

# **Petroleum Tanker Shipping on German Inland Waterways, 1887-1994**

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Tanker shipping today is one of the major branches of German inland navigation. Indeed, the transport of petroleum and its derivatives together comprise nearly twenty percent of total inland shipping; more than 42,000,000 tons of liquid petroleum products were shipped in 1996 by a fleet with a total cargo capacity of more than 500,000 tons.<sup>1</sup> Tanker shipping is by far the largest kind of specialist transportation on German inland waterways. But because of its very special technical requirements, a high degree of dependence on a small group of shippers, and a number of risks peculiar to this trade, there are enough structural differences to make it useful to take a closer look at this sector of inland navigation from an historical perspective.

## **Tanker Shipping on the Rhine and the Danube before 1914**

After the first ocean-going tankers arrived in European harbours in the 1880s, it no longer made sense to continue the inland transport of petroleum in barrels. Instead, it became a bulk good. It is in this context that in 1887 Josef Conrad Fendel, a young shipowner from the mid-Rhine district, decided to invest in the first German tanker for inland navigation. His ship was not a newbuild but rather a converted river barge that he had owned for some time. The conversion of a ship from general cargo to liquid bulk was accomplished by putting tanks into the former cargo bays. The economic risk of converting *Carolina* was not too high for because Fendel could draw on experience with similar ocean-going tankers and could count on a contract with the petroleum merchant Poth that guaranteed a minimum cargo of 50,000 barrels per year between Rotterdam, Antwerp or Amsterdam and Mannheim. A bill of lading shows that *Carolina* must have had a minimum cargo capacity of 4800 barrels, which means that eleven voyages per year were needed to fulfil the contract.<sup>2</sup>

Because of rapidly rising petroleum consumption in Germany and Poth's petroleum trade in Mannheim, Fendel ordered four new tankers in 1890/1891.<sup>3</sup> These ships could be called the first real tankers on German inland waterways because they were specifically built to transport liquid bulk goods. They no longer had separate tanks in the cargo bays; instead, the bays themselves were constructed as tanks. The hull of the ship was at the same time the hull of the tank. This main principle of tanker construction predominated on inland tankers for nearly 100 years.

*The Northern Mariner/Le Marin du nord*, XI, No. 2 (April 2001), 57-67.

Although there were tankers on nearly every waterway, the Rhine and Danube became the main rivers for such traffic. The Rhine connected the main European petroleum importing ports for North America petroleum with the most important industrial regions in western and southwestern Germany. In consequence, tanker shipping was dominated by the international petroleum companies, which used the Rhine as the main transportation route for their European business. Special tankers were developed to transport gasoline and heating oil. Ships with ventilation systems for products with a high volatility were built before 1914, as well as vessels with steam-heated tanks for products with a high congealing temperature.<sup>4</sup>

Tanker shipping on the Rhine enjoyed particularly rapid growth rate between 1887 and 1914. It constituted, however, only a small part of total transportation on that waterway; indeed, only two percent of total cargo on the river consisted of petroleum or its derivatives. For this reason there were only a few shipping companies involved in the business. They firms operated on long-term contracts with the petroleum industry. For example, the Dutch shipping company Van Ommeren was one of the main tanker shipping companies on German inland waterways.' Some of the tankers were even owned by the petroleum companies themselves, like the tanker fleet of the Deutsch-Amerikanische Petroleum-Gesellschaft, the German branch of Standard Oil.

The situation on the Danube, on the other hand, was vastly different. There were neither petroleum import harbours near the river's mouth nor industrial centres along the German part of the river. Nevertheless, the river became one of the most important shipping routes for oil. While the German market was traditionally dominated by North American petroleum, there were other oil-producing countries that were interested in Germany. One of these nations was Romania. Since Romanian petroleum was not as easily refined as its North American counterpart, it had to be very inexpensive to gain a market share.'

The best route for inexpensive transport from Romania to Germany was the Danube. In 1898 the first train of barges reached the German Danube port of Regensburg after taking forty-two days to make the 2100-kilometre voyage with its difficult stretches, like the Iron Gate. Steaua Romana, a Romanian petroleum company, operated the barges and erected oil tanks in Regensburg. Although German petroleum imports from Romania rose from 2570 tons in 1898 to 23,310 tons in 1906, Steaua Romana got into economic trouble when an expansion of company-owned infrastructure coincided with a fall of oil prices. In consequence, Deutsche Bank took over the majority of the company's shares in 1903. Now there were specific German economic interests in the development of the Romanian petroleum industry. Deutsche Bank wanted to break the near-monopoly of the American oil giants in Germany, especially the influence of Standard Oil. As long as Romanian-owned tankers operated on the Danube, Deutsche Bank was dependent on the Romanian government. Because of this dependence the bank, along some other bank groups and the Bavarian government, decided to establish its own shipping company, Bayerischer Lloyd, in 1913 with five tankers.' Through this investment Deutsche Bank hoped to achieve better profits for its Romanian oil activities, while the Bavarian government wanted to increase the foreign trade of a state without a seaport.

Unlike on the Rhine, only crude oil was transported, but the distances were much greater: as much as 2000 kilometres or even more. Although the first Danube tankers had been constructed similarly to those on the Rhine, a rapid technical development soon began. In 1913 Bayerischer Lloyd ordered two self-propelled diesel-driven tankers at the Ruffhof

shipyard in Regensburg; these were the first self-propelled tankers in the European inland navigation and two of the earliest motorships. *König Ludwig III* and *BL II* had cargo capacities of 628 tons and each was fitted with two diesel engines of 320 hp.<sup>8</sup> But the attempt to break the monopoly of North American oil companies still failed. Although the 42,000-ton Bayerischer Lloyd fleet was in operation, petroleum transport on the Danube nearly stagnated (see table 1). There were few additional loads transported by Bayerischer Lloyd, while Romanian tankers abandoned the carriage of petroleum to Germany. The importance of tanker shipping on the Danube was not the total cargo carried but the technical innovation. While on the Rhine tankers had hardly changed since the days of the Fendel ships in the late 1880s and the 1890s, by the outbreak of the Great War Danubian tankers were diesel-driven and built according to the same principles as nearly all tankers for the next sixty or seventy years.

**T a b l e 1**  
**Petroleum-Transport on the Danube**  
**(Iron Gate/upriver)**

	1912	1913	1914
Petroleum and Petroleum Products	21.200 t	26.900 t	23.500 t

*Sources:* Franz Heiderich, *Die Donau als Verkehrsstrasse* (Wien, 1916), 41; and Julius Seress (ed.), *Donau-Handbuch 1917* (Wien, 1917), 200.

### **Tanker Shipping on a Forgotten Waterway: The Case of the Aller**

Beside the great inland waterways like the Rhine and the Danube, there was one small and almost forgotten waterway that was important for tanker shipping. This was the Aller, a small tributary of the Weser. The oldest German petroleum deposits were located at Wietze, near the upper reaches of the Aller. Although production had been going on since the late 1850s, there was no modern infrastructure; indeed, horse-drawn carts were the only means of transport.<sup>9</sup> While the Aller was traditionally used for inland navigation, only small barges of less than 100 tons were able to operate. Clearly, this could not be the basis for tanker shipping.

After an oil boom in 1899/1900 the transport situation became disastrous. Rapidly-rising petroleum output could no longer be accommodated on local roads, and a combination of railways and inland navigation seemed the only solution. But it took until 1908 for the government to decide to modernise the Aller through dredging and canalisation. Tankers of up to 300 tons could now be used on the Aller, after the completion of the hydraulic engineering system, which consisted of four locks and a minimum depth of the fairway of 1.5 metres.<sup>10</sup>

Still, petroleum was not shipped on the Aller for a long time. In 1914, the German navy contracted the tankers of the Celler-Schleppschiffahrts-Gesellschaft, and private shipping did not resume after the peace. Yet this brief history is important for two reasons. It marked the first time that the petroleum industry used its political clout to lobby for a major engineering project to modernise an entire waterway. Moreover, despite its modest size the volumes transported on the Aller were impressive: the 21,240 tons of oil on the river in 1909 were nearly as large as on the Danube."

**1918-1933**

After WW I German industry was wracked by inflation and the postwar world economic crisis. The petroleum industry was not as affected by inflation as most other branches of industry. Most German oil companies were part of international; since shareholders' equity was in US dollars or other international currencies, to some degree they gained from inflation. When inflation ended after 1923 Germany enjoyed a period of relative economic stability. The oil industry reached growth rates higher than any other industrial sector (see table 2). Moreover, tanker owners reaped nearly as much profit as the refineries. On the Rhine, in particular, the volume of cargoes increased exponentially (see table 3).

T a b l e 2  
Annual Rates of Growth, Selected Industrial Sectors, Germany, 1913-1938

Sector	1913-1938 (%)	1913-1925 (%)	<b>1925-1929</b> (%)	1929-1938 (%)
Steel Production	1	-3	7.3	-29.4
Steel Processing	4.2	2.3	6.7	-20.9
Coal	-0.1	-2.9	5.3	-13.8
Chemicals	5	2.4	8.8	-9.4
Petroleum	10.5	1.9	17	11.6

Source: Harold James, *Deutschland in der Weltwirtschaftskrise 1924-1936* (Darmstadt, 1988), 121.

T a b l e 3  
Petroleum-Transport on the Rhine, 1919-1933  
(Emmerich-Lobith/upriver)

	1919	1920	1921	1922	1924	1926	1928	1929	1931	1933
Petroleum and petroleum-products	54.629 t	129.857 t	131.898 t	260.193 t	288.373 t	541.118 t	842.018 t	988.426	945.775 t	1.084.571 t

Source: *Jahresbericht der Zentral-Kommission für die Rheinschifffahrt 1919-1933* (Strassburg, 1920-1934).

The technical side of tanker shipping, however, did not develop as fast as the economic. The main construction principles did not change, although there were many improvements in detail, such as the addition of separate vent pipes to the pipe system and the installation of steam pumps. Instead, the main technical change between 1918 and 1933 was in the size of tankers on the Rhine and the increasing number of motor tankers on the Danube. In the 1920s, some ships on the Rhine reached 3000 tons, such as TS *Bavaria* (3038 tons, built 1926) and TS *Germania* (3292 tons, built 1929). While tankers on the Rhine were still tow-barges, some of the newly-built tankers on the Danube were motorships, like *König Ludwig III*. In 1928 ten motor tankers operated on the Danube, which means that five percent of total tanker tonnage on this waterway was self-propelled. In comparison, only one percent of the dry cargo vessels were self-propelled at the same time.<sup>12</sup>

The Treaty of Versailles declared the Danube to be an international waterway. In addition, some German interests in the Romanian petroleum industry passed to a Romanian-Anglo-French holding,<sup>13</sup> and part of the German Danube-fleet was lost through reparations. This situation allowed foreign shipping companies to participate in Danube tanker shipping. Nevertheless the fleet of the Bayerischer Lloyd remained the largest tanker company on the Danube (see table 4).

**T a b l e 4**  
**International Tanker Shipping on the Danube, 1927/1928**

	<b>Tanker Tow-Barges</b>	<b>Motor Tankers</b>	<b>Cargo Capacity</b>
Bayerischer Lloyd (D)	27	3	22.128 t
Süddeutsche Donau Dampfschiff Ges. (A)	5	0	3.925 t
Donau Dampfschiffahrtsges. (A)	28	0	19.563 t
COMOS (NL)	10	6	12.910 t
Ungar. Fluss- und Seeschiffahrt AG (HU)	15	0	11.456 t
FluBschiffahrt des Kgr. Der Serben, Kroaten und Slowenen (YU)	29	0	23.567 t
Navigatunea Fluviala Romana (RU)	12	0	5.102 t
Societata de Navigatunea pe Dunare (RU)	15	0	14
Astra Romana / Shell (RU/GB)	12	1	8.920 t
Societe de Navigation Danubienne	10	0	7.372 t

*Sources:* K. Ebner, "Mineralöltransporte mit besonderer Berücksichtigung der Transporte zu Wasser." *Petroleum. Zeitschrift für die gesamten Interessen der Petroleum-Industrie und des Petroleum-Handels*, XXIV (1928), 476.

### **UHU: The First European Push Boat**

Despite international competitors, Bayerischer Lloyd's tanker operations on the Danube increased in the 1920s. The company's main business was still shipping crude oil between Romania and the ports Regensburg and Deggendorf. Its fleet consisted of a few motor tankers and tanker tow-barges. Other companies owned the tugboats. Because of the increasing demand for oil shipping, Bayerischer Lloyd sought better capacity utilisation for its tow-barges. Motorisation of the barges or building its own tugs were not feasible solutions because an arrangement between all the Danube shipping companies prohibited such actions. To try to find an alternative, Bayerischer Lloyd began to look at push boats of the type used on American waterways. Trygve Sommerslad, chief engineer of the shipyard Gutehoffnungshütte Oberhausen AG was asked in 1928 for advice on technical and economic aspects of push boat operations on the Danube. His report envisaged an optimistic future for this kind of vessel in the tanker business.<sup>14</sup>

The final decision, however, belonged to the managers of Deutsche Bank, still the main shareholder in Bayerischer Lloyd. Emil Georg von Stauss, the chairman of Deutsche Bank, decided personally that the bank would finance it because he expected it to have a positive influence on its petroleum interests. In 1929 a steam tug was converted provisionally into a push boat, and after successfully pushing several barges, it was decided to build a true push boat. Thus, in October 1930 *UHU* successfully completed its trials and was put into operation between Romania and Germany. Yet despite optimistic predictions, *UHU* was a failure, principally for technical reasons. It used the Voith-Schneider-Propeller that previously was used only for small boats and passenger ships and which proved unsuitable for the 700-horsepower *UHU*.<sup>15</sup> Frequent sorties into the shipyard were typical, but at least *UHU* had proven the feasibility of push boats on European waterways.

It was typical for modern technology to be used first in inland navigation on tankers. This was because the shipping companies were owned by banks or the oil industry. As a result, they had better access to capital than other shipowners. But the experience with *UHU* was also characteristic of German bank and petroleum policy. Some of the factors that led to *UHU* and the engagement of Deutsche Bank in the development of new technology were the same as, for example, the Baghdad Railway. The bank invested in transportation technology solely to increase profits.

### **Tanker Shipping and National Socialist Economic Policy**

One of the main principles of economic policy under National Socialism was autarky. Synthetic products based on coal liquefaction were meant to replace imported petroleum. Unfortunately, this was not as successful as the government expected, mainly because there was little reduction in the outflow of scarce foreign exchange, and few savings compared to the investments required. In short, petroleum imports remained necessary. This dilemma caused the government to concentrate on petroleum imports from southeastern Europe via the Danube. One result was a surge in demand for tanker capacity on the Danube. Special government aid programmes were designed to remedy this. The 1938 programme, for example, called for the construction of ten tanker tow-barges and four motor tankers, while the next year's goal was for forty tankers.<sup>16</sup> But it was impossible to satisfy the demand once World War II began.

While tanker shipping on the Danube increased rapidly, that on the Rhine actually fell at the same time. After the war broke out, Rhine tanker shipping nearly ceased. An initiative by the petroleum industry, especially the *Deutsch-Amerikanische Petroleum-Gesellschaft*, thus started the most unusual shipping operation ever undertaken in tanker shipping. Tankers of sixty-seven metres in length, 8.2 metres in width, and about 2.5 metres between keel and deck were transported as complete ships by road for more than 300 kilometres from the Rhine and other rivers, such as the Elbe, to the Danube." A total of fifteen tankers, with a total cargo capacity of about 12,000 tons were transported in this fashion. Together with some newly-built tankers, it thus became possible to increase German crude oil imports considerably. Indeed, the shift of the tankers may have been the most important part of economic mobilisation in either the oil industry or inland navigation.

Still, the importance of tanker for the German military was insignificant. Tankers were not sufficiently flexible to follow the army or the air force. The navy tried to use inland tankers to connect link big petrol depots and naval bases. But the navy's movement into the

Atlantic and the lack of oil ended these naval-oriented tasks. German tankers could not use the waterways to the Atlantic coast because they were too large for the locks and canals, and the petrol depots were not used because the petroleum went directly into the tanks of the naval vessels. Transportation to the Atlantic ports used French and Belgian tankers, which were either chartered or confiscated.<sup>18</sup> Except for crude oil imports on the Danube before 1944, tankers were relatively unimportant in the German war effort.

### **The Postwar Era**

Tanker shipping after World War II differed sharply from the industry before 1939. Only Rhine tanker shipping continued in much the same way as before the war. On the Danube, tanker shipping was resumed without German companies because of the partition of Europe into two economic and political systems. Tanker shipping on the Elbe, the third of the main German waterways, was determined largely by the fluctuating relationship between the two German states.

After a period of postwar reconstruction, the Rhine tanker fleet earned huge profits because of increasing petroleum consumption in the Federal Republic of Germany (FRG). The industrial base of the FRG changed from coal to oil from the early 1950s, and through the end of the next decade petroleum consumption doubled every five years. This oil had to be imported, mainly from North America and the Middle East. Rotterdam became the most important port again, with petroleum exports to the FRG of more than 800,000 tons per year by the early 1950s. The shipping companies engaged in tanker shipping rebuilt their fleets and began to increase the number of vessels. The tankers looked much the same as the prewar ships. The only difference was the increasing proportion of motor tankers. Some attempts to establish new technologies, such as an ill-fated experiment with aluminium ships failed because of high costs.<sup>19</sup>

A new competitor in petroleum transportation, the pipeline, halted the rapid increase of Rhine tanker shipping in the 1960s. At the end of the 1960s every refinery in the FRG was connected to a crude oil pipeline. But steady growth in petroleum consumption reduced the effects on tankers. Instead of carrying crude oil, the main task of tanker became the transport of refined products to consumers. In addition, some overcapacities were reduced with specialized programmes to scrap older ships.<sup>20</sup> The economics of Rhine tanker shipping were in essence a reflection of the economics of the petroleum industry itself.

The history of tank shipping in the German Democratic Republic (GDR) was a litany of failure. There was no petroleum import harbour along the coast of the GDR, and none of the harbours was connected to inland waterways. So there was no tanker shipping in this area before the war outside of the shipping routes connected with Hamburg. Between 1957 and 1960, however, the GDR built a new harbour for overseas trade in Rostock. A specialised petroleum harbour was part of the project, which was to be connected to the inland system by a new canal between Rostock and the waterways north of Berlin. A fleet of twenty-five tankers was planned to operate between the new harbour and the industrial regions of the GDR.<sup>21</sup> But neither the canal nor the tankers were built. Instead, connections to the hinterland were taken over by the railways.

A second attempt to establish tanker shipping in the GDR was initiated in the hope of stimulating domestic oil production. In 1969/1970 a test drill in the region of Stralsund began. Tankers were envisaged to transport oil to a refinery near Schwedt, a small village

on the River Oder. While the drilling tests were ongoing, four dry-cargo ships were converted to tankers. But the test wells did not result in production. Because of the lack of demand for tanker shipping in the GDR, the new tankers were forced to operate outside its borders. After a few years in the FRG, they mainly operated on the Albert Canal in Belgium. They thus became part of Western European tanker shipping, albeit under the flag of the GDR.<sup>22</sup> With this second failure the GDR's interest in tanker shipping ended before it began.

More interesting than tanker shipping in the GDR itself were the tanker operations of FRG shipping companies on the Elbe within the territory of the GDR. West Berlin had to be provided with oil products, which led to the creation of a special kind of FRG tank shipping, the so-called "transit shipping." Although two waterways connected the western parts of Germany with Berlin, tankers concentrated on the Elbe. The first postwar years were dominated by the Berlin Blockade, and between May 1948 and May 1949 the East Germans blocked the Elbe. Thereafter, inland navigation bound for West Berlin was again possible. But in 1952 the first tankers joined in transit shipping. This ushered in a kind of "golden age" for German inland tanker shipping. The task of supplying Berlin with petroleum was its base. Because of a policy to keep oil reserves high, there was no "just in time" business but rather long-term contracts for the shipping companies. This also meant that there were no seasonal fluctuations. Despite the economic attractions, only a few shipping companies entered transit shipping. Special licenses and permits needed to transit the GDR created a barrier. But those companies that took the plunge did well, since nearly all of West Berlin's energy requirements were met by petroleum. Even the production of municipal gas used gasoline as a raw material.<sup>23</sup>

**T a b l e 5**  
**Petroleum Imports into West Berlin by Tankers, 1960-1977**

	1960	1970	1973	1975	1977
Elbe	397,000 t	1,307,000 t	890,000 t	1,047,000 t	924,000 t
Mittellandkanal	39,000 t	35,000 t	77,000 t	209,000 t	110,000 t
Oder			90,000 t	83,000 t	54,000 t
Total	436,000 t	1,342,000t	1,057,000 t	1,339,000 t	1,088,000 t

*Source:* E. Hirsch, "Die Tankschiffahrt auf der Elbe nach Berlin," *Lauenburger Elbschiffahrtstag 1978* (Lauenburg, 1978), 279.

In 1972 the two German states began a kind of political rapprochement. A contract between the GDR and the FRG allowed the GDR to begin to supply West Berlin. A direct consequence was a decrease in transit tanker shipping (see table 5). The golden age had ended. But transit shipping remained a good business up to German reunification. For example, in 1978 half of all heating oil, sixty-five percent of gasoline and eighty percent of heating oil for power stations in West Berlin was supplied by transit tankers. But some members of the inland navigation lobby saw the political rapprochement as a direct distortion of competition or as a restraint of trade.<sup>24</sup> From their perspective this might have been correct, but in a more general view the changes in transit tanker shipping must be seen as a normalisation of economic relations. In fact, before the rapprochement large subventions for shipping companies resulted in a near-monopoly on shipping between Hamburg and Berlin.

Another remarkable development in transit tanker shipping was the design of special vessels for this business. The waterways between Hamburg and Berlin stagnated at the level of the late 1920s, since the GDR was unwilling to invest in their modernisation.<sup>25</sup> In consequence, modern FRG tankers could use the waterways only with reduced draughts and therefore with smaller cargo capacities. But there was a bright side to this: the width of the locks in the GDR was nine metres, rather than the standard 8.2 metres in the FRG. By the beginning of the 1960s shipping companies using the Elbe decided to construct tankers with optimal dimensions for these conditions (see table 6).

**T a b l e 6**  
**Comparison of Elbe Tanker Dimensions, 1960-1961**

Ship	Year Built	Length	Width	Draught	Cargo Capacity
<i>Ludwig Burmester</i>	1960	67.0 m	8.2 m	2.5 m (2.0 m)	896 t (600 t)
<i>Henri Burmester</i>	1960	67.0 m	9.0 m	2.0 m	809 t
<i>Hans Burmester</i>	1961	67.0 m	9.0 m	2.2	859 t

Source: Elbschiffahrtsarchiv Lauenburg, Konvolut Christoph Burmester.

As long as transit tanker shipping was separated from the other inland navigation of the FRG, these ships were very efficient. But after the increase in costs in the 1970s, and especially after reunification, these ships caused many problems because they could not operate on all the other waterways in the FRG. While they were built with subventions, they also required subsidies to be scrapped. In short, transit tanker shipping and shipbuilding depended more on political than on economic factors.

### From Reunification to 1994

German reunification had some strange effects on tanker shipping. One was obvious: transit shipping lost its significance when the military pipelines in Germany were opened for civil transportation. Another scrapping campaign thus was organised by the EU. Tanker shipping was no longer seen only in national but in European terms because more shipping companies from other European nations entered the German tanker business. While in the late 1980s only one or two tankers were scrapped per year with the help of subventions, thirty-two were scrapped in 1990 and sixteen in 1991.<sup>26</sup>

Tanker operations in the 1990s were marked by stagnation at a level of close to 400 tankers with half a million tons cargo capacity.<sup>27</sup> Since 1994, EU law has clearly changed tanker shipping. The Kabotage-Vorbehalt, which provided some protection for German inland navigation from international competitors, was declared *ultra vires* by the European Commission. This may lead to more international competition and cause some loss of cargoes for German carriers. It may also force a reduction of the significance of petroleum for German inland tanker shipping, which has increasingly concentrated on special goods, like chemicals or liquefied gas, since the early 1990s. But it is not possible to judge this at the moment because the changes are continuing. Therefore, a history of German inland tanker shipping has to stop at about 1994.

## Conclusions

German inland tanker shipping depended directly on economic developments in the petroleum industry. Sometimes this resulted in great differences in comparison to other branches of inland transport. One of the main characteristics of tanker shipping was the structure of shipowning. Only a few shipping and petroleum companies owned tankers, while many owners of one or two vessels owned the remainder of the inland navigation fleet. The shipping and petroleum companies had much better access to capital than other owners, and as a result, many technical innovations in inland navigation were first introduced in tank shipping. Tanker shipping was never governed purely by economics. As we saw in the beginning of tanker shipping on the Danube, or in the discussion of the transit trade, it was much more a matter of political interest by the German government and the strategies of the petroleum industry.

## NOTES

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