

**TECHNOLOGY & COSTS****Technoeconomics - Energy & Chemicals (TECH)****TECH 2019-2 Acrylic Acid and Esters**

## Table of Contents

A Report by **Nexant, Inc.**

Published Date: July 2019

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

1	Executive Summary .....	1
1.1	Introduction.....	1
1.2	Technology Overview.....	2
1.2.1	Acrylic Acid.....	2
1.2.2	Commodity Acrylate Esters.....	2
1.2.3	Acrylic Acid Purification .....	2
1.3	Strategic and Business Considerations .....	3
1.4	Economic Analysis .....	4
1.5	Market Analysis .....	7
1.5.1	End-Use Applications .....	7
1.5.2	Supply and Demand Analysis .....	8
2	Introduction.....	11
2.1	Overview.....	11
2.1.1	Acrylic Acid.....	11
2.1.2	Acrylate Esters .....	13
2.2	Value Chain.....	14
2.2.1	Acrylic Acid.....	14
2.2.2	Acrylate Esters .....	14
2.3	Technology Developments.....	15
2.3.1	Acrylic Acid.....	15
2.3.2	Acrylate Esters .....	16
2.4	Technology Holders and Licensing Status.....	16
2.5	Strategic and Business Considerations .....	17
2.6	Physical and Thermodynamic Properties.....	18
2.6.1	Acrylic Acid.....	18
2.6.2	Acrylate Esters .....	19
2.7	Specifications .....	19
2.7.1	Acrylic Acid.....	19
2.7.2	Acrylate Esters .....	20

2.8	Health Hazards.....	21
2.8.1	Acrylic Acid.....	21
2.8.2	Acrylate Esters.....	21
2.9	Storage and Transportation.....	22
2.9.1	Acrylic Acid().....	22
2.9.2	Acrylate Esters(23,25,12,,).....	24
3	Commercial Technologies.....	25
3.1	Acrylic Acid.....	25
3.1.1	Acrylic Acid via Two-step Propylene Oxidation.....	25
3.2	Glacial Acrylic Acid.....	44
3.2.1	Overview.....	44
3.2.2	Crystallization.....	44
3.2.3	Distillation.....	46
3.3	Acrylate Esters.....	47
3.3.1	Acrylate Esters via Esterification.....	47
3.3.2	Specialty Acrylates via Trans-Esterification.....	52
3.3.3	Environmental Considerations.....	53
3.3.4	Organic Waste.....	53
3.4	Select Company Profiles.....	53
3.4.1	Air Liquide.....	53
3.4.2	Arkema.....	54
3.4.3	BASF.....	56
3.4.4	Celanese.....	56
3.4.5	Dow.....	57
3.4.6	LG Chem.....	57
3.4.7	Mitsubishi Chemical Corporation.....	57
3.4.8	Nippon Kayaku.....	58
3.4.9	Nippon Shokubai.....	58
3.4.10	Rohm and Haas (now Dow).....	59
3.4.11	Sulzer.....	60
3.4.12	Sumitomo Chemical.....	62
3.4.13	Synthomer.....	62
3.4.14	Tosoh Corporation.....	62
3.4.15	Union Carbide.....	62
4	Developing or Alternative Technologies.....	63
4.1	Patents.....	63
4.2	Biotechnology.....	65
4.2.1	Novomer.....	65
4.3	Other Developing Technologies.....	67
4.3.1	Acrylic Acid Production via Formaldehyde and Acetic Acid.....	67
4.3.2	Acrylic Acid Production via Ethanol and Formaldehyde.....	70
4.3.3	Acrylic Acid Production via Propane.....	70

5	Historical Processes.....	75
5.1	Historical Acrylic Acid Technology .....	75
5.1.1	Acrylic Acid via Ethylene .....	75
5.1.2	Acrylic Acid via Acetylene .....	76
5.1.3	Acrylic Acid via $\beta$ -propiolactone .....	79
5.1.4	Acrylic Acid via Propylene .....	79
5.2	Alternative Acrylate Ester Technologies .....	80
5.2.1	Acrylic Esters via Acetylene .....	80
5.2.2	Acrylic Esters via Acrylonitrile .....	81
5.2.3	Acrylic Esters via Ketene .....	82
6	Process Economics.....	83
6.1	Costing Basis .....	83
6.1.1	Investment Basis .....	83
6.1.2	Pricing Basis.....	83
6.1.3	Cost of Production Basis .....	85
6.2	Production Cost Estimates .....	85
6.2.1	Cost of Producing Crude Acrylic Acid via Propylene Oxidation .....	86
6.2.2	Cost of Producing Crude Acrylic Acid via a Gas-Derived Acetylene Complex .....	92
6.2.3	Cost of Producing Crude Acrylic Acid via Direct Oxidation of Propane .....	98
6.2.4	Cost of Producing Glacial Acrylic Acid via the Additive Enhanced Distillation of Crude Acrylic Acid .....	104
6.2.5	Cost of Producing Glacial Acrylic Acid via the Dynamic/Static Crystallization of Crude Acrylic Acid .....	110
6.2.6	Cost of Producing Butyl Acrylate via Esterification of Crude Acrylic Acid with n-Butanol.....	116
6.2.7	Cost of Producing Ethyl Acrylate via Esterification of Crude Acrylic Acid with Ethanol.....	122
6.2.8	Cost of Producing Methyl Acrylate via Esterification of Crude Acrylic Acid with Methanol .....	128
6.2.9	Cost of Producing 2-Ethylhexyl Acrylate via Esterification of Crude Acrylic Acid with 2-Ethylhexanol .....	134
6.3	Comparison of Commercial Processes to Produce Crude Acrylic Acid and Derivatives.....	140
6.4	Sensitivity Analysis.....	146
6.4.1	Sensitivity to Feed Pricing .....	146
6.4.2	Sensitivity to Economy of Scale .....	147
7	Commercial Applications.....	149
7.1	Overview.....	149
7.2	Acrylate Esters .....	149
7.2.1	Coatings .....	150
7.2.2	Adhesives and Sealants.....	153
7.2.3	Textiles and Fibers .....	154
7.2.4	Polymer Additives/Impact Modifiers .....	155

7.2.5	Film and Barrier Resin Applications .....	155
7.2.6	Varnishes and Polishes .....	156
7.2.7	Printing Inks.....	156
7.2.8	Miscellaneous Applications .....	156
7.3	Specialty Acrylate Esters.....	157
7.3.1	Alkyl Acrylates .....	157
7.3.2	Radiation Curing.....	157
7.3.3	Hydroxyalkyl Acrylates .....	158
7.3.4	Dialkylaminoethyl Acrylates .....	158
7.4	Glacial Acrylic Acid.....	159
7.4.1	Polyacrylic Acid .....	159
7.4.2	Super Absorbent Polymers .....	159
7.4.3	Detergent Applications .....	160
7.4.4	Miscellaneous.....	160
8	Regional Market Analysis.....	161
8.1	Acrylic Acid .....	161
8.1.1	Global .....	161
8.1.2	North America .....	164
8.1.3	Western Europe .....	167
8.1.4	Asia Pacific.....	170
8.1.5	Rest of the World.....	174
8.2	Acrylate Esters .....	178
8.2.1	Global .....	178
8.2.2	North America .....	182
8.2.3	Western Europe .....	184
8.2.4	Asia Pacific.....	186
8.2.5	Rest of the World.....	190
9	Glossary .....	194

## Appendices

<b>A</b>	<b>Definitions of Capital Cost Terms Used in Process Economics .....</b>	<b>197</b>
<b>B</b>	<b>Definitions of Operating Cost Terms Used in Process Economics .....</b>	<b>201</b>
<b>C</b>	<b>TECH Program Title Index (2009-2019) .....</b>	<b>204</b>
<b>D</b>	<b>References .....</b>	<b>209</b>

## Figures

Figure 1	Routes to Acrylic Acid and Commodity Acrylate Esters .....	2
Figure 2	U.S. Gulf Coast Summary of Acrylic Acid and Derivatives Production Costs .....	4
Figure 3	Western Europe Summary of Acrylic Acid and Derivatives Production Costs .....	4
Figure 4	China Summary of Acrylic Acid Derivatives Production Costs .....	5
Figure 5	Japan Summary of Acrylic Acid and Derivatives Production Costs .....	5
Figure 6	Southeast Asia Summary of Acrylic Acid and Derivatives Production Costs .....	6
Figure 7	Acrylic Acid and its Derivatives .....	8
Figure 8	Global Acrylic Acid Supply, Demand, and Trade Balance .....	9
Figure 9	Global Acrylate Esters Supply, Demand, and Trade Balance .....	10
Figure 10	Petrochemical-based Routes to Acrylic Acid .....	12
Figure 11	Petrochemical-based Routes to Commodity Acrylates .....	13
Figure 12	Acrylic Acid Value Chain .....	14
Figure 13	Acrylate Esters Value Chain .....	15
Figure 14	Typical Acrylic Acid Storage Facility .....	23
Figure 15	Propylene to Acrolein Reaction Mechanism (Simplified) .....	26
Figure 16	Primary and Secondary Oxidation with Tandem Reactors .....	29
Figure 17	Water Quench Separation Train .....	31
Figure 18	Alternative Quench Separation .....	33
Figure 19	Solvent Quench Separation Train .....	35
Figure 20	Oxidation Reactor Schematic .....	38
Figure 21	Incinerator Design (Simplified) .....	41
Figure 22	Waste Water Treatment System .....	42
Figure 23	BASF Process for Production and Purification of Acrylic Acid .....	45
Figure 24	Methyl Acrylate Production .....	50
Figure 25	Lurgi/Nippon Kayaku Acrylic Acid Process .....	55
Figure 26	Sulzer Falling Film Crystallizer .....	60
Figure 27	Sulzer Falling Film Crystallization Process .....	61
Figure 28	BASF Process for Recovery of Acrylic Acid .....	64
Figure 29	BASF Methanol and Acetic Acid to Acrylic Acid Process .....	69
Figure 30	LG Chem Acrylic Acid via Propane Process .....	72
Figure 31	Acrylic Acid via Propane Oxidative Dehydrogenation .....	74
Figure 32	BASF High Pressure Reppe Process .....	78
Figure 33	U.S. Gulf Coast Summary of Crude Acrylic Acid and Derivatives Production Costs .....	140
Figure 34	Western Europe Summary of Crude Acrylic Acid and Derivatives Production Costs .....	141
Figure 35	China Summary of Crude Acrylic Acid and Derivatives Production Costs .....	142
Figure 36	Japan Summary of Crude Acrylic Acid and Derivatives Production Costs .....	143
Figure 37	Southeast Asia Summary of Crude Acrylic Acid and Derivatives Production Costs .....	144
Figure 38	Raw Material Prices for Crude Acrylic Acid Processes .....	146
Figure 39	Sensitivity of Crude Acrylic Acid and Derivatives Costs of Production to Feed Price .....	147
Figure 40	Sensitivity of Crude Acrylic Acid and Derivatives Costs of Production to Economy of Scale .....	148

Figure 41	End-Use Applications for Commodity Acrylate Esters .....	150
Figure 42	End-Use Applications for Specialty Acrylate Esters .....	157
Figure 43	Global Acrylic Acid Demand by End Use, 2018-e .....	161
Figure 44	Global Acrylic Acid Demand by Region, 2018-e .....	162
Figure 45	Global Acrylic Acid Capacity by Region, 2018-e .....	162
Figure 46	Global Acrylic Acid Supply, Demand, and Trade Balance .....	163
Figure 47	North American Acrylic Acid Demand by End Use, 2018-e .....	164
Figure 48	North American Acrylic Acid Supply, Demand, and Trade Balance .....	166
Figure 49	Western Europe Acrylic Acid Demand by End Use, 2018-e .....	167
Figure 50	Western Europe Acrylic Acid Supply, Demand, and Trade Balance .....	169
Figure 51	Asia Pacific Acrylic Acid Demand by End Use, 2018-e .....	170
Figure 52	Asia Pacific Acrylic Acid Supply, Demand, and Trade Balance .....	174
Figure 53	Rest of the World Acrylic Acid Demand by End Use, 2018-e .....	175
Figure 54	Rest of the World Acrylic Acid Supply, Demand, and Trade Balance .....	177
Figure 55	Global Acrylate Esters Demand by Type, 2018-e .....	179
Figure 56	Global Acrylate Esters Consumption by Region, 2018-e .....	180
Figure 57	Global Acrylate Esters Capacity by Region, 2018-e .....	180
Figure 58	Global Acrylate Esters Supply, Demand, and Trade Balance .....	181
Figure 59	North American Acrylate Esters Demand by Type, 2018-e .....	182
Figure 60	North American Acrylate Esters Supply, Demand, and Trade Balance .....	184
Figure 61	Western Europe Acrylate Esters Demand by Type, 2018-e .....	185
Figure 62	Western Europe Acrylic Acid Supply, Demand, and Trade Balance .....	186
Figure 63	Asia Pacific Acrylate Esters Demand by Type, 2018-e .....	187
Figure 64	Asia Pacific Acrylate Esters Supply, Demand, and Trade Balance .....	190
Figure 65	Rest of the World Acrylate Esters Demand by Type, 2018-e .....	191
Figure 66	Rest of the World Acrylate Esters Supply, Demand, and Trade Balance .....	193

**Tables**

Table 1	Strategic/Business Considerations.....	3
Table 2	Acrylic Acid and Acrylate Esters Technology Holders and Licensors.....	16
Table 3	Acrylic Acid and Commodity Acrylates Strategic/Business Considerations.....	18
Table 4	Key Physical and Thermodynamic Properties of Acrylic Acid.....	18
Table 5	Key Physical and Thermodynamic Properties of Acrylate Esters.....	19
Table 6	Typical Commercial Specifications for Acrylic Acid.....	20
Table 7	Typical Commercial Specifications for Acrylate Esters.....	20
Table 8	NFPA Ratings for Key Acrylate Esters.....	21
Table 9	Experimental Results.....	63
Table 10	Prices of Raw Materials, Products, Utilities, and Labor.....	84
Table 11	Cost of Production Estimate for: Crude Acrylic Acid Process: Propylene Oxidation (Tandem Reactor, Water Quench Separation Train); USGC Basis.....	87
Table 12	Cost of Production Estimate for: Crude Acrylic Acid Process: Propylene Oxidation (Tandem Reactor, Water Quench Separation Train); Western Europe Basis.....	88
Table 13	Cost of Production Estimate for: Crude Acrylic Acid Process: Propylene Oxidation (Tandem Reactor, Water Quench Separation Train); China Basis.....	89
Table 14	Cost of Production Estimate for: Crude Acrylic Acid Process: Propylene Oxidation (Tandem Reactor, Water Quench Separation Train); Japan Basis.....	90
Table 15	Cost of Production Estimate for: Crude Acrylic Acid Process: Propylene Oxidation (Tandem Reactor, Water Quench Separation Train); Southeast Asia Basis.....	91
Table 16	Cost of Production Estimate for: Crude Acrylic Acid Process: Gas-Derived Acetylene Complex; USGC Basis.....	93
Table 17	Cost of Production Estimate for: Crude Acrylic Acid Process: Gas-Derived Acetylene Complex; Western Europe Basis.....	94
Table 18	Cost of Production Estimate for: Crude Acrylic Acid Process: Gas-Derived Acetylene Complex; China Basis.....	95
Table 19	Cost of Production Estimate for: Crude Acrylic Acid Process: Gas-Derived Acetylene Complex; Japan Basis.....	96
Table 20	Cost of Production Estimate for: Crude Acrylic Acid Process: Gas-Derived Acetylene Complex; Southeast Asia Basis.....	97
Table 21	Cost of Production Estimate for: Crude Acrylic Acid Process: Direct Oxidation of Propane; USGC Basis.....	99
Table 22	Cost of Production Estimate for: Crude Acrylic Acid Process: Direct Oxidation of Propane; Western Europe Basis.....	100
Table 23	Cost of Production Estimate for: Crude Acrylic Acid Process: Direct Oxidation of Propane; China Basis.....	101
Table 24	Cost of Production Estimate for: Crude Acrylic Acid Process: Direct Oxidation of Propane; Japan Basis.....	102
Table 25	Cost of Production Estimate for: Crude Acrylic Acid Process: Direct Oxidation of Propane; Southeast Asia Basis.....	103

Table 26	Cost of Production Estimate for: Glacial Acrylic Acid Process: Additive Enhanced Distillation of Crude Acrylic Acid; USGC Basis .....	105
Table 27	Cost of Production Estimate for: Glacial Acrylic Acid Process: Additive Enhanced Distillation of Crude Acrylic Acid; Western Europe Basis .....	106
Table 28	Cost of Production Estimate for: Glacial Acrylic Acid Process: Additive Enhanced Distillation of Crude Acrylic Acid; China Basis .....	107
Table 29	Cost of Production Estimate for: Glacial Acrylic Acid Process: Additive Enhanced Distillation of Crude Acrylic Acid; Japan Basis .....	108
Table 30	Cost of Production Estimate for: Glacial Acrylic Acid Process: Additive Enhanced Distillation of Crude Acrylic Acid; Southeast Asia Basis .....	109
Table 31	Cost of Production Estimate for: Glacial Acrylic Acid Process: Dynamic/Static Crystallization of Crude Acrylic Acid; USGC Basis .....	111
Table 32	Cost of Production Estimate for: Glacial Acrylic Acid Process: Dynamic/Static Crystallization of Crude Acrylic Acid; Western Europe Basis .....	112
Table 33	Cost of Production Estimate for: Glacial Acrylic Acid Process: Dynamic/Static Crystallization of Crude Acrylic Acid; China Basis .....	113
Table 34	Cost of Production Estimate for: Glacial Acrylic Acid Process: Dynamic/Static Crystallization of Crude Acrylic Acid; Japan Basis .....	114
Table 35	Cost of Production Estimate for: Glacial Acrylic Acid Process: Dynamic/Static Crystallization of Crude Acrylic Acid; Southeast Asia Basis .....	115
Table 36	Cost of Production Estimate for: Butyl Acrylate Process: Esterification of Crude Acrylic Acid via <i>n</i> -Butanol; USGC Basis .....	117
Table 37	Cost of Production Estimate for: Butyl Acrylate Process: Esterification of Crude Acrylic Acid via <i>n</i> -Butanol; Western Europe Basis .....	118
Table 38	Cost of Production Estimate for: Butyl Acrylate Process: Esterification of Crude Acrylic Acid via <i>n</i> -Butanol; China Basis .....	119
Table 39	Cost of Production Estimate for: Butyl Acrylate Process: Esterification of Crude Acrylic Acid via <i>n</i> -Butanol; Japan Basis .....	120
Table 40	Cost of Production Estimate for: Butyl Acrylate Process: Esterification of Crude Acrylic Acid via <i>n</i> -Butanol; Southeast Asia Basis .....	121
Table 41	Cost of Production Estimate for: Ethyl Acrylate Process: Esterification of Crude Acrylic Acid via Ethanol; USGC Basis .....	123
Table 42	Cost of Production Estimate for: Ethyl Acrylate Process: Esterification of Crude Acrylic Acid via Ethanol; Western Europe Basis .....	124
Table 43	Cost of Production Estimate for: Ethyl Acrylate Process: Esterification of Crude Acrylic Acid via Ethanol; China Basis .....	125
Table 44	Cost of Production Estimate for: Ethyl Acrylate Process: Esterification of Crude Acrylic Acid via Ethanol; Japan Basis .....	126
Table 45	Cost of Production Estimate for: Ethyl Acrylate Process: Esterification of Crude Acrylic Acid via Ethanol; Southeast Asia Basis .....	127
Table 46	Cost of Production Estimate for: Methyl Acrylate Process: Esterification of Crude Acrylic Acid via Methanol; USGC Basis .....	129
Table 47	Cost of Production Estimate for: Methyl Acrylate Process: Esterification of Crude Acrylic Acid via Methanol; Western Europe Basis .....	130



Table 48	Cost of Production Estimate for: Methyl Acrylate Process: Esterification of Crude Acrylic Acid via Methanol; China Basis.....	131
Table 49	Cost of Production Estimate for: Methyl Acrylate Process: Esterification of Crude Acrylic Acid via Methanol; Japan Basis .....	132
Table 50	Cost of Production Estimate for: Methyl Acrylate Process: Esterification of Crude Acrylic Acid via Methanol; Southeast Asia Basis.....	133
Table 51	Cost of Production Estimate for: 2-Ethylhexyl Acrylate Process: Esterification of Crude Acrylic Acid via 2-Ethylhexanol; USGC Basis.....	135
Table 52	Cost of Production Estimate for: 2-Ethylhexyl Acrylate Process: Esterification of Crude Acrylic Acid via 2-Ethylhexanol; Western Europe Basis .....	136
Table 53	Cost of Production Estimate for: 2-Ethylhexyl Acrylate Process: Esterification of Crude Acrylic Acid via 2-Ethylhexanol; China Basis.....	137
Table 54	Cost of Production Estimate for: 2-Ethylhexyl Acrylate Process: Esterification of Crude Acrylic Acid via 2-Ethylhexanol; Japan Basis .....	138
Table 55	Cost of Production Estimate for: 2-Ethylhexyl Acrylate Process: Esterification of Crude Acrylic Acid via 2-Ethylhexanol; Southeast Asia Basis.....	139
Table 56	U.S. Gulf Coast Summary of Crude Acrylic Acid and Derivatives Production Costs .....	140
Table 57	Western Europe Summary of Crude Acrylic Acid and Derivatives Production Costs .....	141
Table 58	China Summary of Crude Acrylic Acid and Derivatives Production Costs .....	142
Table 59	Japan Summary of Crude Acrylic Acid and Derivatives Production Costs .....	143
Table 60	Southeast Asia Summary of Crude Acrylic Acid and Derivatives Production Costs .....	144
Table 61	Global Acrylic Acid Supply, Demand, and Trade Balance .....	163
Table 62	North American Acrylic Acid Capacity, 2018-e.....	165
Table 63	North American Acrylic Acid Supply, Demand, and Trade Balance.....	166
Table 64	Western Europe Acrylic Acid Capacity, 2018-e.....	168
Table 65	Western Europe Acrylic Acid Supply, Demand, and Trade Balance.....	169
Table 66	Asia Pacific Acrylic Acid Capacity, 2018-e .....	172
Table 67	Asia Pacific Acrylic Acid Supply, Demand, and Trade Balance .....	174
Table 68	Rest of the World Acrylic Acid Capacity, 2018-e.....	176
Table 69	Rest of the World Acrylic Acid Supply, Demand, and Trade Balance .....	177
Table 70	Global Acrylate Esters Demand by Type .....	179
Table 71	Global Acrylate Esters Supply, Demand, and Trade Balance.....	181
Table 72	North American Acrylate Esters Capacity, 2018-e .....	183
Table 73	North American Acrylate Esters Supply, Demand, and Trade Balance .....	183
Table 74	Western Europe Acrylate Esters Capacity, 2018-e .....	185
Table 75	Western Europe Acrylate Esters Supply, Demand, and Trade Balance .....	186
Table 76	Asia Pacific Acrylate Esters Capacity, 2018-e .....	188
Table 77	Asia Pacific Acrylate Esters Supply, Demand, and Trade Balance .....	189
Table 78	Rest of the World Acrylate Esters Capacity, 2018-e .....	192
Table 79	Rest of the World Acrylate Esters Supply, Demand, and Trade Balance .....	193

# 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.