

**TECHNOLOGY & COSTS****Technoeconomics - Energy & Chemicals (TECH)****TECH 2019-4 Xylenes**

## Table of Contents

A Report by **Nexant, Inc.**

Published Date: October 2019

[www.nexantsubscriptions.com](http://www.nexantsubscriptions.com)**Contents**

1	Executive Summary .....	1
1.1	Introduction.....	1
1.2	Xylenes Production .....	2
1.3	Xylenes Recovery .....	3
1.4	Configuration Options.....	5
1.5	Technology Licensors .....	5
1.6	Process Economics.....	8
1.6.1	U.S. Gulf Coast Summary.....	8
1.6.2	China Summary.....	9
1.6.3	Integrated Aromatics Complex Regional Comparison .....	10
1.7	Commercial Overview .....	11
1.7.1	Consumption .....	11
1.7.2	Supply .....	13
1.7.3	Supply, Demand, and Trade .....	14
2	Introduction.....	16
2.1	Technology Overview.....	18
2.1.1	Aromatics Complex Configurations.....	19
2.2	Business Developments.....	21
2.3	Aromatics Technology and Licensors .....	22
2.3.1	UOP LLC .....	22
2.3.2	Axens .....	22
2.3.3	BP/McDermott.....	24
2.3.4	GTC Technology .....	24
2.4	Xylenes Specifications .....	24
2.5	Physical and Thermodynamic Properties.....	25
2.6	Health Hazards.....	26
2.7	Storage and Transportation .....	26
3	Xylenes Production .....	27
3.1	Catalytic Reforming .....	27
3.1.1	Overview .....	27

	3.1.2	Process Chemistry .....	28
	3.1.3	Hydrotreating .....	31
	3.1.4	Reforming Catalysts .....	33
	3.1.5	Reformer Types .....	34
	3.1.6	UOP CCR Platforming™ .....	38
	3.1.7	Axens Aromizing™ and Octanizing™ Processes .....	41
	3.1.8	Sinopec .....	43
	3.1.9	Other Commercial Reforming Technologies .....	44
	3.2	Steam Cracking (Pyrolysis Gasoline) .....	45
	3.3	BTX Extraction .....	48
4		Toluene Disproportionation (TDP), Transalkylation, and Alkylation .....	51
	4.1	Overview .....	53
	4.2	Process Chemistry .....	53
	4.3	Toluene Disproportionation and Transalkylation Technologies .....	55
	4.3.1	UOP Tatoray™ Process .....	55
	4.3.2	Axens' TransPlusSM Process .....	58
	4.3.3	GTC Technology's GT-TransAlkSM Technology .....	61
	4.3.4	Sinopec S-TDT™ .....	61
	4.3.5	SK Innovation .....	63
	4.4	Selective Toluene Disproportionation (STDP) .....	65
	4.4.1	UOP's PX-Plus™ Process .....	65
	4.4.2	Axens' PxMaxSM Process .....	66
	4.4.3	GTC Technology's GT-STDPSM Process .....	70
	4.5	Toluene Methylation .....	71
	4.5.1	Sinopec S-MTX Process .....	71
5		Xylenes Recovery .....	74
	5.1	<i>para</i> -Xylene Recovery by Adsorption .....	75
	5.1.1	UOP Parex™ Adsorption Process .....	77
	5.1.2	Axens' Eluxyl+ Adsorption Process .....	84
	5.2	<i>para</i> -Xylene Recovery by Crystallization .....	86
	5.2.1	General Process Description .....	86
	5.2.2	BP/Lummus Technology <i>para</i> -Xylene Crystallization Technology .....	91
	5.2.3	GTC Technology's CrystPXSM Process .....	94
	5.3	Xylenes Isomerization .....	98
	5.3.1	Process Chemistry .....	98
	5.3.2	Process Description .....	100
	5.3.3	Commercial Isomerization Technologies .....	100
	5.4	<i>ortho</i> -Xylene .....	102
	5.5	<i>meta</i> -Xylene .....	104
	5.5.1	Adsorption .....	105
	5.5.2	Extraction .....	109
	5.6	Ethylbenzene .....	109
6		Developing Technologies .....	111

6.1	GTC Technology .....	111
6.1.1	GT-ToAlkSM Technology .....	111
6.1.2	Process Description .....	111
6.1.3	Process Improvements.....	113
6.2	UOP .....	113
6.2.1	Toluene Methylation .....	113
6.2.2	Two Xylenes Columns.....	114
6.2.3	Combined Isomerization and Transalkylation Units .....	117
6.2.4	Heavy Aromatics Isomerization.....	117
6.3	ExxonMobil .....	120
6.3.1	Selective Adsorption with Two Rotary Valves.....	120
6.3.2	Syngas to Aromatics .....	120
6.4	Developing Bio-Based Aromatics Technologies .....	122
6.4.1	Anellotech, Inc. ....	122
6.4.2	Origin Materials .....	123
6.4.3	Virent, Inc. ....	126
6.4.4	Gevo .....	129
7	Process Economics .....	132
7.1	Costing Basis .....	132
7.1.1	Investment Basis .....	132
7.1.2	Pricing Basis.....	133
7.1.3	Cost of Production Basis .....	133
7.1.4	<i>para</i> -Xylene Capacity .....	135
7.2	Process Economics.....	136
7.2.1	Overall Aromatics Complex.....	136
7.2.2	Adsorption or Crystallization and Isomerization .....	145
7.2.3	Toluene Disproportionation, Transalkylation, and Toluene Alkylation .....	184
7.2.4	UOP's MX Sorbex™ Process .....	220
7.2.5	Cost of Production Summary .....	227
7.2.6	Sensitivity Analysis.....	232
8	Commercial Applications.....	238
8.1	Mixed Xylenes .....	239
8.2	<i>para</i> -Xylene .....	240
8.3	<i>ortho</i> -Xylene .....	241
8.4	<i>meta</i> -Xylene .....	242
9	Regional Market Analysis.....	243
9.1	Mixed Xylenes .....	243
9.1.1	Global .....	243
9.1.2	North America .....	244
9.1.3	Western Europe .....	244
9.1.4	Asia Pacific.....	245
9.2	<i>para</i> -Xylene .....	246
9.2.1	Global .....	246

9.2.2	North America .....	251
9.2.3	Western Europe .....	254
9.2.4	Asia Pacific .....	257
10	Glossary .....	264

## Appendices

A	Definitions of Capital Cost Terms Used in Process Economics .....	265
B	Definitions of Operating Cost Terms Used in Process Economics .....	270
C	TECH Program Title Index (2009-2019) .....	273

## Figures

Figure 1	Xylenes Value Chain .....	1
Figure 2	Mixed Xylenes Technologies .....	2
Figure 3	Equilibrium Concentrations for C <sub>8</sub> -Aromatic Compounds .....	4
Figure 4	Configuration Options for an Integrated Aromatics Complex .....	6
Figure 5	Comparison of <i>para</i> -Xylene Production by Technology in the U.S. Gulf Coast .....	9
Figure 6	Comparison of <i>para</i> -Xylene Production by Technology in China .....	10
Figure 7	Regional Cost of Production of <i>para</i> -Xylene from an Integrated Aromatics Complex .....	11
Figure 8	Global <i>para</i> -Xylene Demand by End Use .....	12
Figure 9	Global <i>para</i> -Xylene Demand by Region .....	13
Figure 10	Regional <i>para</i> -Xylene Capacity .....	14
Figure 11	Global <i>para</i> -Xylene Supply, Demand, and Trade .....	15
Figure 12	Chemical Structure of Xylene Isomers .....	16
Figure 13	Mixed Xylenes Technologies .....	17
Figure 14	Configuration Options for an Integrated Aromatics Complex .....	20
Figure 15	Reformer within the Aromatics Complex .....	29
Figure 16	Dehydrogenation of Naphthenes Sample Reaction .....	30
Figure 17	Conversion of Alkylcyclopentane to Aromatics .....	30
Figure 18	Dehydrocyclication of Paraffins Sample Reaction .....	30
Figure 19	Isomerization of Paraffins Sample Reaction .....	31
Figure 20	Hydrocracking Sample Reaction .....	31
Figure 21	Naphtha Hydrotreater Process Flow Diagram .....	32
Figure 22	Reforming Catalyst Regeneration Steps .....	34
Figure 23	Semi Regenerative Reformer Process Flow Diagram .....	35
Figure 24	Cyclic Catalytic Reformer Process Flow Diagram .....	37
Figure 25	UOP CCR Platforming™ Process Flow Diagram .....	39
Figure 26	UOP's Chlorsorb™ System .....	40
Figure 27	Axens' Aromizing™ Reforming Process Flow Diagram .....	42
Figure 28	Axens' RegenC™ Catalyst Regeneration System .....	43
Figure 29	UOP Cyclar™ Process Reactions .....	45
Figure 30	Effect of Steam Cracker Feedstock on Aromatics Yield .....	46
Figure 31	Effect of Severity on BTX Yields for a Full Range Naphtha Feed .....	47

Figure 32	Simplified LLE and ED Flow Diagrams .....	49
Figure 33	Aromatics Extraction within an Aromatics Complex .....	50
Figure 34	TDP/Transalkylation/Methylation within the Aromatics Complex .....	52
Figure 35	Toluene Disproportionation, Transalkylation, and Dealkylation Reactions .....	54
Figure 36	Equilibrium Distribution of Methyl Groups .....	55
Figure 37	Toluene Methylation (Alkylation) Reaction .....	55
Figure 38	UOP Tatoray™ Product Yields by Feed slate .....	56
Figure 39	UOP Tatoray™ Process Flow Diagram.....	57
Figure 40	Axens' TransPlus <sup>SM</sup> Xylenes Yield .....	59
Figure 41	Axens TransPlus <sup>SM</sup> Process Flow Diagram.....	60
Figure 42	GT-TransAlk <sup>SM</sup> Process.....	62
Figure 43	Sinopec S-TDT Process Flow Diagram.....	64
Figure 44	UOP PX-Plus™ Process Flow Diagram.....	67
Figure 45	Axens' PxMax <sup>SM</sup> Process Flow Diagram .....	69
Figure 46	S-MTX Toluene Methylation Process Flow Diagram.....	72
Figure 47	Equilibrium Concentrations for C <sub>8</sub> -Aromatic Compounds .....	75
Figure 48	Xylenes Recovery Section within an Aromatics Complex.....	76
Figure 49	UOP HD Parex™ Process.....	79
Figure 50	<i>para</i> -Xylene Production via UOP Parex™/Isomar™ Process.....	80
Figure 51	UOP LD Parex™ Process Flow Diagram.....	83
Figure 52	Axens' Eluxl 1.15 Process Flow Diagram.....	85
Figure 53	<i>para</i> -Xylene Production via Crystallization/Isomerization .....	87
Figure 54	Cascaded Ethylene/Propylene Refrigeration Systems.....	90
Figure 55	BP/Lummus Technology <i>para</i> -Crystallization Technology.....	93
Figure 56	GTC's CrystPX <sup>SM</sup> Process Flow Diagram for Equilibrium Feedstock .....	95
Figure 57	GTC's CrystPX <sup>SM</sup> Process Scheme for Enriched Feedstock .....	97
Figure 58	Xylenes Isomerization Unit Chemical Reactions.....	99
Figure 59	Xylenes Isomerization Process Flow Diagram .....	101
Figure 60	<i>ortho</i> -Xylene Recovery from Mixed Xylenes by Fractionation .....	103
Figure 61	<i>meta</i> -Xylene Production via UOP MX-Sorbex™ Process.....	106
Figure 62	<i>meta</i> -Xylene Production via Axens Eluxyl-MX <sup>®</sup> Adsorption Process .....	108
Figure 63	Ethylbenzene Extraction by Superfractionation.....	110
Figure 64	GT-TolAlk <sup>SM</sup> Process Flow Diagram.....	112
Figure 65	UOP Toluene Methylation .....	115
Figure 66	UOP Two Xylenes Columns Configuration .....	116
Figure 67	Combined Isomerization and Transalkylation Units (U.S. Patent US9776936 B2).....	118
Figure 68	Heavy Aromatics Isomerization (U.S. Patent US10214465 B2) .....	119
Figure 69	ExxonMobil Dual Rotary Valve Selective Adsorption .....	121
Figure 70	Anellotech Process Chain .....	122
Figure 71	Anellotech Biomass to BTX Block Flow Diagram.....	124
Figure 72	Origin Materials <i>para</i> -Xylene Process via DMF .....	125
Figure 73	Virent Aqueous Phase Reforming Pathway to PX .....	126
Figure 74	Virent Bioforming Process Flow Diagram.....	128

Figure 75	Gevo Isobutanol and <i>para</i> -Xylene Process Chain .....	129
Figure 76	Gevo Process to Convert Isobutanol to Renewable <i>para</i> -Xylene .....	130
Figure 77	Global and Regional Average Capacities of <i>para</i> -Xylene Separation/Isomerization .....	135
Figure 78	Regional Cost of Production of <i>para</i> -Xylene from an Integrated Aromatics Complex .....	144
Figure 79	Regional Cost of Production of <i>para</i> -Xylene from Light Desorbent Adsorption/Isomerization (with EB Isomerization) .....	182
Figure 80	Regional Cost of Production of <i>para</i> -Xylene from Crystallization and Isomerization .....	183
Figure 81	Regional Cost of Production of <i>para</i> -Xylene from STDP and 1 Stage Crystallization .....	215
Figure 82	Regional Cost of Production of <i>para</i> -Xylene from Conventional TDP with a Pure Toluene Feed followed by Adsorption/Isomerization.....	216
Figure 83	Regional Cost of Production of <i>para</i> -Xylene from TDP/Transalkylation with a Toluene/C <sub>9</sub> Feed followed by Adsorption/Isomerization.....	217
Figure 84	Regional Cost of Production of <i>para</i> -Xylene from C <sub>9</sub> Transalkylation with a pure C <sub>9</sub> Feed Followed by Adsorption/Isomerization .....	218
Figure 85	Regional Cost of Production of <i>para</i> -Xylene from Toluene Methylation Followed by Adsorption/Isomerization .....	219
Figure 86	Regional Cost of Production of <i>meta</i> -Xylene from UOP's MX Sorbex™ Process .....	226
Figure 87	Comparison of <i>para</i> -Xylene Production by Technology in the U.S. Gulf Coast .....	228
Figure 88	Comparison of <i>para</i> -Xylene Production by Technology in China.....	229
Figure 89	Comparison of <i>para</i> -Xylene Production by Technology in Western Europe .....	230
Figure 90	Comparison of <i>para</i> -Xylene Production by Technology in Southeast Asia.....	231
Figure 91	Comparison of <i>para</i> -Xylene Production by Technology in the Middle East .....	232
Figure 92	Xylenes, Benzene, and Toluene Price History .....	233
Figure 93	Adsorption and Crystallization COP Sensitivity to Benzene Pricing .....	234
Figure 94	TDP and Transalkylation COP Sensitivity to Benzene Pricing.....	234
Figure 95	TDP and Transalkylation COP Sensitivity to Toluene Pricing .....	235
Figure 96	TDP and Transalkylation COP Sensitivity to C <sub>9+</sub> Pricing.....	236
Figure 97	Integrated Aromatics Complex COP Sensitivity to CAPEX.....	237
Figure 98	Xylenes Value Chain .....	238
Figure 99	Global <i>para</i> -Xylene Demand by End Use .....	248
Figure 100	Global <i>para</i> -Xylene Demand by Region.....	248
Figure 101	Regional <i>para</i> -Xylene Capacity .....	249
Figure 102	Global <i>para</i> -Xylene Supply, Demand, and Trade.....	251
Figure 103	North America <i>para</i> -Xylene Consumption by End Use .....	252
Figure 104	North America <i>para</i> -Xylene Supply, Demand, and Trade .....	254
Figure 105	Western Europe <i>para</i> -Xylene Consumption by End Use .....	255
Figure 106	Western Europe <i>para</i> -Xylene Supply, Demand, and Trade .....	257
Figure 107	Asia Pacific <i>para</i> -Xylene Demand by End Use .....	258
Figure 108	Asia Pacific <i>para</i> -Xylene Supply, Demand, and Trade .....	263

**Tables**

Table 1	Xylene Isomer Demand versus Production via Reformate .....	2
Table 2	Typical Compositions of Aromatics Sources .....	3
Table 3	Properties of Xylenes Isomers and Ethylbenzene.....	3
Table 4	Licensors of Aromatics Technologies .....	7
Table 5	Global <i>para</i> -Xylene Supply, Demand, and Trade.....	15
Table 6	Typical BTX Composition from Pygas and Reformate.....	17
Table 7	Xylene Isomer Demand versus Production via Reformate .....	17
Table 8	Licensors of Aromatics Technologies .....	23
Table 9	Typical <i>para</i> -Xylene Specification .....	24
Table 10	Typical <i>ortho</i> -Xylene Specification .....	25
Table 11	Typical <i>meta</i> -Xylene Specification .....	25
Table 12	Key Physical and Thermodynamic Properties of Xylenes .....	25
Table 13	Typical Composition of Mixed Xylenes by Source .....	27
Table 14	Pyrolysis Gasoline Analysis.....	47
Table 15	Toluene Conversion Technologies .....	51
Table 16	Tatoray™ Process Feedstock Specifications <sup>(4)</sup> .....	56
Table 17	HAT™ Catalyst Series Performance Specifications.....	63
Table 18	Reactor Operating Conditions of MSTDP and PxMax <sup>SM</sup> .....	70
Table 19	GT-STDP <sup>SM</sup> Process Operating Conditions.....	70
Table 20	S-MTX Process Conditions and Performance.....	73
Table 21	Properties of Xylenes Isomers and Ethylbenzene.....	74
Table 22	C <sub>8</sub> Aromatics – Physical Properties.....	86
Table 23	CrystPX <sup>SM</sup> <i>para</i> -Xylene Product Specifications.....	98
Table 24	Composition of Mixed Xylenes following <i>ortho</i> -Xylene Removal.....	104
Table 25	Composition of Mixed Xylenes Lean in Ethylbenzene .....	109
Table 26	Prices of Raw Materials, Byproducts, Utilities, and Labor.....	134
Table 27	Heavy Naphtha Feedstock Specifications for an Integrated Aromatics Complex .....	136
Table 28	Cost of Production Estimate for <i>para</i> -Xylene Process: Integrated Aromatics Complex, USGC.....	138
Table 29	Cost of Production Estimate for <i>para</i> -Xylene Process: Integrated Aromatics Complex, China.....	139
Table 30	Cost of Production Estimate for <i>para</i> -Xylene Process: Integrated Aromatics Complex, Western Europe.....	140
Table 31	Cost of Production Estimate for <i>para</i> -Xylene Process: Integrated Aromatics Complex, Southeast Asia .....	142
Table 32	Cost of Production Estimate for <i>para</i> -Xylene Process: Integrated Aromatics Complex, Middle East .....	143
Table 33	Regional Cost of Production of <i>para</i> -Xylene from an Integrated Aromatics Complex .....	144
Table 34	Summary of <i>para</i> -Xylene Recovery Process Economics .....	145
Table 35	Cost of Production Estimate for: <i>para</i> -Xylene Process: Adsorption/Isomerization (EB Isomerization), USGC .....	147



Table 36	Cost of Production Estimate for: <i>para</i> -Xylene Process: Adsorption/Isomerization (EB Dealkylation), USGC .....	148
Table 37	Cost of Production Estimate for: <i>para</i> -Xylene Process: Adsorption/Isomerization (EB Isomerization) w/ <i>ortho</i> -Xylene Byproduct, USGC .....	149
Table 38	Cost of Production Estimate for: <i>para</i> -Xylene Process: LD Adsorption/Isomerization (EB Isomerization), USGC .....	150
Table 39	Cost of Production Estimate for: <i>para</i> -Xylene Process: LD Adsorption/Isomerization (EB Dealkylation), USGC .....	151
Table 40	Cost of Production Estimate for: <i>para</i> -Xylene Process: Crystallization/Isomerization (EB Dealkylation), USGC .....	152
Table 41	Summary of <i>para</i> -Xylene Recovery Process Economics .....	153
Table 42	Cost of Production Estimate for: <i>para</i> -Xylene Process: Adsorption/Isomerization (EB Isomerization), China .....	154
Table 43	Cost of Production Estimate for: <i>para</i> -Xylene Process: Adsorption/Isomerization (EB Dealkylation), China .....	155
Table 44	Cost of Production Estimate for: <i>para</i> -Xylene Process: Adsorption/Isomerization (EB Isomerization) w/ <i>ortho</i> -Xylene Byproduct, China .....	156
Table 45	Cost of Production Estimate for: <i>para</i> -Xylene Process: LD Adsorption/Isomerization (EB Isomerization), China.....	157
Table 46	Cost of Production Estimate for: <i>para</i> -Xylene Process: LD Adsorption/Isomerization (EB Dealkylation), China .....	158
Table 47	Cost of Production Estimate for: <i>para</i> -Xylene Process: Crystallization/Isomerization (EB Dealkylation), China .....	159
Table 48	Summary of <i>para</i> -Xylene Recovery Process Economics .....	160
Table 49	Cost of Production Estimate for: <i>para</i> -Xylene Process: Adsorption/Isomerization (EB Isomerization), Western Europe .....	161
Table 50	Cost of Production Estimate for: <i>para</i> -Xylene Process: Adsorption/Isomerization (EB Dealkylation), Western Europe .....	162
Table 51	Cost of Production Estimate for: <i>para</i> -Xylene Process: Adsorption/Isomerization (EB Isomerization) w/ <i>ortho</i> -Xylene Byproduct, Western Europe .....	163
Table 52	Cost of Production Estimate for: <i>para</i> -Xylene Process: LD Adsorption/Isomerization (EB Isomerization), Western Europe .....	164
Table 53	Cost of Production Estimate for: <i>para</i> -Xylene Process: LD Adsorption/Isomerization (EB Dealkylation), Western Europe .....	165
Table 54	Cost of Production Estimate for: <i>para</i> -Xylene Process: Crystallization/Isomerization (EB Dealkylation), Western Europe.....	166
Table 55	Summary of <i>para</i> -Xylene Recovery Process Economics .....	167
Table 56	Cost of Production Estimate for: <i>para</i> -Xylene Process: Adsorption/Isomerization (EB Isomerization), Southeast Asia .....	168
Table 57	Cost of Production Estimate for: <i>para</i> -Xylene Process: Adsorption/Isomerization (EB Dealkylation), Southeast Asia .....	169
Table 58	Cost of Production Estimate for: <i>para</i> -Xylene Process: Adsorption/Isomerization (EB Isomerization) w/ <i>ortho</i> -Xylene Byproduct, Southeast Asia.....	170



Table 59	Cost of Production Estimate for: <i>para</i> -Xylene Process: LD Adsorption/Isomerization (EB Isomerization), Southeast Asia .....	171
Table 60	Cost of Production Estimate for: <i>para</i> -Xylene Process: LD Adsorption/Isomerization (EB Dealkylation), Southeast Asia .....	172
Table 61	Cost of Production Estimate for: <i>para</i> -Xylene Process: Crystallization/Isomerization (EB Dealkylation), Southeast Asia.....	173
Table 62	Summary of <i>para</i> -Xylene Recovery Process Economics .....	174
Table 63	Cost of Production Estimate for: <i>para</i> -Xylene Process: Adsorption/Isomerization (EB Isomerization), Middle East.....	175
Table 64	Cost of Production Estimate for: <i>para</i> -Xylene Process: Adsorption/Isomerization (EB Dealkylation), Middle East.....	176
Table 65	Cost of Production Estimate for: <i>para</i> -Xylene Process: Adsorption/Isomerization (EB Isomerization) w/ <i>ortho</i> -Xylene Byproduct, Middle East .....	177
Table 66	Cost of Production Estimate for: <i>para</i> -Xylene Process: LD Adsorption/Isomerization (EB Isomerization), Middle East.....	178
Table 67	Cost of Production Estimate for: <i>para</i> -Xylene Process: LD Adsorption/Isomerization (EB Dealkylation), Middle East.....	179
Table 68	Cost of Production Estimate for: <i>para</i> -Xylene Process: Crystallization/Isomerization (EB Dealkylation), Middle East .....	180
Table 69	Regional Cost of Production of <i>para</i> -Xylene from Light Desorbent Adsorption/Isomerization (with EB Isomerization) .....	181
Table 70	Regional Cost of Production of <i>para</i> -Xylene from Crystallization and Isomerization.....	183
Table 71	Summary of TDP/Transalkylation/Alkylation Process Economics.....	184
Table 72	Cost of Production Estimate for: <i>para</i> -Xylene Process: Selective Toluene Disproportionation Followed by One-Stage Crystallization, USGC .....	186
Table 73	Cost of Production Estimate for: <i>para</i> -Xylene Process: Conventional TDP – Pure Toluene Feed Followed by Adsorption/Isomerization, USGC .....	187
Table 74	Cost of Production Estimate for: <i>para</i> -Xylene Process: TDP – Toluene/C <sub>9</sub> Aromatics Feeds Followed by Adsorption/Isomerization, USGC .....	188
Table 75	Cost of Production Estimate for: <i>para</i> -Xylene Process: C <sub>9</sub> Transalkylation Followed by Adsorption/Isomerization, USGC .....	189
Table 76	Cost of Production Estimate for: <i>para</i> -Xylene Process: Toluene Alkylation with Methanol, Followed by Adsorption/Isomerization, USGC .....	190
Table 77	Summary of TDP/Transalkylation/Alkylation Process Economics.....	191
Table 78	Cost of Production Estimate for: <i>para</i> -Xylene Process: Selective Toluene Disproportionation Followed by One-Stage Crystallization, China .....	192
Table 79	Cost of Production Estimate for: <i>para</i> -Xylene Process: Conventional TDP – Pure Toluene Feed Followed by Adsorption/Isomerization, China .....	193
Table 80	Cost of Production Estimate for: <i>para</i> -Xylene Process: TDP – Toluene/C <sub>9</sub> Aromatics Feeds Followed by Adsorption/Isomerization, China .....	194

Table 81	Cost of Production Estimate for: <i>para</i> -Xylene Process: C <sub>9</sub> Transalkylation Followed by Adsorption/Isomerization, China .....	195
Table 82	Cost of Production Estimate for: <i>para</i> -Xylene Process: Toluene Alkylation with Methanol, Followed by Adsorption/Isomerization, China .....	196
Table 83	Summary of TDP/Transalkylation/Alkylation Process Economics .....	197
Table 84	Cost of Production Estimate for: <i>para</i> -Xylene Process: Selective Toluene Disproportionation Followed by One-Stage Crystallization, Western Europe .....	198
Table 85	Cost of Production Estimate for: <i>para</i> -Xylene Process: Conventional TDP – Pure Toluene Feed Followed by Adsorption/Isomerization, Western Europe .....	199
Table 86	Cost of Production Estimate for: <i>para</i> -Xylene Process: TDP – Toluene/C <sub>9</sub> Aromatics Feeds Followed by Adsorption/Isomerization, Western Europe .....	200
Table 87	Cost of Production Estimate for: <i>para</i> -Xylene Process: C <sub>9</sub> Transalkylation Followed by Adsorption/Isomerization, Western Europe .....	201
Table 88	Cost of Production Estimate for: <i>para</i> -Xylene Process: Toluene Alkylation with Methanol, Followed by Adsorption/Isomerization, Western Europe .....	202
Table 89	Summary of TDP/Transalkylation/Alkylation Process Economics .....	203
Table 90	Cost of Production Estimate for: <i>para</i> -Xylene Process: Selective Toluene Disproportionation Followed by One-Stage Crystallization, Southeast Asia .....	204
Table 91	Cost of Production Estimate for: <i>para</i> -Xylene Process: Conventional TDP – Pure Toluene Feed Followed by Adsorption/Isomerization, Southeast Asia .....	205
Table 92	Cost of Production Estimate for: <i>para</i> -Xylene Process: TDP – Toluene/C <sub>9</sub> Aromatics Feeds Followed by Adsorption/Isomerization, Southeast Asia .....	206
Table 93	Cost of Production Estimate for: <i>para</i> -Xylene Process: C <sub>9</sub> Transalkylation Followed by Adsorption/Isomerization, Southeast Asia .....	207
Table 94	Cost of Production Estimate for: <i>para</i> -Xylene Process: Toluene Alkylation with Methanol, Followed by Adsorption/Isomerization, Southeast Asia .....	208
Table 95	Summary of TDP/Transalkylation/Alkylation Process Economics .....	209
Table 96	Cost of Production Estimate for: <i>para</i> -Xylene Process: Selective Toluene Disproportionation Followed by One-Stage Crystallization, Middle East .....	210
Table 97	Cost of Production Estimate for: <i>para</i> -Xylene Process: Conventional TDP – Pure Toluene Feed Followed by Adsorption/Isomerization, Middle East .....	211
Table 98	Cost of Production Estimate for: <i>para</i> -Xylene Process: TDP – Toluene/C <sub>9</sub> Aromatics Feeds Followed by Adsorption/Isomerization, Middle East .....	212
Table 99	Cost of Production Estimate for: <i>para</i> -Xylene Process: C <sub>9</sub> Transalkylation Followed by Adsorption/Isomerization, Middle East .....	213

Table 100	Cost of Production Estimate for: <i>para</i> -Xylene Process: Toluene Alkylation with Methanol, Followed by Adsorption/Isomerization, Middle East .....	214
Table 101	Regional Cost of Production of <i>para</i> -Xylene from STDP and 1 stage Crystallization.....	215
Table 102	Regional Cost of Production of <i>para</i> -Xylene from Conventional TDP with a Pure Toluene Feed followed by Adsorption/Isomerization.....	216
Table 103	Regional Cost of Production of <i>para</i> -Xylene from TDP/Transalkylation with a Toluene/C <sub>9</sub> Feed followed by Adsorption/Isomerization.....	217
Table 104	Regional Cost of Production of <i>para</i> -Xylene from C <sub>9</sub> Transalkylation with a Pure C <sub>9</sub> Feed followed by Adsorption/Isomerization .....	218
Table 105	Regional Cost of Production of <i>para</i> -Xylene from Toluene Methylation followed by Adsorption/Isomerization .....	219
Table 106	Cost of Production Estimate for: <i>meta</i> -Xylene Process: UOP MX Sorbex™, USGC .....	221
Table 107	Cost of Production Estimate for: <i>meta</i> -Xylene Process: UOP MX Sorbex™, China .....	222
Table 108	Cost of Production Estimate for: <i>meta</i> -Xylene Process: UOP MX Sorbex™, Western Europe .....	223
Table 109	Cost of Production Estimate for: <i>meta</i> -Xylene Process: UOP MX Sorbex™, Southeast Asia .....	224
Table 110	Cost of Production Estimate for: <i>meta</i> -Xylene Process: UOP MX Sorbex™, Middle East.....	225
Table 111	Regional Cost of Production of <i>meta</i> -Xylene from UOP's MX Sorbex™ Process .....	226
Table 112	Global <i>para</i> -Xylene Supply, Demand, and Trade.....	250
Table 113	<i>para</i> -Xylene Capacity in North America, 2018 .....	253
Table 114	North America <i>para</i> -Xylene Supply, Demand, and Trade.....	254
Table 115	<i>para</i> -Xylene Capacity in Western Europe, 2018 .....	256
Table 116	Western Europe <i>para</i> -Xylene Supply, Demand, and Trade .....	257
Table 117	Asia Pacific <i>para</i> -Xylene Capacity, 2018.....	259
Table 118	Asia Pacific <i>para</i> -Xylene Supply, Demand, and Trade .....	262

# Nexant Inc.

## TECHNOLOGY & COSTS

### Technoeconomics - Energy & Chemicals (TECH)

The Nexant Subscriptions' Technoeconomics - Energy & Chemicals (TECH) program is recognized globally as the industry standard source for information relevant to the chemical process and refining industries. Technoeconomics - Energy & Chemicals (TECH) reports are available as a subscription program or on a single report basis.

#### Contact Details:

##### Americas:

Marcos Nogueira Cesar, Vice President, Global Products, E&CA: Nexant Subscriptions  
Phone: + 1-914-609-0324, e-mail: mcesar@nexant.com

Erica Hill, Client Services Coordinator, E&CA-Products  
Phone: + 1-914-609-0386, e-mail: ehill@nexant.com

##### EMEA:

Anna Ibbotson, Director, Nexant Subscriptions  
Phone: +44-207-950-1528, aibbotson@nexant.com

##### Asia:

Chommanad Thammanayakatip, Managing Consultant, Energy & Chemicals Advisory  
Phone: +66-2793-4606, email: chommanadt@nexant.com

Nexant, Inc. ([www.nexant.com](http://www.nexant.com)) is a leading management consultancy to the global energy, chemical, and related industries. For over 38 years, Nexant has helped clients increase business value through assistance in all aspects of business strategy, including business intelligence, project feasibility and implementation, operational improvement, portfolio planning, and growth through M&A activities. Nexant has its main offices in San Francisco (California), White Plains (New York), and London (UK), and satellite offices worldwide.

Copyright © by Nexant Inc. 2018. All Rights Reserved.