Research on optimization of crude oil transportation development system in the Yangtze River based on transportation capacity regulation

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Abstract: Based on the Yangtze River macroeconomic regulation and control of hazardous cargo transportation market background, the article analyzes the economic and trade situation and policy environment of the crude oil transportation market in view of the contradiction between supply and demand of crude oil transportation in the Yangtze River, and analyses the future supply and demand development trend of the transportation capacity, puts forward the optimization of development plan and related recommendations for the Yangtze River inland crude oil transportation system.

1. General analysis of development of crude oil transportation in Yangtze River
In 2011, China's Ministry of Transport issued the notice on strengthening macro-control of the transport market for dangerous goods of the Yangtze River[1], strictly controlled the newly increased shipping capacity and operators, suspended the approval for new interprovince (except for special circumstances) shipping capacity for dangerous goods of the Yangtze River, accelerated the withdrawal of old and single-hull ships of dangerous goods from the market. Since the implementation of the capacity control policy, the Yangtze River cargo dangerous goods transport operators have substantially reduced. There were 272 operators in early 2012, but the number of operators decreased by 33% to 182 in the first half of 2017, the number of crude oil transport enterprises also dropped sharply to 10.

With the implementation of "One Belt and One Road" construction, Yangtze River economic belt strategy, Yangtze River golden waterway construction in recent years, the urbanization process of the Yangtze River basin has been accelerated, industrial clusters and industrial clusters along the river are developing rapidly. With the increase in demand and the release of production capacity, the crude oil transportation of the Yangtze River has maintained an overall sustained growth. However, the development situation in different regions is different: due to the gradual improvement of pipeline construction in the downstream areas, the crude oil transportation of waterways has remained stable overall. In the middle and upper reaches of the region, due to the limited coverage of crude oil pipelines, crude oil and waterway transportation continued to grow rapidly with industry concentration, demand growth and capacity release. Crude oil water transportation generally showed a net inflow situation: in 2016, the proportion of crude oil throughput of ports above the scale reached 74% and the proportion of crude oil outbound reached 26%. The crude oil transportation of the above-scale ports in the middle and upper reaches of the Yangtze River (except Wuhan port) shows a one-way inflow, which is also the main research scope of this paper, namely the three-way transportation of the crude oil of the Yangtze River.
2. Analysis on the development trend of Yangtze River crude oil transportation demand

Crude oil transportation in the Yangtze River Basin is undertaken by pipeline transportation and inland waterway transportation. The market demand for inland crude oil transportation is closely related to pipeline transportation capacity.

According to the "13th Five-Year Plan for Oil and Gas Development", the construction of offshore crude oil import channels in the "13th Five-Year Plan" of the Yangtze River Economic Belt is mainly concentrated in the lower reaches of the Yangtze River: Yichang Double Line YiZheng-JiuJiang Section, RiYi Transmission, Lianyungang-YiZheng Crude oil pipeline. However, the oil pipeline network in the middle and upper reaches of the Yangtze River has limited coverage and relatively weak pipeline capacity, especially in the upper reaches. Judging from the transportation capacity of the development plan of Oil Pipeline and the design capacity of major petrochemical enterprises along the Yangtze River, the demand for crude oil transportation still exceeds 35 million tons. In this context, with convenient water transportation conditions and economic advantages, the Yangtze River crude oil transportation faces good development opportunities.

According to the survey and analysis of major petrochemical enterprises, the enterprises that have already carried out waterway transportation will continue to increase the volume of crude oil that is planned to be transported by waterway in the next five years. In 2017, the transportation volume of crude oil in the Yangtze River reached about 5.3 million tons. According to the statistics of petrochemical enterprises and shipping companies, the demand for inland crude oil transportation in the Yangtze River by 2020 will exceed 6.6 million tons. That is, the increase in transportation demand will exceed 1.3 million tons, an increase of more than 25%.

Table 1. Main petrochemical production capacity and pipeline transport capacity

| Basin            | Statistics of major enterprises                                                                 | Design capacity | Pipe capacity | Demand gap |
|------------------|--------------------------------------------------------------------------------------------------|-----------------|---------------|------------|
| Upper Yangtze    | PetroChina Sichuan Petrochemical Co., Ltd., MeiShan AoXin Energy Technology Co., Ltd., China     | 1330            | 1000          | 330        |
| River            | Shipping Asphalt (Sichuan) Co., Ltd., Chongqing LongHai Petrochemical Co., Ltd.                    |                 |               |            |
|                  | China Petrochemical Corporation Wuhan Branch, JinAo Technology (Hubei) Chemical Co., Ltd., China | 3600            | 2000          | 1600       |
| Middle Yangtze   | Petrochemical Corporation ChangLing Branch, China Petrochemical Corporation Baling Branch, Hengyang |                 |               |            |
| River            | Petrochemical Logistics Co., Ltd.                                                                |                 |               |            |
3. Analysis on the development of transportation capacity of Yangtze River crude oil transportation vessels

Since the implementation of the Yangtze River crude oil transportation capacity control policy and capacity requirements, with the elimination of some small and medium-sized enterprises and the accelerated elimination of old and single-shell tankers, due to the shipping downturn and the lack of capital investment by ship owners, some of the dismantling and scrapping capacity has not been updated in time. The overall capacity of the Yangtze River crude oil transportation vessels in the market has dropped significantly. As of the first half of 2017, only one enterprise’s self-owned shipping capacity in the Yangtze River crude oil transportation was in compliance with the requirements.

![Figure 2. Distribution of crude oil barge age](image)

The total capacity of the Yangtze River crude oil transport vessel is about 250,000 gross tons. From the perspective of ship type, the tanker capacity of the Yangtze River crude oil transport ship accounts for about 30% and the barge capacity accounts for nearly 70%. The existing oil tankers mainly have 1,000 tons, 2,000 tons, 3,500 tons and 5,000 tons, of which 1000 tons of crude oil ships accounted for more than 60%. The main types of barges are 3,500 tons and 5,000 tons, of which 3,500 tons of crude oil accounted for 67%. In terms of age, the average age of crude oil tankers is about 12 years and the average age of crude oil barges is 24 years.

For the existing old barges, due to the relatively poor technical conditions, the ship inspection and other departments require mandatory special inspection every year, the maintenance and management costs are increasing day by day and the operating hours are reduced. By 2020, more than 40 crude oil barges will be over 26 years old and will not carry heavy oil. Some barges do not meet the specifications of the double-shell structure, there is a possibility of being stopped at any time. For small and medium-sized enterprises with unsatisfactory capacity, the risk of elimination will also be faced in the future[2]. At the same time, the existing ship operating rate and operating capacity are
basically close to the limit. For example, the operating rates of pushers and crude oil barges are 95% and 98% respectively. In addition, due to the reduced efficiency of the Three Gorges Gate, the cancellation of water transfer and the decline in the operating rate of old ships, the existing ship transportation capacity will decline in the future.

4. Analysis on Development Trend of Yangtze River Crude Oil Transportation Organization
The Yangtze River crude oil transportation organization mainly includes barge fleet transportation and tanker transportation. The barge fleet and tanker transportation can be divided into two voyages in general and the demarcation point is Chenglingji. From Nanjing to Chenglingji route, according to the current navigation conditions, the existing fleet of 14,000 tons will be fully loaded throughout the year, and the draft will have room for improvement. The current 5,000-ton tanker draught is restricted by the water depth conditions of the channel and the dry load period needs to be reduced by more than 20%. From the perspective of existing waterways and ship types, it is advisable to use the fleet transportation mode from Nanjing to Chenglingji. At present, in the Three Gorges reservoir area have no barge fleet mode and are all self-propelled ship transportation modes, which is mainly due to the limitation of insufficient water depth maintenance in the navigation channel, the high maneuverability requirements of the Gezhouba and the Three Gorges ship lock fleet, the difficulty in arranging the sluice and the difficulty to meet highly demanding fleet tug horsepower.

With the change of market environment in recent years, the transportation mode of crude oil fleets has been increasingly recognized by the market. The advantages of fleet transportation are mainly reflected in the following aspects:

1. Strong adaptability and conducive to large-scale transportation. Pushing fleet transportation has a strong adaptability to the water depth of the channel, which is of great significance for the realization of large-load transportation on the mid-upstream route with limited water depth (maintaining water depth of 4.0 m or less during dry season).

2. The overall economic advantage is significant. The transportation of the Yangtze River crude oil fleet is basically point-to-point transportation from the downstream to the middle and upper reaches. In the long-distance inland river transportation, the advantage of the barge unit's unit power tonnage can be exerted. According to the existing operation of the barge fleet and tanker from Nanjing to Chenglingji section, the profit of the fleet is more than double that of the tanker transportation mode.

3. Energy saving and efficient, green and environmentally friendly. According to the actual operation statistics of the existing barge fleet and tanker, the fuel consumption per unit of the fleet transportation mode is 4.1 (kg/kt.km), which is 31.7% lower than the fuel consumption per unit of fuel tank transportation 6.0 (kg/kt.km). The energy saving and emission reduction effect is very prominent, which is in line with the direction of green shipping development in the Yangtze River Economic Belt.

4. Market environment changes bring opportunities[3]. In recent years, the supply and demand relationship in the water transport market has reversed, demand growth has been weak, overcapacity has been severe. In addition to transformation and upgrading, water transport enterprises have become the first choice for enterprises. At the same time, some port terminals have been in surplus and idle capacity. All these provide favorable conditions for the development of barge fleet transportation.

5. Transportation industry policy guidance support.
From the direction of transportation industry policy guidance, Yangtze River crude oil transportation faces the opportunities of policy support. Released in August 2017, Guiding Opinions of the Ministry of Transport on Promoting the Development of Green Shipping in the Yangtze River Economic Belt, clearly put forward: support the development of a large liquid bulk cargo push fleet, and encourage port companies to give priority to the top-loading fleet to rely on preferential treatment such as berthing and priority loading and unloading[4].

5. Research on the matching of transport demand and transport capacity development
Based on the above analysis, combined with the investigation of relevant enterprises, the transportation gap will require more than 22 new ships and 97,000 deadweight tons by 2020.
addition, considering the unpredictable factors such as policy regulation, the lock of the Three Gorges ship lock, the cancellation of water transfer and the withdrawal of non-standard enterprises, the market traffic gap will require more than 30 new 4,000-ton barges by 2020.

Table 2. Transport capacity demand analysis

| Regions | Upper Yangtze River | Middle Yangtze River |
|---------|---------------------|----------------------|
|         | Sichuan             | Chongqing            | Hubei                |
| Traffic demand increment (10,000 tons) | 26                  | 36                   | 75                   |
| New demand | Ship type tonnage (tons) | 4000                | 4000                | 5000                |
|           | Annual average transport capacity of a single ship (10,000 tons) | 4.5                  | 5.2            | 8.5             |
|           | Required ship number | 6                    | 7                    | 9                    |
|           | Total number of ships |                     |                      | 22                  |
| Substandard ship capacity | Substandard capacity (GT) | 35459               |                      |
|           | Number of new barges to be built (5000t) |                     | 7                    |
| Ship capacity to update at the end of "13th Five-Year" | Elimination of barge type and quantity | 40 ships, 3,500 tons of barge |
|           | New barge type and quantity to be built | 35 ships, 4000 tons of barge |

Note: factors such as delay time of ship lock and the cancellation of water transfer are not considered.

6. Transportation system development optimization plan and recommendations

According to the above analysis, to give full play to the advantages of water transport economy and environmental protection to better serve the green development of the Yangtze River economic zone, we put forward the following proposals for the regulation and control of future transport capacity development:

1. Appropriate release of fleet capacity. According to the mission requirements of the Ministry of Transport “to vigorously develop green transportation organization and support the development of large liquid bulk cargo push fleet”, Appropriate increase the capacity of the crude oil push transport fleet, Support the development of the Yangtze River crude oil push-up transport fleet and guide the development of green shipping, better utilize the comprehensive benefits of the Yangtze River golden waterway, adapt to the new requirements for the development of the Yangtze River Economic Belt. Provide more powerful support for the economic and social development of the Yangtze River Economic Belt.

2. Targeted regional capacity development and adjustment. In the middle and lower reaches of the Yangtze River, the development of push-boat fleet transportation mode was promoted, the tanker transportation mode was developed in the area above the Chenglingji. The capacity gap in the middle and lower reaches is filled by new fleets, while the upper reaches fill the capacity gap by adjusting existing tankers in the middle and lower reaches to the upper reaches.

3. Innovative development model to optimize transportation organization. Actively carry out "Internet + Shipping", make full use of cloud computing, big data, mobile Internet, Internet of Things and other technologies, deeply integrate with the shipping industry, change the traditional management and management mode, accurately locate. Develop green and efficient new ship types, further optimize transportation organization, realize fleet formation and organization more scientific and rational, transfer system more efficient. Improve the quality and service capacity of traditional Yangtze River crude oil transportation services, further tap potential and increase efficiency.
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