

Feasibility on Construction of Mega Scale Indirect Coal Liquefaction Plant based on Core Technology Developed by China

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Background

- Conflict in world oil demand & supply, China's net oil import exceeded 118.75 MT in 2005.
- Study the feasibility on construction of Mega scale indirect coal liquefaction plant, based on F-T synthesis catalyst and process developed by Yankuang Energy R&D Corp., Ltd. ,Shanghai

Market Anticipation

- **International Market anticipation**

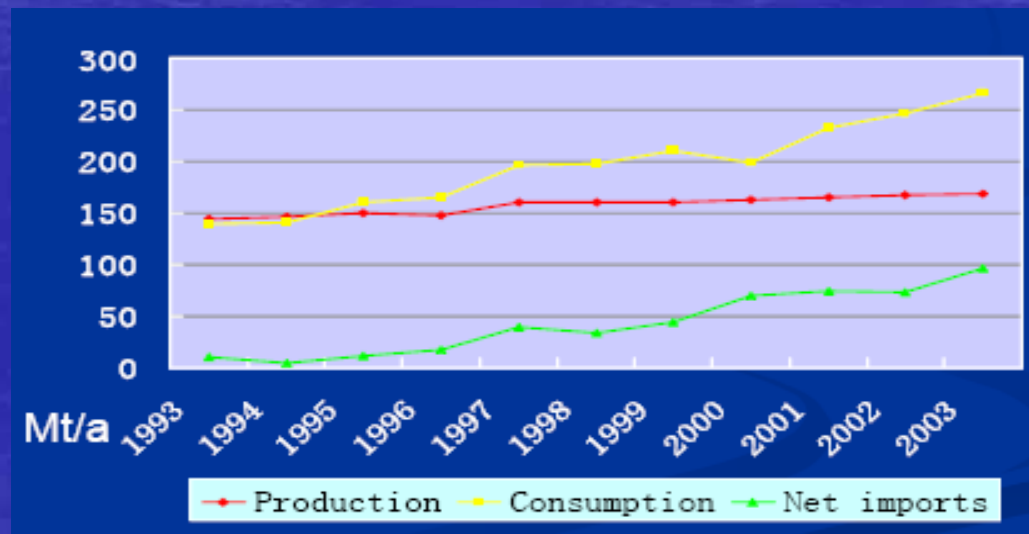
based on 2000 world energy outlook:

- World oil demand increases at 1.9% annually before 2020,
- World oil demand will reach 5.735 BT/A by 2020, converted to 115 million barrel per day

Half world total reserves will be exploited by 2020

Demand outlook

- Domestic demand anticipation
 - ◆ By second half of 2004, China's balance petroleum is 2.3 billion, accounting for 1.4 of the world total
 - ◆ China's net oil import was 120 mil tons in 2004
 - ◆ China's net oil import was 119 mil tons in 2005



Demand outlook

- Domestic demand anticipation
 - China's oil consumption to reach 450-610 million tons by 2020
 - Vehicle to reach 130 million consuming 256 million ton oil
 - Domestic oil production to reach 180-200 million tons, 60% of total demand to be imported from offshore

Products

- Diesel, naphtha, LPG and sulfur
- Product naphtha is high quality feedstock for ethylene manufacture
- Product diesel is suitable for blending and is environment friendly

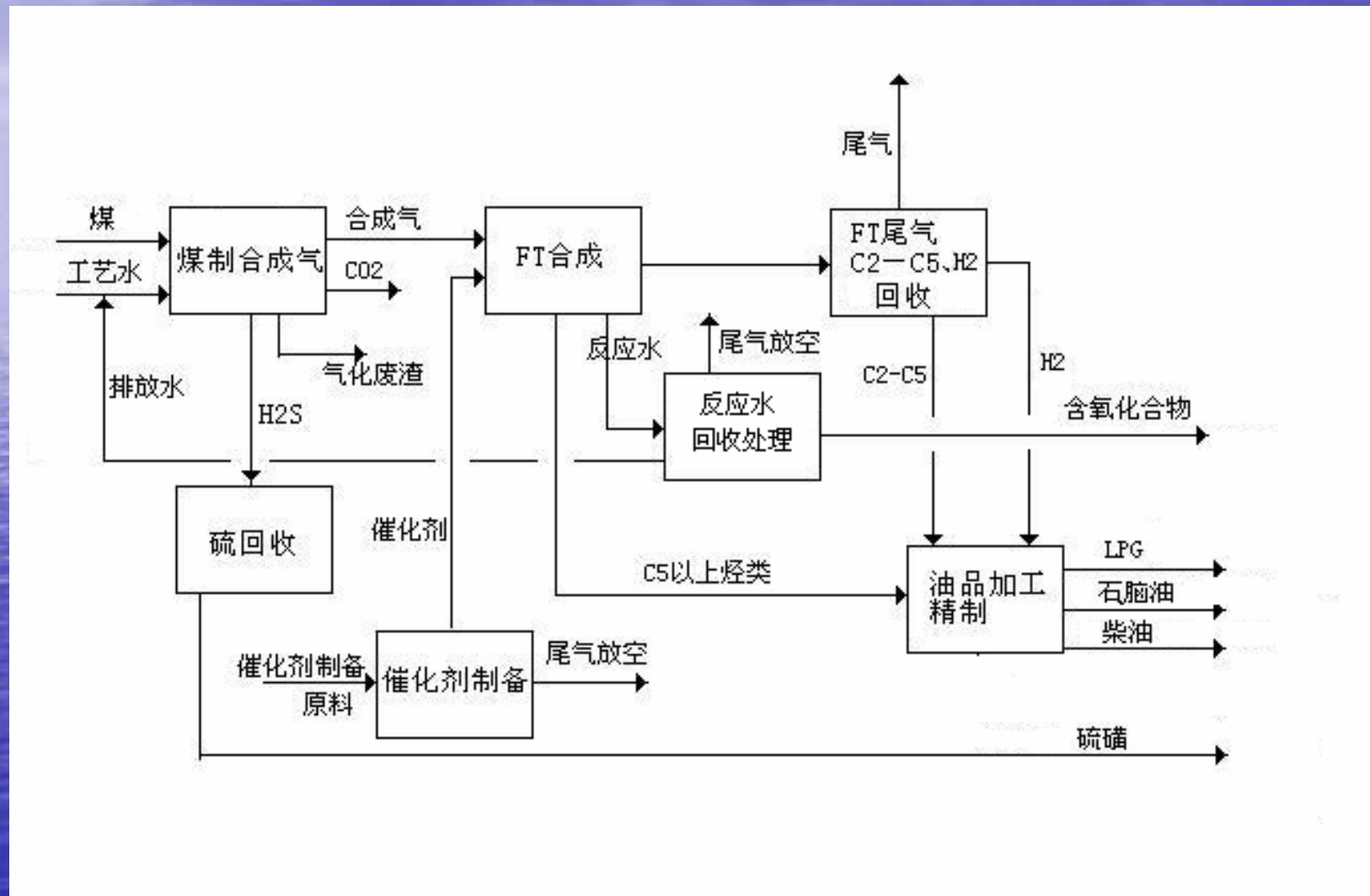
Production scale

item	Specification	Unit	Quantity
1	Mixed diesel	KT/A	900
2	Mixed naphtha	KT/A	230
3	LPG	KT/A	30
4	Total	KT/A	1160
5	By-product: sulfur	KT/A	depends on coal quality

Plant address selection

- China is rich in coal, mainly distributed in west area
- Analysis based on the coal resources of a northwest province

Main process



Comparison and Selection of Main Technical Schemes

(1) Coal gasification technology

	BGL	Shell	Texaco	Multi-nozzle contraposition
Approach	Moving-bed pressurization gasification	Pulverized coal gasification	Water coal slurry gasification	Water coal slurry gasification
Disadvantages	<ol style="list-style-type: none"> (1) High methane and nitrogen contained in generated gas (2) Long purification process, difficult on waste treatment 	<ol style="list-style-type: none"> (1) Less commercialization experience, in dependence on imported technology, low localization (2) Long supply period of gasifier, big equipment volume 	<ol style="list-style-type: none"> (1) Requirement on Coal: ash melting point, ash composition and content (2) High oxygen consumption, high cost on ASU 	<ol style="list-style-type: none"> (1) Requirement on Coal: ash melting point, ash composition and content (2) High oxygen consumption, high cost on ASU (3) Less commercialization experiences
Advantages	<ul style="list-style-type: none"> ● Simple structure of gasifier, low cost, manufactured in China ● Good adaptability to various coals, low oxygen consumption 	<ul style="list-style-type: none"> ● High efficiency, high content of effective gases ● Good adaptability to various coals, lower oxygen consumption 	<ul style="list-style-type: none"> ● Above 90% localization ● Rich operating experience in China 	<ul style="list-style-type: none"> ● Independent R&D

Comparison and Selection of Main Technical Schemes

(2) FT synthesis and catalyst preparation technologies

- **FT synthesis and catalyst preparation technologies**

Based upon the independent-developed technology of Yankuang Energy R&D Co., Ltd., (YETECH) Shanghai. the technology is of independent intellectual property, 8 patents, and passed appraisal of China Petrochemical Association.

- **Established commercialized pilot unit with capacity of 10,000t/a**

Under design load and various operating conditions, continuously running for 200days, obtain reliable data for scale-up. The synthetic coarse oil product is of good quality.

- **Established FT synthesis catalyst pilot unit with capacity of 100t/a**

The batch produced catalyst is of stable performance, and better index than catalyst prepared in lab.

Preliminary Demonstration on Process Technology Scheme

(3) FT synthetic oil product hydro-refining technology

- Little sulfur and nitrogen contained in the product after FT synthesis, mainly consists of straight chain paraffins, olefin and a little oxygen-containing compound. So the major processes are hydrogenation and hydro-isomerization.
- YETECH R&D Co. ,Ltd. ,Shanghai developed successfully the technology (including catalyst) together with Beijing Petroleum Science Research Institute, and passed technical appraisal.
- Based on rich experiences on diesel oil and heavy oil hydrogenations in China, and R&D achievements, the hydro-refining technology for coal based synthetic oil is reliable.







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Preliminary Demonstration on Process Technology Scheme

(4) Selection of main technical schemes

- After many comparisons and demonstrations, the main technical schemes defined on the plant planned to be built in Northeast China are as follows:
- coal gasification: advanced technology worldwide;
- Gas purification: Rectisol technology in principle;
- Synthetic oil: low-temperature FT synthesis technology and catalyst developed by SYEST R&C Corp. Ltd.;
- Synthetic oil hydro-refining: technology jointly developed by SYEST R&C Corp. Ltd. and Beijing Petroleum Science Research Institute.

Raw Coal Consumption

No.	Name and Spec	Annual consumption (Mt)
1	Raw coal (ash $\sim 10\%$, moisture $< 10\%$)	3.78
2	Fuel coal (same as above)	0.92

Utility Consumption

(1) Water

Need 1670t/h of fresh water

(2) Power

Whole plant power consumption: 105.019MW where, 70MW generated by process remaining heat of LP steam, the balance is supplied by others or install one more set of 30MW coal-fired generator.

(3) Steam

Plant steam is supplied by self-built heat and power station and recovered process remaining heat.

Environmental Protection

(1) Waste gas

- Purification unit tail gas: to sulfur recovery unit for recovering sulfur;
- Sulfur recovery tail gas, flue gas from heater in oil-product refining unit: venting;
- Tail gas from catalyst preparation: qualified after treatment, venting;
- Dust from coal storage & transportation system, boiler flue gas: after de-dusting, venting;
- Tail gas from gasifier, Rectisol unit and water treatment unit: to flare;
- FT synthesis tail gas: after recovering C₂—C₅ components and H₂, coming into plant fuel gas piping network as fuel gas.

Environmental Protection

(2)Waste Water and liquid

- Waste water from FT synthesis unit : to reaction water treatment unit;
- Waste water from Rectisol and reaction water treatment unit: as make-up water for coal mill;
- Waste water from gasification, catalyst preparation, oil product processing & refining unit, living waste water: to waste water treatment unit;
- After waste water treatment and reach first-grade standard, go into reused waste water treatment unit for further treatment, finally, return to circulating water system as make-up water.

Environmental Protection

(3) Waste slag

- Coarse slag from gasification, coal boiler: to outside of plant, as construction material, or for brick-making;
- Fine slag from ash-water treatment: burning in boiler;
- Waste catalyst from oil product processing & refining unit and shift section: recovery and reuse;
- Molecular sieves of ASU: disposal outside of plant;
- Waste catalyst of FT synthesis, waste slag of catalyst preparation unit, waste adsorptive material of PSA (Pressure Swing Adsorption) : land fill disposal.

Environmental Protection

(4) Noise

- Mainly from steam turbine compressor, air compressor of ASU, steam turbine, fans and various pumps, the max. value is about 105dB(A).
- Try to select low-noise equipment, take different ways to eliminate noise under different conditions, so as to reach or be lower than the relative standard.

Investment Estimation Basis

- **Construction location:** Northwest China
- **Plant capacity:** 1.16Mt/a, oil products
- **Construction period:** construction:3years, production: 15years, Calculation: 18years
- **Basic discount rate:** $I_c = 12\%$
- **Price of main raw material, fuel and power:** Coal 150 RMB / t , fresh water 1.3 RMB/ t ,
power 0.35 RMB/Kwh
- **Average staff salary:** staffs 984 , average salary and additions 50000 RMB / person .year。
- **Production cost:** Capital assets: comprehensive depreciation: 15years, maintenance cost: 3% of capital assets original cost; other maintenance cost: 2% of capital assets original cost. Amortization cost: Intangibles, 10years; others, 5years
- **Management cost:** Sales management cost: 3% of sales income; others: 2times of salary.
- **Product sales:** Naphtha: 3558 RMB / t; Diesel oil: 3692RMB/t; LPG: sales price:3057RMB / t

Investment Estimation and Main Economic Index

Main Cost Components

No.	Item	Cost (million RMB)	Percentage
1	Purchased raw material, accessorial material	660.12	28.58%
2	Purchased fuel and power	247.69	10.72%
3	Salary and welfare	42.40	1.84%
4	Reparation cost	240.91	10.43%
5	Depreciation charge	549.87	23.81%
6	Byproduct recovery	0	0.00%
7	Amortization cost	88.31	3.82%
8	Interest	105.88	4.58%
9	Other management cost	84.80	3.67%
10	Other manufacturing cost	160.61	6.95%
11	Sales management cost	128.95	5.58%
12	Total costs	2309.54	100%
13	Variable costs	907.81	39.31%
14	Fixed costs	1401.73	60.69%
15	Operating cost	1565.47	67.78%

Investment Estimation and Main Economic Index

- Financial Appraisal:

- (1) Product sales income

- Annual sales income: 4.38602Billion RMB

- Average annual sales income: 4.2983Billion RMB

- (2) Profits (income tax, 15% of total profits)

- Average annual total profits: 1.31202Billion RMB

- Average annual income tax: 418.21M RMB

- Average annual after-tax profits: 893.82M RMB

Financial Analysis on Capability of Making Profit

Index	Unit	Number	Remarks	
Profit to investment ratio	%	12.67		
Tax to investment ratio	%	19.20		
Internal Rate of Return (IRR)	%	15.86		Before income tax
Internal Rate of Return (IRR)	%	12.68		After income tax
Financial net cash value	Million RMB	2084.34	(Ic=12%)	Before income tax
Financial net cash value	Million RMB	334.16	(Ic=12%)	After income tax
Financial investment recovery period	Year	8.02	Including construction period	Before income tax
Financial investment recovery period	Year	8.85	Including construction period	After income tax

Indeterminacy Analysis

(1) Analysis of Sensitivity

Item	Variation rate	IRR before tax	IRR after tax
Construction investment increase	10%	12.72	9.88
Construction investment decrease	-10%	19.63	16.05
Sales income increase	10%	18.61	14.89
Sales income decrease	-10%	12.86	10.31
Operating cost increase	10%	15.20	12.15
Operating cost decrease	-10%	16.51	13.19

It shows in above table that variation of each item impacts IRR in varying degrees, but the variations of construction investment and sales income are of the most sensitivity.

Indeterminacy Analysis

(2) Breakeven balance analysis

The break-even - point (BEP) indicated by the usage rate of the productivity is 52.14%. In other words, the enterprise may suffer no loss of capital when the production load reached 52.14%, which means the demonstration unit has ability to anti risk to some extent.

Indeterminacy Analysis

(3) The influence of the increase of feedcoal price on the main economic index

The influences on the main economic index when the price of the feedcoal increased 50%, namely the coal price is 225 yuan/t

Item	Unit	Value
Profit Margin of Investment	%	9.66
Tax Rate of Investment	%	15.78
IRR Before Tax	%	13.27
IRR After Tax	%	10.63

Conclusion

- Constructing a megaton-scale indirect liquefaction CTL unit based on the proprietary key technology is available and technically feasible.

The key technology of this project - the low temperature FT synthesis technology is based on the proprietary technology developed by Yankuang Energy R&D Co., Ltd., Shanghai. It's reliable to take the technology as the basis of magnifying the project.

The other process technologies that the megaton demonstration plant planned to use have rich commercial practice experiences.

Conclusion

➤ It's economically feasible

The preliminary economic analysis indicated that constructing an ICL plant in the area of rich coal resources in China, which the price of coal is low and the oil resource is short, to convert coal into clean oils is economically feasible, if the capacity reaches 1 million t/y, the project will have quite good profit.

Conclusion

- conforming to the state's industrial policy, with good economic benefit and social efficiency

Constructing a commercial CTL plant based on the FT synthesis technology, which has the independent intellectual property rights, conforms to the energy policy, which is not only helpful for the development of the local economy, but also conforms to the state's industrial policy and the requirements of the western development and the sustainable development, the good environmental benefit and the social efficiency will be reached.

Conclusion

- An important route of solving China's Energy Security problem

After the successful operation of the megaton-scale ICL demonstration project, the ICL project may be spread extensively at lower investment price in the areas where the condition is satisfied. Therefore, the project will make an important contribution to China's energy security.

A photograph of a vast blue ocean under a bright blue sky with wispy white clouds. The sun is visible on the horizon, creating a shimmering reflection on the water's surface.

Thank You !