

**TECHNOLOGY & COSTS****Technoeconomics - Energy & Chemicals (TECH)****TECH 2020S9 Carbon Black**

## Table of Contents

A Report by **NexantECA, Inc.**

Published Date: July 2020

[www.nexanteca.com/subscriptions-and-reports](http://www.nexanteca.com/subscriptions-and-reports)**Contents**

|       |                                               |    |
|-------|-----------------------------------------------|----|
| 1     | Executive Summary .....                       | 1  |
| 1.1   | Overview.....                                 | 1  |
| 1.2   | Feedstock.....                                | 2  |
| 1.3   | Supply Landscape.....                         | 3  |
| 1.4   | Technology Overview.....                      | 4  |
| 1.5   | Technology Holders and Licensing Status.....  | 5  |
| 1.6   | Process Economics.....                        | 6  |
| 1.6.1 | Grade Comparison.....                         | 6  |
| 1.6.2 | Regional Comparison.....                      | 7  |
| 1.6.3 | Specialty Grades.....                         | 7  |
| 1.7   | Market Analysis.....                          | 9  |
| 1.7.1 | Overview.....                                 | 9  |
| 1.7.2 | Applications by Grade.....                    | 10 |
| 1.7.3 | Summary.....                                  | 12 |
| 1.7.1 | Global Demand.....                            | 14 |
| 1.7.2 | Global Supply, Demand, and Trade.....         | 15 |
| 2     | Introduction.....                             | 16 |
| 2.1   | Overview.....                                 | 16 |
| 2.2   | Business Developments.....                    | 17 |
| 2.3   | Strategic and Business Considerations.....    | 18 |
| 2.4   | Technology Overview.....                      | 19 |
| 2.5   | Technology Holders and Licensing Status.....  | 20 |
| 2.6   | Types, Grades and Specifications.....         | 21 |
| 2.6.1 | Carbon Black Types.....                       | 21 |
| 2.6.2 | Carbon Black Grades.....                      | 21 |
| 2.6.3 | Soft versus Hard Grades.....                  | 23 |
| 2.7   | Physical and Chemical properties.....         | 24 |
| 2.7.1 | Carbon Black Morphology and Nomenclature..... | 24 |
| 2.7.2 | Particle Size.....                            | 26 |
| 2.7.3 | Structure and Aggregate Size.....             | 26 |
| 2.7.4 | Surface Area and Chemistry.....               | 27 |

|        |                                                  |    |
|--------|--------------------------------------------------|----|
| 2.7.5  | Porosity .....                                   | 28 |
| 2.7.6  | Physical Form.....                               | 28 |
| 2.8    | Health Hazards.....                              | 28 |
| 2.9    | Storage and Transportation .....                 | 28 |
| 3      | Feedstocks .....                                 | 29 |
| 3.1    | Introduction.....                                | 29 |
| 3.1.1  | BMCI (Bureau of Mines Correlation Index) .....   | 30 |
| 3.2    | Fluid Catalytic Cracking (FCC) Decant Oil .....  | 31 |
| 3.3    | Coal Tar Distillates .....                       | 32 |
| 3.4    | Ethylene Bottom Oil .....                        | 33 |
| 3.5    | Natural Gas .....                                | 33 |
| 4      | Commercial Technologies.....                     | 34 |
| 4.1    | Introduction.....                                | 34 |
| 4.2    | Chemistry and Mechanism.....                     | 35 |
| 4.3    | Formation .....                                  | 36 |
| 4.4    | Production Routes.....                           | 38 |
| 4.4.1  | Acetylene Black.....                             | 38 |
| 4.4.2  | Channel Black .....                              | 39 |
| 4.4.3  | Electric Plasma.....                             | 41 |
| 4.4.4  | Furnace Black .....                              | 42 |
| 4.4.5  | Gas Black .....                                  | 50 |
| 4.4.6  | Lamp Black.....                                  | 51 |
| 4.4.7  | Thermal Black .....                              | 52 |
| 4.4.8  | After Treatment and Surface Modifications.....   | 54 |
| 4.5    | Aditya Birla .....                               | 55 |
| 4.6    | Asahi Carbon Company .....                       | 60 |
| 4.6.1  | Furnace Black .....                              | 60 |
| 4.6.2  | Thermal Black .....                              | 62 |
| 4.7    | BlackCat Corporation .....                       | 64 |
| 4.8    | Cabot Corporation .....                          | 64 |
| 4.9    | China Synthetic rubber Corporation.....          | 68 |
| 4.9.1  | Thermal Black .....                              | 69 |
| 4.10   | DENKA Denki Kagaku Kogyo KaBushiki Kaisha .....  | 70 |
| 4.11   | EuroTecnica SpA .....                            | 71 |
| 4.12   | Kvaerner ASA.....                                | 75 |
| 4.13   | Mitsubishi Carbon.....                           | 78 |
| 4.14   | Orion Engineered Carbon .....                    | 80 |
| 4.14.1 | Furnace Black .....                              | 80 |
| 4.14.2 | Gas Black .....                                  | 82 |
| 4.14.3 | Lamp Black.....                                  | 84 |
| 4.14.4 | Other Developments .....                         | 84 |
| 4.15   | Petrokemija d.d. Kutina .....                    | 84 |
| 4.16   | Philips Carbon Black Limited.....                | 85 |
| 4.17   | Imerys Graphite & Carbon (Formerly Timcal) ..... | 85 |
| 4.18   | Tokai Carbon .....                               | 85 |

|       |                                                |     |
|-------|------------------------------------------------|-----|
|       | 4.18.1 Thermal Black .....                     | 86  |
|       | 4.18.2 Furnace Black .....                     | 87  |
| 5     | Developing Technologies .....                  | 88  |
| 5.1   | Introduction .....                             | 88  |
| 5.2   | Green Chemistry and Biotechnology .....        | 88  |
| 5.3   | Solar Carbon Black .....                       | 88  |
| 5.4   | Recycling of Tires .....                       | 90  |
| 5.4.1 | Advanced Pyrotech Sdn. Bhd. ....               | 92  |
| 5.4.2 | Black Bear Carbon Company .....                | 92  |
| 5.4.3 | Carbon Green LLC .....                         | 93  |
| 5.4.4 | Pyrolyx AG (formerly Scutum Capital AG) .....  | 93  |
| 5.4.5 | Environmental Waste International .....        | 94  |
| 6     | Process Economics .....                        | 95  |
| 6.1   | Costing Basis .....                            | 95  |
| 6.1.1 | Investment Basis .....                         | 95  |
| 6.1.2 | Pricing Basis .....                            | 95  |
| 6.1.3 | Cost of Production Basis .....                 | 97  |
| 6.2   | Furnace Process .....                          | 97  |
| 6.2.1 | Coal Tar Distillate (China) .....              | 99  |
| 6.2.2 | Ethylene Bottom Oils (NW Europe) .....         | 107 |
| 6.2.3 | FCC Slurry Oils (USGC) .....                   | 108 |
| 6.2.4 | Grade Comparison .....                         | 113 |
| 6.2.5 | Regional Comparison .....                      | 114 |
| 6.3   | Specialty Grades .....                         | 115 |
| 6.3.1 | Thermal Carbon Black (N990) .....              | 115 |
| 6.3.2 | Acetylene Black .....                          | 115 |
| 6.3.3 | Plasma Process .....                           | 115 |
| 6.3.4 | Comparison .....                               | 119 |
| 7     | Commercial Applications .....                  | 120 |
| 7.1   | Overview .....                                 | 120 |
| 7.1.1 | Applications by Grade .....                    | 122 |
| 7.1.2 | Applications by Type .....                     | 124 |
| 7.2   | Summary .....                                  | 125 |
| 8     | Regional Market Analysis .....                 | 127 |
| 8.1   | Global Outlook .....                           | 127 |
| 8.1.1 | Global Consumption .....                       | 127 |
| 8.1.2 | Supply .....                                   | 127 |
| 8.1.3 | Global Supply, Demand, and Trade .....         | 129 |
| 8.2   | North America .....                            | 130 |
| 8.2.1 | Supply .....                                   | 130 |
| 8.2.2 | North America Supply, Demand, and Trade .....  | 131 |
| 8.3   | Western Europe .....                           | 131 |
| 8.3.1 | Supply .....                                   | 131 |
| 8.3.2 | Western Europe Supply, Demand, and Trade ..... | 132 |
| 8.4   | Asia Pacific .....                             | 132 |

|       |                                                  |     |
|-------|--------------------------------------------------|-----|
| 8.4.1 | Supply .....                                     | 132 |
| 8.4.2 | Asia Pacific Supply, Demand and Trade.....       | 136 |
| 8.5   | Rest of the World.....                           | 137 |
| 8.5.1 | Supply .....                                     | 137 |
| 8.5.2 | Rest of the World Supply, Demand and Trade ..... | 138 |
| 9     | Glossary .....                                   | 139 |

## Appendices

|   |                                                                     |     |
|---|---------------------------------------------------------------------|-----|
| A | Definitions of Capital Cost Terms Used in Process Economics.....    | 141 |
| B | Definitions of Operating Cost Terms Used in Process Economics ..... | 146 |
| C | TECH Program Title Index (2010-2020) .....                          | 149 |
| D | References .....                                                    | 152 |

## Figures

|           |                                                                                    |    |
|-----------|------------------------------------------------------------------------------------|----|
| Figure 1  | Carbon Black Value Chain .....                                                     | 1  |
| Figure 2  | Carbon Black Capacity Breakdown by Major Feedstocks .....                          | 2  |
| Figure 3  | Global Carbon Black Supply, 2020.....                                              | 3  |
| Figure 4  | Costs of Production Comparison for Carbon Black Grades .....                       | 6  |
| Figure 5  | Regional Analysis for Costs of Production of N330 Carbon Black .....               | 7  |
| Figure 6  | Costs of Production for Thermal, Acetylene and Plasma Carbon Blacks .....          | 8  |
| Figure 7  | Global Carbon Black Demand by Application, 2020 .....                              | 9  |
| Figure 8  | Global Carbon Black Demand by Grades, 2020 .....                                   | 11 |
| Figure 9  | Simplified Property Considerations for a Compounder using Carbon Black.....        | 13 |
| Figure 10 | Simplified Product Application Mapping in Relation to Carbon Black Properties..... | 14 |
| Figure 11 | Global Carbon Black Supply, Demand, and Trade .....                                | 15 |
| Figure 12 | Carbon Black Value Chain .....                                                     | 16 |
| Figure 13 | Carbon Black Structure Development .....                                           | 25 |
| Figure 14 | SEM Representative of Carbon Black Aggregate .....                                 | 25 |
| Figure 15 | Particle Size Comparison Illustration.....                                         | 26 |
| Figure 16 | Comparison of Carbon Black Structures .....                                        | 27 |
| Figure 17 | Carbon Black Capacity Breakdown by Major Feedstocks .....                          | 29 |
| Figure 18 | Channel Process .....                                                              | 40 |
| Figure 19 | Plasma Black Process .....                                                         | 42 |
| Figure 20 | Generic Furnace Black Process .....                                                | 43 |
| Figure 21 | Dry Pelletization Process.....                                                     | 49 |
| Figure 22 | Wet Pelletizer.....                                                                | 50 |
| Figure 23 | Lamp Black Process .....                                                           | 51 |
| Figure 24 | Thermal Black Process Using Natural Gas Feed .....                                 | 53 |
| Figure 25 | Aditya Birla Carbon Black.....                                                     | 56 |
| Figure 26 | Aditya Birla 2013 Reactor Schematic .....                                          | 58 |
| Figure 27 | Columbian Chemical Reactor Schematic.....                                          | 59 |
| Figure 28 | Asahi Carbon Reactor .....                                                         | 61 |

|           |                                                                                    |     |
|-----------|------------------------------------------------------------------------------------|-----|
| Figure 29 | Asahi Thermal Reactor .....                                                        | 63  |
| Figure 30 | Asahi Thermal Black Reactor .....                                                  | 63  |
| Figure 31 | Asahi Thermal Reactor 3 .....                                                      | 64  |
| Figure 32 | Cabot Furnace Black Reactor .....                                                  | 65  |
| Figure 33 | Cabot Low Structure Black Reactor .....                                            | 67  |
| Figure 34 | CCBI Reactor.....                                                                  | 69  |
| Figure 35 | Eurotecnica ET Black™ CB Process.....                                              | 73  |
| Figure 36 | System for Production of Carbon Black .....                                        | 77  |
| Figure 37 | Mitsubishi Reactor .....                                                           | 79  |
| Figure 38 | Orion Carbon Black Reactor.....                                                    | 81  |
| Figure 39 | Orion Gas Black Generator .....                                                    | 83  |
| Figure 40 | Carbon Black Aerosol Technology .....                                              | 84  |
| Figure 41 | Tokai Carbon Black Reactor.....                                                    | 86  |
| Figure 42 | Carbon Black Refractory System .....                                               | 87  |
| Figure 43 | Solar Reactor.....                                                                 | 89  |
| Figure 44 | Solar-thermal Hydrogen and Carbon Black Co-product Plant .....                     | 89  |
| Figure 45 | Solar Carbon Black.....                                                            | 91  |
| Figure 46 | Costs of Production Comparison for Carbon Black Grades .....                       | 113 |
| Figure 47 | Regional Analysis for Costs of Production of N330 Carbon Black.....                | 114 |
| Figure 48 | Costs of Production for Thermal, Acetylene and Plasma Carbon Blacks .....          | 119 |
| Figure 49 | Global Carbon Black Demand by Application, 2020 .....                              | 120 |
| Figure 50 | Global Carbon Black Demand by Grades, 2020 .....                                   | 123 |
| Figure 51 | Simplified Property Considerations for a Compounder Using Carbon Black .....       | 125 |
| Figure 52 | Simplified Product Application Mapping in Relation to Carbon Black Properties..... | 126 |
| Figure 53 | Global Carbon Black Supply, 2020.....                                              | 128 |
| Figure 54 | Global Carbon Black Supply, Demand, and Trade .....                                | 129 |

**Tables**

|          |                                                                                                                       |     |
|----------|-----------------------------------------------------------------------------------------------------------------------|-----|
| Table 1  | Carbon Black Technology Overview .....                                                                                | 4   |
| Table 2  | Major Carbon Black Licensors, Technology Holders, and Producers .....                                                 | 5   |
| Table 3  | Typical Application by Carbon Black Grade .....                                                                       | 10  |
| Table 4  | Key Physical and Thermodynamic Properties of Select Grades.....                                                       | 12  |
| Table 5  | Global Carbon Black Consumption by Region .....                                                                       | 14  |
| Table 6  | Global Carbon Black Supply, Demand, and Trade .....                                                                   | 15  |
| Table 7  | Carbon Black Technology Overview .....                                                                                | 19  |
| Table 8  | Major Carbon Black Licensors, Technology Holders, and Producers .....                                                 | 20  |
| Table 9  | Ranges of Carbon Black Properties .....                                                                               | 21  |
| Table 10 | ASTM Digit Assignment for Typical Average Carbon Black Particle Size.....                                             | 22  |
| Table 11 | Commercial Specifications for select Carbon Blacks grades .....                                                       | 22  |
| Table 12 | Types of Carbon Black Used in Tires (ref: IARC 1996).....                                                             | 23  |
| Table 13 | Physical and Thermodynamic Properties .....                                                                           | 24  |
| Table 14 | Typical Feedstock Specifications .....                                                                                | 31  |
| Table 15 | Typical Reactor Conditions for Different Carbon Black Grades .....                                                    | 38  |
| Table 16 | Heats of Formation and Theoretical Maximum Temperatures Involved in<br>Decomposition of Selected Hydrocarbons .....   | 70  |
| Table 17 | Prices of Raw Materials, Products, Utilities, and Labor, Q1 2020.....                                                 | 96  |
| Table 18 | Cost of Production Estimate for: Carbon Black N121<br>Process: Generic Furnace Black, China, First Quarter 2020 ..... | 99  |
| Table 19 | Cost of Production Estimate for: Carbon Black N220<br>Process: Generic Furnace Black, China, First Quarter 2020 ..... | 100 |
| Table 20 | Cost of Production Estimate for: Carbon Black N234<br>Process: Generic Furnace Black, China, First Quarter 2020 ..... | 101 |
| Table 21 | Cost of Production Estimate for: Carbon Black N330<br>Process: Generic Furnace Black, China, First Quarter 2020 ..... | 102 |
| Table 22 | Cost of Production Estimate for: Carbon Black N339<br>Process: Generic Furnace Black, China, First Quarter 2020 ..... | 103 |
| Table 23 | Cost of Production Estimate for: Carbon Black N375<br>Process: Generic Furnace Black, China, First Quarter 2020 ..... | 104 |
| Table 24 | Cost of Production Estimate for: Carbon Black N550<br>Process: Generic Furnace Black, China, First Quarter 2020 ..... | 105 |
| Table 25 | Cost of Production Estimate for: Carbon Black N660<br>Process: Generic Furnace Black, China, First Quarter 2020 ..... | 106 |
| Table 26 | Cost of Production Estimate for: Carbon Black N330<br>Process: Generic Furnace Black, NWE, First Quarter 2020 .....   | 107 |
| Table 27 | Cost of Production Estimate for: Carbon Black N115<br>Process: Eurotecnica ET Black™, USGC, First Quarter 2020.....   | 108 |
| Table 28 | Cost of Production Estimate for: Carbon Black N115<br>Process: Eurotecnica ET Black™, USGC, First Quarter 2020.....   | 109 |
| Table 29 | Cost of Production Estimate for: Carbon Black N330<br>Process: Eurotecnica ET Black™, USGC, First Quarter 2020.....   | 110 |
| Table 30 | Cost of Production Estimate for: Carbon Black N550<br>Process: Eurotecnica ET Black™, USGC, First quarter 2020 .....  | 111 |

|          |                                                                                                                                      |     |
|----------|--------------------------------------------------------------------------------------------------------------------------------------|-----|
| Table 31 | Cost of Production Estimate for: Carbon Black N660<br>Process: Eurotecnica ET Black™, USGC, First quarter 2020 .....                 | 112 |
| Table 32 | Cost of Production Estimate for: Thermal Carbon Black N990<br>Process: Generic Thermal Black, USGC, First Quarter 2020 .....         | 116 |
| Table 33 | Cost of Production Estimate for: Acetylene Carbon Black<br>Process: Generic Acetylene Black, USGC, First quarter 2020 .....          | 117 |
| Table 34 | Cost of Production Estimate for: Carbon Black<br>Process: Kvaerner Carbon Black and Hydrogen Process, USGC, First quarter 2020 ..... | 118 |
| Table 35 | Typical Application by Carbon Black Grade .....                                                                                      | 122 |
| Table 36 | Key Physical and Thermodynamic Properties of Select Grades.....                                                                      | 124 |
| Table 38 | Carbon Black Capacity by Region.....                                                                                                 | 128 |
| Table 39 | Global Carbon Black Supply, Demand, and Trade .....                                                                                  | 129 |
| Table 40 | Carbon Black Capacity in North America .....                                                                                         | 130 |
| Table 41 | North American Carbon Black Supply, Demand, and Balance .....                                                                        | 131 |
| Table 42 | Carbon Black Capacity in Western Europe .....                                                                                        | 131 |
| Table 43 | Western Europe Carbon Black Supply, Demand, and Trade.....                                                                           | 132 |
| Table 44 | Carbon Black Capacity in Asia Pacific.....                                                                                           | 133 |
| Table 45 | Asia Pacific Carbon Black Supply/Demand Balance.....                                                                                 | 136 |
| Table 46 | Carbon Black Capacity in Rest of the World .....                                                                                     | 137 |
| Table 47 | Rest of the World Carbon Black Supply/Demand Balance .....                                                                           | 138 |



## TECHNOLOGY & COSTS

# Technoeconomics - Energy & Chemicals (TECH)

The NexantECA's 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: NexantECA Subscriptions  
Phone: + 1-914-609-0324, e-mail: mcesar@nexantECA.com

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

#### EMEA:

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

#### Asia:

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

NexantECA ([www.nexantECA.com](http://www.nexantECA.com)) is a leading management consultancy to the global energy, chemical, and related industries. For over 38 years, NexantECA 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. NexantECA has its main offices in White Plains (New York), and London (UK), and satellite offices worldwide.

Copyright © by NexantECA 2020. All Rights Reserved.