



SEW Tubing Casing Annulus Manufacturing Technology

Science & Technology Management Department, CNPC

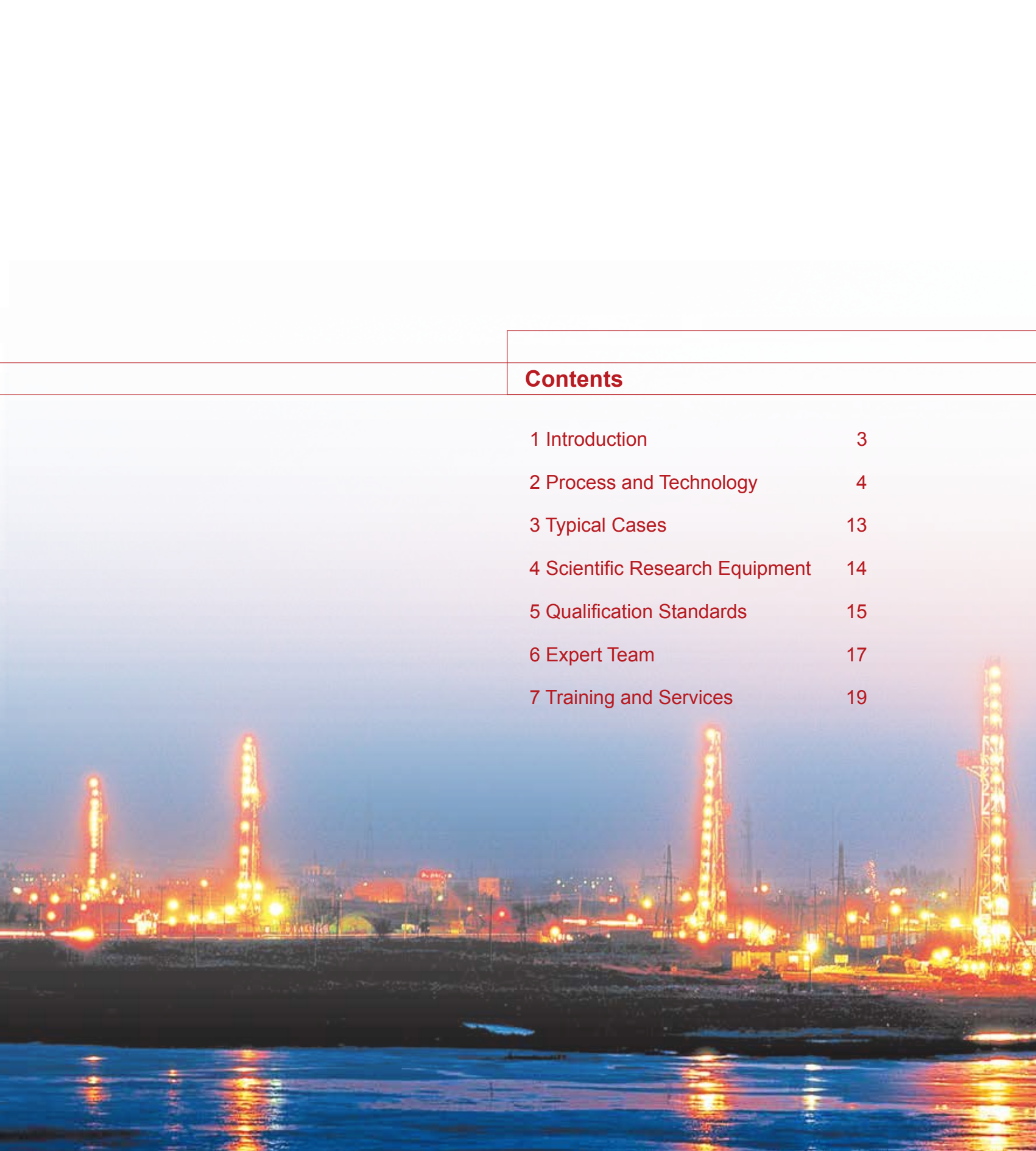
2015



CHINA NATIONAL PETROLEUM CORPORATION

*SEW Tubing Casing Annulus : New Generation
Special Energy-saving Petroleum Pipe with
Low Consumption!*





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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.

SEW tubing casing annulus manufacturing technology is one of representatives for major innovations of CNPC.

OFFERING ENERGY SOURCES, CREATING HARMONY

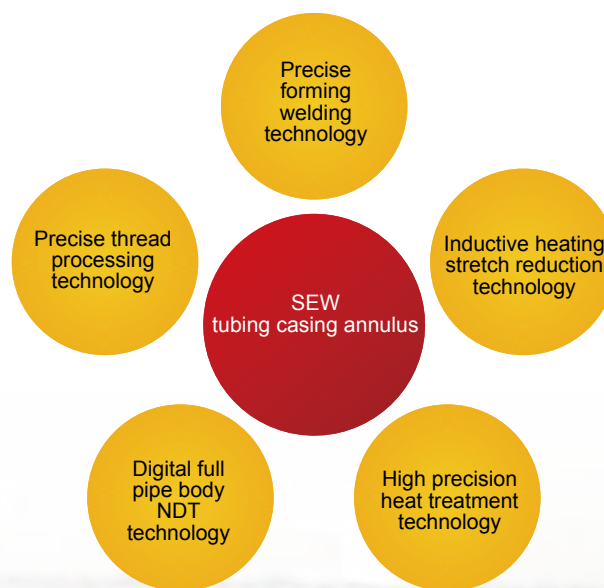
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INTRODUCTION

SEW tubing casing annulus are the abbreviated of Hot Stretch reducing Electric Welding casing and tubing. The manufacturing technology integrates the advantages of HFW welding pipes and seamless steel pipes. The combined technology including “HFW welded pipe technology+ tubular product hot mechanical rolling technology” is used; continuous rolling of the fully heated (completely austenitized) HFW mother pipe is performed for multiple rounds; after subsequent heat treatment and tube machining, high-performance SEW tubing casing annulus are finally manufactured. Compared with seamless tubing casing annulus, SEW tubing casing annulus have advantages such as uniform wall thickness, good tenacity and strong anti-collapse capacity and can remarkably reduce the comprehensive production cost of oil wells. SEW tubing casing annulus technology is an advanced tubing casing annulus manufacturing technology which has been widely used internationally at present.

BSG has internationally advanced SEW tubing casing annulus manufacturing technology, can manufac-

ture high-performance tubing casing annulus meeting the requirements of API standards and non-API standards, is devoted to providing services to domestic and foreign oil and gas exploration and development, and provides customers with better products and services.

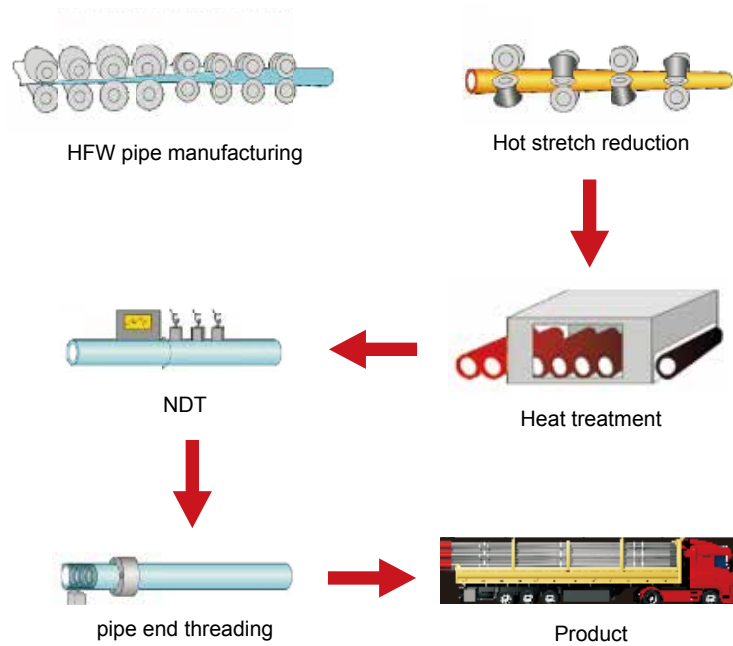


2 PROCESS AND TECHNOLOGY

◆ SEW tubing casing annulus

SEW tubing casing annulus have good comprehensive performance and can solve common problems including breakage, detachment, collapse, etc. The core technologies include:

◆ Main technological schemes

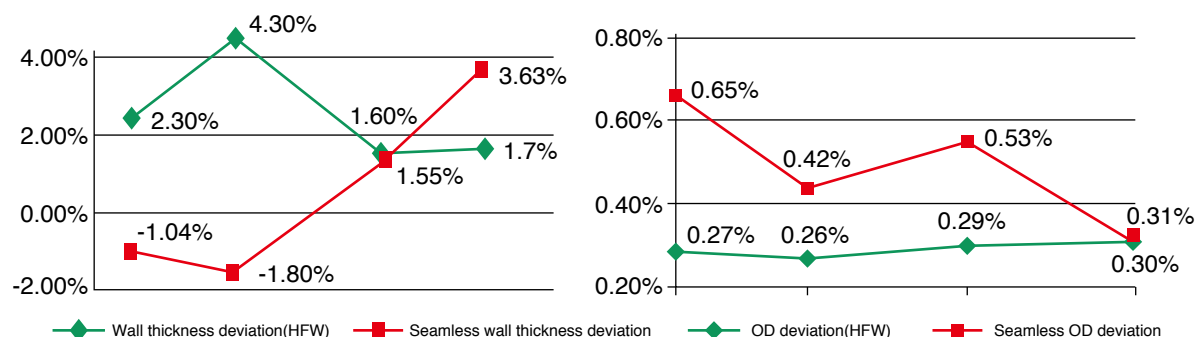


API series	
Steel grade	J55, N80, L80, T90, C95, P110, Q125
Steel pipe OD	ϕ 60.3 ~ 177.8 mm
Steel pipe wall thickness	4.83 ~ 13.72 mm
Steel pipe length	8000 ~ 12500 mm
Executive standard	API SPEC 5CT
Ultra-high strength series tubing casing annulus	
Steel grade	BSG-130, BSG-140, BSG-150
Non-API series	
Steel pipe OD	60.3 ~ 177.8 mm
Steel pipe wall thickness	4.83 ~ 13.72 mm
Steel pipe length	8000 ~ 12500 mm
Executive standard	API SPEC 5CT, BSG standard
High-tenacity series tubing casing annulus	
Steel grade	BSG-80L, BSG-90L, BSG-110L, BSG-125L
High-collapse strength series tubing casing annulus	
Steel grade	BSG-80T, BSG-80TT, BSG-90T, BSG-90TT, BSG-110T, BSG-110TT, BSG-125T, BSG-125TT
Anti-sulfur series tubing casing annulus	
Steel grade	BSG-80S, BSG-90S, BSG-110S, BSG-125S

◆ Precise forming welding technology

The precise forming welding technology is the combination of finite element high-rigidity roll forming technology with high carbon equivalent high-frequency welding technology. The high precision band steel manufactured with TMCP technology is rolled using the multi-roller forming technology as per the finite element design, so that the band steel is coiled gradually and forms a round pipe billet with opening clearance; by adjusting squeeze rollers, welding seam clearance is precisely set and the ends of crater is

made to be flush. Control welding input energy in real time and realize precise forming welding depending upon the skin effect and proximity effect of alternating current. Control the key production process data such as plate edge quality, forming precision, high frequency welding parameter, etc. Forming precision is high and welding quality is stable and reliable, so that HFW welded pipe product is characterized by uniform steel pipe wall thickness and high geometric size precision. Compared with seamless steel pipes, this product has better anti-collapse property.



Forming equipment

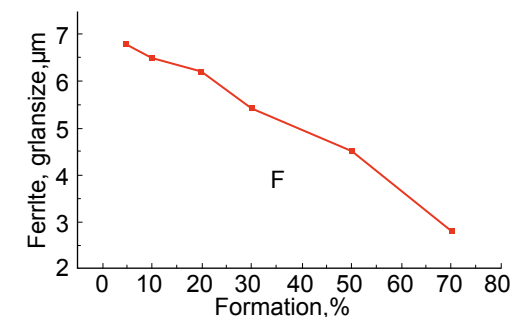
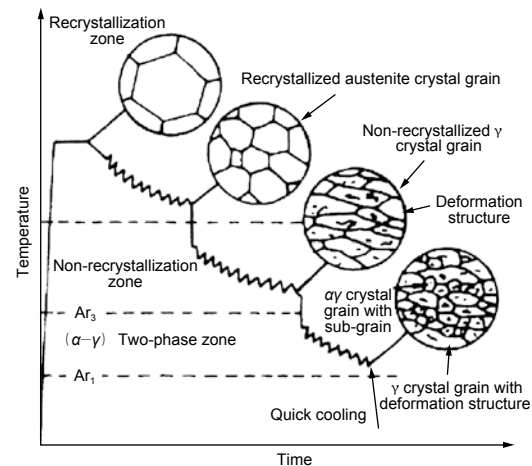
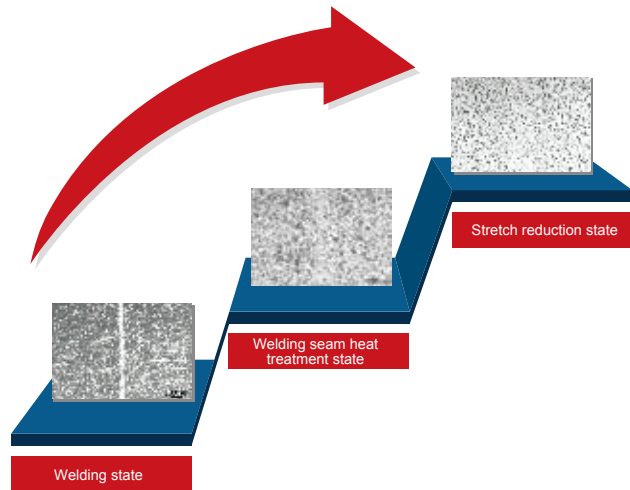
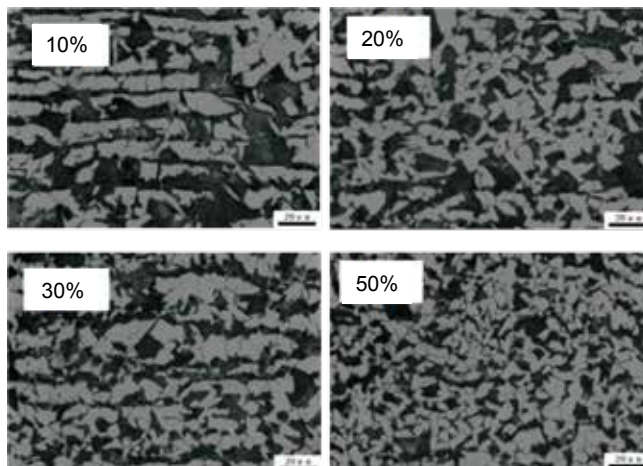


Welding equipment

◆ Inductive heating stretch reduction technology

The inductive heating stretch reduction technology is the combination of high-efficiency full digital electric inductive heating technology with single-roll driven multi-chassis tension rolling technology. Heat a high-precision and high-frequency welded mother pipe to over 850°C piecewise using large-power temperature-controlled electric induction coils; quickly enter a stretch-reducing mill to carry out longitudinal stretching and radial thinning or thickening of the mother pipe; after precise sizing, SEW pipe billets of different outer diameters and wall thicknesses are generated. Ensure precise rolling temperature using the servo closed loop heating temperature-control technology and finely control inter-roll tension and radial pressure using the single-roll adjustable rolling system, so that pipe billets have good appearance and inherent quality after stretch reduction. The product is characterized by fine crystal, high tenacity, small metallographic structure different and stable mechanical property.

The structure and crystal grains of the tubular product are further refined through hot mechanical rolling (950°C rolling).



Relation of deformation amount with crystal grain size



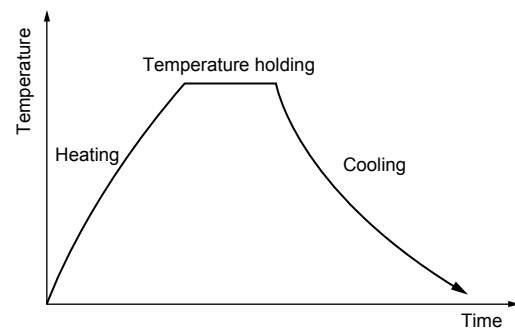
Hot stretch reduction equipment



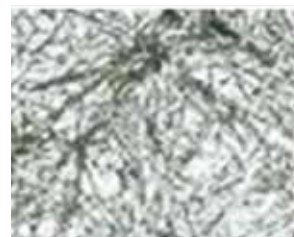
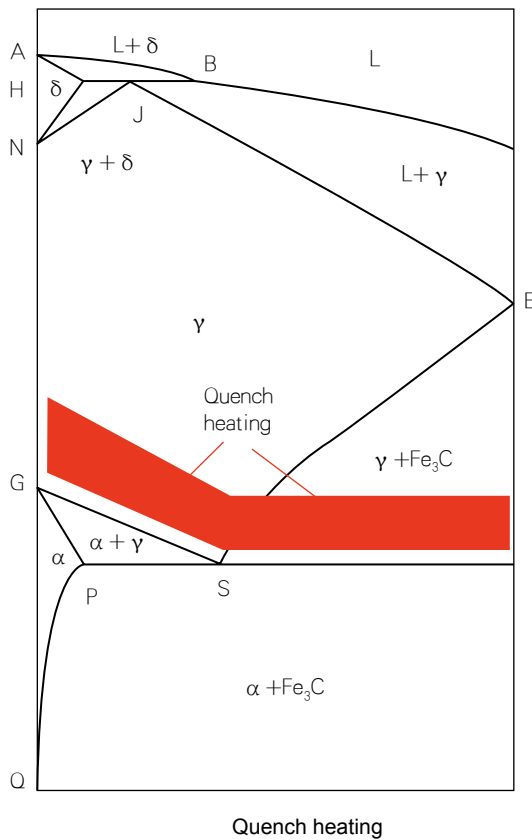
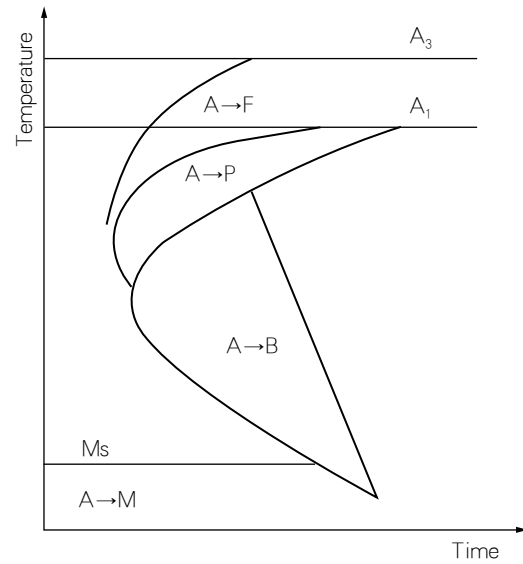
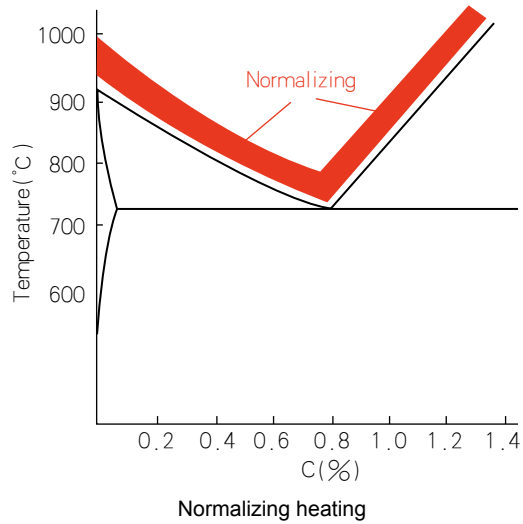
Cooling control equipment

◆ High precision heat treatment technology

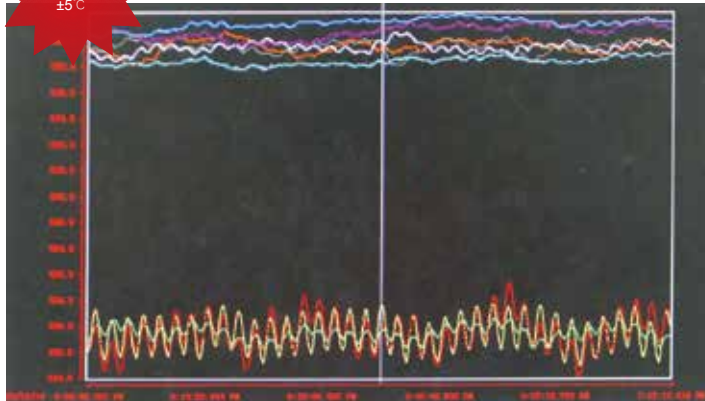
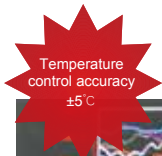
The high precision heat treatment technology is combination of normalizing, quenching and tempering. Pipe billets are heated to the process temperature precisely and according to different performance requirements of heat treatment pipe billets uniformly . Manufacture SEW pipe billets of different strengths using the processes such as air cooling, water quenching, tempering, straightening, etc. SEW pipe billets with high precision, high strength and high tenacity can be manufactured by precisely controlling temperature curve, temperature holding time, cooling and straightening parameters.



Heat treatment process schematic



Typical structure



Tempering furnace temperature curve

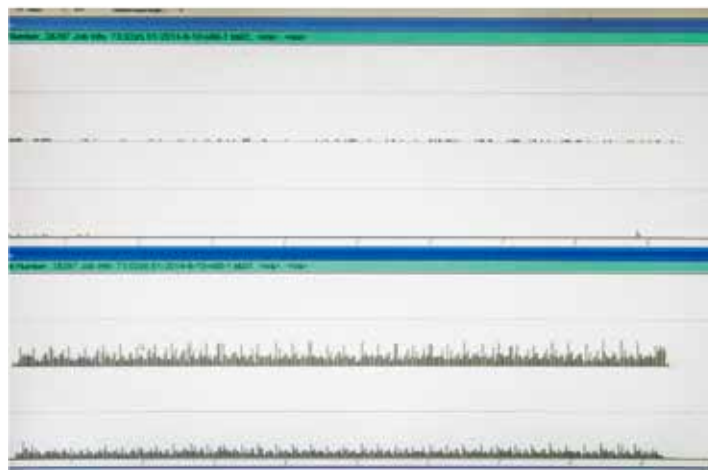


High precision heat treatment

◆ Digital full pipe body NDT technology

The digital full pipe body NDT technology is combination of full pipe body magnetic leakage detection, full pipe body UT and pipe end magnetic particle inspection technologies. Carry out full-coverage magnetic leakage detection and UT of SEW pipe billets according to technological requirements.

Carry out magnetic particle inspection of the blind area of pipe end to ensure that over 100% testing covers high precision full pipe body. Fundamentally ensure the accuracy and reliability of the NDT result of SEW pipe billets through precise control of sample pipe calibration precision and high-frequency online verification of testing equipment. The NDT precision reaches international advanced level.





Full pipe body UT method

Technical method	Parameter
Pipe end blind area testing	Flat end pipe ≤ 150mm (longitudinal, thickness measurement) 150mm+2 × wall thickness path length(3 wall thicknesses) End upsetting pipe: actual upsetting length + 200mm
Number of ultra-sonic probes	27
Max flaw detection speed (longitudi-nal, transverse, thickness mea-surement /layer-ing)	0.6m/s
Separate testing of inner and outer flaw zones	Longitudinal: ≥ 4mm; transverse: ≥ 7mm (dependent upon the selected probe size as required by flaw detection)

Full pipe body MFL testing method

Technical method	Parameter
Ambient sensitivity difference control	Longitudinal (MFL) ±1.5dB (3 times) Transverse (MFL) ±2 dB (3 times)
Pipe end blind area testing	No larger than 200mm for flat head pipe at 1m/s; No larger than 230mm at 2m/s; For an upsetting pipe, the value of the blind area is the above value + upsetting end length
Separate testing of inner and outer flaw zones	≥ 6mm
Number of testing channels	32 (longitudinal) 24 (transverse)

◆ Precise thread processing technology

The precise thread processing technology is the combination of finite element thread design technology, high-speed, large power and high precision thread processing technology and testing technology. According to the requirements of the thread design technology, the international first-class thread processing technology is used to carry

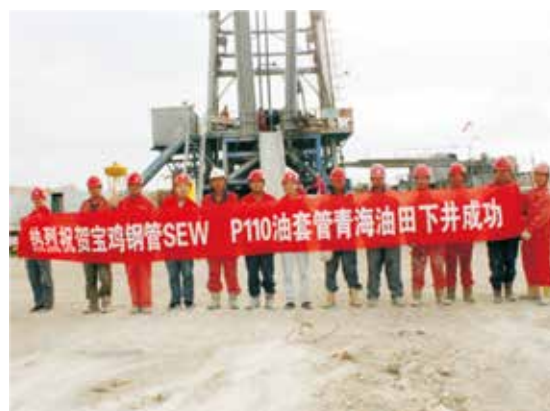
out thread processing, testing, collar tightening and connection, water pressure test, thread protector processing, etc. of SEW pipe billets. Ensure high precision, high quality and high stability of thread processing by controlling the process data including thread processing parameter, surface smoothness, tightening torque, hydraulic test pressure, etc. The thread processing precision of SEW tubing casing annulus can reach to 0.01mm.



3 TYPICAL CASES

◆ SEW tubing casing annulus running operation

J55, N80 and P110 SEW tubing casing annulus have been run in hole under different geologic conditions in China's oilfields such as Daqing, Changqing, Jilin, Qinghai, Tuha, Jiangnan, Yanchang, Xinjiang, Jidong, etc. The application effect is good.



◆ Popularization and application of SEW tubing casing annulus

Till the end of 2013, over 56000 tons of SEW tubing casing annulus had been used in China. In addition, SEW tubing casing annulus have been exported to multiple countries such as Russia, South Korea, Mexico, Columbia, US, etc., and their quality and excellent performance have been unanimously approved by customers.

4 SCIENTIFIC RESEARCH EQUIPMENT

National Oil and Gas Pipe Engineering Research Center was set up in BSG. BSG has over 60 pieces (sets) of special tubing casing annulus performance

testing equipment with international advanced level, thus ensuring stable and reliable quality of SEW tubing casing annulus products.



Make-up and break-out equipment



Heat treatment equipment



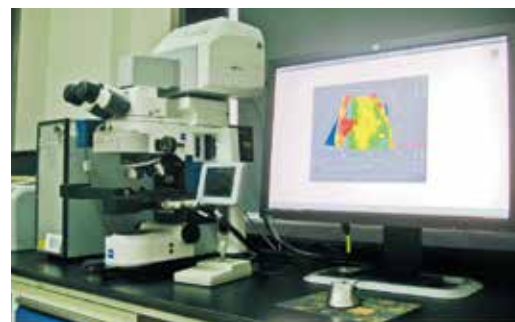
Composite loading equipment



Internal collapse equipment



Thermal simulation tester



Laser microscope

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先后取得了美国石油协会 API5CT、挪威船级社 (DNV) ISO9001 证书。



All products have passed the testing and certification by the third party : the only state-authorized tubing casing annulus testing unit in China National Quality Supervision and Inspection Center of Petroleum Tubular Goods.

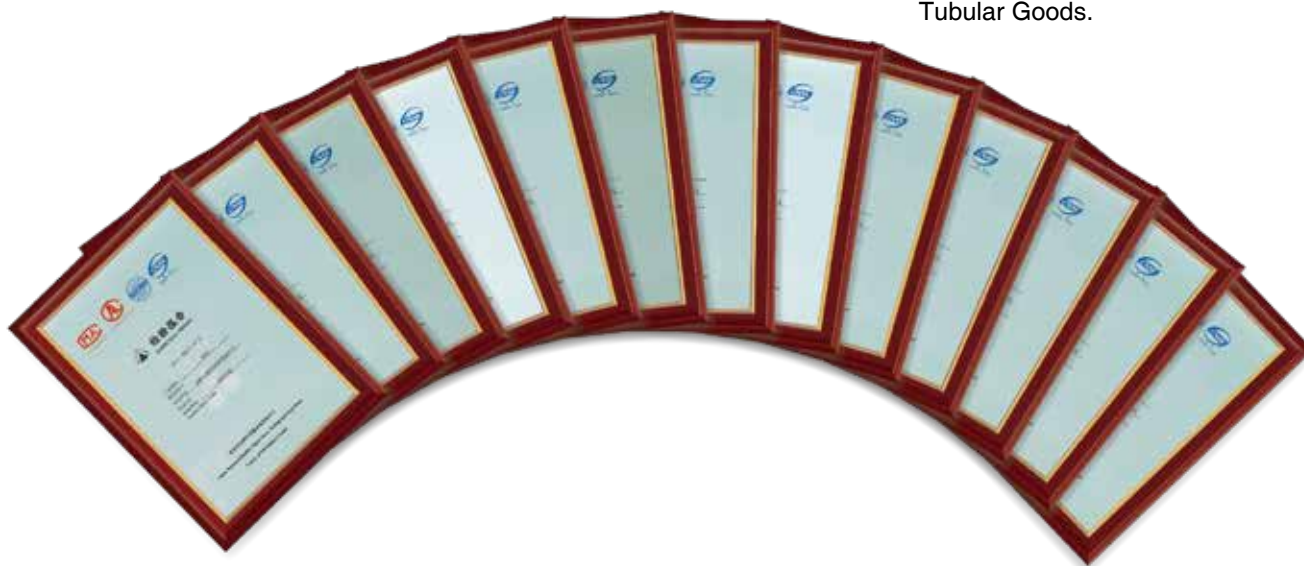




表 12 静水压力试验失败试验数据		
试验编号	试验压力 (MPa)	失效位置
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13	静水压力 120.5	失效位置: 失效位置
14	静水压力 49.0	失效位置: 失效位置
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Patent

Patent name	Patent type	Remarks
A round thread metal seal pipe thread connecting structure based on API standard	Utility model patent	Application No. 201020641460.X
A petroleum casing thread connecting structure with good air-tight sealing property	Utility model patent	Application No. 201120036268.2
A manufacturing method for P110 straight welded pipes	Invention patent	Application No. 201110421067.9
A high-collapse strength SEW petroleum casing and its manufacturing method	Invention patent	Application No. 201110427453.9
A method for optimizing HFW welded pipe seam structure and performance	Invention patent	Application No. 201110427453.4
An online controlled cooling method and device for increasing robustness of HFW welded pipes after hot rolling	Invention patent	Application No. 201310093389.4
A high-performance SEW expansion casing with low carbon micro-alloyed steel content and its manufacturing method	Invention patent	Application No. 201310093146.0
A corrosion-resistant high-collapse strength petroleum casing and its manufacturing method	Invention patent	Application No. 201310111616.1
An 80Ksi petroleum casing resistant to H ₂ S corrosion and its manufacturing method	Invention patent	Application No. 201310150513.6
A high-strength high-tenacity petroleum casing and its manufacturing method	Invention patent	Application No. 201310150588.4
An air-tight seal joint structure for SEW tubing casing annulus based on round thread	Utility model patent	Application No. 201320220541.6
A high temperature external pressure device for full-scale evaluation of petroleum tubular goods	Invention patent	Application No. 201310150586.5

6

EXPERT TEAM



Li Helin

Academician of the Chinese Engineering Academy, Director of the Technical Committee of National Oil and Gas Pipe Engineering Research Center, professor level senior engineer, Ph.D. doctor, expert in mechanical engineering materials and petroleum pipe engineering. He has been long engaged in science and technology research on steel for petroleum and petroleum pipe engineering. He is one of pioneers in China's oil and gas tubular goods field. He has taken charge of development over 10 new materials. 23 achievements of which he took charge were awarded with provincial and ministerial science and technology advance prizes. 7 monographs and over 170 papers written by him have been published.

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Ding Xiaojun

Senior technical expert, professor level senior engineer, Ph.D. candidate supervisor. He has taken charge of and participated in multiple national "863" projects and CNPC's major scientific research projects. He has obtained 12 national, provincial and ministerial science and technology prizes and 10 patents. Over 20 papers written by him have been published in journals.

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Lei Shengli

Senior technical expert, professor level senior engineer, Ph.D. candidate supervisor. He has taken charge of and participated in completing multiple national and CNPC's major scientific research projects. He has obtained 8 national, provincial and ministerial science and technology prizes and 5 patents. Over 20 papers and 1 monograph written by him have been published.

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Yang Zhongwen Senior technical expert, professor level senior engineer, Deputy Director of Welded Pipe journal, member of National Specialized Standardization Technical Committee, member of Special Tubular Goods Standard committee of CPS. He has taken charge of completing over 10 scientific research projects. He has drafted and translated over 20 international standards, national standards and industrial standards. 17 papers written by him have been published. He has obtained 9 provincial and ministerial science and technology prizes and 17 technology patents.
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Su Qi Senior technical expert, senior engineer. He has taken charge of and participated in over 10 CNPC's major scientific research projects. He has participated in drafting of multiple national petroleum steel pipe manufacturing industry standards. He has obtained 6 CNPC science & technology advance prizes.
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Email: bsgsq@cnpc.com.cn



Bi Zongyue Senior technical expert, doctor. He has taken charge of and participated in completing over 10 major scientific research projects. Over 30 papers written by him have been published. He has drafted 4 standards. He has obtained 10 provincial and ministerial prizes and 15 patents.
Tel: 0917-3398475
Email: bsgbzy@cnpc.com.cn

7

TRAINING AND SERVICES

Domestic Trade

General Sales Company
Tel: 0917-3398586 3399087
Fax: 0917-3398629

Xinjiang Sales Company
Tel: 0991-4889362
Fax: 0991-4889362

Southwest Sales Company
Tel: 028-26395068
Fax: 028-26395065

International Trade

International Trade Department of
General Sales Company
Tel: 0917-3398573 3398516
Fax: 0917-3398590

Beijing Office
Tel: 010-84378085 84378792
Fax: 010-84378798

Beijing Office
Tel: 010-84378793 84378792
Fax: 010-84378798

Zhongyuan Sales Company
Tel: 0317-86617303
Fax: 0317-86617303

Huadong Sales Company
Tel: 021-51798018
Fax: 021-56921979

Shanghai Office
Tel: 021-51798018 51798006
Fax: 021-56921979

Xi'an Sales Company
Tel: 029-86181638
Fax: 029-86181638

Northeast Sales Company
Tel: 0419-3663562 3663549
Fax: 0419-3663548

Huabei Sales Company
Tel: 0335-5353036 5353236
Fax: 0335-5353038

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