

Research article

The core pipeline equipment localization process and application prospects in China

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Abstract

To improve the economic efficiency of gas pipelines, core equipment such as compressor sets and large-diameter valves must be localized. For this purpose, in alliance with other related enterprises, PetroChina Company Limited established an equipment localization R&D system and a new product testing system and successfully developed a 20 MW class motor-driven compressor set, a 30 MW-class gas turbine-driven compressor unit, and a high-pressure and large-diameter welded ball valve. First, the motor-driven compressor R&D focuses on three main units. The developed frequency-control device structure is a cascaded multilevel with a capacity of 25 MVA. The developed anti-explosion dynamo with a motor speed of 4800 rpm can produce a power of 22 MW. The developed compressor is PCL800 with features of a high efficiency and a wide flow-operating point-adjustment range. Second, there are two steps of the R&D of a GT-driven compressor unit (product A + product B): auxiliary supporting systems and control systems are developed for the imported GT25000 gas turbine, together with China-made compressors, to constitute product A; simultaneously, the R&D of product B of a gas turbine is carried out, which would replace the imported one. Third, aiming to solve the problems of sealing and welding, we developed the high-pressure and large-diameter all-welded ball valves in full replace of the same kind of imported products with three different sizes: NPS40 Class 600, NPS48 Class 600, and NPS48 Class 900.

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According to statistics, 99% of the onshore natural gas in the world is transmitted via pipelines. In China, the construction of gas pipelines commenced in the 1970s, but the development was slow. Since 2000, represented by West-East Gas Pipeline I, the construction of gas pipelines has entered a rapid development period, with the accumulative mileage of pipelines put into operation exceeding 16 000 km. During the 12th Five-year Plan period, the construction of gas pipelines in China has ushered in a new peak, e.g. West-East Gas Pipelines II and III, and Myanmar-China Gas Pipeline have been constructed successively. It is expected that the mileage of

pipelines to be put into operation will be more than 21 000 km (exclusive of urban pipe networks), exceeding the total mileage in previous years. These pipelines connect China's four major gas field areas (namely Tarim, Qaidam, Changqing and Sichuan-Chongqing), imported LNG receiving stations in coastal areas and the neighboring regions like Central Asia, Russia and Myanmar, and take underground gas storage as the supporting means for peak regulation and gas storage [1], forming a new pattern for gas pipelines in China (Table 1). It can be found through comprehensive survey that, modern gas pipelines have the following technical characteristics, namely high transmission pressure grade (the transmission pressure of most pipelines is 10 MPa or 12 MPa), high steel grade (X70 steel and X80 steel are widely used) [2,3], and high transmission flow rate (the flow rate of trunk pipelines is more than

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Table 1
Main gas pipelines put into operation by PetroChina and parameters thereof.

Name of pipeline	Mileage/km	Pipe diameter/mm	Designed transmission annual capacity (10^8 m^3)
Shanxi-Beijing Gas Pipeline II	983	1016	170
Shanxi-Beijing Gas Pipeline III	894	1016	150
Trunk Line of West-East Gas Pipeline I	3836	1016	170
Branch Line of West-East Gas Pipeline I	540		
Trunk Line of Hebei-Ningxia Pipeline	886	711	110
Branch Line of Hebei-Ningxia Pipeline	366		
Jiangsu LNG (Rudong-Jiangdu)	222	1016	135
Trunk Line of Western Section of West-East Gas Pipeline II	2434	1219	300
Trunk Line of Eastern Section of West-East Gas Pipeline II	2477	1219	280
Branch Line of West-East Gas Pipeline II	4210		
Zhongwei-Guiyang Connecting Line	1074	1219	150
West-East Gas Pipeline III	5220	1219	300
Myanmar–China Gas Pipeline	2638	1016	120

$100 \times 10^8 \text{ m}^3/\text{a}$). If the above-mentioned technologies are adopted, a compressor station composed of 2–4 compressor sets shall be set up on trunk pipelines at the interval of 150–170 km [4,5], so as to maintain high-pressure and large-flow transmission; and a valve chamber shall be set up at the interval of 30 km, so as to cut off the pipeline in case of emergency and maintenance. With the gradual promotion of natural gas as a kind of clean energy in industrial and civil applications in China, PetroChina Company Limited (hereinafter referred to as “PetroChina”) will, in accordance with the strategic energy planning of China, construct West-East Gas Pipelines III IV and V, as well as several underground gas storages. And these major projects will have huge demands on high-speed directly-connected frequency-conversion speed-regulating centrifugal compressor sets, high-speed gas turbine-driven centrifugal compressor sets, natural gas engine-driven reciprocating compressor sets, motor-driven reciprocating compressor sets and high-pressure large-diameter welded ball valves [6].

At present, however, the core technologies, pricing rights and subsequent technical services of the above-mentioned equipment are held by a few developed countries. Therefore, to carry out the localized research, manufacturing, promotion and application of relevant equipment is imperative for not only the gas pipeline enterprises but also the equipment manufacturers.

1. Significance of gas pipeline equipment localization under new situations

1.1. To conform to the requirements of the national policies about pipeline equipment localization

Over recent years, for promoting the development of equipment manufacturing industry, China has issued a series of planning outlines and measure documents, including the *Several Opinions of State Council on Accelerating Revival of Equipment Manufacturing Industry* (2006), and the Circular on Import Tax Policies for Implementation of the Several Opinions of State Council on Accelerating Revival of

Equipment Manufacturing Industry (2007), and has clearly given in the approval documents the requirements on gradual localization of steel pipes, booster sets and large-diameter valves in the approval documents for gas pipeline projects.

1.2. To guarantee the national energy security

China has preliminarily constructed the strategic passages for importing energy in northeast, northwest, southwest and coastal regions, but all the core equipment for gas pipeline transmission has to be imported. Under normal conditions, it is relatively easy for us to obtain the technical equipment, after-sales service and spare parts necessary for ensuring smooth operation of pipelines. However, once any abnormal situation occurs, the failure of compressor sets will reduce the transmission capacity of pipelines and even stop the gas transmission via pipelines and the production in gas fields, and the failure of valve chambers on pipelines may even directly stop the transmission and production. Therefore, to promote the localization of gas pipeline equipment is also of strategic significance for guaranteeing the national energy security.

1.3. To effectively increase the efficiency of gas pipeline industry

The operational reliability and economic efficiency of gas transmission pipelines to a great extent depends on the performance of compressor sets adopted. The investment of compressor stations accounts for 20%–25% of the total investment of gas transmission pipelines, and the operating expenses of compressor stations account for 40%–50% of the total pipeline operating expenses. The investment of compressor sets accounts for more than 50% of the total investment of compressor stations, and the energy consumption of compressor sets contribute to about 70% of operating expenses of compressor stations. Therefore, in the design of gas transmission pipelines, selecting the technically-advanced and economically-reasonable equipment and suppliers which can provide after-sales services with high performance-price ratio

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