

High-Performance Carbon Fiber

Science & Technology Management Department, CNPC

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CHINA NATIONAL PETROLEUM CORPORATION

*Carbon Fiber of CNPC High Performance
everywhere,
in the air, on the land, under the sea!*





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China National Petroleum Corporation (CNPC) is a state-authorized investment agency and a state holding company. On July 1998, with the implementation of the Institutional reform of the State Council, CNPC was reorganized to become an integrated oil company of cross-regions, cross-industries and cross-countries, it adopts modern enterprise system to realize the integrations of upstream and downstream operations, internal and external trade, production and marketing. CNPC's business covers six main sectors: oil and gas operations, petroleum engineering service, petroleum engineering construction, petroleum equipment manufacturing, financial services and new energy development. In 2014 CNPC produced 113.67 million tons of crude oil and 95.46 billion cubic meters of natural gas, while crude processing volume reached 150.2 million tons. The total revenue of RMB 2,730 billion with a profit of RMB173.4 billion had been achieved the same year.

CNPC was ranked 3th among the world's largest 50 oil companies and 4th in Fortune Global 500 in 2014.

CNPC strictly follows by the combined strategies of increasing resource capacity, expanding market shares and consolidating the international role, and persists in regarding technical innovation as a key framework to advance technological progress. To develop its core businesses, focuses will be placed on the solutions of key bottleneck technologies and key proprietary technologies. Thanks to continuously improving of the technical innovation system, optimizing the configuration of technological resources and strengthening the construction of strong talent teams, CNPC's technological creativity has been considerably upgraded. Consequently, a large number of technologies have been developed independently, with its own intellectual property.

High-performance Carbon Fiber is one of representatives for major innovations of CNPC.

OFFERING ENERGY SOURCES, CREATING HARMONY

1

INTRODUCTION

1.1 Carbon Fiber

Carbon fiber is the inorganic polymeric fiber with carbon content over 90%. It combines inherent properties of carbon materials and softness and processibility of textile fiber.

Superior performance of composite material produced by compositing carbon fiber with various matrices includes high specific strength, high specific modulus, high temperature resistance, low coefficient of thermal expansion.

Composite materials of carbon fiber resin has a tensile strength over 3500Mpa which is 7~9 times of that of steel, and specific strength over 2000MPa/(g/cm³) which is 33 times of that of A3 steel.

1.2 Types of Carbon Fiber

Series with high strength: T300, T700, T800, T1000

Series with high modulus: M30, M40, M46, M50, M60

Series with high strength and high modulus: M40J, M50J, M60J, M70J

Series product by CNPC: JHT35 (T300), JHT45 (T700), JHT55 (T800)



1.3 Purpose of Carbon Fiber

In aviation and aerospace fields: Specific strength and specific stiffness of carbon fiber allow lighter aircrafts and spacecrafts.



Application in Sports and Leisure Fields



Vehicle

Wind power

Oilfield

Oilfield

General Application in Industrial Fields

2

UNIQUE
PRODUCTS

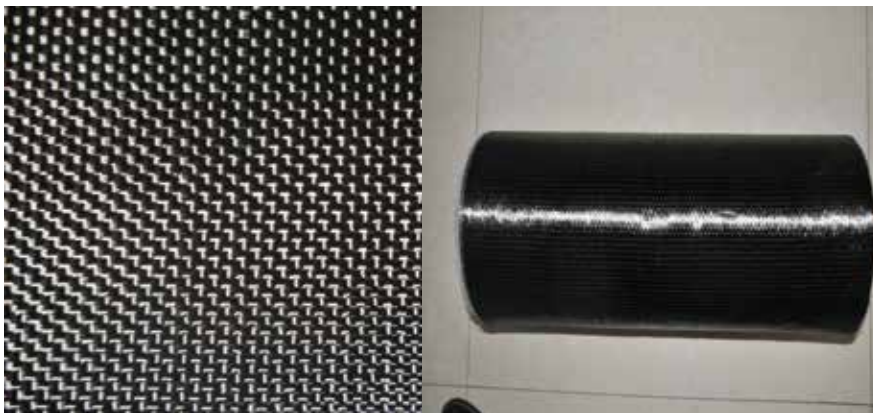
2.1 Products of Carbon Fiber by CNPC

Mechanical Properties	Specification	Linear Density (g/m)	Linear Density (g/m)	Tensile Strength (Gpa)	Tensile Strength (Gpa)	Tensile Modulus (Gpa)
JHT30	3K	0.198±0.006	1.78±0.02	≥ 3.00	≥ 1.0	≥ 220
	6K	0.400±0.012				
	12K	0.800±0.040				
JHTD30	12K	0.480±0.050	1.79±0.02			
JHT35	3K	0.198±0.006	1.78±0.02	≥ 3.50	≥ 1.4	≥ 220
	6K	0.400±0.012				
	12K	0.800±0.040				
JHTD35	12K	0.480±0.050	1.79±0.02			
JHT40	3K	0.198±0.006	1.78±0.02	≥ 4.00	≥ 1.6	≥ 220
	6K	0.400±0.012				
	12K	0.800±0.040				
JHTD40	12K	0.480±0.050	1.79±0.02			
JHT45A	12K	0.800±0.040	1.78±0.02	≥ 4.50	≥ 1.9	≥ 220
JHTD45A	12K	0.480±0.050	1.79±0.02			
JHT45	12K	0.800±0.040	1.78±0.02	≥ 4.90	≥ 1.9	≥ 220
JHTD45	12K	0.480±0.050	1.79±0.02			
JHT55A	12K	0.445±0.012	1.79±0.02	≥ 5.00	≥ 1.9	≥ 270
JHT55	12K	0.445±0.012	1.79±0.02	≥ 5.49	≥ 1.9	≥ 270

2.2 Subsequent Products of Carbon Fiber



Prepreg Product of Carbon Fiber



Carbon Fiber Sheet

3 R&D EQUIPMENT

CNPC possesses a national carbon fiber Engineering technical research center, key laboratory of carbon fiber, carbon fiber research institution and carbon fiber plant, which support research and development, technical service, production and operation.

Carbon fiber pilot plant and carbon fiber production facilities of hundreds-ton.



Pilot plant



Production facilities



Analyzing and Experiment Instrument

Possess analysis laboratory equipped with advanced equipments, establish analytical standards for raw materials, central control and products.



Analyzing and Experiment Instrument

Established production procedures and quality control system for carbon fiber and raw silk, which ensure stable production of T300 carbon fiber and raw silk.

4 QUALIFICATIONS & STANDARDS

CNPC applied for over 20 patents of invention in carbon fiber field, possesses 21 technical secrets, compiled Production of PAN-based Carbon Fiber, over 50 papers published, established 20 technical standards. In 2008, passed certification of ISO 2000 Quality Management System.



In 2009, National Carbon Fiber Engineering Technical Research Center was Established at CNPC.

4.1 Applied for 21 Patents

List of Patents

No.	Patent Titles	Application No./Patent No.
1	A pot for deaeration of spinning solution of polyacrylonitrile raw silk used for carbon fiber	ZL200910238553.X
2	A pot for deaeration of spinning solution of polyacrylonitrile raw silk used for carbon fiber	200910238554.4
3	A method for cooling and treating carbon fiber at outlet of carbonization furnace	200910238555.9
4	A method and plant for carbonization and prepreg of polyacrylonitrile raw silk used for carbon fiber	200910238556.3
5	A method and plant for incineration processing of waste gas from production of carbon fiber	200910238557.8
6	An intermittent polymerizing pot for spinning solution of polyacrylonitrile raw silk used for carbon fiber	ZL 200910238558.2
7	A plant for electrolytic anode oxidation at surface of carbon fiber	200910238559.7
8	A system for wet spinning coagulation of polyacrylonitrile raw silk used for carbon fiber	ZL200910238560.X
9	A plant and sealing method for steam draw of polyacrylonitrile raw silk under dwell pressure	200910238562.9
10	A method and plant for water washing of polyacrylonitrile raw silk used for carbon fiber	200910238561.4
11	A method for preparing polyacrylonitrile fiber used for carbon fiber	200410087319.9
12	A spinneret plate for dry-jet wet spinning of PAN raw silk for producing high-performance carbon fiber	2011101475860
13	A method and tractor for fiber passing through low temperature carbonization furnace during production of carbon fiber	ZL201120293791.3

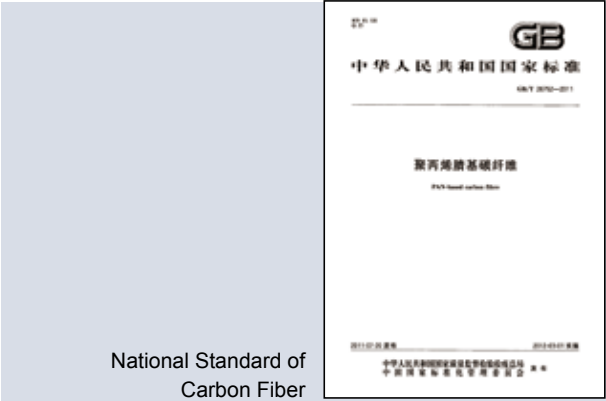
No.	Patent Titles	Application No./Paten No.
14	A method for quick separation of fiber passing oxidizing furnace during production of carbon fiber	ZL201120293735.X
15	A method for treating surface of new carbon fiber	201010246016.2
16	A washing plant for graphite guide roller in anode electrolytic oxidation tank of carbon fiber	ZL 201020513925.3
17	Corrosion resistant stainless steel guide roller in carbon fiber electrolytic tank	ZL 201120038304.9
18	A burner for heat preservation in pre-oxidation	201020570802.3
19	A high efficient sampling device for testing fiber density	ZL 200920277710.3
20	A charge pipe for feeding acrylonitrile polymerization initiator	201220380297.5
21	A plant for circulation and steady flow in coagulating bath of polyacrylonitrile raw silk	201220366067.3

4.2 19 Technical Secrets

List of Technical Secrets

No.	Technical Secret
1	Technology of Dual Yarn Draw in High Temperature Carbonization Furnace
2	Technology of Anti-blocking in Recovery of Acrylonitrile Monomer
3	Technology for Treating Yarn Splice during Oxidation
4	Technology for Modular Off-line Yarn Changing
5	Waste Gas Slit in Low Temperature Carbonization Furnace
6	Technology for Improving Hydrophilism of Macromolecule of Polyacrylonitrile
7	Technology for Spewing Surface Treatment
8	Procedure of PAN raw silk Coagulation
9	Technology for Removing Monomer in Spinning Solution
10	Technology for Cleaning Spinning Solution Filter

No.	Technical Secret
11	Technology for raw silk Draw
12	Technology for Water Washing of raw silk
13	Technology for Coagulation of Spinning Solution
14	Structure Design of Spinneret Plate for Dry-jet Wet Spinning
15	Technology for Treating Spinneret Jetting
16	Technology for Cooling and Treating Fiber at Outlet of Carbonization Furnace
17	Technology for Treating Surface of Electrolytic Anode Oxidization
18	Technology of Prepreg for Carbonization
19	Technology for Energy Conservation in Waste Gas Incineration



5 EXPERT TEAM

From small scale tests to pilot tests until industrialization, CNPC R&D team is dedicated and developed packaged technologies in PAN-based carbon fiber and raw silk by DMSO method and series of products of JHT35/JHT45/JHT55.

Consists of 2 senior experts from CNPC, 3 experts from local branches, 4 PhD, 24 masters, 98 undergraduates; 33 with senior professional title, 65 with intermediate professional title, the carbon fiber team has strong talent basement and complete speciality.



Cai Xiaoping

Professorial senior engineer. He has been dedicated in research in carbon fiber and raw silk. He participated in a number of research projects including national “863” and projects from the Ministry of Science and Technology. 20 papers published and 19 patents of invention granted.

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Professorial senior engineer. He has been dedicated in research in carbon fiber and raw silk. He participated in a number of research projects including national “863” and projects from the Ministry of Science and Technology. 10 papers published and 10 patents of invention granted .

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