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# The Origin of Artificial Petroleum Facilities in North Korea Aoji Petrochemical Kombinat

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## 1. Artificial Petroleum extracted from Coal

At the time of World War I, the large warships, especially the dead weight capacity of warships became an important indicator of naval power. Since the giant warships needed a large amount of fuel 'coal', the country, like UK, that could supply coal, ammunition, water, food and so on to colonies around the world, had favorable position in war. However, since the United States, which took second place in the struggle for colonization, used oil instead of coal as a fuel, the maneuverability of the US warships was excellent to astonish the world. On the other hand, Germany and Japan also participated in the colonial contest as latecomers, but they had limitations in securing oil fields and coal ports. Thus, naturally Japan has become interested in the technology of producing petroleum from coal. Since then, Japan has built coal liquefaction plants in Aoji of Korea.

During World War II, Japan had a partnership with Nazi Germany. Japan was receiving 'Artificial petroleum technology' from Germany and UK and 'Crude oil refining technology' from US. The Japanese government has built various artificial petroleum facilities in Korea, mainland Japan, Sakhalin, Manchuria and mainland China based on the technology that has been transferred.

## 2. C1 defined by Kim Jong-Eun: A Technology to extract gasoline from coal

There are several definitions for Carbon 1 ("C1") industry in North Korea. According to professor, Kim Tae Mun of Kim Il Sung University, "C1 chemical industry is a process to synthesize various organic compounds such as gasoline through drying, liquefaction and gasification and catalysts (especially, ferrite and nickel, etc) using coals and oil stones". The North Korean press easily explains to ordinary readers that "C1 industry is a technology to extract gasoline from coal." There has been considerable debate in Korea at the point of extracting oil from coal. In fact, if you search for artificial petroleum, coal petroleum, coal liquefaction, semi-coke, etc. on the internet such as Naver and Google search engine as well as coal chemical research

papers, they explain about artificial petroleum in detail. However, some people in Korea insisted a logic that such claims of North Korea are impossible with the industrial technology and economic power of North Korea. However, the coal chemical industry that produces artificial petroleum is an old technology that was already verified and industrialized in the Aoji coal mine in the 1930s. In other words, the logic about C1 industry in Nodong Shinmun, Chosun Central Broadcasting and the journals are being verified from the political point of view in Korea.

### 3. Construction of Artificial Petroleum Plant in Aoji by Japanese Navy

Immediately after the World War I, Japan centered on the naval fuel plant, South Manchurian Railway Co., Ltd. (Joint Military and Industry Complex, 'Manchurian Railway'), and 'Joint Military and Industry Complex' consisting of universities including Tokyo University, fuel research centers, large scaled companies and chemical companies to carry out joint technical research and production experiments. Among them, the naval, Manchurian Railway and Gwandong Army carried out a dry run test of the oil shale of Mushun coal mine at Dalian Central Test Laboratory of Manchurian Railway and extracted artificial petroleum from the oil shale. This was the first successful example in Japan of 'Shale Energy Development (Artificial Petroleum Resources Development)'. At the same time, the Navy Fuel Division built a refinery in 1921 and started refining crude oil.

Professor Oshima of Tokyo University, who led the artificial petroleum development of Japan at that time, summarized the artificial petroleum development technology of Europe and Japan in three ways (Professor Kim Tae-Moon of Kim Il Sung University also explained similar in the <Labor Newspaper>). The first is the dry distillation method. This is also called as 'carbonization', or 'dry distillation', is a process in which coal (lignite) or oil shale is intercepted and heated without contact with air to obtain semi-cokes, coal tar and coal gas.

The second is the hydrogenation method (Bergius method). It was developed in 1913 by Friedrich Bergius of Germany. It is a 'liquefaction method' in which coal is finely pulverized in a heat resistant steel barrel, and high temperature and high pressure are applied directly to add hydrogen. In a word, it is easy to understand if you put it in a pressure cooker and boil it. The chemical specialized companies such as 'Japan Nitrogen Industry' mainly introduced this 'hydrogenation method' into artificial petroleum process. The Japanese Nitrogen Industry was the unique liquefied petroleum process facility built at Aoji by Noguchi Shitagou, Japan treated this technology as a secret at the time. The United States, which became a victor of World War I, secretly sealed these artificial petroleum technologies of Germany and Japan for a period of time.

The third is the Fischer-Tropsch synthesis process. This is a method of 'gasifying' coal to carbon monoxide and hydrogen ( $H_2 + Co$ ) and making artificial petroleum from hydrocarbons using catalysts. It is also a technique to produce various organic chemical products. The 'gasification method' was developed in 1921 by Germany, the coal sector of the Binh Erumu Institute, and

succeeded in extracting artificial petroleum in 1923. Mitsui and other Japanese conglomerates have mainly introduced this third artificial petroleum extraction method, the 'gasification process'.

With above three artificial petroleum process technologies, Germany produced fighter fuel when World War II took place. At that time, in Germany, the maximum annual amount of liquid petroleum fuel extracted from coal was 5 million tons, and if include Nazi German occupied territories, about 2 million tons of crude oil produced in Germany and Austria to make total approx. 7 million tons of imported oil from. In Germany, oil production peaked in May 1943 ~ 1944, with 150,000 tons of aviation oil per month (135,000 tons per month for dual air force), 25,000 tons per month for civilian gasoline, and 21,000 tons per month for export, 135,000 tons per month for army vehicle gasoline, 750,000 tons per month for military diesel and 45,000 tons per month for civilian diesel respectively.

Oil production in Germany, early 1944 (10,000 tons/ Annual)							
	Hydrogenation	Fischer Method (Gasification)	Crudeoil refinery	Distillation of lignite, bituminous coal	Aromatics (Benzene)	Import from Rumania and Hungary	Total
Aviation oil	190.0	—	—	—	5.0	10.0	205.0
Gasoline	35.0	27.0	16.0	3.5	33.0	60.0	174.5
Diesel	68.0	13.5	67.0	11.0	—	48.0	207.5
heavy oil	24.0		12.0	75.0	—	—	111.0
Lubricants	4.0	2.0	78.0	—	—	—	84.0
Others	4.0	16.0	4.0	5.0	—	—	29.0

As shown in the table above, Germany produced about 95% of aircraft fuels and about 4 million tons of total petroleum by the Hydrogenation Method. Using today's common artificial petroleum process technology, it is possible to produce 4 million tons of oil from 20 million tons of coal. That is, about 20% of the total coal input is extracted as petroleum from coal. More specifically, about 1 ton of artificial oil is produced with about 4 tons of coal. However, when extracting petroleum from coal, it is necessary to apply heat, pressure, or electricity, which consumes about 1 ton of coal. Thus, 1 ton of synthetic oil (artificial petroleum) can be produced with 4 tons of coal and 1 ton of fuel coal.

#### 4. How much will be the annual coal mining of North Korea when translated to artificial petroleum?

According to the official announcement of the North Korean authorities, in 2010, the amount of coal mined in North Korea is about 30 million tons. Recently, the amount of coal mined in North

Korea has surged, so it is estimated to be much higher. According to the defectors interviewed by the author besides of the official statistics of the authorities, the claim that "the amount of coal produced in North Korea will be more than 100 million tons a year because the coal production of private coal mines is two to three times that of the national coal mine". Therefore, assuming that the total amount of coal mined in North Korea is 100 million tons per year based on the information of North Korean refugees, the total amount of oil extracted from coal in a year is about 20 million tons. Of course, Sasol which has the best technology of artificial oil production may more effectively produce the artificial petroleum. In opposition, if North Korea's technology level is at the test level, it can be considered that the production efficiency is much lower.

Hydrogenation Plants in Germany		
	1939	1945
Name of Plant	Main Material	Main material / Alkylation
Reuna	Ignite	Ignite and <b>Ignite Tar</b> ●
Boeren	<b>Ignite Tar</b>	<b>Ignite Tar</b> ●
Magdeburg	<b>Ignite Tar</b>	<b>Ignite Tar</b> ×
Zeiz	<b>Ignite Tar</b>	<b>Ignite Tar</b> ×
Schelben	Bituminous coal	Bituminous coal ●
Belheim	<b>Bituminous coal Tar, Pitch</b>	—
Gelsenberg	Bituminous coal	Bituminous coal ×
Bernheim	—	<b>Pitch, Tar</b> ×
Sternberinz	—	Bituminous coal, <b>Pitch, Tar, Petroleum pitch</b> ●
Reugendorf	—	<b>Tar, Petroleum pitch</b> ×
Busenring	—	Rhine Ignite ●
Bruks	—	<b>Ignite</b> ●
Brezbihama	—	Bituminous coal ●

When investigate the 13 plants that produced gasoline in Nazi Germany with the "hydrogenation system", the main material was Ignite (Brown Coal) and produced gasoline with Ignite Tar which was produced by distilling ignite using hydrogenation method. After that, 'octane number' (numerical value indicating the degree that abnormal explosion does not occur when gasoline is burned) is increased through 'Alkylation catalyst process (catalytic action based on acid by the production method using solid acid catalyst) to produce gasoline. Professor Kim Tae Mun of Kim Il Sung University, Professor Kim Ryu Sung of Hamheung Branch of National Academy of Sciences, Professor Shindong Cheol of Hamheung Chemical University claimed similar theories.

One of the reasons why it is important to increase the octane number through the 'Alkylation process' is that if the gasoline with low octane number is put into the fighter plane, the performance

of the fighter engine will deteriorate and it will not function properly. Therefore, unlike civil fuel, putting 'optimized fuel' according to usage in military fuels is a very important task. It is not a big problem in the industrial structure like North Korea that the speed of the private bus is injected the similar fuel to go from Pyongyang to Sinuiju, but the speed and power output of the tank and the fighter in the war means that the war can not be carried out.

In other words, it is important to know whether North Korea is capable of producing artificial petroleum by coal, and what is the level of current technology of North Korea that produces artificial petroleum. In the past, there were farmers who stole asphalt in Korean farms and produced their own similar fuel for cultivators. In this process, people were killed by toxic gas poisoning. In North Korea, there was a phenomenon similar to the time of the hardship march, and there was a crackdown. Although the technical principle of artificial petroleum production is not difficult, the assessment of artificial petroleum industry in North Korea has a very different meaning depending on whether it was the level of petroleum production technology used for farmers in Korea or the level of technology of Sasol in South Africa.



Google Satellite Image. Chemical Plant in Aoji

In fact, if you look at Aoji's "coal chemical Kombinat" as a Google satellite, you can observe a round-shaped facilities which are assumed to be 10 petroleum facilities. According to the defectors' interview, it was said that it was No. 120 enterprise of Aoji coal mine as and 'artificial oil facility'. Therefore, additional verification is needed in the future.

In March 1939, in the House of Representatives of Japan, Yokohama Mitsumasa, a Navy Minister said, "The United States has imposed sanctions against Japan due to the invasion to Manchuria and China under the pretext of moral petroleum containment and Japan had to discuss about invasion of Hawaii against such sanction" Since the Japanese invasion of China in 1937,

the United States has intensively attacked the raw materials needed for major Japanese industries such as Japan's oil, iron and machine tools. In July 1939, the United States and Japan abolished the Nautical Voyage Treaty, and in December 1939, US corporations declared a so called "Moral petroleum embargo", a measure prohibiting the construction of aircraft gasoline manufacturing facilities and the export of construction rights to Japan. In August 1941, all oil exports to Japan were banned, step by step, while strengthening the strength of economic and oil sanctions.

“The research for artificial petroleum has been completed ... The operation of plants in Aoji and Youngan has been started”

'Economic sanctions against oil' was a key step toward military sanctions. In 1939, Japan was dependent on the United States by 90% of its oil imports. To overcome this, the Japanese government was promoting artificial petroleum development. The context of these sanctions and provocations is quite similar to that of the present Kim Jong Eun regime, so the author would like to summarize some of the statements made by Yonai, the Navy Minister in that time and compare it with the current situation in North Korea. At that time, the Japanese government was also worried about technical difficulties and financial problems like North Korea now.

*"Our country (Japan), which lacks natural resources, discussed the current status and technology prospects at this conference to develop artificial petroleum businesses surrounding the empire fuel companies in order to achieve self-sufficiency of liquid fuels such as heavy oil and petroleum. As a result of the Navy's efforts for more than 10 years, the artificial petroleum business has been completed and commercialization has reached "profitability." The artificial petroleum factories of Aoji, Youngan in Chosun Wanishi, Ube and Nihoro (Sakhalin) and other factories are expected to commence operations soon and the current status and prospects of this project are expected to be very high. About the technical problems of the artificial petroleum business, all three points of 'foreign technical assistance' including first, the manufacturing method, second, the production of artificial petroleum machinery, third, the technology manufacturing skill (work force) became unnecessary. The quality and quantity of crude oil production is expected to be the same as the natural oil "- Yonai Mitsmasa, Navy Minister.*

Under this strategy, Japan built the "Aoji Artificial Oil Factory" in 1936, in Hoeam Dong Sangha Myun, Gyeongheung Gun, Hamgyeongbuk-Do, facing borders with Manchuria and the Soviet Union. The factory was built within a few kilometers of Aoji Station of the Manchurian Railway. The plant produced gasoline, petroleum, light oil, heavy oil, methyl alcohol and lubricating oil with the world first 'hydrogenation direct liquefaction method (Bergius method)'.

Aoji was at the forefront of the border, and in 1938 there was a war of 'Jangobong War' in 1938 and 'Nomonhan War' in 1939 in the vicinity of the Aoji Artificial Oil Factory. At that time, the

situation at the Aoji Military Plant was confidential. According to the Dong-A Ilbo in January 1938, the artificial oil development of the Aoji coal mine was built for national defense and industrial purposes, and the construction of a coal liquefaction plant with the goal of producing 1 million kl per year, including gasoline and heavy oil. When converted to the current unit, it is about 660,000 tons (6.3 million barrels). In March 1938, about 60,000 tons of synthetic liquefied petroleum was produced at the Aoji plant. In 1939, the United States increased production on a large scale as the "Moral oil embargo" was strengthened. In the same year, in the middle of July, Dong-A Ilbo reported that "It is enough to sell even in the general market through Chosun Oil".

## 5. Status of Artificial Petroleum in the time of Kim Jeong Eun

In 1939, Japan was dependent on the United States for 90% of its oil imports. In the US military diplomacy strategy, 'oil sanctions' taken against the target countries was a key process just before the military action. In response to US petroleum sanctions, Japan implemented both the artificial oil development and the Pearl Harbor surprise attack. The Japanese government built the "Aoji Artificial Oil Factory" in 1936 to overcome the oil problem. Aoji's artificial oil contributes to the Pacific War by providing gas to the Kanto region and the Navy.

These coal industrial technologies have already been developed actively since the end of the 19th century, and especially during World War II and Japan's invasion war, Nazi Germany procured gasoline and aviation oil as well as various chemical products through coal liquefaction and gasification processes. The most commercially successful corporations are Sasol of South Africa. In addition, developed countries maintain a pilot plant for the purpose of economic reasons to prepare synthetic petroleum facilities for high oil prices or to develop environmentally friendly energy. Although large commercial productions such as South Africa are not aimed, small quantities of 100 tons per day (35,000 tons per year) is never small at the position of the country which under sanction of the United Nation. If only 15 small test facilities are used, it would have the effect that the amount of artificial oil from such facilities would be similar to that North Korea imports from China.

Kim Il Sung also emphasized the development of coal liquefaction and gasification at all times, with petroleum chemistry as a precaution, since petrochemicals may not be brought in from outside. The representative C1 industrial facilities from the time of Japanese colony to the time of Malima Speed include Aoji factory, 2.8 Vynalon factory, Heungnam fertilizer factory, Sungjin steel plant and thermal power plants.