiyoda technology produces ethylbenzene. In our evaluations, we assumed a scheme whereby ethylbenzene from a 266 million lb/yr (121,000 t/yr) DSM-Chiyoda unit is combined with 798 million lb/yr (362,000 t/yr) of ethylbenzene produced by conventional alkylation of benzene with ethylene. The combined ethylbenzene stream is then dehydrogenated to styrene in a Fina/Badger unit of 1,000 million lb/yr (454,000 t/yr) capacity.

GLOSSARY

Symbol or Term	Definition
ABS	Acrylonitrile-butadiene-styrene
ACN	6-Aminocapronitrile
ADA	Adipic acid
ADN	Adiponitrile
BD	Butadiene
BDO	Butanediol
BLI	Battery limits
CAPM	Caprolactam
COD	1,5-Cyclooctadiene
DMF	Dimethyl formamide
DMN	Dimethyl naphthalene
DMT	Dimethyl terephthalate
EB	Ethylbenzene
ECH	Ethylcyclohexane
EPB	3,4-Epoxy-1-butene
HCN	Hydrocyanic acid
HMDA	Hexamethylenediamine
HMI	Hexamethyleneimine
2M2BN	2-Methyl-2-butenenitrile
2M3BN	2-Methyl-3-butenenitrile
M2P	Methyl-2-pentenoate
M3P	Methyl-3-pentenoate
M4P	Methyl-4-pentenoate
M5FV	Methyl 5-formylvalerate
M6AC	Methyl 6-aminocaproate
MBN	Methyl butenenitrile
NDA	Naphthalenedicarboxylic acid

GLOSSARY (Concluded)

Symbol or Term	Definition
PBR	Polybutadiene rubber
PEN	Polyethylene naphthalate
PN	Pentenenitrile
Ra-Co	Raney cobalt
Ra-Ni	Raney nickel
ROI	Return on investment
SB	Styrene-butadiene
SBR	Styrene-butadiene rubber
TFC	Total fixed capital
THA	Tetrahydroazepine
THF	Tetrahydrofuran
TPB	Triphenylborane
VCH	Vinylcyclohexene

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