



CCUS Projects of Sinopec

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中国政府郑重承诺：2020年比2005年单位GDP的CO₂排放强度要下降40~45%。中国石化SINOPEC作为中国主要石油天然气开发企业，开发石油资源的同时，积极开展二氧化碳减排，目前已在CCS+EOR/CCUS等方面做了大量技术攻关和实质性工作。

***The Chinese Government's solemn commitment:* Reduce the intensity of carbon dioxide emissions per unit of GDP in 2020 by 40 to 45 % compared with the level of 2005.**

***SINOPEC* actively responds to the policies of emission reduction and energy production, over the years dedicated to research of the related technologies.**



Content



100t/d CCUS Pilot Project



Large-Scale CCUS Projects



Recognition



100t/d CCUS Pilot Project

自2008年起，中国石化在胜利油田开展了100吨/天燃煤烟道气CO₂捕集与EOR全流程示范工程建设。该示范工程将胜利发电厂燃煤烟道气中体积浓度约14%的CO₂捕集出来，并进行压缩、液化，最终把纯度达99.5%的CO₂输送至胜利低渗透油藏进行封存和驱油。该工程已于2010年9月全流程投产运行成功。

Since 2008, SINOPEC has been operating a 100 tons-per-day CO₂ capture, storage and EOR pilot project in Shengli Oilfield. The pilot project captures the CO₂ from the flue gas of the Shengli Power Plant, and the product CO₂ is transported to the low-permeability reservoirs in Shengli Oilfield to storage and EOR. The whole process of the project was successfully put into operation in September 2010.



100t/d CCUS Pilot Project



捕集：胜利发电厂CO₂捕集纯化 (PCC)

**Capture : Capture and purify the CO₂-rich gas from Shengli Power Plant
(EPC: Sinopec-SLECC)**

Flue gas handling capacity :

20000Nm³/h

Recovery of CO₂ :

2200 Nm³/h(100t/d).

CO₂ recovery : ≥85%.

CO₂ purity : ≥ 99.5%.





100t/d CCUS Pilot Project

Include Five Units



捕集纯化

Capture and purify



压缩

Compress



干燥

Dehydrate



液化

Liquefaction



储存装车

Storage

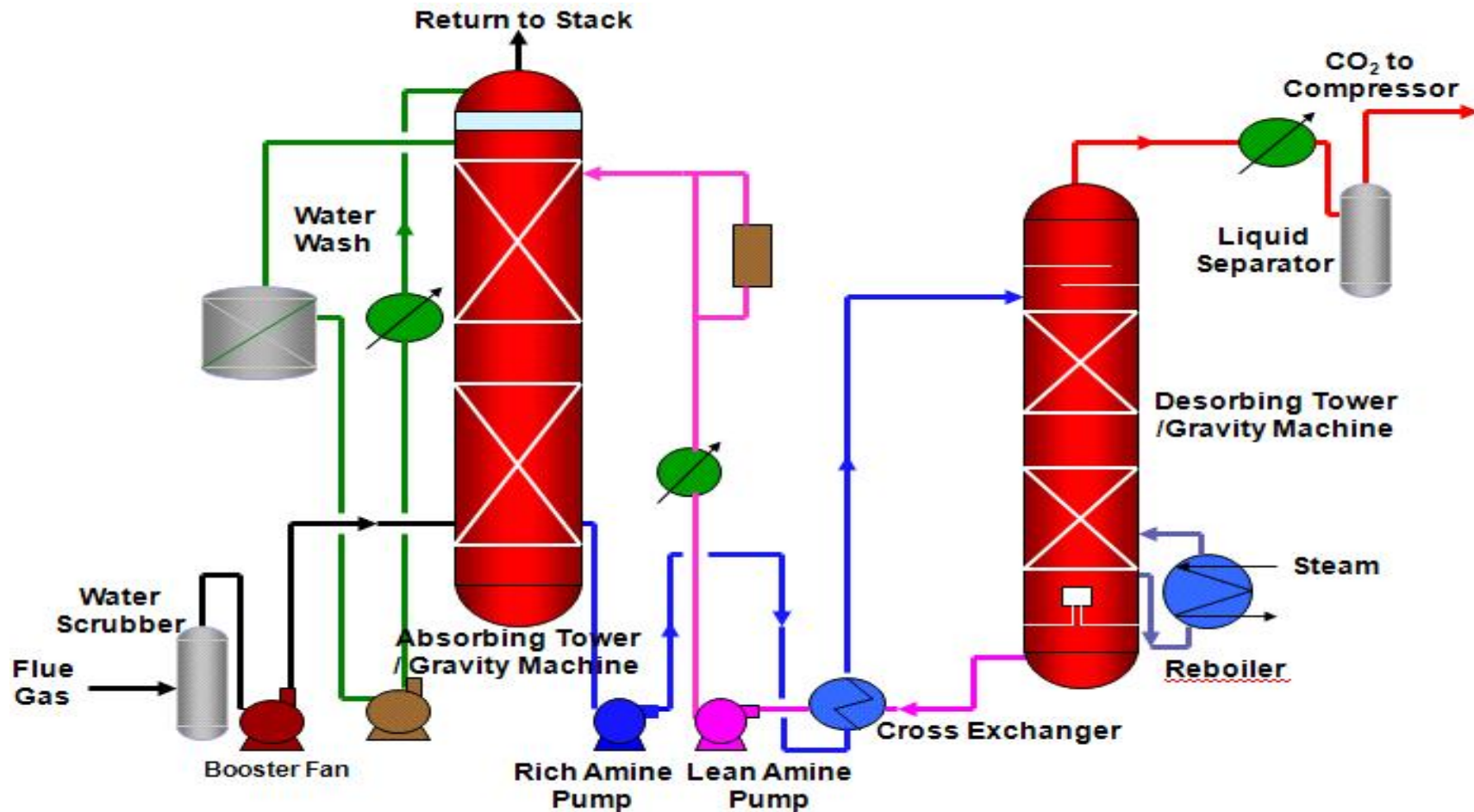
最终产品——液态CO₂由槽车送往胜利油田高89二氧化碳驱先导试验区用于强化采油。

The product ---liquid CO₂ is transported to the Gao-89 block for the pilot test of CO₂-EOR.



100t/d CCUS Pilot Project

Capture Process : Amine Absorption

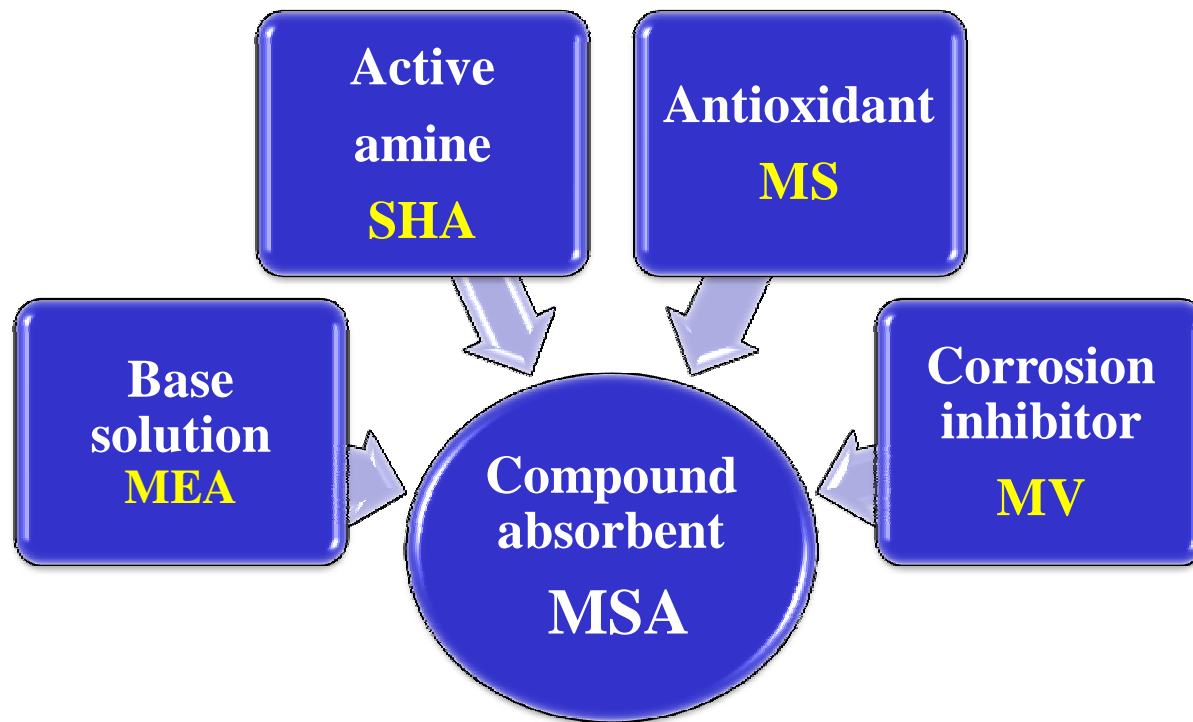




100t/d CCUS Pilot Project

工程采用中石化自主研发的化学吸收剂MSA。MSA是一种以MEA为主溶剂，添加活性胺SHA、抗氧化剂MS和缓蚀剂MV的优良复合吸收剂MSA。

The SINOPEC patent absorbent MSA is used in this project.





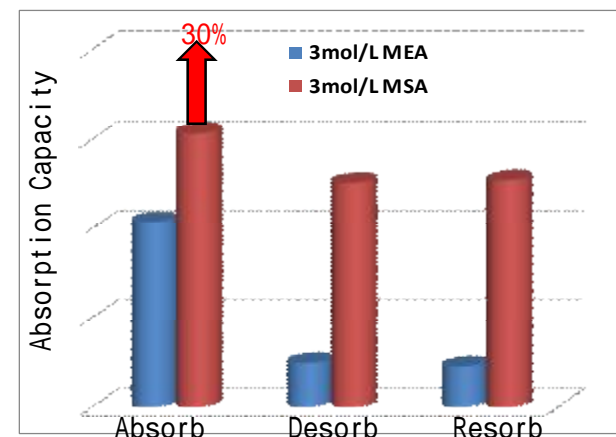
100t/d CCUS Pilot Project

MSA吸收能力提高30%，同时腐蚀速率、降解速率有大幅下降。

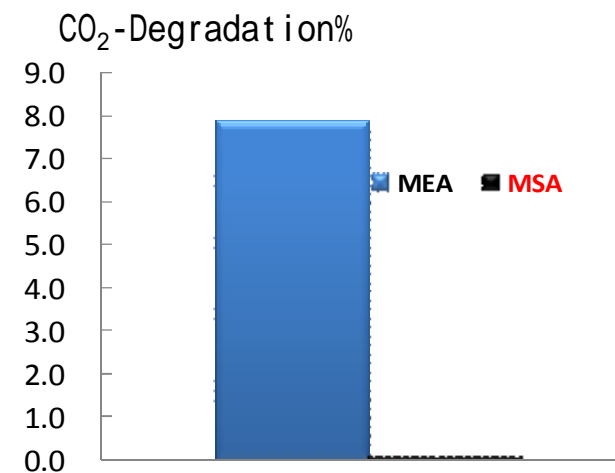
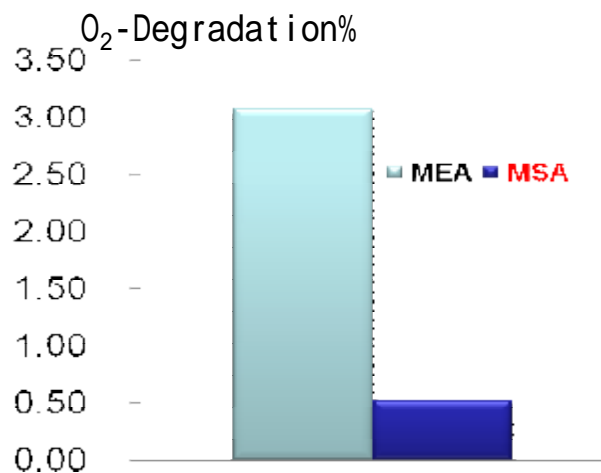
Ø Higher absorbency

Ø Excellent Anti-degradation capability

Ø Lower Corrosion Rate



Solvent	Corrosion rate mm/a (Carbon steel)
5mol/L MEA	1.54
5mol/LMSA	0.0030





100t/d CCUS Pilot Project





100t/d CCUS Pilot Project



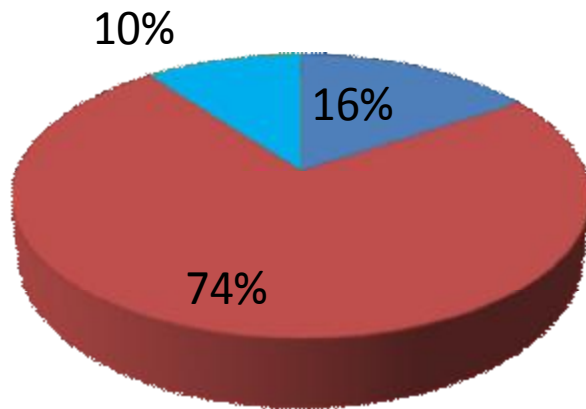


100t/d CCUS Pilot Project

Energy Consumption

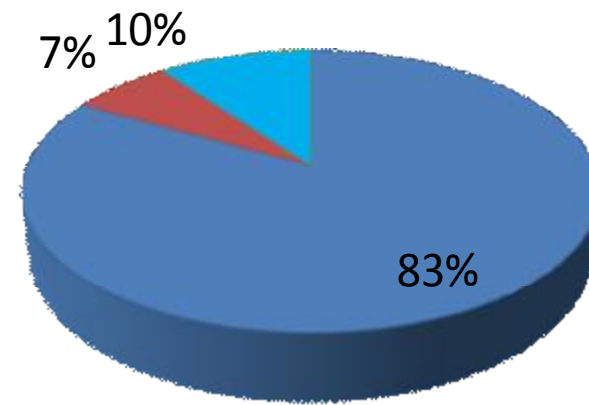
Energy Consumption of Capture System

■ Power ■ Steam ■ Circulating Water



Energy Consumption of Compress & Liquify System

■ Power ■ Steam ■ Circulating Water

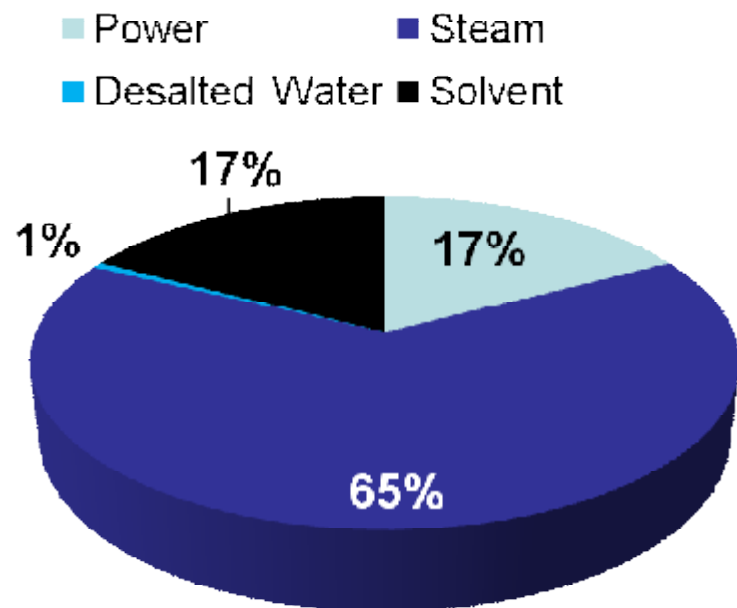




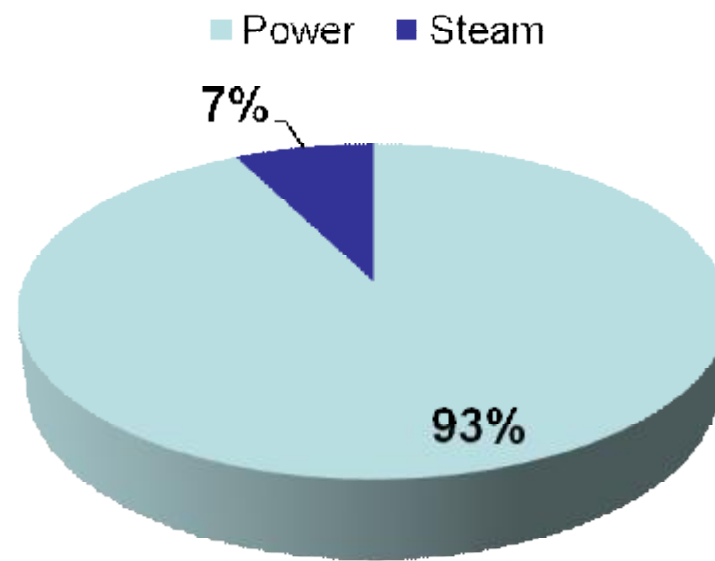
100t/d CCUS Pilot Project

Running Cost

Running Cost of Capture System



Running Cost of Compress & Liquify System





100t/d CCUS Pilot Project

Capture

Transport

EOR+Storage

Recycle CO₂



输送：胜利电厂至高89CO₂-EOR区块，80km，100t/d，槽车

Transport : From Shengli Power Plant to G89 CO₂-EOR Block, 80km,100t/d, Tank Truck





100t/d CCUS Pilot Project

Capture

Transport

EOR+Storage

Recycle CO₂

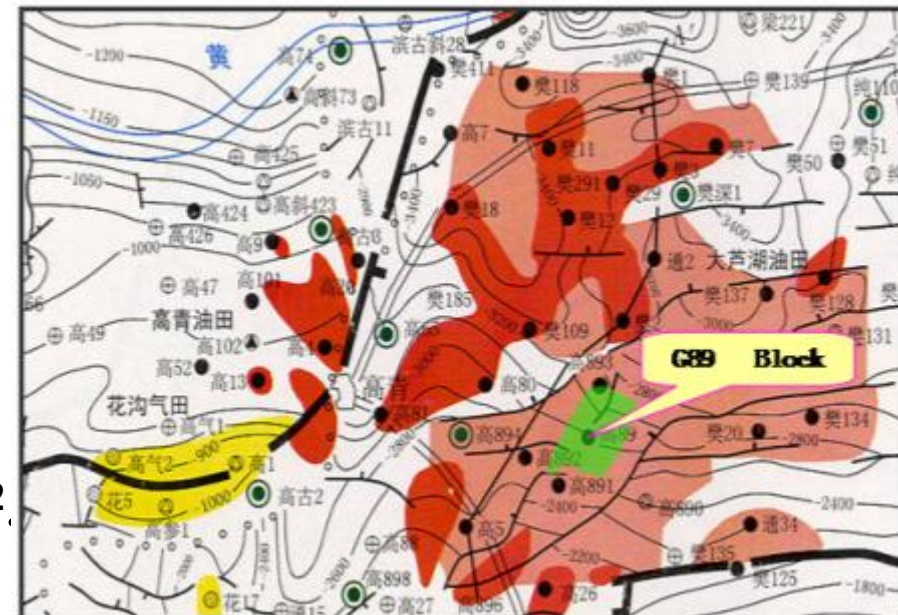
驱油+封存：胜利油田纯梁高89区块
EOR+Storage : Shengli Oilfield G89 Block

油藏埋深Depth: 3000m

有效厚度Thickness: 10.5m

孔隙率Porosity: 12.5%

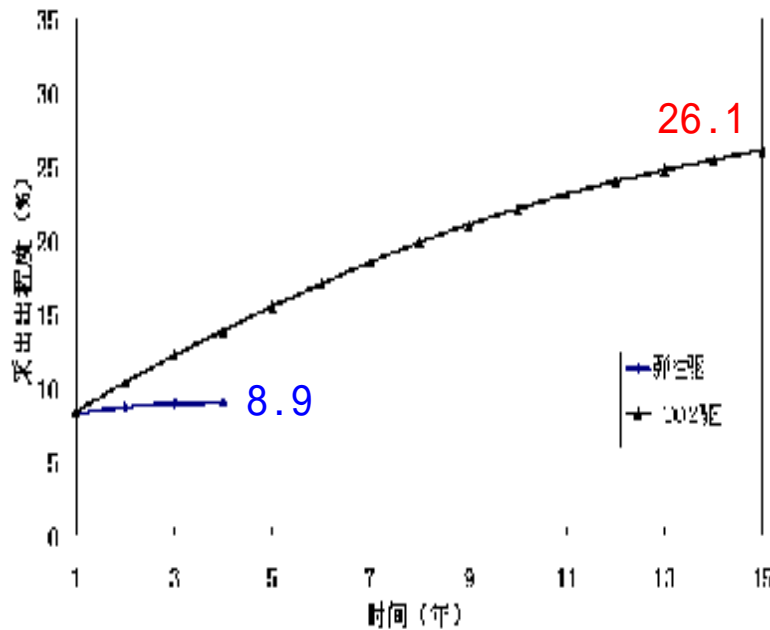
渗透率Permeability: $4.7 \times 10^{-3} \mu\text{m}^2$



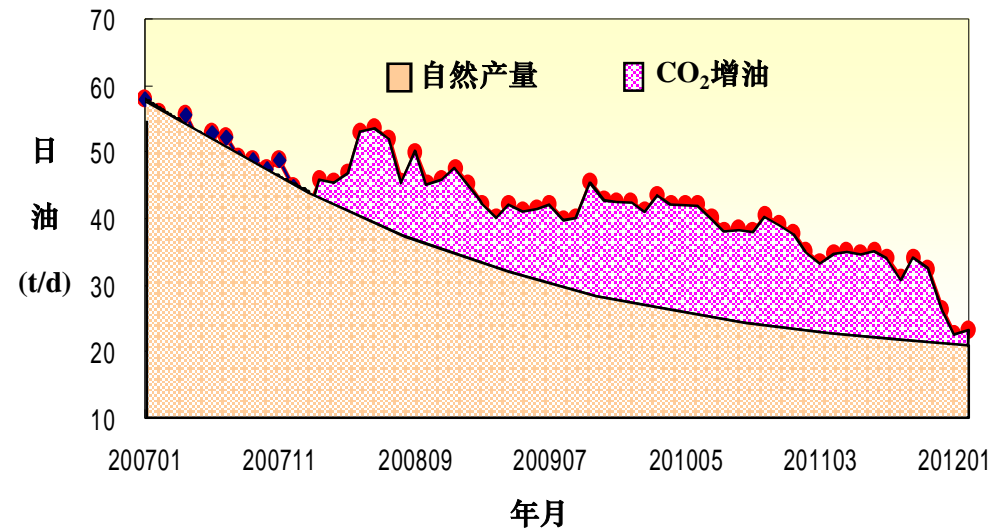


100t/d CCUS Pilot Project

驱油+封存：胜利油田纯梁高89区块
EOR+Storage：Shengli Oilfield G89 Block



Estimated oil recovery can be increased by 17.2% in 15 years.



Initial gas injection : Jan.,2008
Total CO₂ injection volume: **66,000 tons**
Total increased amount of oil: **15,500 tons**



100t/d CCUS Pilot Project

驱油+封存：胜利油田纯梁高89区块
EOR+Storage：Shengli Oilfield G89 Block



Injection Station



Injection Well

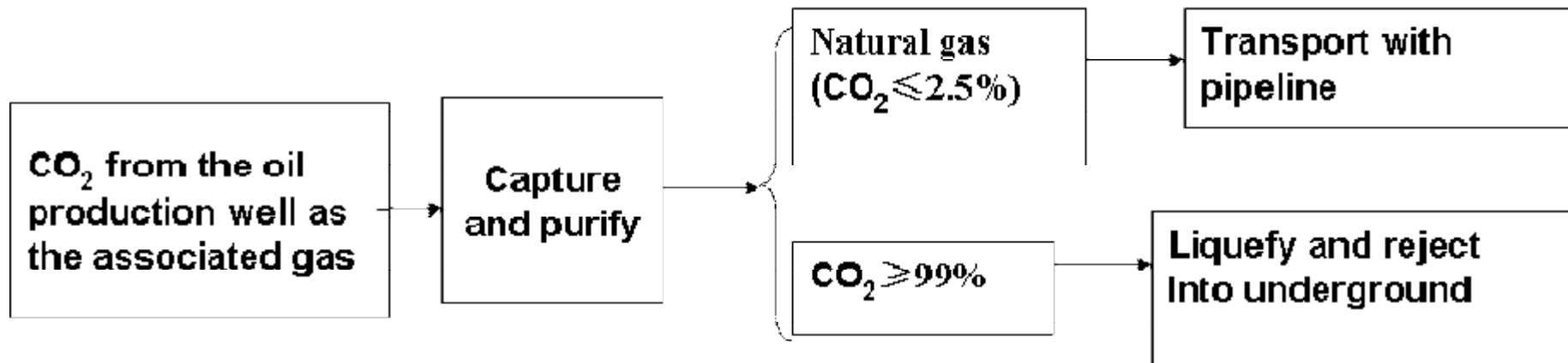




100t/d CCUS Pilot Project



采出气CO₂回收：变压吸附
Recycle CO₂ : PSA

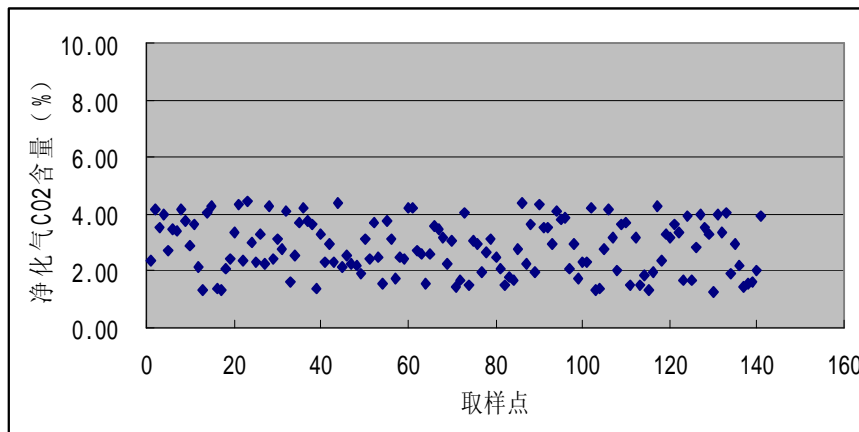
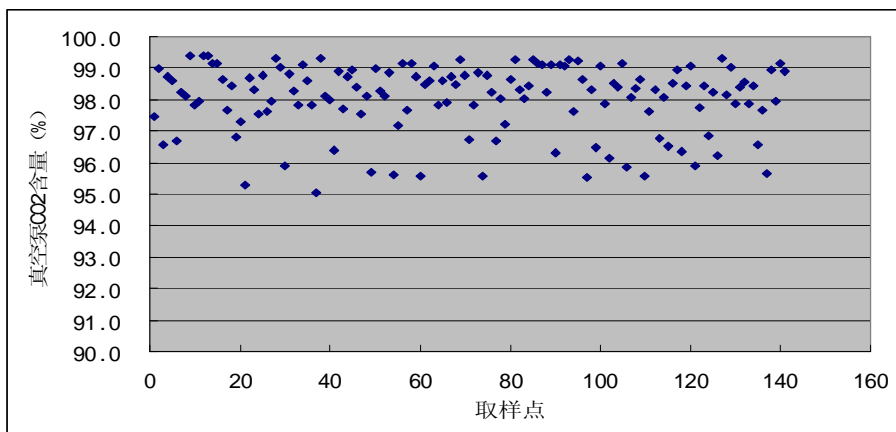




100t/d CCUS Pilot Project

PSA Instrument

运行参数	数值
进气量	1000Nm ³ /d
原料气CO ₂ 浓度	30-60%
产品CO ₂ 纯度	≥96%
净化气中CO ₂ 浓度	≤5%





100t/d CCUS Pilot Project

SINOPEC正在进行大规模CO₂回收工艺开发。

- 设计处理量： $3 \times 10^4 \text{Nm}^3/\text{d}$



Content



100t/d CCUS Pilot Project



Large-Scale CCUS Projects



New development



Large-Scale CCUS Projects(Execute Stage)

两个大规模CCUS项目 (CCS-EOR)



胜利电厂低浓度CO₂
(CO₂14%)

MEA化学吸收工艺

100万吨/年 管输

现河及纯梁油区



齐鲁煤制气高浓度CO₂
(CO₂90%)

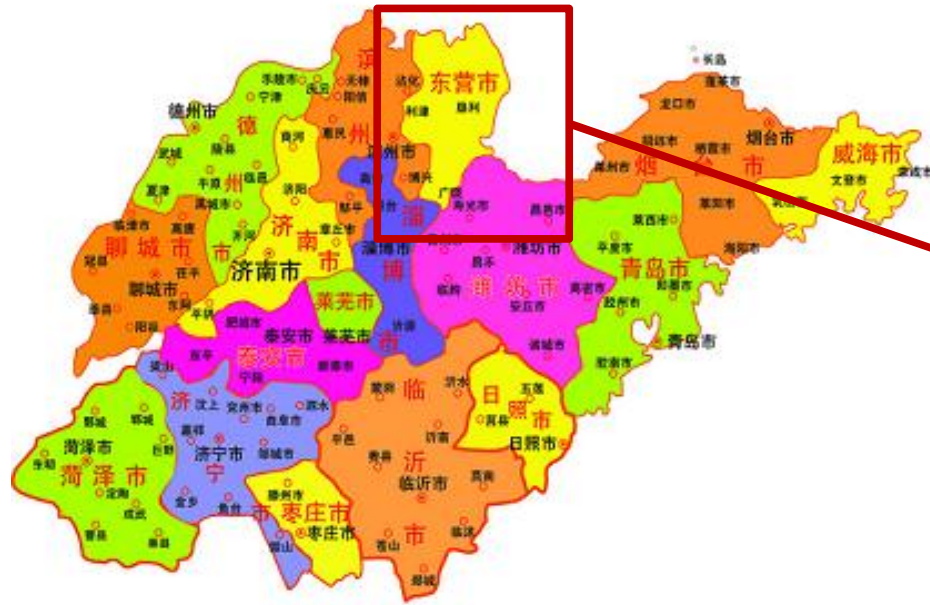
低温精馏工艺

50万吨/年 管输

纯梁油区



Large-Scale CCUS Projects(Execute Stage)



山东省





Large-Scale CCUS Projects(Execute Stage)

Schedule

齐鲁煤制气

50万吨/年CCUS项目

2012年12月：完成工程方案及可行性研究

2014年6月：完成工程建设及投产

胜利电厂烟气

100万吨/年CCUS项目

2012年1月-2013年6月：基础研究

2014年12月：工程建设

2015年：运行、监测及评价



Large-Scale CCUS Projects(Execute Stage)




另外，对于胜利电厂燃煤烟道气CO₂捕集来说，在生产主产品CO₂的同时，生成了副产品N₂，可直接采用该资源进行油田氮气驱三次采油(中石化正在开展相关先导试验)。

mol%	N ₂	O ₂	CO ₂	Others
空气 Air	78.08	20.95	0.03	0.94
脱碳后烟道气 Flue Gas after decarbonization	91.4	5.27	3.33	---

主产品CO₂用于CO₂驱油，副产品N₂用于N₂泡沫驱油。经初步估算，如果将CO₂与N₂均用于油田驱油，驱油综合成本将降低30%。

Main product CO₂ will be used for CO₂ flooding, and by-product N₂ will be used for nitrogen foam flooding. If utilize CO₂ and N₂ for flooding at the same time, the cost of oil production will be reduced by 30%.

Content

-  **100t/d CCUS Pilot Project**
-  **Large-Scale CCUS Projects**
-  **Recognition**



Recognition

实现大规模全流程CCUS工业应用，还需要做什么？

What to do to realize large scale CCUS commercial application?

- I 进一步降低捕集成本：高效药剂、新型复合捕集工艺、余热利用、与电厂系统匹配
- I 安全保障技术：安全输送、泄漏监测、运移跟踪及监测、环境影响监测
- I CCUS选址：CO₂-EOR适应性评价、封存潜力评价、源汇匹配



Recognition

实现大规模全流程CCUS工业应用，还需要做什么？

What to do to realize large scale CCUS commercial application?

I CCUS实施：油藏方案优化（驱油效益、封存率最大化）、注采系统配套技术（封窜、调堵、防腐）、集输系统配套技术（防腐、阻垢、采出气CO₂回收）

I 大规模CCUS全流程工程及综合分析评价：工程化技术、全流程经济分析、驱油效果评价、封存效果评价

I 政策法规：公众认知？安评、环评规范？相关责任？融资？碳税或碳补贴？

以上内容已纳入中石化承担的国家“十二五”科技项目！



THANKS!

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Zhangjian

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