Coal to Chemicals

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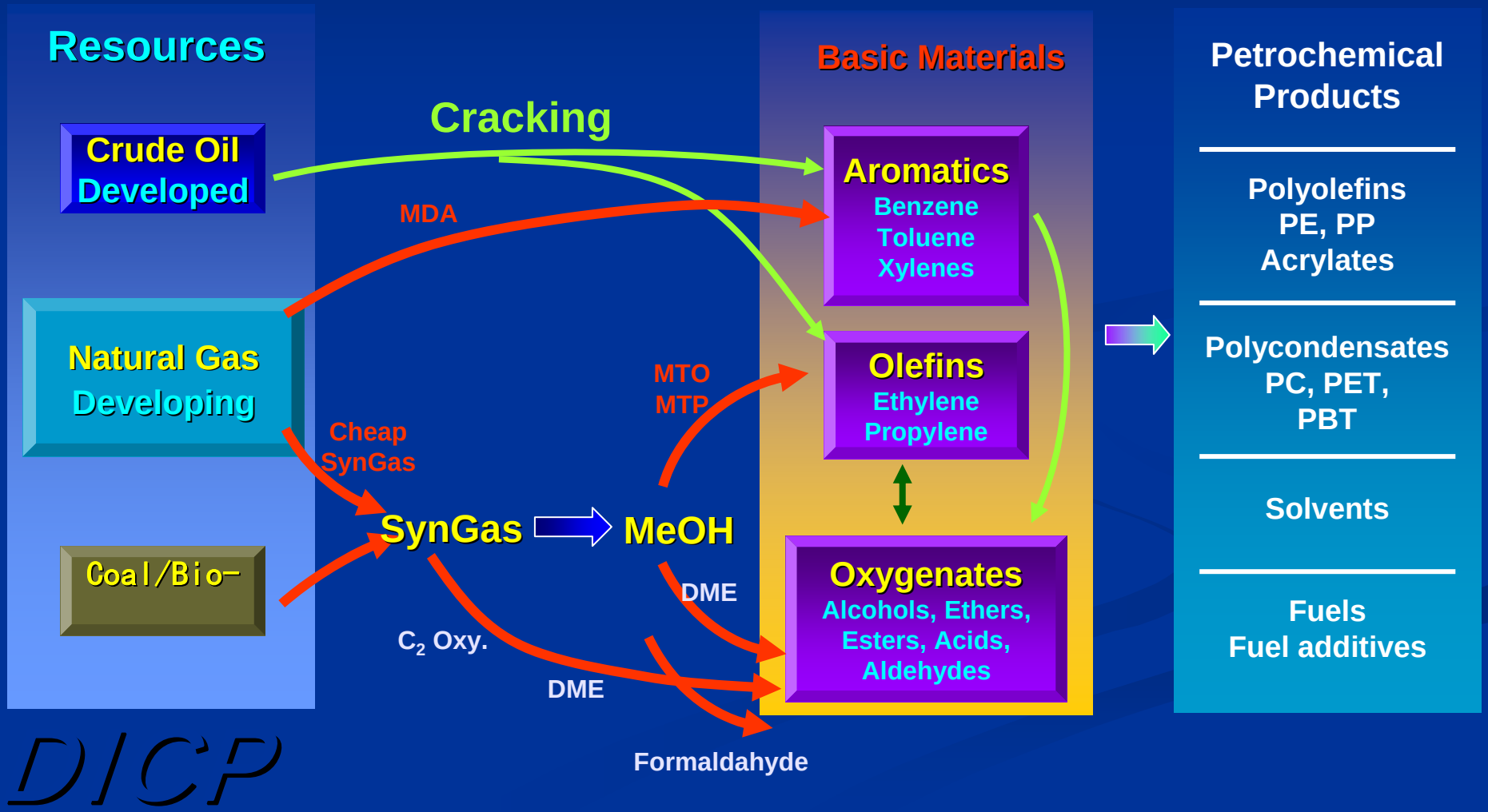
Routes for oil substitution by gas and coal



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Roadmap for technology development

Project	Now	2010
Methanol to Olefin DMTO technology	Demonstration test finished	commercialization unit in operation
Methanol to Propylene	Pilot test	demonstration
Methanol to DME	Commercialization	1mt/a commercialization
Methanol to diesel	R&D	Demonstration
Syngas to fuel and wex	Demonstration	Large scale commercialization
Syngas to C2 oxygenates	Process development	commercial unit in construction
Methanol to aromatics	R&D	10-50kt/a Demonstration
Syngas to DME	Pilot test	demonstration
Coal to acetylene	R&D	Demonstration
Neutral gas to ethylene	R&D	Pilot test
Methanol to poly-formalhyde	Demonstration	commercial unit in construction
Ethylene glycol	R&D	Demonstration

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Contents

- C2 Oxygenates (ethanol)
- Methanol to DME
- DMTO technology

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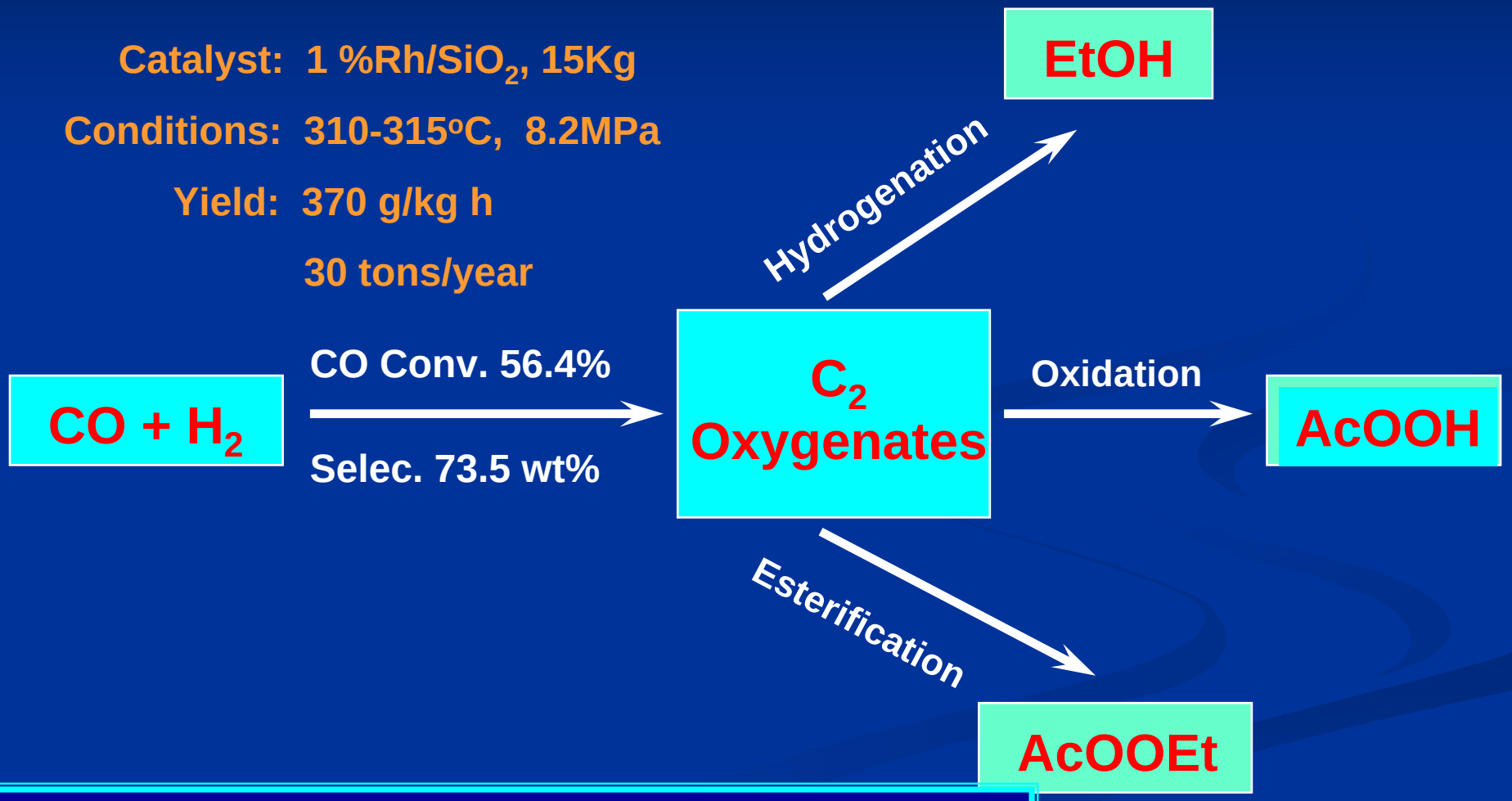
C_2 Oxygenates Synthesis from Syngas (1st Generation)

Catalyst: 1 %Rh/SiO_2, 15Kg

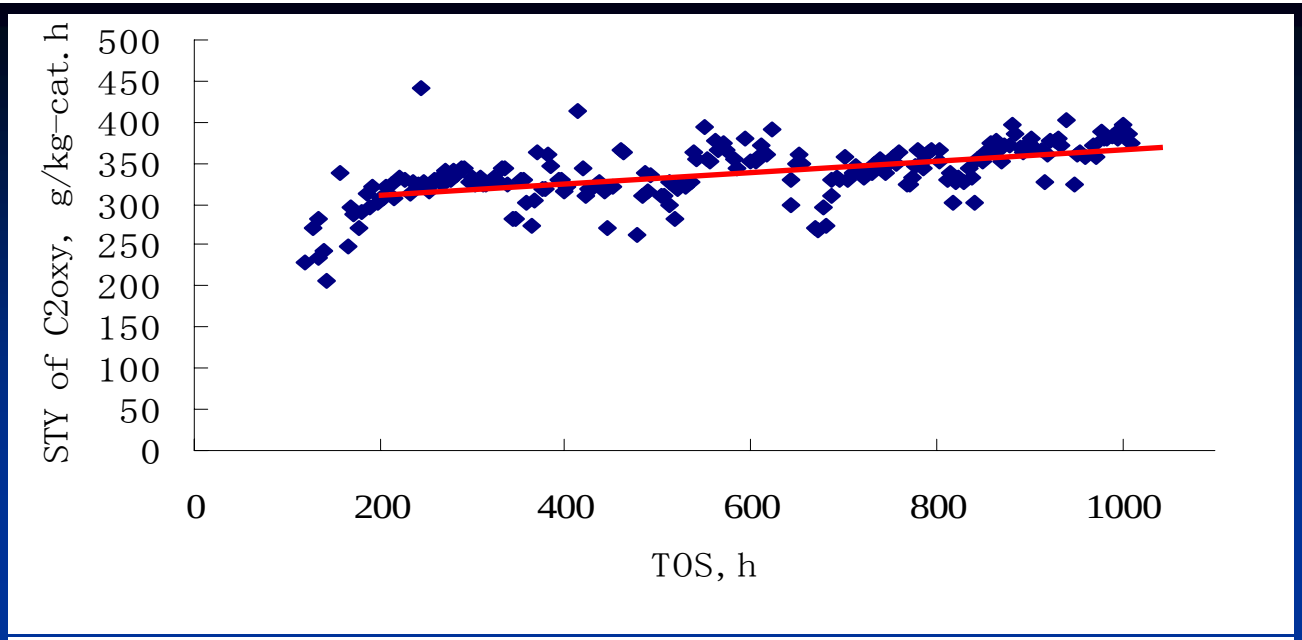
Conditions: 310-315°C, 8.2MPa

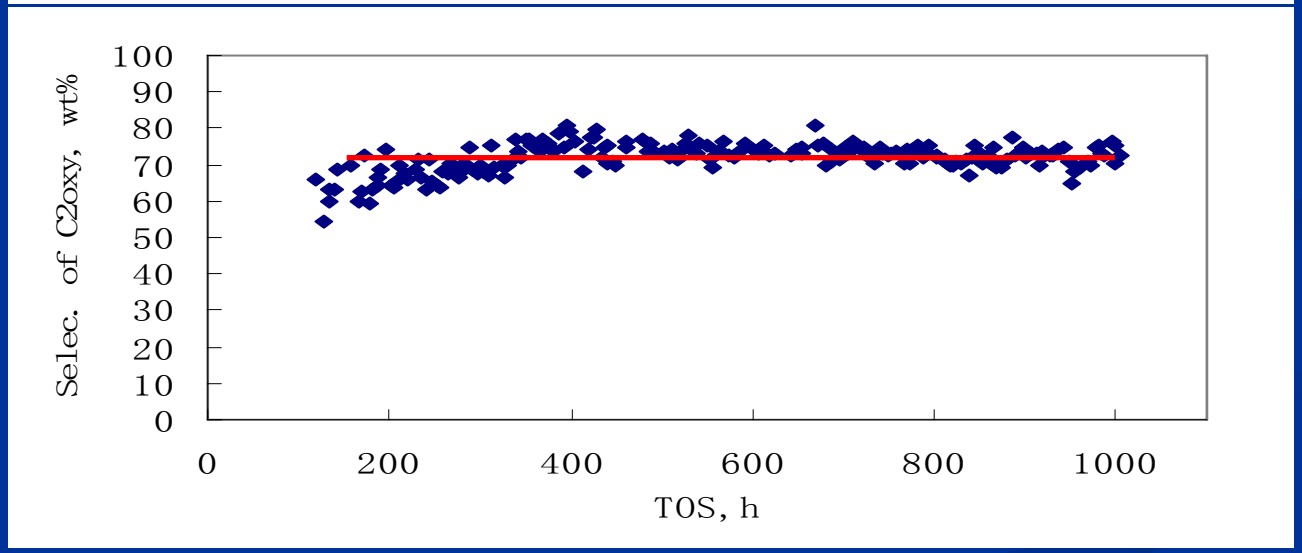
Yield: 370 g/kg h

30 tons/year



1 ton of CO yields 0.54 ton C_2/oxygenates





Long term stability of the catalyst

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Methanol to Dimethyl Ether (DME)

Commercialized Technology

Modifized Zeolite Catalyst, Fixed Bed Reaction

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Methanol to Dimethyl Ether (DME)

Many plant will be constructed

	Customer	Scale (kt/a)	State	
1	Shandong Yuhuang Chemical Co.	**50**	Under construction	Start operation at November of 2006
2	Ningxia Baota Petrochemical Co.	**100**	Under construction	Start operation at April of 2007
3	Hebei Zhongjie Petrochemical Group	**100**	Under construction	Start operation at April of 2007
4	Sanxu LPG Co. (Shaowu, Fujian)	**20**	Design	
5	Milkway Co (Huaibin, Henan)	**100**	Feasibility study completed	
6	Shanxi Huawei Engineering Co.	**400**	Feasibility study completed	
7	Benxi City	**500**	Feasibility study	
8	Yili Group (Neimeng)	**1200**	Feasibility study	

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DMTO Technology

DMTO: R&D Course in DICP

Pilot test
in DICP (Fixed Bed)
$C_2^{=}+C_3^{=}+C_4^{=}$: 85% 1993

Lab test
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$C_2^{=}+C_3^{=}$ 90%

Pilot test
In Shanghai (Fluidized Bed)
$C_2^{=}+C_3^{=}$>80%, 1995

Demo
Shangxi, Huaxian

From 1980

"75","85", "973"
National Project

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2004.08

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Shanxi Xinxing Co
LPEC

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DMTO Demonstration

- Objective
  - To develop DMTO technology for the design of large scale commercial unit
- Partner
  - Dalian Institute of Chemical Physics, CAS
    - Providing pilot technology for design and production of the catalyst
  - Luoyang Petrochemical Engineering Company, Sinopec
    - Engineering design
  - Shanxi Xinxing Coal Chemical Technology Ltd
    - Investment, construction, management, operation
    - joint venture company: Shanxi Investment Group, Zhengda Coal Chemical Ltd, Shanxi Coal and Chemical Group

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Design and Construction

- The corporation started on August 8 of 2004
- Feasibility study finished and passed on October 11 of 2004
- Basic design approved on February 27 of 2005
- Construction was finished in December of 2005
- Test was finished in June of 2006

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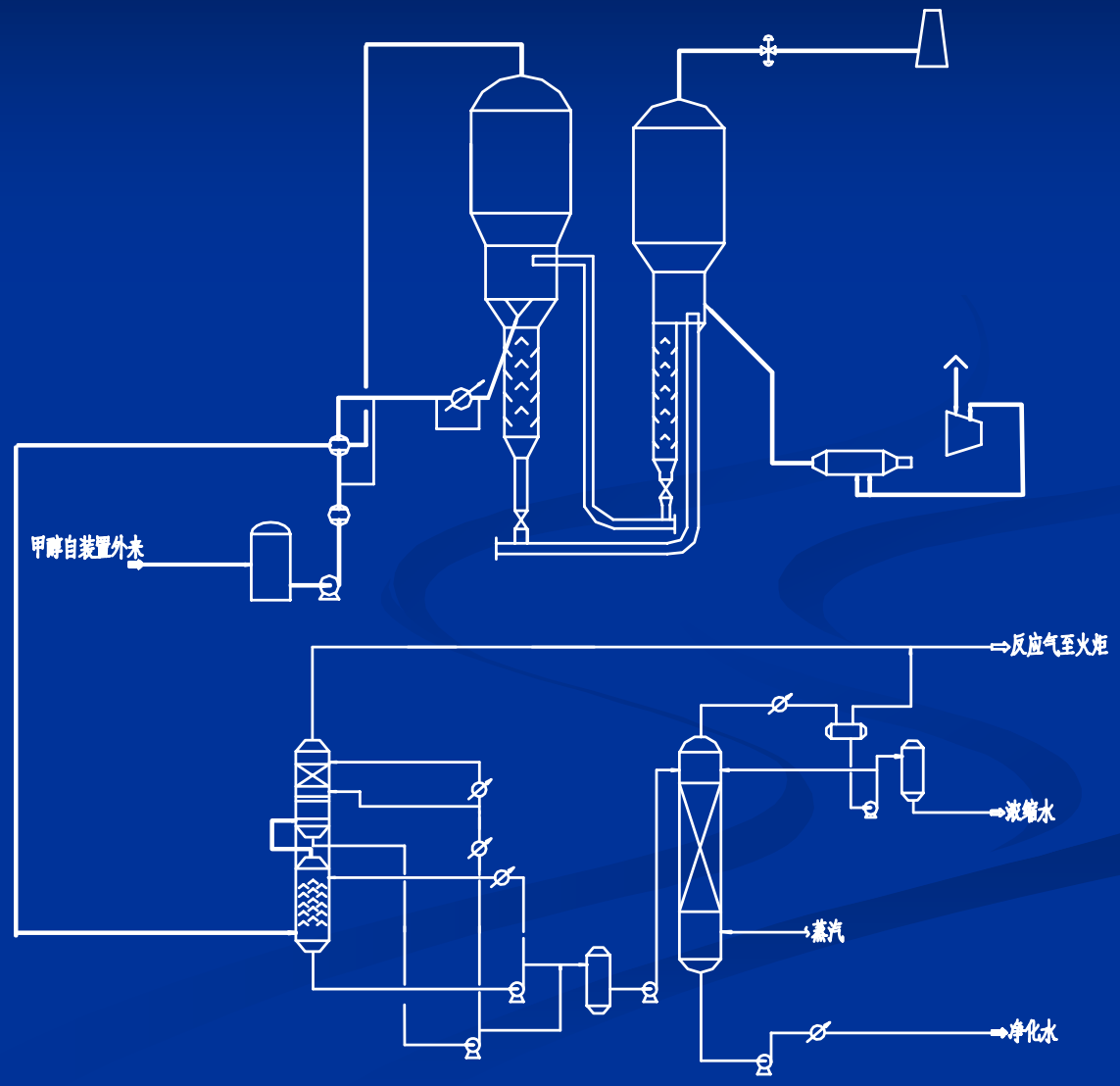
Methanol or Dimethylether to Olefin (DMTO) Demonstration Plant Near Xi'an

Flow chart of the DMTO demo unit

According to the feasibility study, deep cooling separation would not be tested.



DMTO装置主要工艺流程简图

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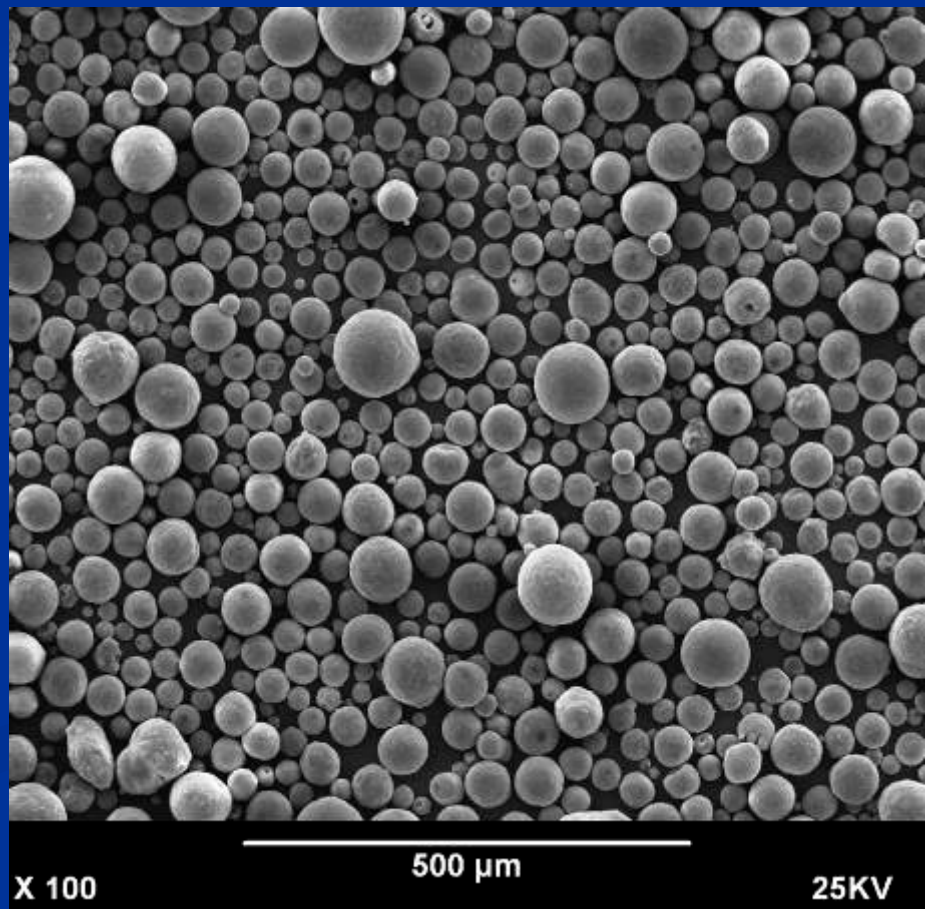
Loading catalyst to the
DMTO demonstration plant

DMTO catalyst



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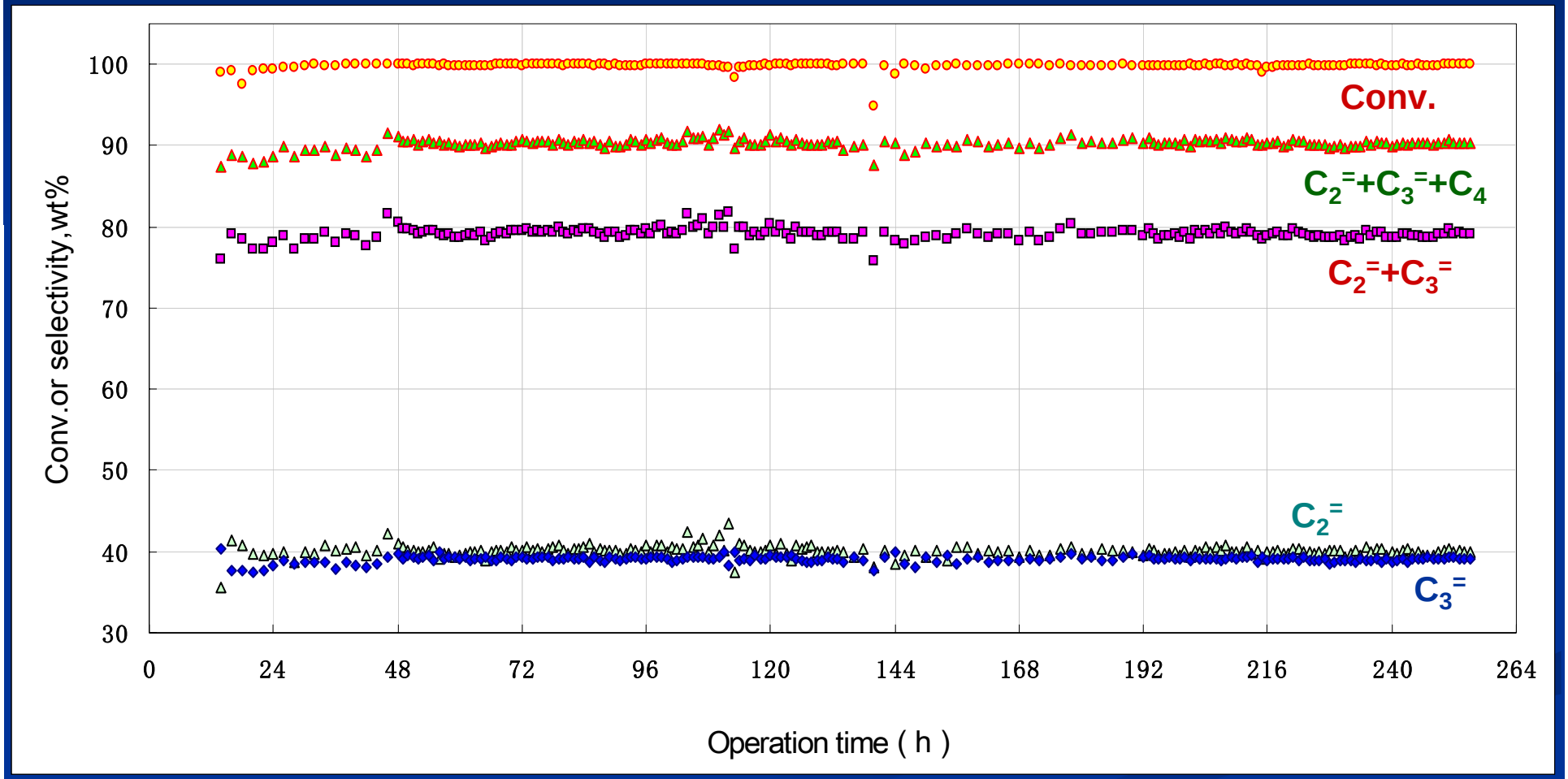
Typical results



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Comparison of the product stream comparison: naphtha *vs* DMTO

composition	Naphtha cracking （mol%）	DMTO（mol%）
H_2	14.13	2.06
CO	0.18	0.30
H_2S	0.03	
CH_4	23.68	3.01
C_2H_2	0.45	0.002
C_2H_6	6.41	0.67
C_2H_4	31.69	38.10
C_3H_6	9.44	24.83
C_3H_4	0.46	0.0002
1,3-C_4H_8	1.65	0.118
C_4H_6		0.014

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NOx in flue gas

- Flue gas from regenerator
  - CO ： 9.62 v%
  - CO_2： 5.18 v%
  - NOx ： 0.2 ppm
- NOx in product gas
  - ppb grade

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Economics

DMTO

Methanol Price (RMB/t)		1100	1300	1500	1700	1900	2100	2300	2500
MeOH Cos (RMB/t)		3278	3874	4470	5066	5662	6258	6854	7450
Cost of C2 & C3 olefin mixture (RMB/t)		3961	4560	5129	5637	5937	6718	7189	7806
Price of Olefin mixture (RMB/t)	ROI=10%	4471	5069	5639	6159	6736	7252	7724	8340
	ROI=12%	4644	5242	5812	6342	6919	7423	7902	8519

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Economics

Naphtha Cracking

Price of Naphtha (RMB/t)		1800	2100	2400	2800	3200	3600	4000	4400	4800	5200	5500	5800	6100
Naphtha Cost 扣除副产后石脑油在成本中费用（可变成本）(RMB/t)		2431	2883	3295	3897	4496	5246	5758	6141	6735	7314	7678	8044	8410
Cost of Olefin (RMB/t)		3792	4250	4667	5288	5903	6662	7179	7572	8181	8770	9144	9520	9896
Price of Olefin (RMB/t)	**ROI=10%**	4899	5357	5774	6395	7009	7554	8070	8463	9072	9661	10035	10411	10787
	ROI=12%	4960	5418	5835	6456	7097	7857	8373	8766	9375	9986	10360	10736	11112

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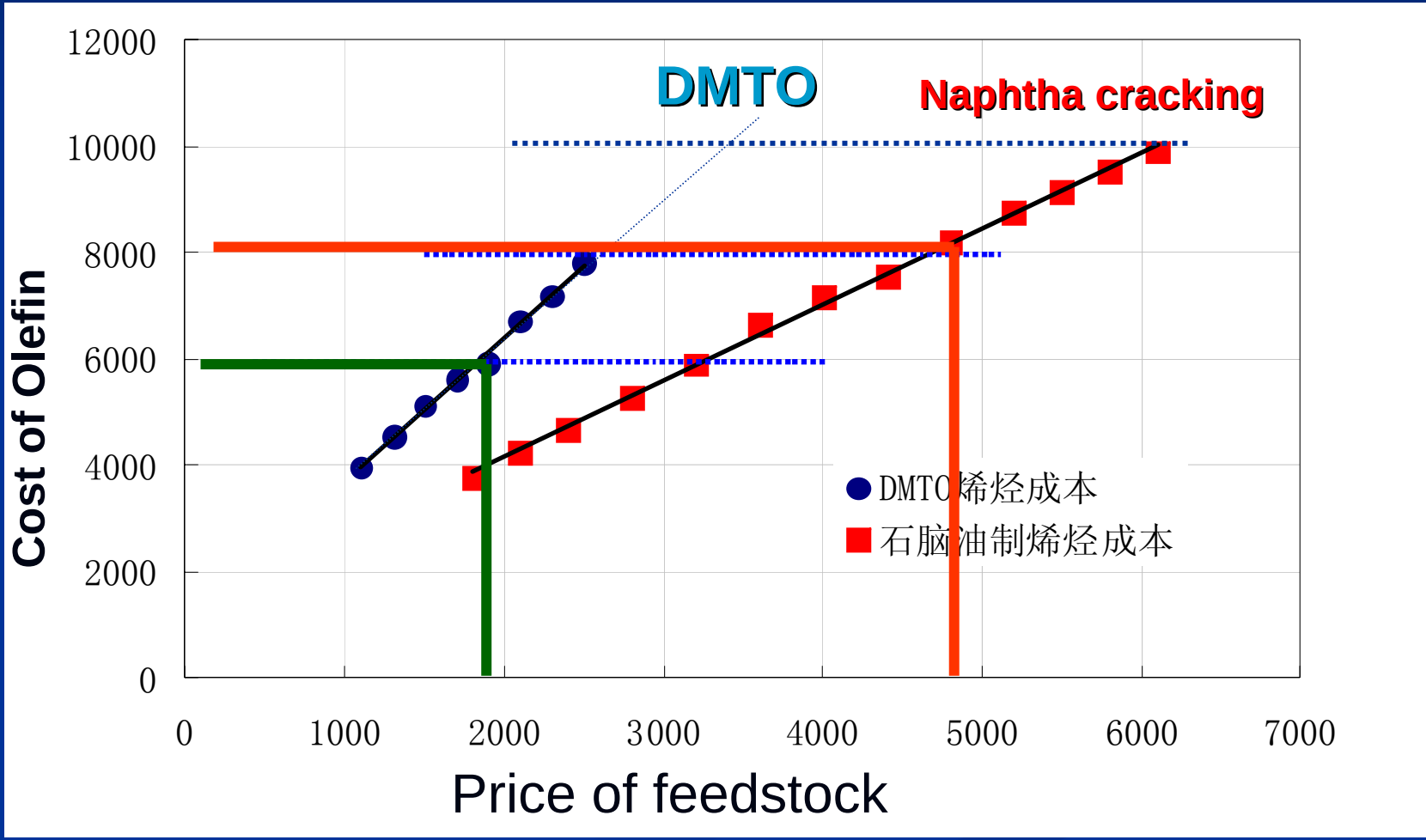
Cost: DMTO & Naphtha cracking



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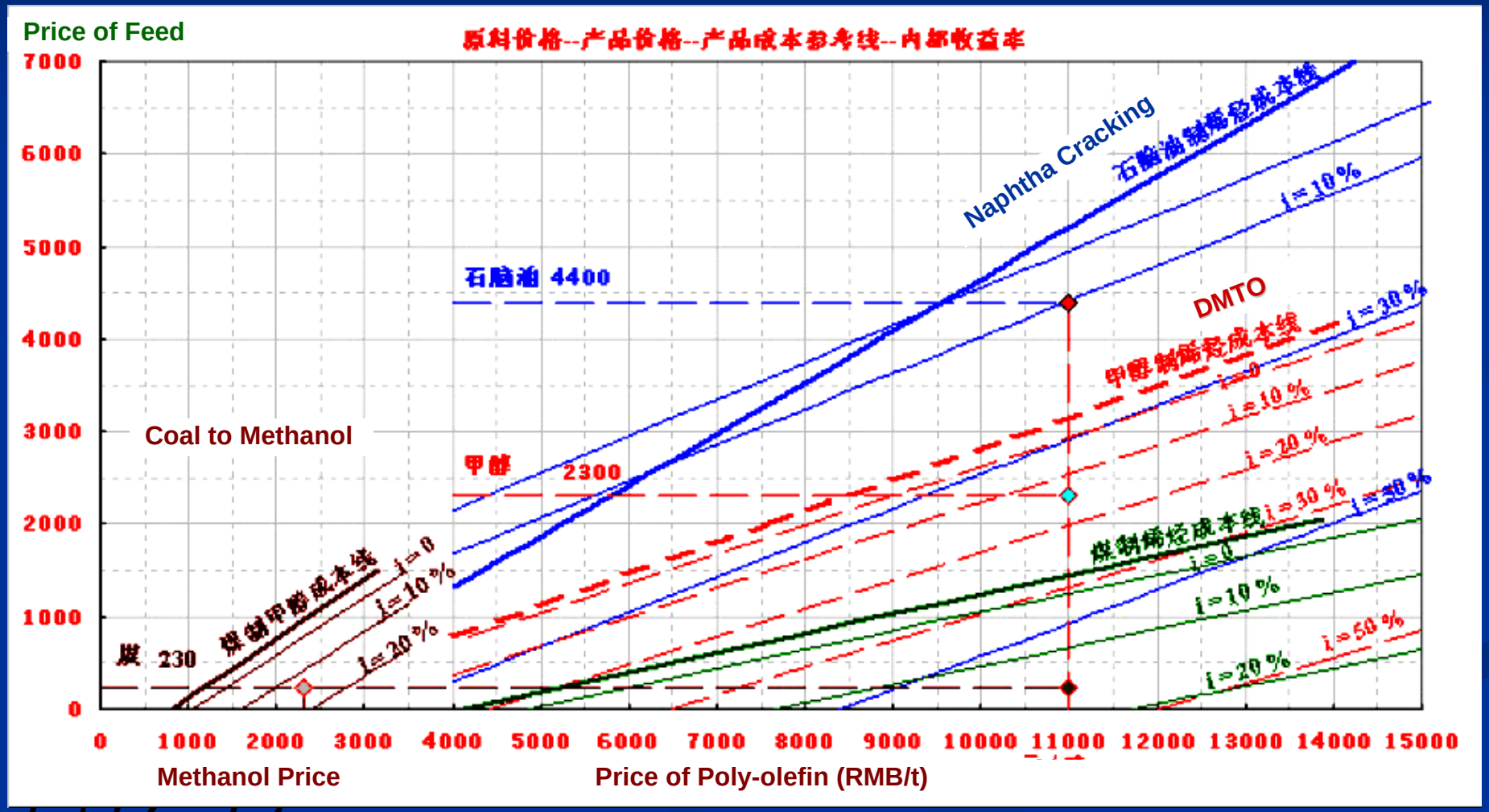
Economics: DMTO & naphtha cracking



Further development of DMTO technology

- The construction of commercially demonstration plant in China
  - Scale: 200kta olefin
  - Will be approved by NDRC
  - New related technology will be applied
    - Olefin selectivity ~90%(wt)
  - It is expected before the commercial plant
- The construction of commercially plant (600kta olefin)
  - Scale: 600kta olefin
  - Approved by NDRC
- The construction of commercially unit will be licensed outside China
  - Many international olefin companies have contact us for the technology licensing
  - Partner is expected for licensing the technology worldwide

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Thanks !