World Congresson Climate Change

CO_2 EOR and Sequestration Technologies in PetroChina

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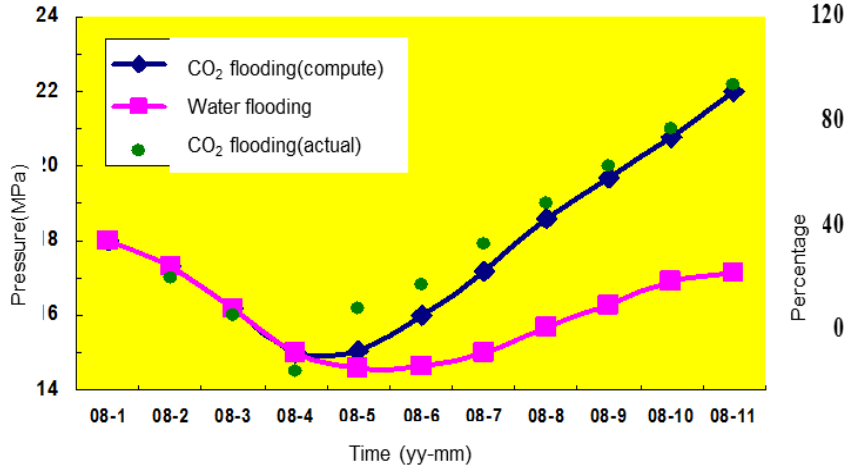
October 2016, Valencia, Spain

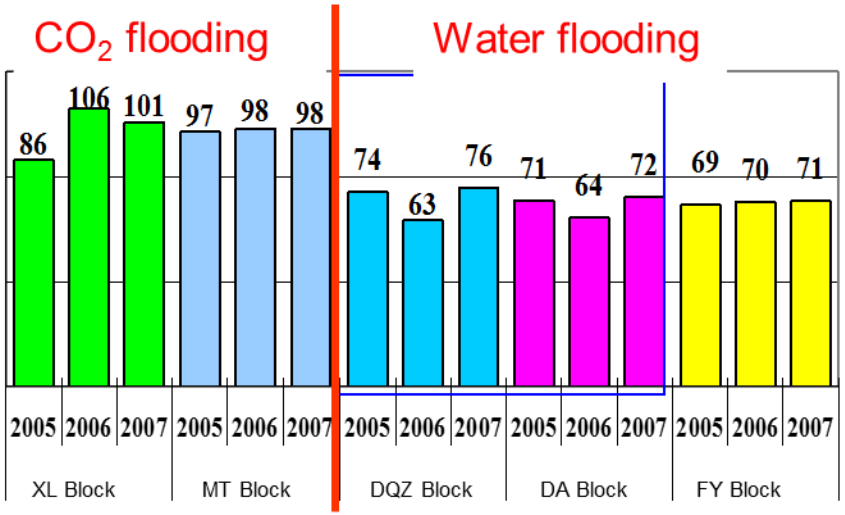
Outline

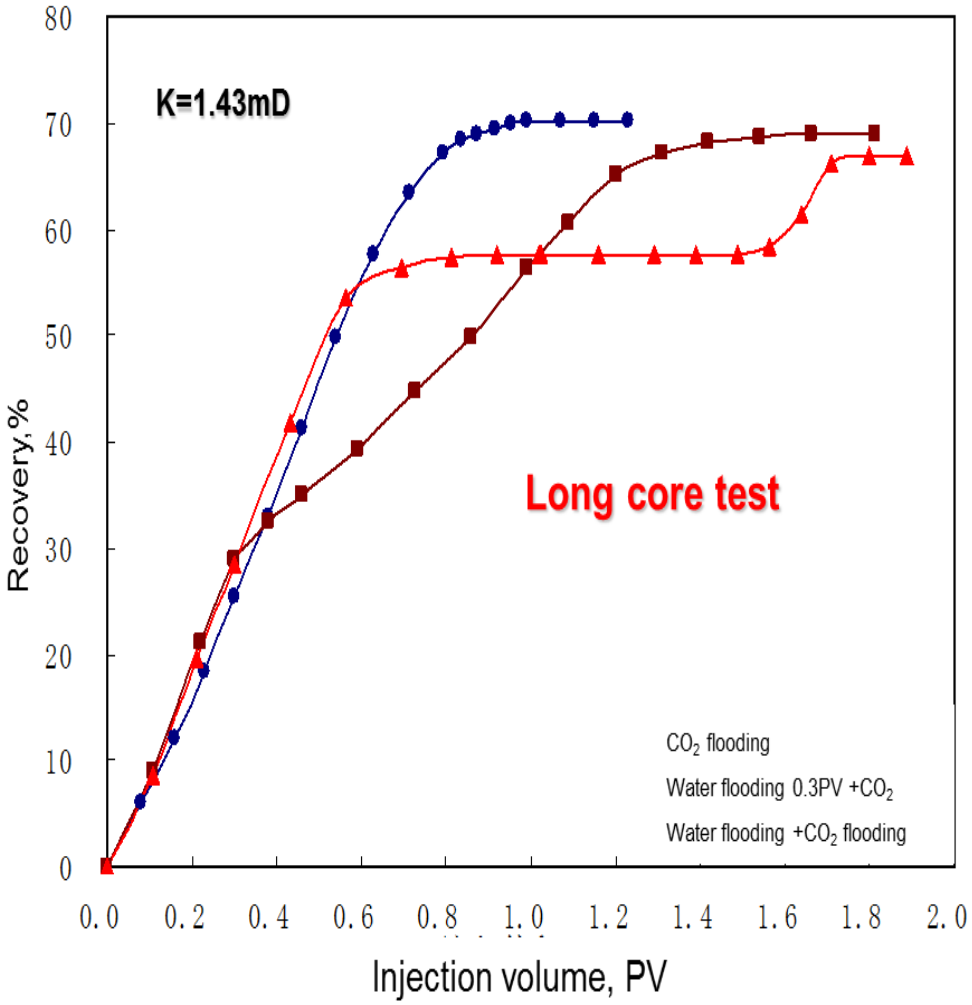
- Backgrounds
- CO_2-EOR in PetroChina
- Challenges

Backgrounds

1、CO_2 flooding is one of the effective oilfield development means for ultra-low permeability reservoirs

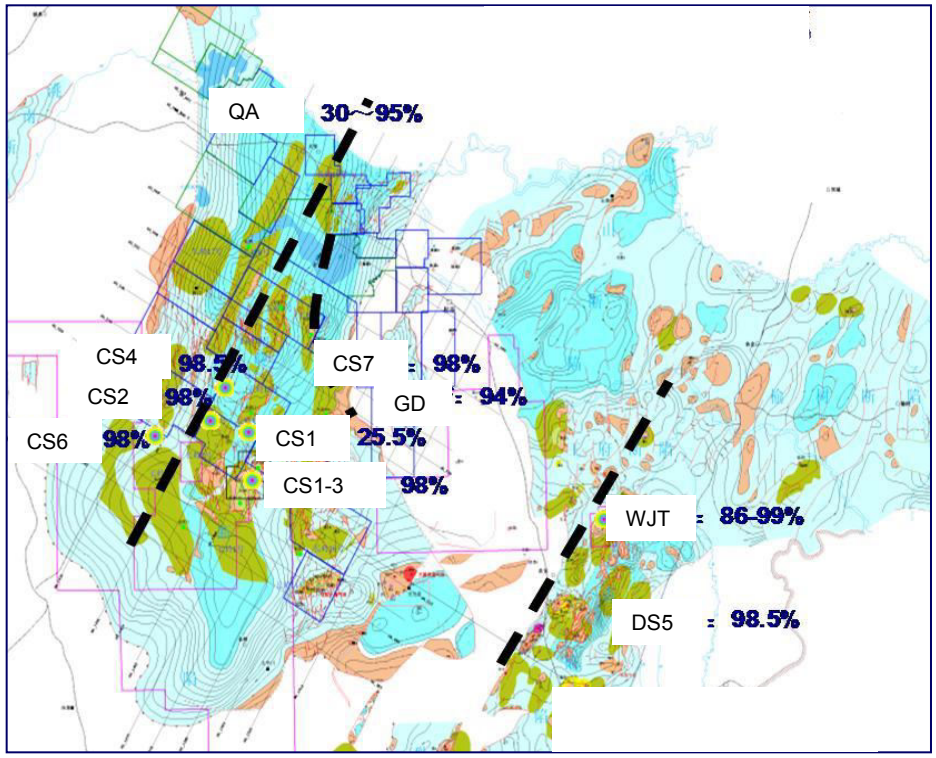




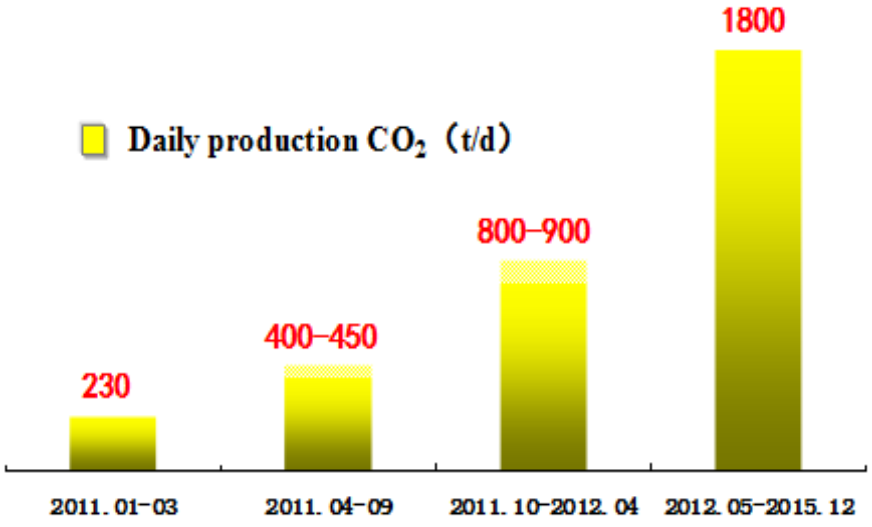


Backgrounds

2、Plenty of CO_2 rich gas reservoirs needed to be developed in Songliao Basin.



The southern Songliao Basin



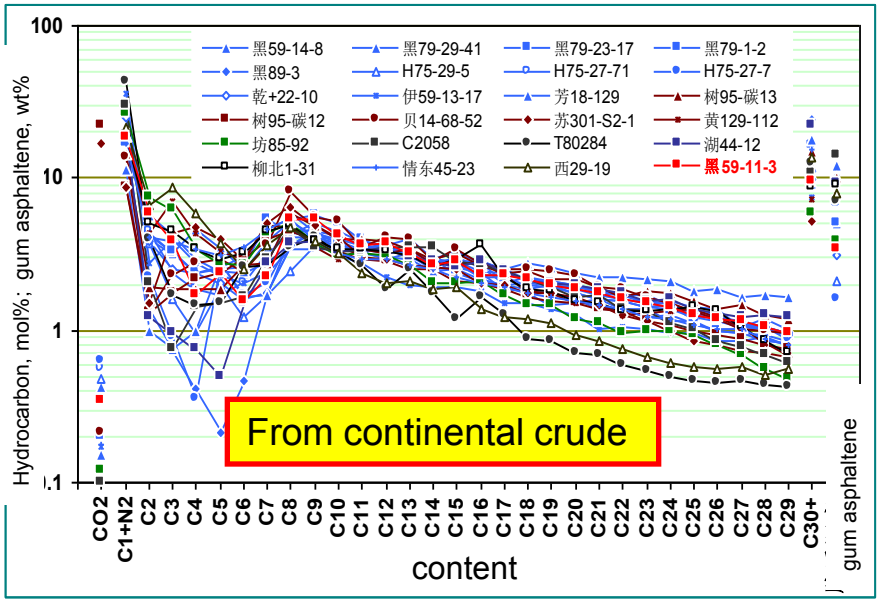
Daily CO_2 production in one of these gas fields

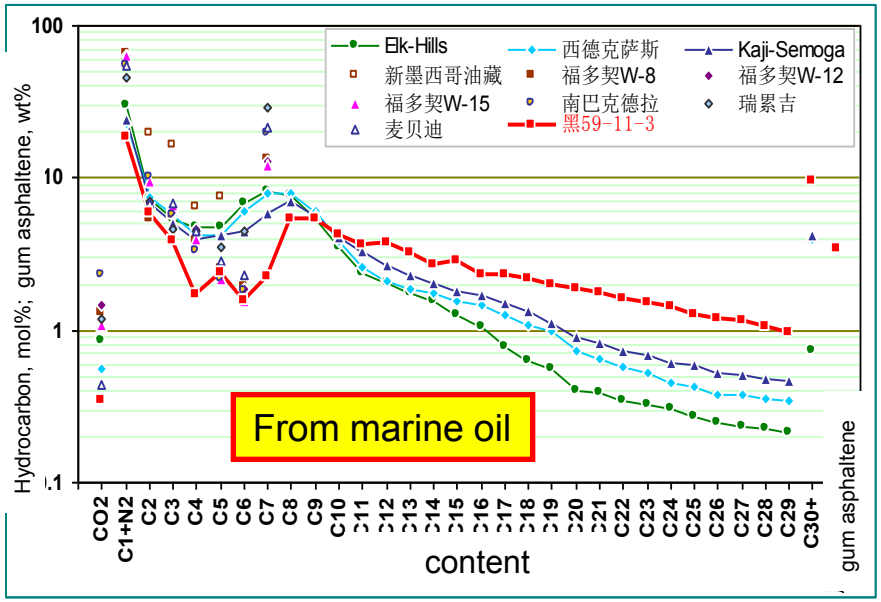
Outline

- Backgrounds
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1. Oil-CO_2 phase behavior study

- Compared to marine crude, the C_2-C_6 components in continental crude are much lower， while C_{11+} and gum asphaltene components are relative higher



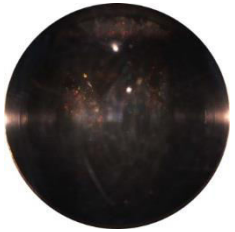




Increase pressure



Increase pressure



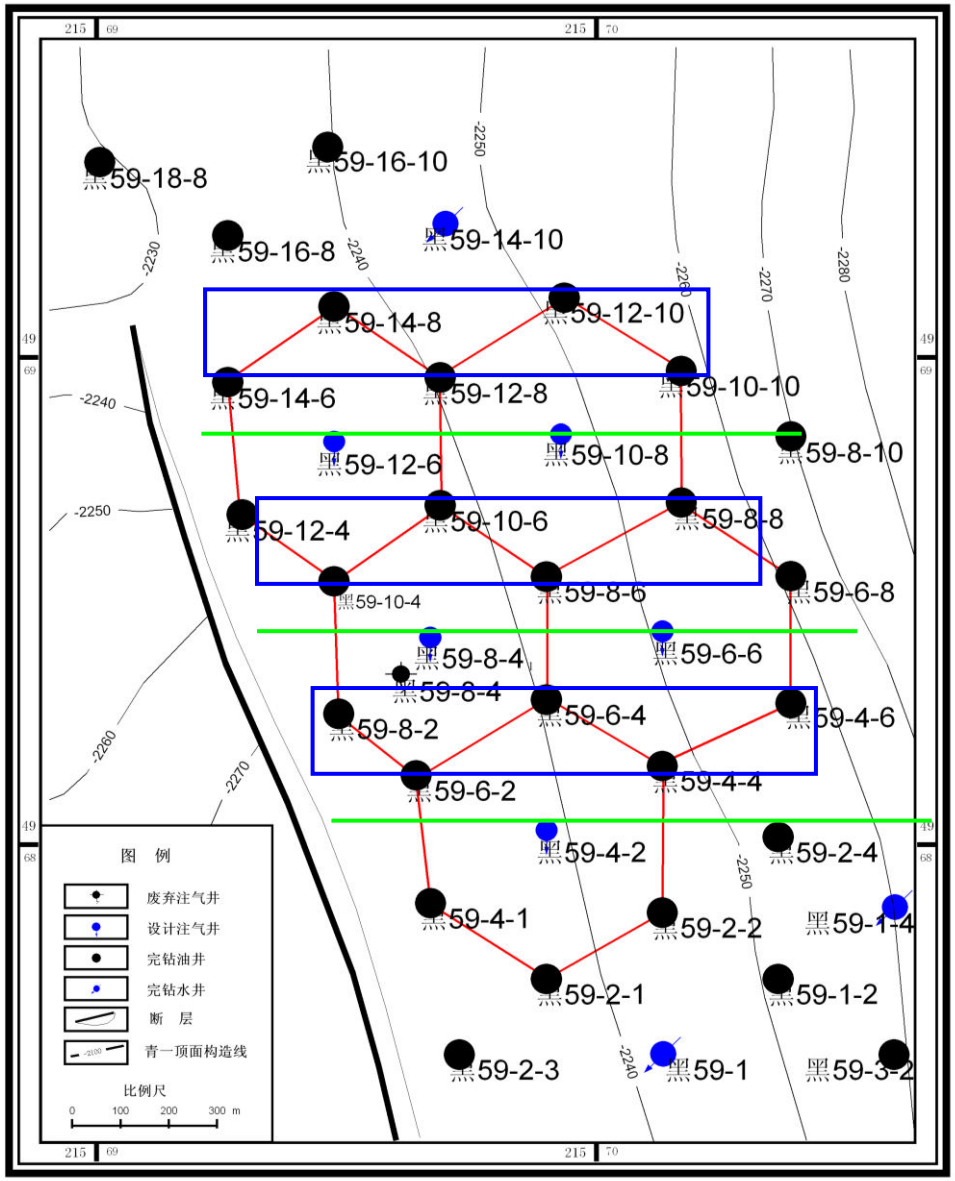
mass transfer between CO_2 and C_2-C_6.

mass transfer with C_7-C_{15}. formed rich hydrocarbon transition phase

further miscible with heavy hydrocarbon components

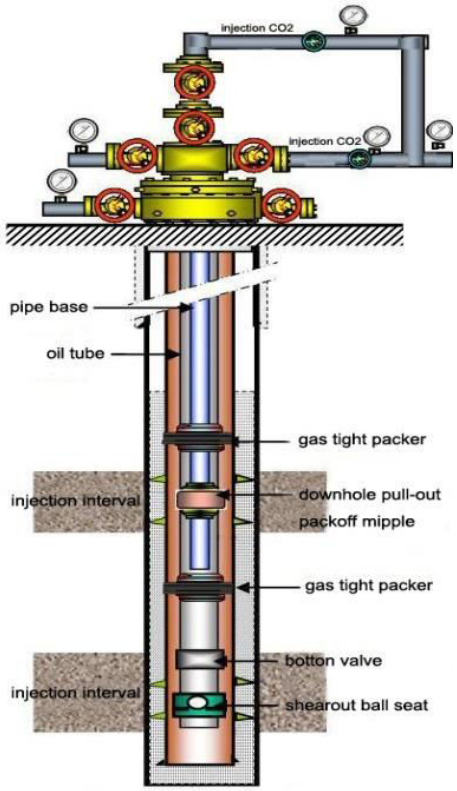
2. Reservoir engineering design and optimization

- well pattern matched with fracture network, realizing linear displacement
- Wave-like linear seven spot well pattern favorable for gas breakthrough retarding and plane adjustment
- Injection to production well ratio: 1:2, economical

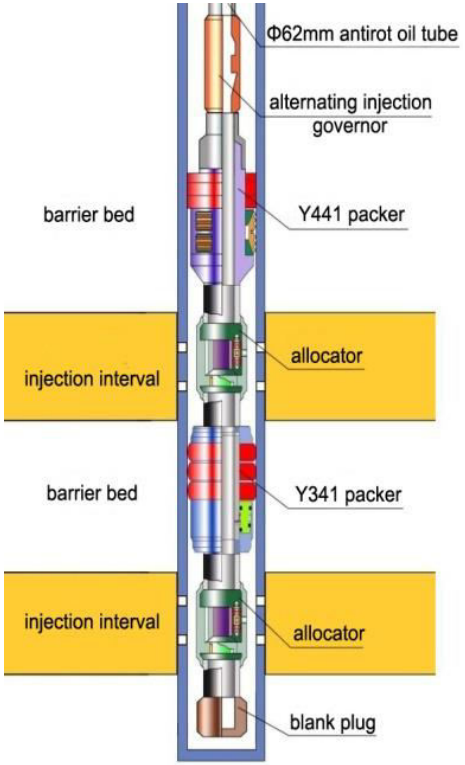


3. Separated layer CO_2 flooding technology

- *PetroChina* has conducted research on concentric double-barrelled- and single-barrelled separated layer gas injection technologies
- Pilot test in Daqing Oilfield were implemented, which effectively reduce gas cross flow between layers that caused by commingled gas injection



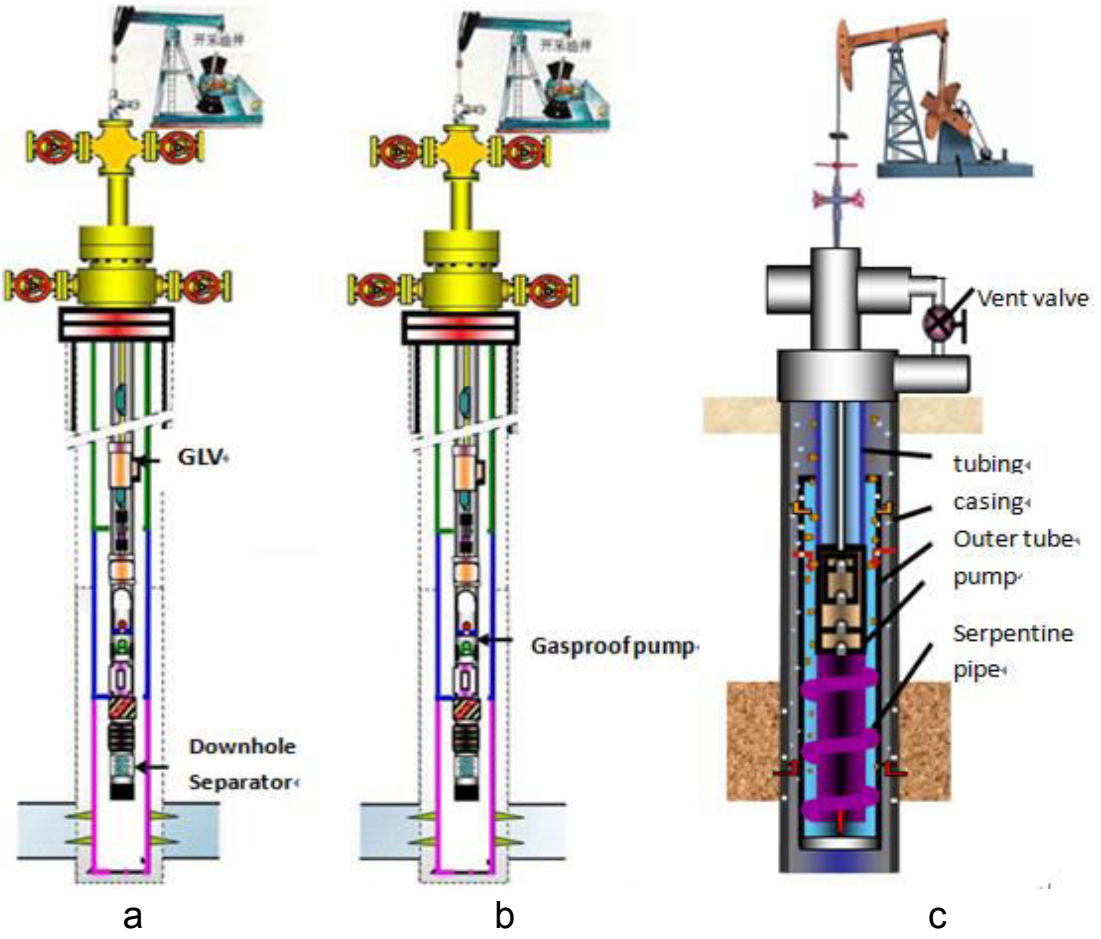
The separated layer gas flooding process with concentric dual tubing



The separated layer gas flooding process with single pipe

4. High efficiency lift technology

- we have developed core lift equipment, and 3 kinds of effective lift technology
- *PetroChina* has also finished field test of 17 wells in Jilin Oilfield and Daqing Oilfield, which apparently improves the efficiency of the pump

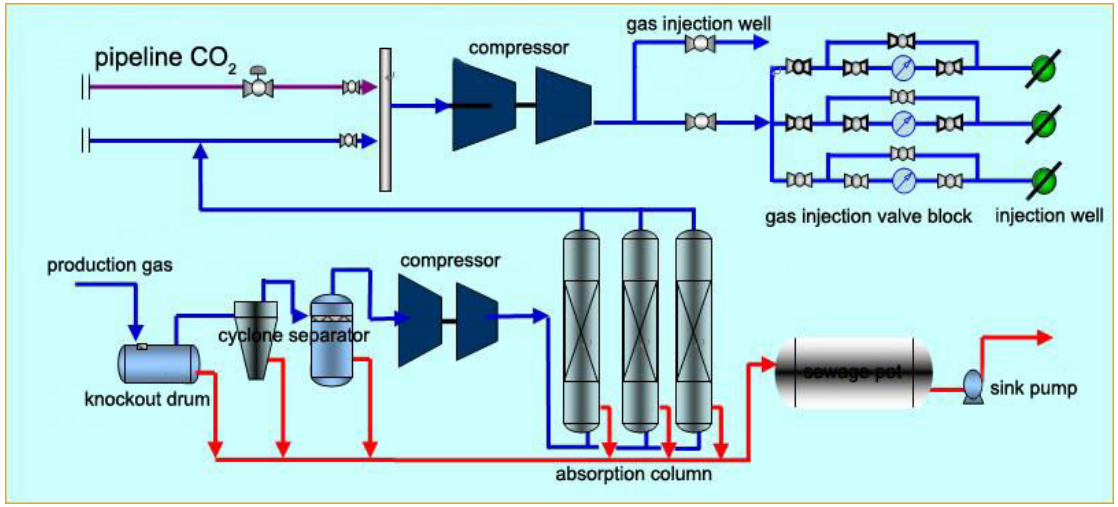


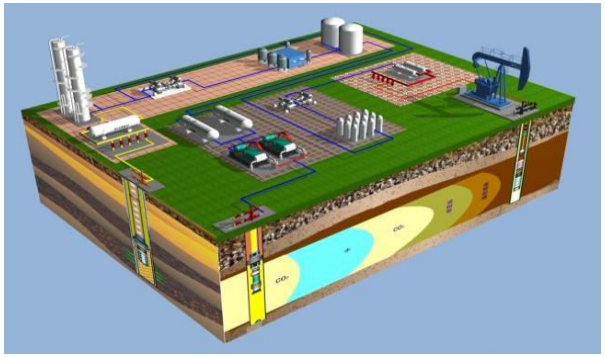
three kinds of high efficient lifting technology

(a:gas lifting-assisted pumping-casing control integration lifting technology; b:gasproof high efficient lifting technology; c:the out pump gasproof lifting technology)

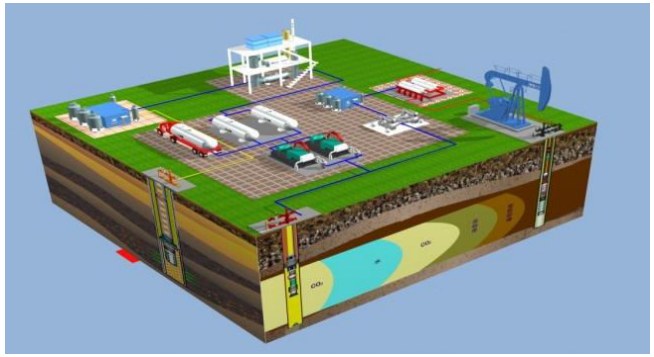
5. Long distance pipeline transportation and injection technology

- optimization method and process of pipeline design
- Long distance pipeline transportation and supercritical injection technology

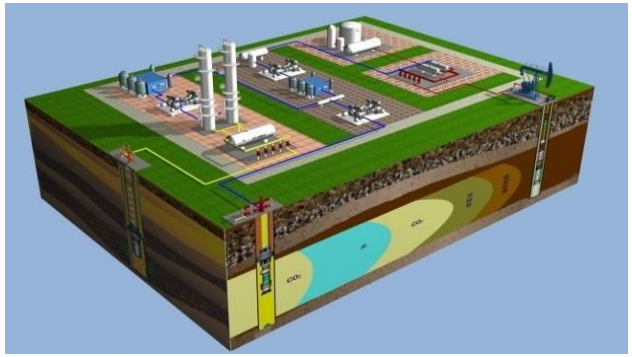




The pilot test mode: applied to Block Hei59, meet the in-truck injection mode in pilot test, cycling gas is reinjected after mixing



The liquid injection mode: applied to Block Hei79, meet the concentration injection mode in expanding test, cycling gas is injected after purification.



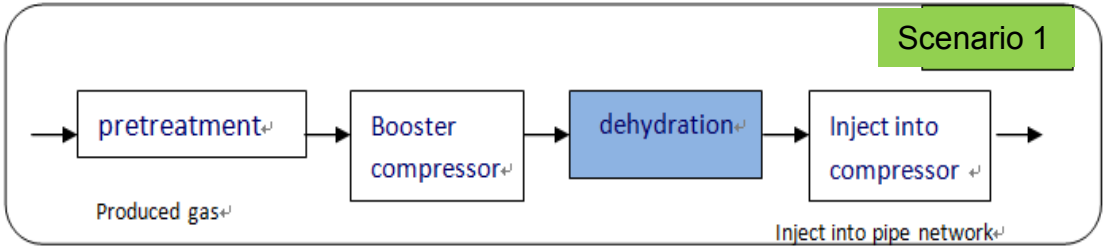
The supercritical injection mode: applied to Block Hei46, meet the supercritical injection mode in industrializion, cycling gas is injected after mixing

Three kinds of injection mode

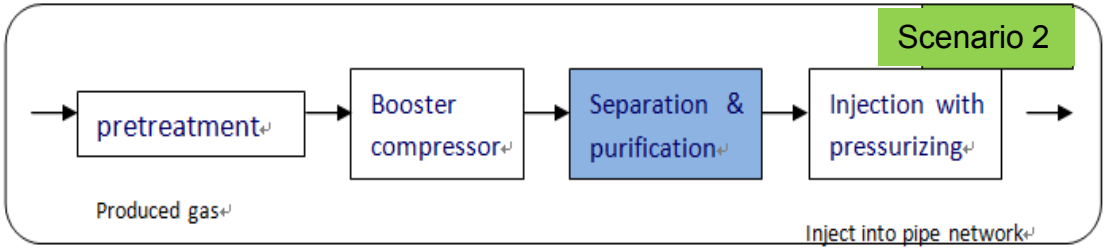
6. Cycling gas injection technology

Three scenarios of CO_2 flooding produced gas re-injection technologies were formed, and we also completed the production gas separation and purification device in Block H79 and thus achieved CO_2 cyclic injection and zero atmosphere emissions.

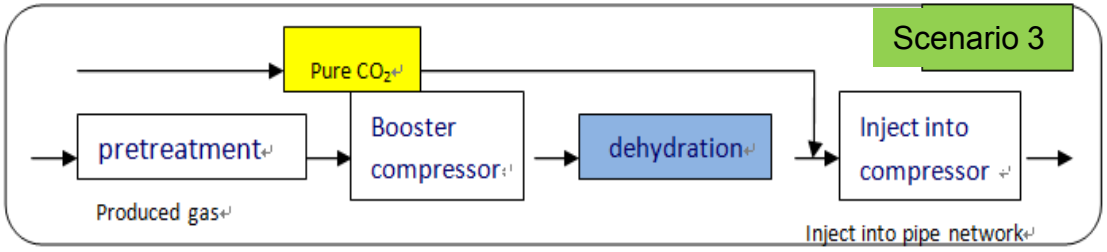
Supercritically reinject produced gas directly, cost ¥110.8/ton.



Inject produced gas after separating and purifying ,cost ¥125.52/ton.



Supercritically inject produced gas mixed with pure CO_2,cost ¥110.8/ton.





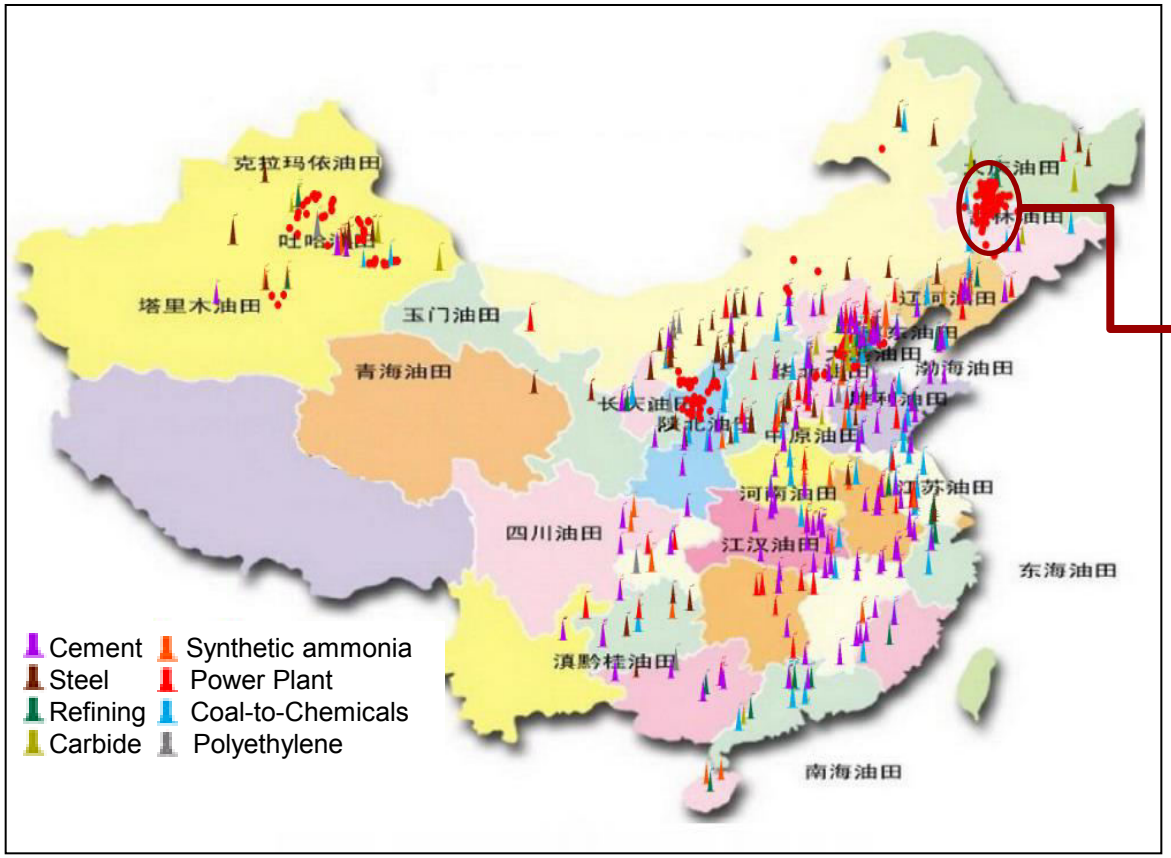
Facilities of supercritical mixing reinjection in Block Hei59

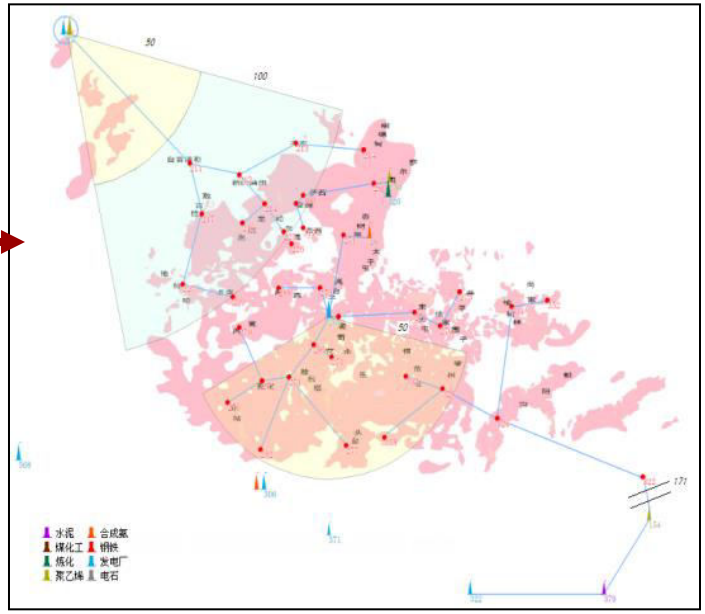


Facilities of pressure swing adsorption separation and purification in Block Hei79

7. Strategic planning for CCS

- We collected the CO_2 emission data of more than 600 enterprises involving 8 major industries, and then built up the basic database
- Based on the structure features of the CO_2 emission source cost, we conducted the primary matching plan of field sinks and CO_2 sources





match architecture of Daqing Oilfield and nearby CO_2 sources

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- Backgrounds
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Challenges

1. CO_2 resources condition

- The Lack of relatively cheap CO_2 resources
- The price for CO_2 capture from electricity plants by coal consumption higher at $80/tone, it will be beneficial if the price lower than $20-30/tone

2. Reservoir condition

- The complexity of continental depositional environment and strong reservoir heterogeneity

3.Fluid condition

- The complexity of source rock, higher oil viscosity, higher wax content and higher MMP

Thanks!