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Innovating green chemical industry to promote sustainable development in China

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Consulting Project of the Chinese Academy of Engineering and ministry of industry and information technology :

Engineering science and technology strategy for green industry development

- Iron and Steel
- Nonferrous metal
- Chemical industry
- PetroChemical industry
- Building materials
- Papermaking industry



- 1. Research Framework
- 2. Analysis of Green Chemical Industry development
- 3. Strategy Analysis and Development Goals in Green Chemical Industry
- 4. Engineering Science and Technology Strategy in Green Chemical Industry
- 5. Key Technologies and Innovating Projects in Green Chemical Industry

1.Research Framework



- Three Developments :
 - Circular development
 - Green development
 - Low-carbon development

2. Analysis of Green Chemical Industry development

International Development of Green Chemical Industry

Development Status of Green Chemical Industry

- Europe--Propose solutions of technology and market
- America—Law of green chemical action
- Japan—Develop pollution reducing projects in chemical indust

Experience and Enlightenment

- European Reach Regulations: Environmental protection product oriented regulation, will force the greening development of the chemical production process.
- DuPont Development Model : The market-oriented development model, promote the Green Development in the production process.
- American Presidential Green Chemistry Challenge Award : Green Chemical Industry will be the inevitable choice of Chinese Chemical Industry Development in the future.

2. Analysis of Green Chemical Industry development

Chinese Development of Green Chemical Industry

- General Problems
- Excess production capacity

Fertilizer Industry

	Fertilizer in total	Nitrogen Fertilizer (convert into N)	Phospha Fertilizer (co into P ₂ O ₅	Kalium Fertilizer (convert into K ₂ O)	
Domestic Production	106	111	115		56
Capability in $2010(\%)$		Excess production	capacity	Ins	ufficient production capacity

- The Traditional Coal Chemical Industry: Coke production was 442.32 million tons in 2012, meanwhile the excess production was 120.47 million tons. Calcium Carbide production was 18.69 million tons, meanwhile the excess production was 1.66 million tons.
- Green Chemical Industry Development Activities : mainly focused on the production stage, more techniques of resource utilization, high value-added product development, and system integration, etc. are needed.

Example : The New Coal Chemical Industry Analysis

Problems and challenges in the New Coal Chemical Industry





Some important new coal chemical products

MTAMTPMTOEGSNGLiquid Fuel(Aromatic)(Propylene)(Olefine)(Ethylene glycol)(Natural gas)(Gasoline)



MTA : The New Coal Chemical Industry Aanlysis

The advantage of MTA

The domestic aromatics price order in recent years



• Since the economic crisis of 2008, aromatic market prospect was good.

- The main competitor is on the decline
- Domestic aromatics sources : Coking benzene
 20%+petroleum benzene 80%
- Domestic petroleum base aromatic competitiveness is on the decline
- Domestic coking benzene competitiveness is on the decline
- Main competitor is on the decline, It benefits the MTA industrialization.

MTA : The New Coal Chemical Industry

The Risk of MTA

■ FMTA industrial technology conference (2013)



• Tsinghua University and Huadian Group Share FMTA technical research.

- The prior stage of the MTA industrial experimental data
- Liquid products :
 C6 (Benzene, B) 8%;
 C7 (Methylbenzene, T) 28%;
 C8 (Dimethylbenzene, X) 50%;
 C9 (Trimethylbenzene) =<14%;
 BTX+Trimethylbenzene=90% in the solution
- The MTA technology was only a pilot scale (10000ton/year). Large-scale industrialization are still building.

MTA : The New Coal Chemical Industry

MTA : Technical Economy Analysis



• When the coal prices was equal to 650Yuan/ton, the average value of BTX was equal or greater than 6776Yuan/ton, the Projects could be profitable. When the Coal prices was equal to 270Yuan/ton, the Projects could be profitable anyway.

MTA :Profits Vary with Methanol Prices



Resistance of Raw Material Price Volatility Risk : MTA project which did not include the coal to methanol section was less than the MTA project which included the coal to methanol section.



- There are two routes downstream of the MTA chemical products development, one is the polyester industry chain under the leader of C8, another is fine chemical industry chain under the leader of C6.
- The MTA has a larger advantage and potential in the market, technology, economy and availability.

2. Analysis of Green Chemical Industry development

Green technology List of Fertilizer Industry

	Resource	Process	Product	Application	Integration
Phosphate Fertilizer					
Cyclic Development	5	3			2
Green Development		3	5	4	
Low-carbon Development		5	1		
Nitrogenous Fertilizer					
Cyclic Development	2	11	4	3	1
Green Development		5			
Low-carbon Development		12			
Potash Fertilizer					
Cyclic Development	6				3
Green Development		5	8	4	
Low-carbon Development					

2. Analysis of Green Chemical Industry development

Green technology List of Coal Chemical industry

	Resource	Р	rocess	Product	Application	Integration				
Coke		[D 1 1	1	· C' · · · · · · 1					
Cyclic Development			new type of	f coal water slurr	gasification techn y gasification tech	nology And the				
Green Development	1		Coal seam gas in low temperature catalytic gasification technology; Coal base catalyst for ethylene glycol improvement techniques;Catalyst regeneration utilization technology: The use of circulating water and regeneration air:							
Low-carbon Development	1									
Calcium Carbide			High tempe	High temperature/low temperature coal indirect liquefaction						
Cyclic Development										
Green Development			1	_		4				
Low-carbon Development			2	/						
New Coal Chemical Industry										
Cyclic Development			7	2		2				
Green Development	2		2							
Low-carbon Development			3			1				

Two "Kuznets curve" mo

In the long term, resources consumption, energy consumption and environmental impact will be followed as the general two "Kuznets curve" in turn

- ✓ Intensity Curve
- ✓ Total Quantity Curve

Different curve peak experience of time could be shortened, and the difference between peak could be reduced. Resource consumption, energy consumption, waste and pollutant emissions

Green Chemical Industry : Analysis of the present situation and development trend



Total energy consumption /Ten thousand tons of standard coal

resources

thousand tons



Peak point judgment: Before 2020, it sustains growth. It will reach peak in 2030.

Peak point judgment: Energy consumption of phosphate rock resources will be reached its peak in 2015.

Green Chemical Industry : Analysis of the present situation and development trend

 (\square) Total discharge of the pollutants



Analysis of the sustainable development ways: Structural adjustment and greening development

- Optimize the raw material
- Optimize the product structure
- Eliminate backward production capacity, control the total amount
- Develop Green Chemical Technology
- Optimize the industrial structure
- Extend production to application
- Strengthen energy saving and emissions reducing

Goals in the Green Chemical Industry

- 1. Reverse the process of cleaner production and energy saving and emissions reducing into full lifecycle of greening industry.
- Reduce waste emission and resource consumption before 2015, and energy consumption before 2030.
- 3. Strengthen the green technology in the production process, resource exploitation, product design, consumption and industrial chain integration.

Green Chemical Industry : Strategic Goals

Energy consumption intensity target



Wastewater emissions targets



Phosphate resources consumption goal



COD emissions targets



Sulfur dioxide emissions targets



Ammonia nitrogen emissions targets



Coal Chemical Industry

The target of new coal chemical industry

- Upgrade and adjust the industrial structure. Encourage petrochemical associated with coal or electricity together. Form more than 10 large enterprises as the main body of the electrochemical heat integration coal industry cluster and large-scale coal chemical production base before 2020.
- Advance technology. Breakthrough a number of core technology, key technology and upgrade the coal liquefaction, MTO,FMTP technology and equipment, EG, MTA in the large-scale coal chemical industry.
- Energy saving and emission ruducing. Raise efficiency in coal chemical industry and encourage the water-saving technology and the CCS technology.

Coal Chemical Industry Circular Economy Industrial Chain



Engineering Science and Technology Strategy in Green Chemical Industry



4. Engineering science and technology strategy in green chemical industry

Policy Dimensions

	Resource	Process	Produ	ict Integ	ration Fi	nance and Tax	Finance R	egulation	Support 7	Technology Mar	ket Comp	ehensive
Phosphatic	;											
Fertilizer	~			~	\checkmark	\checkmark	\checkmark	\checkmark	~			
Potash Fertilizer	~			~						~	\checkmark	~
Nitrogenous Fertilizer	s 🗸	•	/	~	1	~						~
Calcium Carbide	~		/		\checkmark				~			
Coke	~		/		\checkmark				~			~
New Coal Chemical	~	~	/		\checkmark		\checkmark					24
Industry												24

Technologies and Innovating Projects in Green Chemical Industry

y Technologies

logies to be applied	DMTO technology; PMTP technology; Technology of comprehensive utilization of phosphogypsum; Technology for purification of wet phosphoric acid; Gasification technology with fixed-bed gasifier; Clean production technology of nitrogen fertilizer; Technology for production of energy-saving and water-saving ; Technology of methane production by coke oven gas
logies to be ialized in the near	MTA technology; Coal-water slurry gasification with opposed multi- burners; Technology for Pulverized Coal Gasification under Pressure in Aerospace Gasifier; Utilization technology of water-insoluble potassium ore resource; Utilization technology of slow controlled release fertilizer; New technology of polysilicon production with fluidized bed;
logies to be hed	Recycling technology of associated resources of phosphate ore; Production technology of high value-added material in new coal chemical industry; Technology that coke oven gas directly reduced iron;

Technologies and Innovating Projects in Green Chemical Industry

nificant innovating projects

- Innovating project for chemical fertilizer industry served modern circular agriculture
- Innovating project for energy chemical industry to solve vehicle fuel and pollution problem
- New technology for thermo-chemical comprehensive utilization of coal
- Innovating project for new coal chemical products

nsformation Strategy of Green Chemical Industry



reen Agriculture

bood supply and land scarcity are the key factors limiting economic levelopment in China.

	Population Density person/km ²	Arable land Ha/person	water m ³ /person	Mine dollar/person	Energy ton/person
China	131	0.1	2220	546	49.4
ld's Average	44	0.23	6956	1163	128
rcentage%	297%	43%	32%	47%	39%

lodern agricultural production based on drip irrigation, mechanization and aformationization is a fundamental way in the future.



Freen Agriculture

w Planting Pattern

ving water, land, fertilizer, manpower and reducing usage of pesticide. creasing food output, as well as raising land and resource productivity.

r example (drip irrigation for rice planting in Tianye Enterprise, Xinjiang)

Saving more than 50% water
Reducing fertilizer use by 30%
Increasing effective land utilization
Saving manpower and cost
Raising rice yield by 30%
Improving rice product quality
Reducing plant diseases and insect pests
Reducing methane emission

reen Agriculture

w Planting Pattern

anye provided drip irrigation equipment (PVC pipe etc)

- PVC pipes underground for drip irrigation can be used for 20 to 30 years, the investment of per acre is 700 Yuan.
- PVC pipes on the ground and PE drip irrigation belts are replaced every five years and a year respectively. The cost each year is more than 100 Yuan per mu.
- At first it was used for commercial crop and the economic benefit was very good. Then it has been popularized for a variety of crops all over the country.
- The huge demand of facility agriculture for products based on PVC and other raw materials can solve overcapacity problem of the related industries.

Freen Agriculture

ilizer industry needs to innovate, and extend industrial duction to agrochemical service.

- Product: According to the land, crops and their growth cycle, modern agricultural production requires fine, efficient intelligent fertilizer with a variety of nutrition balanced, to meet the different needs.
- Service: Based on data of crop growth and fertility data of soil and water, scientific service of fertilization will be provided.





Freen Agriculture

nefit

ncrease utilization rate of fertilizers. From the current 30% to above 80%.

Eveluce fertilizer usage, save resources and improve resource productivity. If drip rigation reaches 50% in China, the use of nitrogen and phosphate fertilizer will be educed by 15.63 million tons and 5.42 million tons respectively. It equals saving coal 3.44 million tons, phosphate rock 13.7 million and improving resource productivity nore than 100%.

Active pollution. Reduce pollution emissions in fertilizer production; greatly reduce vater eutrophication caused by the unabsorbed fertilizers and air pollution caused by mmonium.

ave water. Save agricultural water 180 million tons.

ave land resources. Increasing the yield of Grain is equivalent to save25% land and elease more than 200 million mu land.

mprove enterprise benifit. Benefit of fertilizer enterprises will be from high quality ervice and value-added products.

reen Agriculture

esides drip irrigation and fertilizer, the chemical industry also can vide green pesticide products and animal feeds, as well as provide nology and service in waste recycling such as straw, waste ching films, drip irrigation, livestock manure.

While promoting the development of green agriculture, chemical lizer and related chemical industry will be simultaneously sformed and upgraded, achieving comprehensively green and ainable development.

oblem

- Air pollution seriously
- Automotive Exhaust Emission: Organic hydrocarbon, NO_x , SO_2 What can Chemical Industry do?





lution

- Improving oil quality by hydrorefining
- Heavy oil hydrocracking



- Develop alcohol ether alternative fuel, replace gasoline and diesel by methanol, dimethyl ether, DMMI etc.
- Its energy efficiency is significantly higher than that of coalto-liquid fuels.
- Exhaust pollutant emissions is reduced. Adding 5-30% DMMI into diesel will lead the NO_x in the exhaust gas reduced by 7-10%, particulate matter by 5% 35%.
- The reform of petrochemical industry brings opportunity for development of alcohol ether fuel.

Develop electric vehicles and utilize solar photovoltaic. Cost of ysilicon is the bottleneck. New polysilicon production with idized bed can greatly lower energy and cost.



onclusions

Breen transformation of chemical industry is not only its own eed, but also the demand of whole society sustainable evelopment.

Ouring the third industrial revolution, green transformation needs o change the traditional thinking, and design new products and ervice for users' demands directly, which need innovating ndustry pattern, product and technology.

or overcapacity problem, solution firstly comes from strict nvironmental monitoring and market competition, and also from movating to push more new products for users in the future.

THANK YOU!

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