



中国石化
SINOPEC

Sinopec Closed Coke Handling System (S-CCHS)

Safe and Eco-friendly Delayed Coking
Technology for Petroleum Coke Removal,
Conveying and Storage

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Overview

•Current Status of Delayed Coking Unit

Delayed coking is an important approach of residue oil processing. Hydraulic coke removal is widely used to remove coke in coke drum. Its principle is to use high pressure water to cut coke in coke drum. The cut coke flows into the coke pit together with the coke cutting water. The coke pit is in the open air. The decoking water in the tank is recycled after sedimentation and filtration in the baffling tank. The coke is transported bucket by bucket with grab crane or on the train or truck for transportation. Hydraulic coke removal method is easy, reliable with simple process and low investment, it is widely used in delayed coking units.



Overview

•Problems of open hydraulic coke removal method

- ❑ During coke transportation - Coke spills during grabbing and in train or car compartment, coke powder spills on the ground, coke and coke powder pollution to the surrounding environment.
- ❑ Coke stored in the open pit - with the evaporation of water, coke will fly around and polluting the surrounding environment.
- ❑ Floating oil, coke powder and oil sludge in the decoking water.
- ❑ When the top cover of the coke drum is opened for decoking, toxic gases and volatile organic compounds are emitted from the top cover and the open pit. Uncontrolled Emission of these gases will pollute the atmosphere.
- ❑ In the process of coke removal , the operators will manually operate the equipment on the top platform of the coke drum with an elevation of more than 50 meters, which is not only labor intensive, but also posed potential safety hazards.
- ❑ Dozens of valves need to be operated in the process of switching coke drums, and it is easy to misoperate and cause accidents.



Overview

•Solutions

SINOPEC Guangzhou Engineering Co., Ltd. / SINOPEC Luoyang Engineering Co., Ltd. (LPEC), together with Zhenhai Refining & Chemical Co., Ltd., Tahe Petrochemical Co., Ltd., SINOPEC Research Institute of Safety Engineering and Luoyang Jianguang Special Equipment Co., Ltd., has developed Sinopec Closed Coke Handling System (S-CCHS). The technology has been successfully put in operation in dozens of projects. The actual operation results show that S-CCHS has achieved closed operation of the whole petroleum coke treatment process, fundamentally solved the safety and environmental protection problems of delayed coking unit, change the image of serious pollution of delayed coking and improve the safety level of the unit.



before S-CCHS



after S-CCHS

Technical Route Selection and Technical Characteristics

- Technological Concepts

- ◆ Objective: Closed operation from coke removal to conveying, transportation and storage, minimize the labor intensity and fundamentally improve the image of delayed coking as a heavy pollution unit.
- ◆ On the basis of the technology developed in the past few years in the field of coke removal, and combining with the mature experience and technology of other industries, we have developed a number of new technologies to realize the closed operation of whole coke treatment process.



Technical Route Selection and Technical Characteristics

S-CCHS includes the following four sub-systems:

- Closed petroleum coke removal system;
- Closed petroleum coke conveying, storage and loading system;
- Remote intelligent coke removal control system;
- Programmed control and interlock system for coking operation.



Technical Route Selection and Technical Characteristics

Functions of each sub-system of S-CCHS :

① Closed petroleum coke removal system:

Closed operation in the process of coke removal, dewatering and coke extraction, eliminate coke powder pollution in open coke pit;

Waste gas and tail gas centralized collection and treatment, the emission indicators of NMHC-related VOC, dust and odor meet the requirements of national standards;

② Closed petroleum coke conveying, storage and loading system:

Closed coke conveying, storage and loading

Remote automatic storage, extraction and quantitative loading

Elimination of coke powder pollution in the process.

③ Remote intelligent coke removal control system:

Remote and full automatic operation and monitoring of the hydraulic coke removal process

Elimination of the safety risk of operators

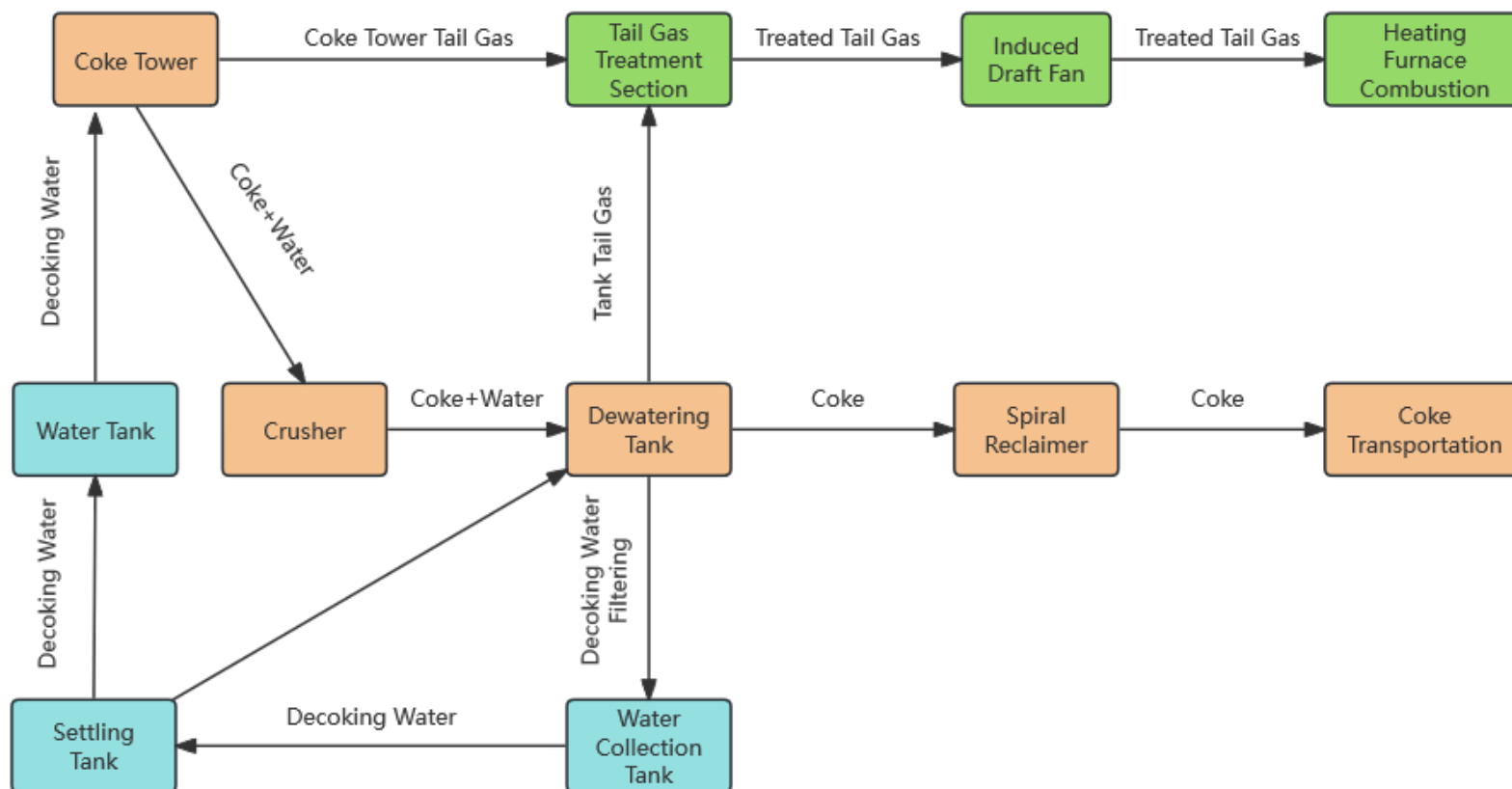
④ Programmed control and interlock system for coking operation:

Comprehensive and complete coke drum operation safety control.

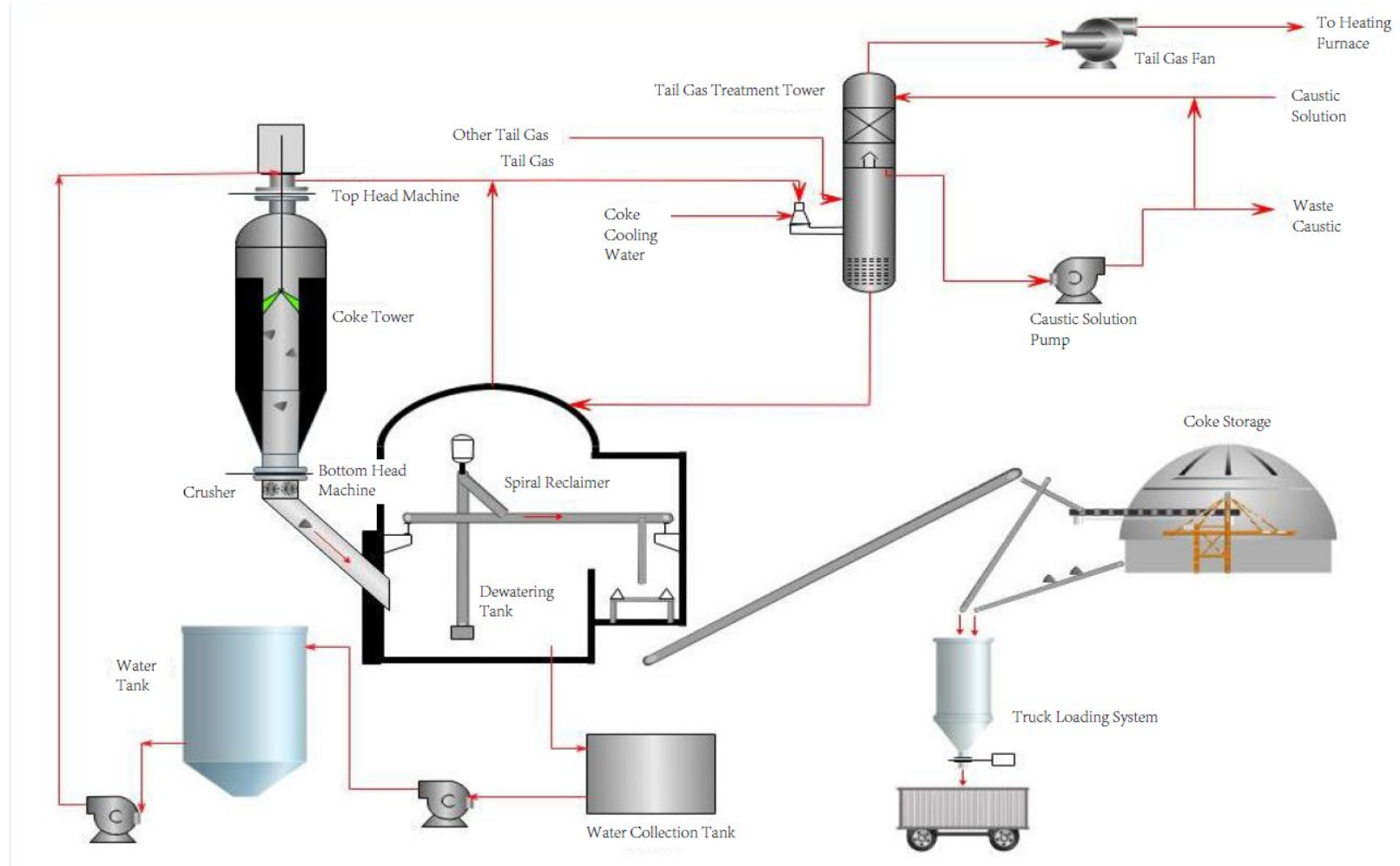


Technical Route Selection and Technical Characteristics

•Process Flow Chart



Technical Route Selection and Technical Characteristics



Technical Route Selection and Technical Characteristics

- Combined engineering design and application of bottom head machine, flexible connection and crusher
- Study of upgrading coke pit to closed dewatering tank
- Study on coke and water flow distribution in storage and dewatering bin
- Research of rapid dewatering of petroleum coke, self-filtration cleaning of coke cutting water and anti-clogging technology
- Study on vertical spiral lifting technology of petroleum coke
- Research on remote intelligent decoking technology
- Research on tail gas collection and treatment technology
- Closed conveying, closed storage yard and quantitative loading system
- Study on ventilation and safety evaluation of dewatering bin system

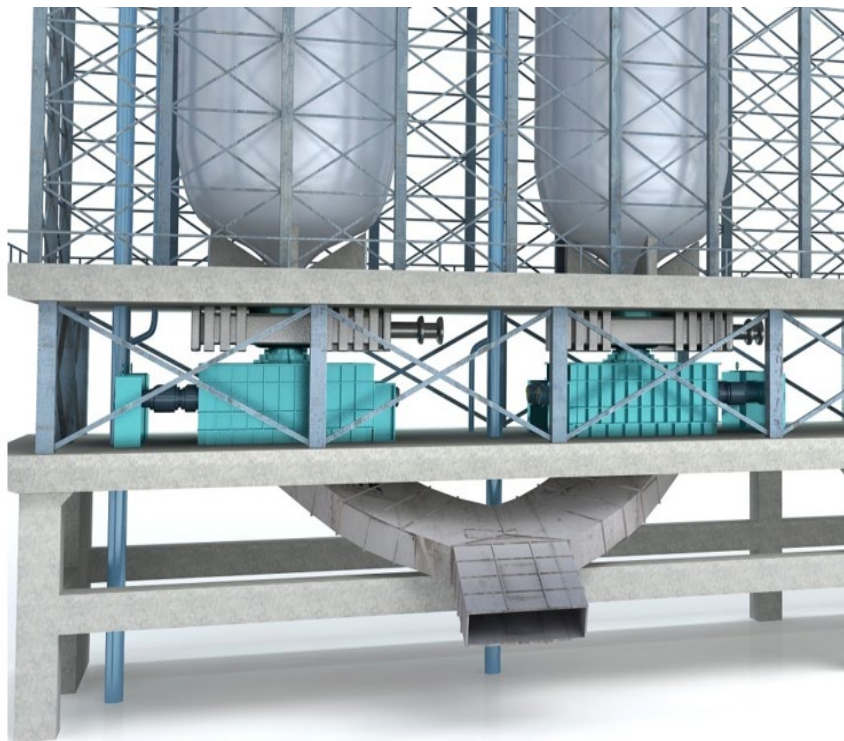


Technical Route Selection and Technical Characteristics

- Combined engineering design and application of bottom head machine, flexible connection and crusher
 - ✓ Ultra thin gate valve bottom head machine
 - ✓ Large flow, double roller double drive crusher
 - ✓ High strength flexible connection
 - ✓ Proper Installation position



Technical Route Selection and Technical Characteristics

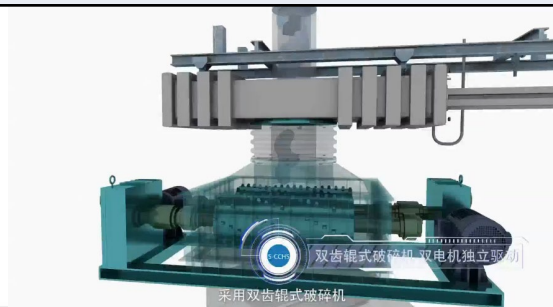


Technical Route Selection and Technical Characteristics

- Integrated technology of ultra thin bottom head machine, crusher and flexible connection

The overall structure is compact, and the space from the bottom of coke drum to the chute is effectively used to facilitate the technical transformation of the closed decoking from the existing coking unit.

Technical problems	Solutions and innovations
The coke falls unevenly and has great impact to crusher	The strength of the roller shaft is increased, the crushing roller is cast as a whole, and the surface of the roller teeth is overlaid with hard wear-resistant alloy.
The crushing size is required to be appropriate.	Small roller grate gear hobbing structure is designed with screening and crushing functions.
How to solve the problem of coke jamming crusher? How to repair the crusher quickly?	The design of double motor, double gearbox and direct drive applied, work independently, with both rotation direction. The bearing assembly of crusher is located outside the machine for easy maintenance.
Overall structure of ultra thin bottom head machine	Single valve plate, double sealing surface, pressure chamber design, simple structure
Sealing problem of ultra thin bottom head machine	Double-sided sealing. Hanging installation, zero stress between bottom head machine and coke drum flange
Connection mode of crusher and bottom cover machine.	Flexible connection is adopted.



Technical Route Selection and Technical Characteristics

- Reconstruction of closed dewatering bin from coke pit of existing plant
- ◆ The layout and capacity of the dewatering bin, the gas phase space of the dewatering bin and the induced draft fan selection are based on the coke production of the unit and the position of coke chute and coke pit of respective sites condition. The bottom structure of coke pit is not changed, and the construction period is minimized.
- ◆ S-CCHS adopts closed dewatering bin instead of open coke pit. The dewatering bin is only required to hold one tower of coke. It is small in volume and easy to be constructed. Two coke drums are equipped with a single closed dewatering bin which can meet the operation time requirements of coking cycle.



Technical Route Selection and Technical Characteristics

- Study on coke and water flow distribution in storage and dewatering bin
- ◆ Solving the problem of coke accumulation near the exit of chute
- ◆ The parameters and distribution of the coke feeder and the flow of petroleum coke and water in the dewatering bin are studied.



Technical Route Selection and Technical Characteristics

- Technology of coke water flow distribution in storage and dewatering bin

Using the buoyancy of water to increase the fluidity of coke instead of grab to realize the leveling of petroleum coke and prevent coke from blocking at the coke chute

Technical problems

The coke is dropped near the chute, which affects the process of coke removal.

Large coke volume, heavy weight.



经过破碎机破碎的焦炭经过溜槽进入脱水仓

Solutions and innovations

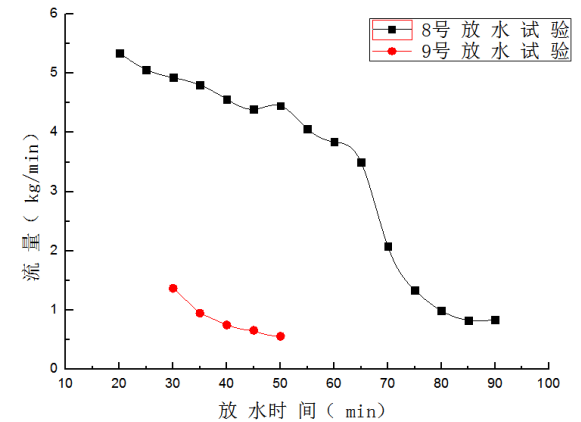
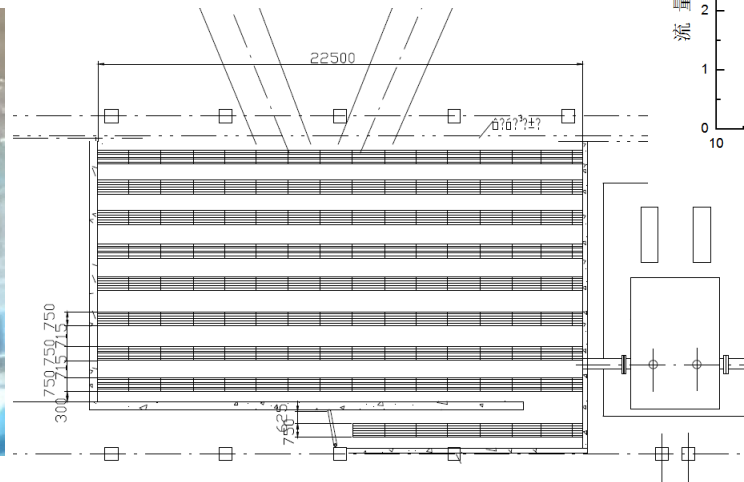
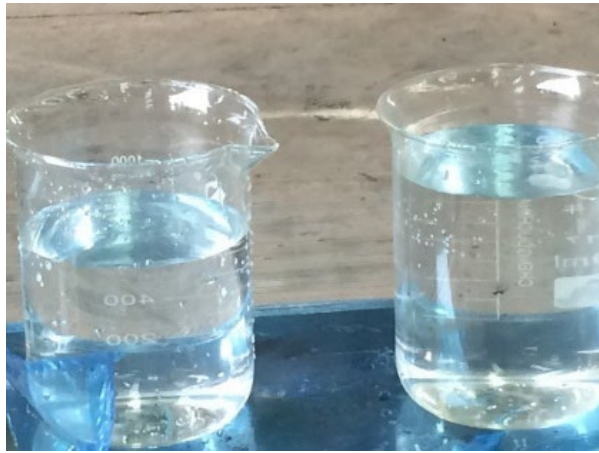
Hydraulic coke feeder is adopted in water storing and coke removal to realize the function of spreading petroleum coke in the dewatering bin.

The buoyancy of petroleum coke in water is used in storage coke remover and hydraulic coke feeder to improve the fluidity. There is no direct contact of the equipment with coke powder, which can reduce wear and is easy to maintain.



Technical Route Selection and Technical Characteristics

- Rapid dewatering of petroleum coke, self filtration cleaning of coke cutting water and anti-clogging technology
- ◆ Rapid dewatering of Johnson screen at the bottom of dewatering bin
- ◆ Self-filtration cleaning process of coke cutting water
- ◆ Anti-clogging technology of dehydration system



Technical Route Selection and Technical Characteristics

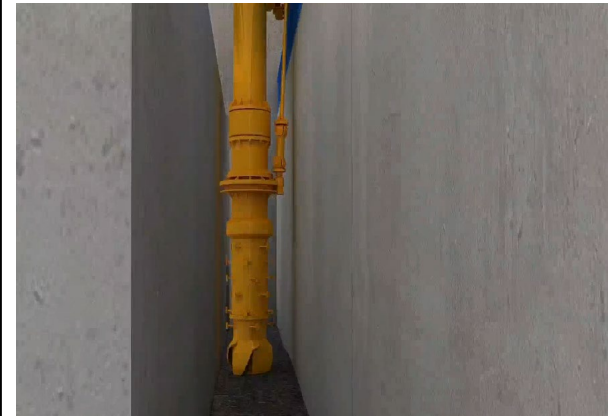
- Study on vertical spiral lifting technology of petroleum coke
 - ◆ The key equipment of S-CCHS technology -- vertical screw reclaimer
 - ◆ Research and improvement on adaptability to petroleum coke
 - ◆ Feeding screw and lifting screw has been adopted for the vertical screw reclaimer, the traveling crane and trolley mechanism to reclaim without dead area in the coke tank, coke is lifted vertically and smoothly into the belt conveyor. Continuous operation can be achieved for the process.
 - ◆ Ultrasonic material imaging system or camera monitoring system and other auxiliary methods are used in the reclaiming process to realize full imaging and remote programmed operation in the monitoring room.



Technical Route Selection and Technical Characteristics

•Screw reclaiming technology and screw reclaimer

Technical problems	Solutions and innovations
The coke particles are not uniform, and it is easy to drop when the coke is lifted vertically	Select appropriate parameters. Feed particle size, helix angle, friction angle between material and helix blade, friction coefficient between material and helix blade, speed and power
Petroleum coke contains water, high viscosity, and is easy to stick to spiral sheet. Petroleum coke accumulation make it difficult to move the screw reclaimer in tank.	Water flushing facilities. A feeding screw is arranged, and the feeding screw moves reversely relative to the lifting screw. Automatic loosening device is arranged to improve feeding efficiency.
The coke in the corner of the dewatering bin is not easy to reclaim	The elevator is combined with the horizontal moving bridge to reclaim without blind angle in the dewatering bin.
The working environment of the screw reclaimer is poor,clogging.	The driving device of the reclaiming head is moved above the platform to keep away from coke pollution.



Technical Route Selection and Technical Characteristics

- Screw reclaiming technology and screw reclaimer



Technical Route Selection and Technical Characteristics

- Closed conveying, closed storage yard and quantitative loading system
 - ◆ When the coke is stored and loaded in the existing unit, the grab crane is used for open operation. Working environment of the operators is poor, the grabbed coke causes the scattering of materials and coke powder, serious environmental pollution.
 - ◆ Belt or pipe belt closed transportation, closed storage yard and closed quantitative loading system are designed to realize the fully closed remote operation of petroleum coke conveying, storage and loading.
 - ◆ Development of strip silo and truck loading for specific customer needs



Technical Route Selection and Technical Characteristics

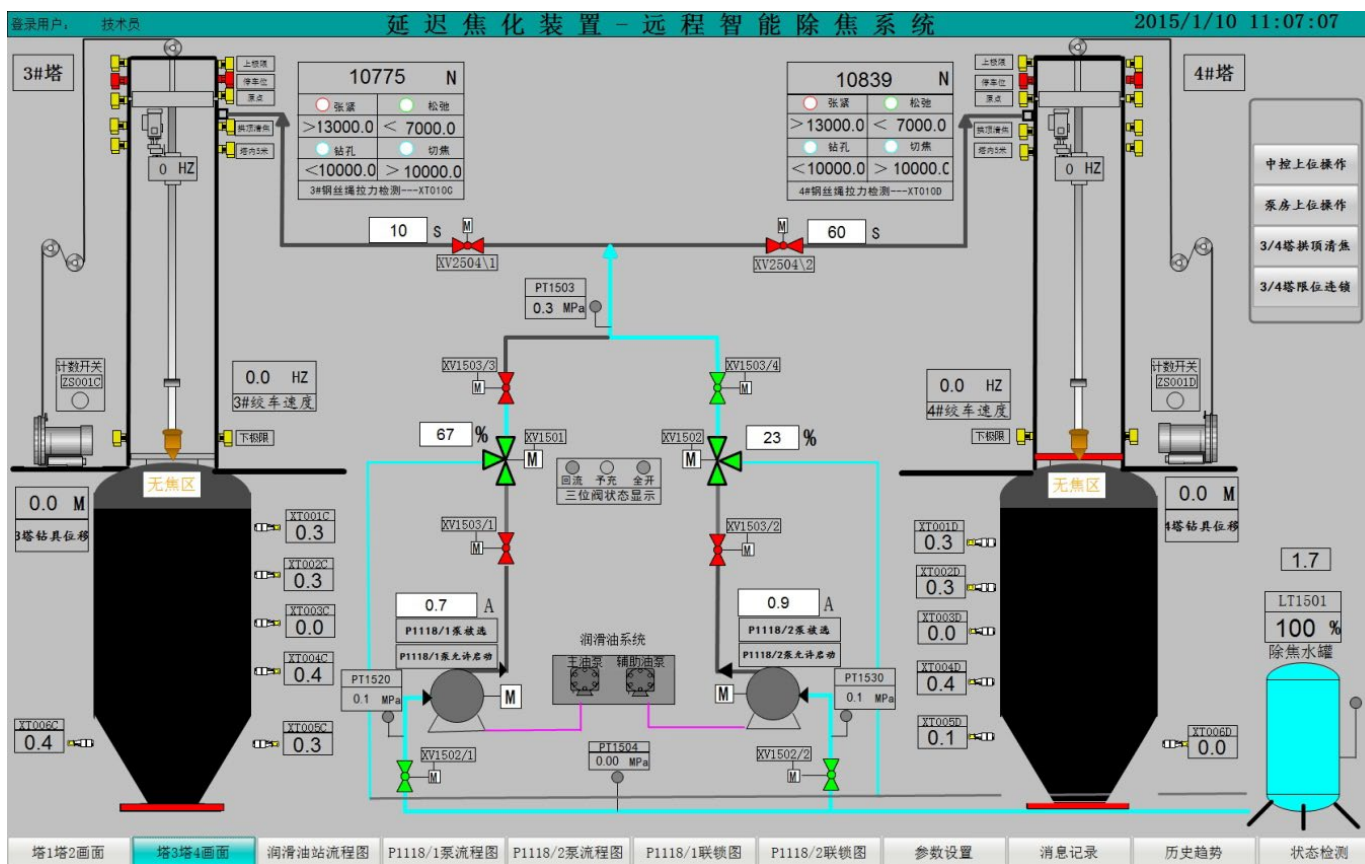
- Remote intelligent coke removal control system

Online coke monitoring expert system is used to detect the process of coke removal instead of the manual operation on top of the coke drum, depending on hearing the sound manually to judge to coke removal process. Operators can operate remotely and away from dangerous areas.



Technical Route Selection and Technical Characteristics

- Remote intelligent coke removal control system



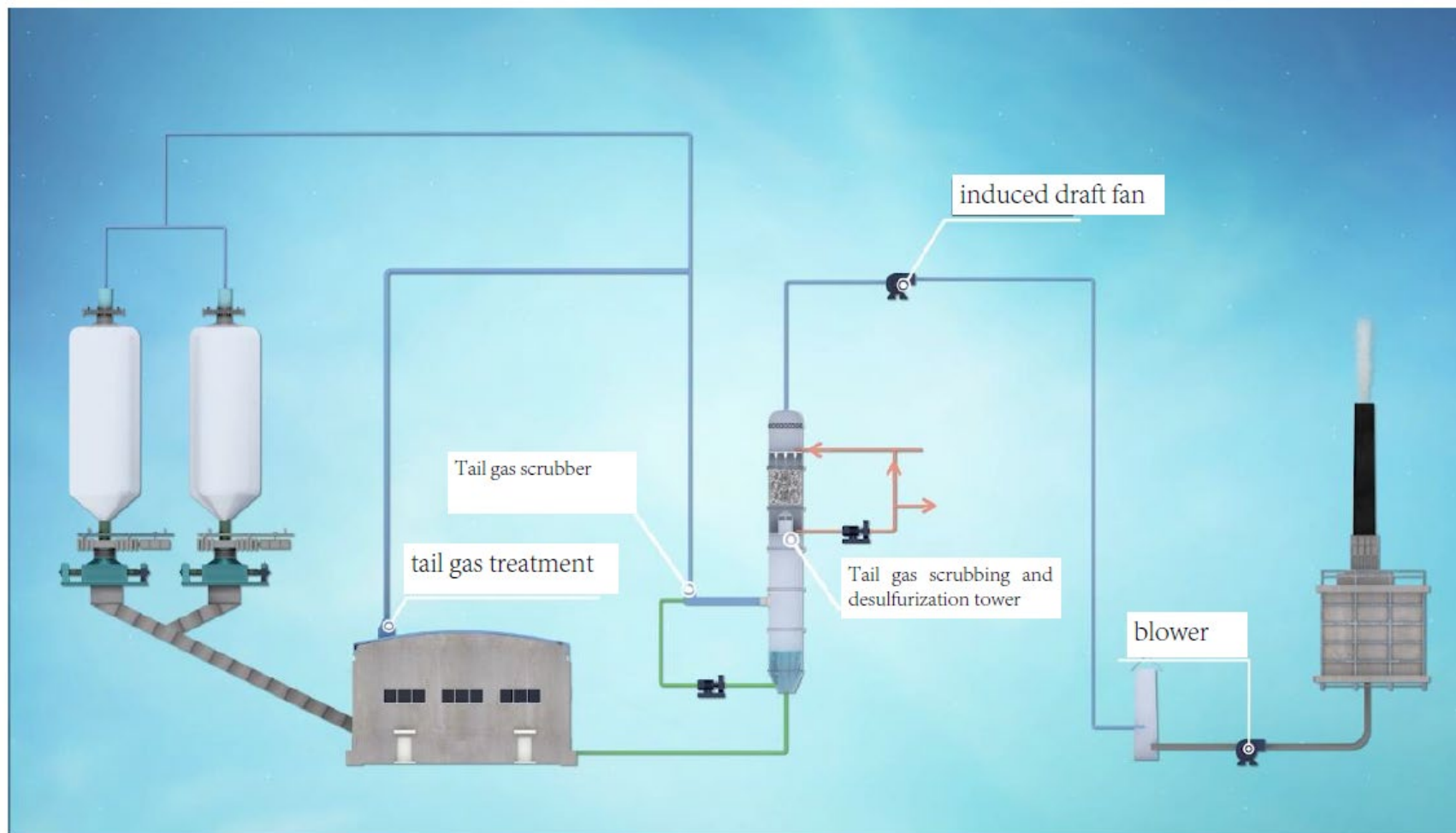
Technical Route Selection and Technical Characteristics

•Research on tail gas collection and treatment technology

- ✓ The tail gas collection facilities are arranged at the top cover of coke drum and dewatering bin to collect the tail gas at the top cover of coke drum and coke chute for centralized treatment.
- ✓ Negative pressure operation is adopted in closed dewatering bin.
- ✓ The tail gas scrubbing and desulfurization tower is designed for the cooling and washing of the tail gas to remove coke powder. H₂S from the tail gas is removed. The tail gas after scrubbing and desulfurization meets the emission requirements of Pollutant Emission Standard for Petroleum Refining Industry (GB31570-2015) and Sinopec internal control standards.
- ✓ The purified tail gas is put into the heating furnace for combustion to remove VOCs.



Technical Route Selection and Technical Characteristics



Technical Route Selection and Technical Characteristics

- Study on ventilation and safety evaluation of dewatering bin system
 - ❑ Sinopec Research Institute of Safety Engineering has carried out actual measurement on several coking plants in Qingdao Refining & Chemical Co., Ltd., etc.
 - ❑ CFD modeling analysis of gas flow field in dewatering bin
 - ❑ Conclusion: the current ventilation design will not produce dangerous gas accumulation, and the equipment is designed with explosion-proof zone II, which meets the safety requirements.



Technical Route Selection and Technical Characteristics

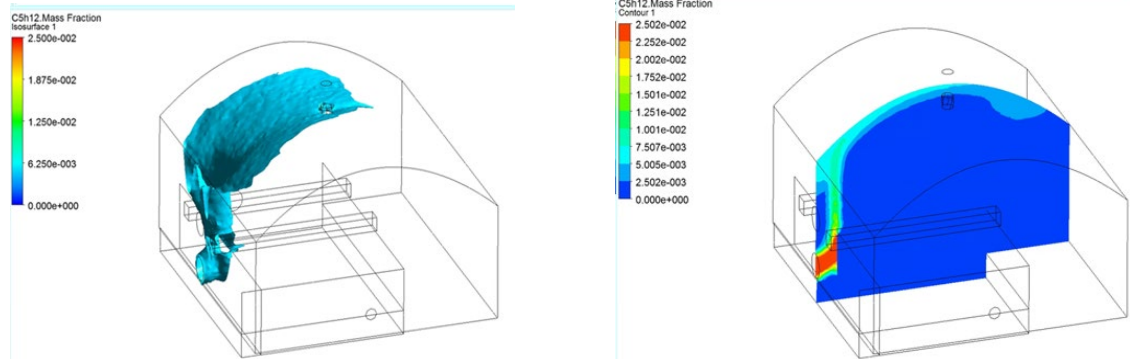
- Safety analysis on closed coke removal

By analyzing the composition of coking waste gas, monitoring, alarm, interlock and other measures are arranged. Through the analysis of flow field, the shape and ventilation design of dewatering bin and silo are optimized.

The risk of combustion and explosion in closed dewatering bin is low.

No dust explosion hazard.

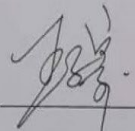
The risk of spontaneous combustion is low.



Implementation and Reference Projects



鉴定意见
1. 提供的技术资料和经费使用报告齐全,数据可信,完成了股份公司科技开发合同“封闭式智能除焦、输送及装储技术开发”(合同号 313092)及“十条龙”攻关项目“安全环保型延迟焦化密闭除焦、输送及存储成套技术”规定的任务,符合项目鉴定和档案管理要求。 2. 针对延迟焦化装置石油焦处理过程各相关生产环节存在的粉尘污染、尾气污染及安全隐患等现状,开发了安全环保型延迟焦化密闭除焦、输送及存储成套技术(S-CCHS)。主要创新点为:开发了筛分破碎-脱水仓-螺旋取焦-尾气集中治理技术、脱水仓技术、石油焦脱水与过滤集成一体化技术等;研制了适用于石油焦体系的筛分破碎机、超薄底盖机和柔性连接、螺旋取料机、管带机、圆形和条形料仓、自动定量装车系统成套机械设备;开发了密闭除焦控制系统、远程自动水力除焦控制系统、焦炭输送/储存及装车控制系统、焦炭塔操作安全控制系统。 3. 该项目技术成果已在镇海炼化、塔河炼化焦化装置成功应用,运行平稳、可靠,实现了石油焦处理全过程密闭、清洁和安全生产操作,改善了焦化装置区域及周边环境,各项环保指标满足《石油炼制工业污染物排放标准》(GB31570)与《恶臭污染物排放标准》(GB 14554)要求,改善了延迟焦化装置污染严重的形象,提升了装置安全环保水平,社会效益显著。 4. 该项目已申请 22 项专利,授权 16 项;形成 5 项中国石化专有技术。该成套技术处于国际领先水平。 5. 建议加快推广应用。

鉴定委员会主任: 

2018 年 11 月 21 日



中国石化
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中石化洛阳工程有限公司
SINOPEC LUOYANG ENGINEERING CO., LTD.



Implementation and Reference Projects

No.	Unit Name	Capacity	Remarks
1	No.2 Coking Unit of Zhenhai Refining & Chemical Co., Ltd.	2 million tons/year, 2 furnaces and 4 towers	Completed in 2014
2	No.2 Coking Unit of Tahe Refining & Chemical Co., Ltd.	2.3 million tons/year, 3 furnaces and 6 towers	Completed in 2015
3	No.2 Coking Unit of Shanghai Petrochemical Co., Ltd.	1.2 million tons/year, 1 furnace and 2 towers	Completed in 2018
4	Heavy Oil Upgrading Unit of Yangzi Petrochemical Co., Ltd.	0.6 million tons/year, 2 furnaces and 4 towers	Completed in 2018
5	Coking Unit of Shandong Chambroad Petrochemical Co., Ltd.	0.8+1 million tons/year, 2 furnaces and 4 towers	Completed in 2018
6	Coking Unit of Shandong Super Energy Industrial Company	1 million tons/year, 2 furnaces and 4 towers	Completed in 2018
7	Coking Unit of Jinan Refining & Chemical Co., Ltd.	0.5+0.7 million tons/year, 2 furnaces and 4 towers	Completed in 2019
8	Coking Unit of Qingdao Refining & Chemical Co., Ltd.	2.9 million tons/year, 2 furnaces and 4 towers	Completed in 2019
9	No. 3 Coking Unit of Jinling Petrochemical Company	1.6million tons/year, 1 furnace and 2 towers	Completed in 2019
10	Coking Unit of Zhejiang Petrochemical Company	2.6 million tons/year, 2 furnaces and 4 towers	Completed in 2019
11	No. 3 Coking Unit for Guangdong Petrochemical Company	1.4 million tons/year, 1 furnace and 2 towers	Completed in 2019
12	Coking Unit of Anqing Petrochemical Company	1 million tons/year, 2 furnaces and 4 towers	Completed in 2019
13	Coking Unit of Beihai Refining & Chemical Co. , Ltd.	1.4 million tons/year, 1 furnace and 2 towers	Completed in 2020
14	Coking Unit of Tianjing Petrochemical Company	1.2 million tons/year, 1 furnace and 2 towers	Completed in 2020
15	Coking Unit of Wuhan Petrochemical Company	1.5 million tons/year, 1 furnace and 2 towers	Completed in 2021
16	Coking Unit of Qilu Petrochemical Company	1.7 million tons/year, 1 furnace and 2 towers	Completed in 2021
17	Coking Unit of Yangzi Petrochemical Co. Ltd.	1.6 million tons/year, 1 furnace and 2 towers	Completed in 2021
19	Coking Unit of PetroChina Guangdong Petrochemical Co.	3 million tons/year, 2 furnaces and 4 towers, two sets	Completed in 2023



Implementation and Reference Projects



No. 3 Coking Unit for Guangdong Petrochemical Company



Needle Coke Unit of Jinling Refinery

Thank you!



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