Regenerative Catalytic Oxidation Technology of Ultra-low Concentration CMM

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Contents

1 Technology principle

2 Security measures

3 Application value

4 Application cases

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01 Part One Technology Principle

Regenerative Catalytic Oxidation Technology of Ultra-low Concentration CMM

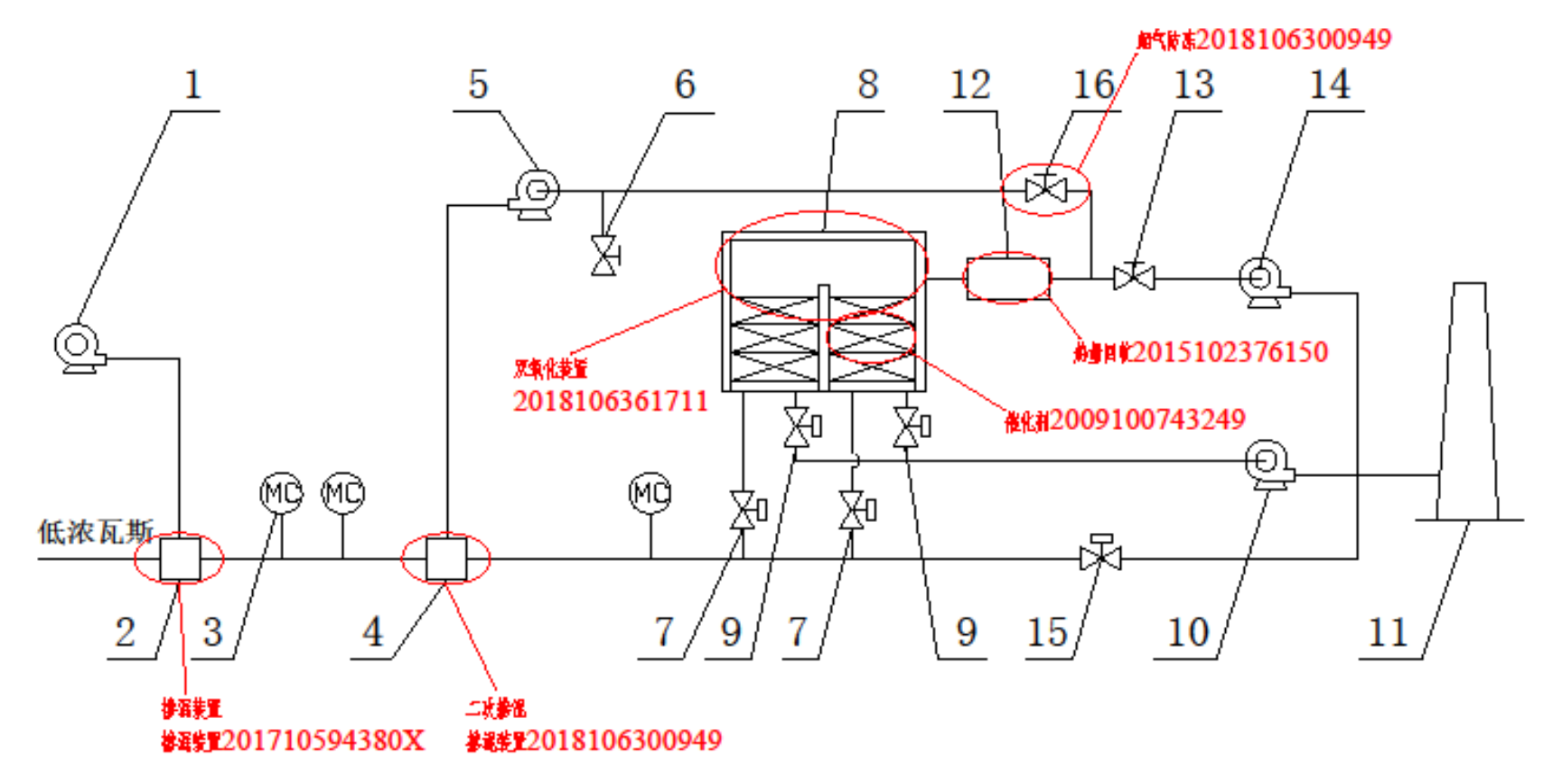
Ultra-low Concentration CMM

- Coal mine gas with methane concentration of 0.3%-3%. Gas with methane concentration less than 3% will not burn under natural conditions.
- Fill in the technical gap of 1.2%~3% CMM utilization (Gas with methane concentration below 8% can not be utilized by internal combustion engine, and the annual discharge volume is very large).

Operating Principle

- Catalytic oxidation: Reducing the ignition temperature of CMM.
- Regenerative oxidation: realizing continuous and stable oxidation of low concentration gas, with a wide range of applicable concentration.

Oxidation Technological Process



1 primary mixing fan, 2 primary mixing fan, 3 methane concentration sensor, 4 secondary mixing fan, 5 secondary mixing fan, 6 fresh air valve, 7 inlet switching valve, 8 oxidation device, 9 outlet switching valve, 10 main induced draft fan, 11 chimney, 12 heat exchanger, 13 exhaust gas regulating valve, 14 boiler induced draft fan, 15 emergency release valve, 16 anti-freezing gas valve

Patents of CMM Utilization

Patent Type	Patent Title	Patent Number
Invention	One Kind of CMM Boiler with Extremely Low Concentration and Its Operation Method	2015102376150
Utility Model	Gas Mixing System	2017208822785
Invention	Gas Mixing System and Gas Mixing Concentration Control Method	201710594380X
Invention	Regenerative Catalytic Oxidation Devices and Design Method	2018106361711
Utility Model	Regenerative Catalytic Oxidation Devices	2018209437051
Invention	Regenerative Catalytic Oxidation System of Ultra-low Concentration CMM	2018106300949
Utility Model	Regenerative Catalytic Oxidation System of Ultra-low Concentration CMM	201820945341X
Utility Model	A System for Preparing Bath Hot Water by CMM Oxidation Heat	2018210105817
Utility Model	A System for Building Heating by CMM Oxidation Heat	201821008814X
Utility Model	A System for Shaft Freezing Prevention by CMM Oxidation Heat	2018210111466
Invention	One Kind of Air Pressure System Using Ultra-low Concentration CMM and Its Control Method	2018113056732
Utility Model	One Kind of Air Pressure System Using Ultra-low Concentration CMM	2018218074499

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Catalytic Oxidation Experimental Devices

- Maximum capacity: 500Nm^3/h
- The range of methane concentration for stable operation is 2.5%-4.5%.
- Methane conversion rate: 99%
- The cumulative running time of the experimental device is 1062 hours, and the maximum running time of a single operation is 168 hours.

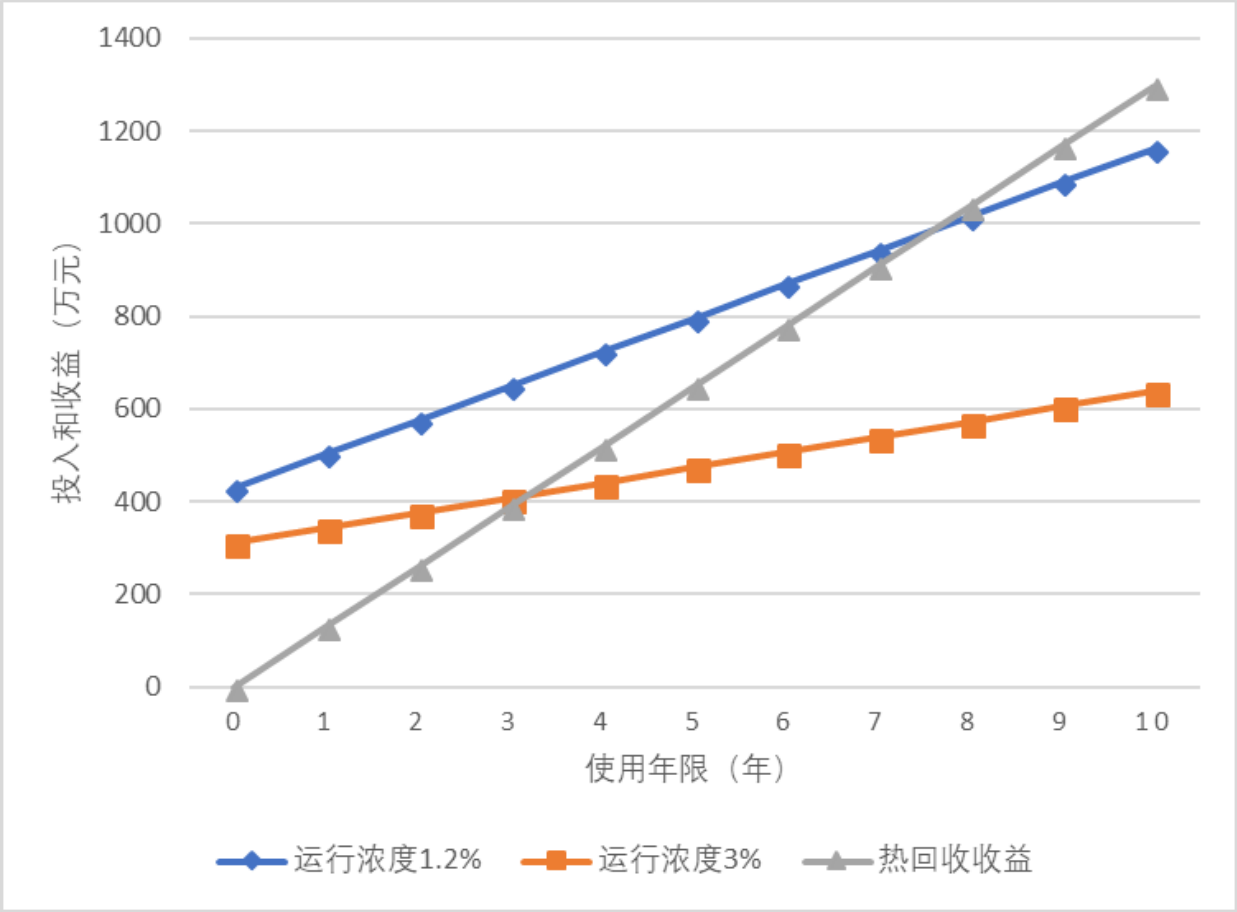
Technical Parameters of Oxidation Device

Specification of Oxidation Device	WLCO10/2.8- Q2-1.25/192	WLCO10/2.8-S1.4-70/90	WLCO20/2.8- Q4-1.25/192	WLCO20/2.8-S2.8-70/90
Designed Processing Capability	10000Nm^3/h		20000Nm^3/h	
Designed Concentration	2.8%（V/V）			
Applicable Concentration Range	0.3%～3.0%（V/V）			
Rated Output	2 Steam Ton /h	1.4MW	4 Steam Ton /h	2.8MW
Rated Pressure / Temperature	1.25MPa/192℃	/	1.25MPa/192℃	/
Rated Backwater / Effluent Temperature	/	70℃/90℃	/	70℃/90℃

Technology Characteristic of Regenerative Catalytic Oxidation

- The gas concentration fluctuation range is large and the lower limit of gas concentration is 0.3%.
- The upper limit of gas concentration has been raised from 1.2% to 3%. The equipment investment is small and the operation cost is low.
- Reducing the initial reaction temperature (450℃~ 500℃), the oxidation reaction of CMM is gentle, safe and reliable.
- The upper limit of concentration is 3%, and reasonable safety margin is reserved.
- Using non-noble metal catalyst, the production cost is low, the service life is long, and the maintenance workload is small.

Economic Comparison of Different Operating Concentrations (2 Steam Tons/h)



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- The operating concentration is 1.2%, and the static investment payback period is 7.6 years.
- The operating concentration is 3.0%, and the static investment payback period is 3.0 years.

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02 Part Two Security Measures

Measures to Ensure Safe Operation of Oxidation System

- All safety standards for low concentration gas power generation are implemented, and the pipelines and equipment contacted with gas in the oxidation system are all designed and managed according to the series standards of “AQ-1076-2009-Design Specification for Safety Guarantee System of Low Concentration Gas Pipeline Transportation in Coal Mines”.
- The basic factor to ensure the safe operation of the oxidation system is methane concentration, and the reliability of methane concentration control is further improved by adopting two-stage gas mixing device.
- The temperature of catalyst bed is used as a safety chain protection measure. When the temperature of catalyst bed is higher than 550℃, the inlet valve of the oxidation device is cut off.

Current Safety Standards for Utilization of Low Concentration CMM

- Safety Regulations in Coal Mine (Vertion 2018)
- GB50183-2015 Code for Fire Protection of Crude Oil and Natural Gas Engineering Design
- AQ1072-2009 Technical specification of water seal fire-proof and explosion-relief device for gas pipeline transportation
- AQ1073-2009 Technical specification of automatic explosion-proof device for gas pipeline transportation
- AQ1074-2009 Dry Fire Retarder for Coal Mine Gas Pipeline
- AQ1076-2009 Design Specification for Safety Guarantee System of Low Concentration Gas Pipeline Transportation in Coal Mines
- AQ1078-2009 Genenral specifications for transmission system of low concentration coal mine gas blending with water mist
- AQ1079-2009 General technical requirements of automatic powder spraying and explosion suppression device for gas pipeline transportation

Security Devices and Equipment

Water Sealing of Fire Barriering & Explosion Venting Device

Dry Fire Retarder

Automatic Preventing Explosion Device

Security Devices and Equipment

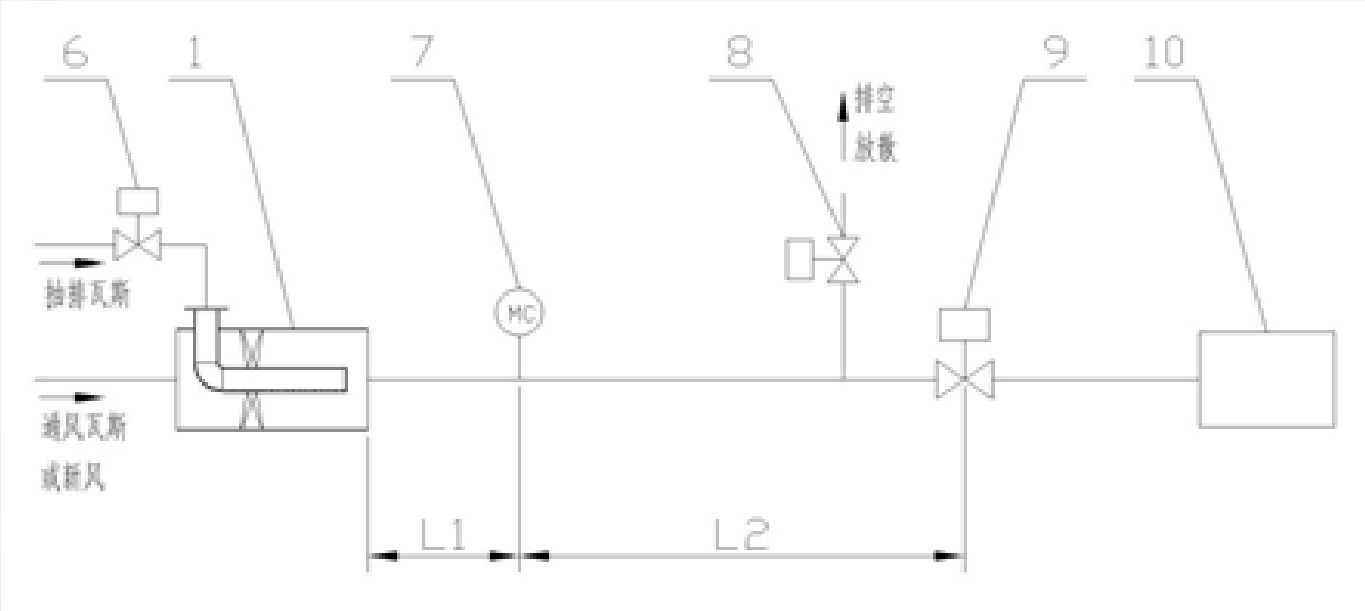
Safety transmission device for low concentration coal mine gas blending with water mist

Automatic spurting powder explosion suppression device

Methane concentration sensor

Gas Mixing and Concentration Control Patent

- Patent Title: Gas Mixing and Concentration Control System
- Patent Nubber: 2017208822785
- Date of Authorization: March 2nd, 2018



证书号第7035325号

实用新型专利证书

实用新型名称：瓦斯掺混系统

发 明 人：江河;萧琪

专 利 号：ZL 2017 2 0882278.5

专利申请日：2017年07月20日

专 利 权 人：山西文龙中美环能科技股份有限公司

授权公告日：2018年03月02日

本实用新型经过本局依照中华人民共和国专利法进行初步审查，决定授予专利权，颁发本证书并在专利登记簿上予以登记。专利权自授权公告之日起生效。

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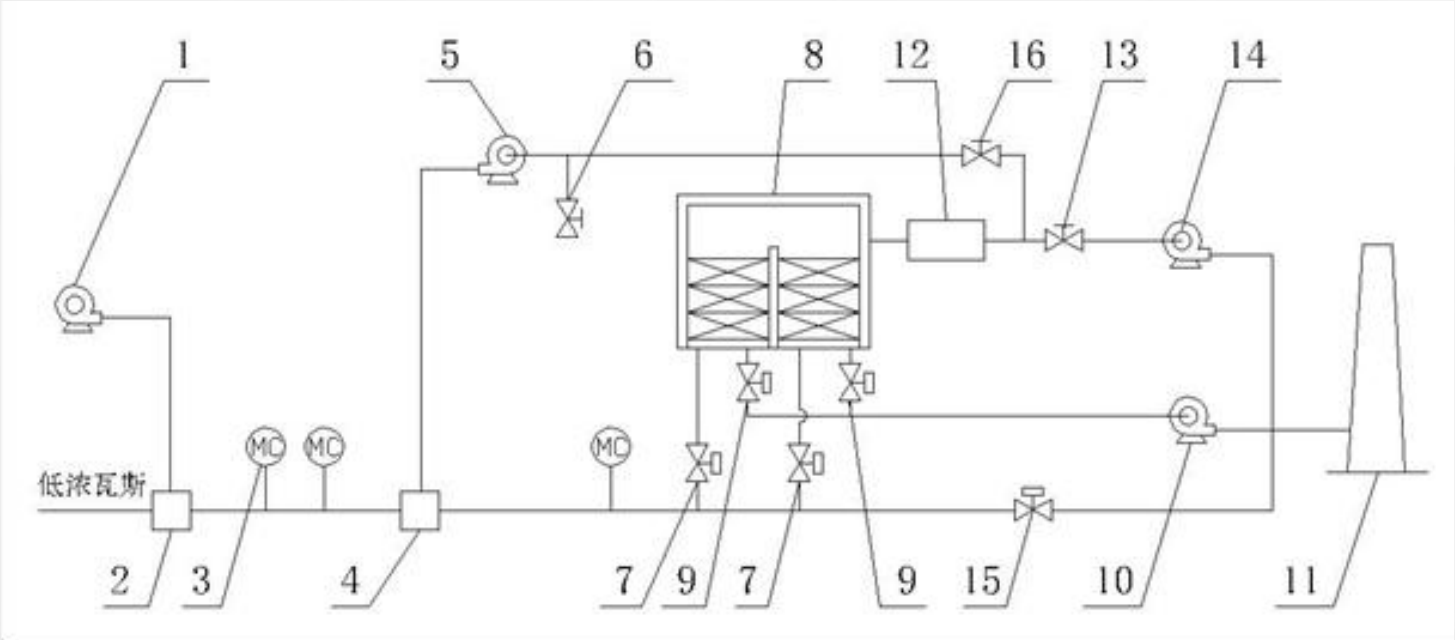
2018年03月02日

第1页(共1页)

Oxidation Syster Patent

- Patent Title: Oxidation System of Ultra-low Concentration CMM
- Patent Nubber: 201820945341X
- Date of Authorization: Feb 22nd, 2018



证书号第8515361号

实用新型专利证书

实用新型名称：一种瓦斯氧化系统

发 明 人：江河;肖凤强;萧琦

专 利 号：ZL 2018 2 0945341.X

专利申请日：2018年06月19日

专 利 权 人：山西文龙中美环能科技股份有限公司

地 址：030000 山西省太原市晋源区长兴南街8号阳光城环球金融中心1703室

授权公告日：2019年02月22日 授权公告号：CN 208526264 U

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2019年02月22日

第1页(共2页)

其他事项参见背面

截图

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03 Part Three Application Value

Ways to Utilize CMM Oxidation Energy

- Heat supply

Gas oxidation heat produce hot water or saturated steam for coal mine bathing, winter heating and wellbore freezing prevention. Compared with natural gas and electric heating, heating costs are lower.

- Electricity generation

Gas oxidation heat produce superheated steam, drive steam turbines and drive generators to generate electricity; exhausted steam is used for heating. The cascade utilization of energy has higher efficiency and can be used all the year round.

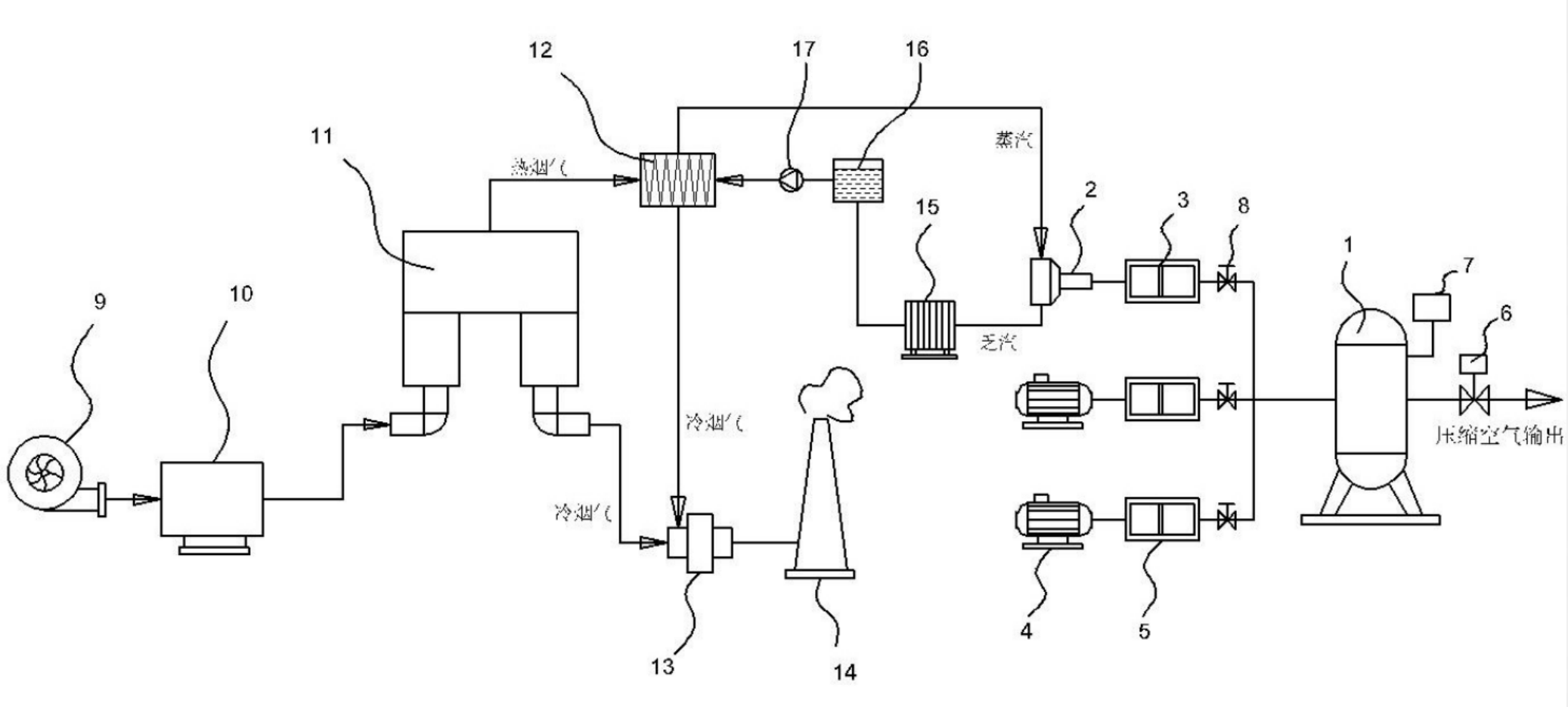
- Driving power equipment

Gas oxidation heat produce steam, drive steam turbines, drive power equipment such as fans and pumps (instead of electric drive); exhaust steam is used for heating.

Utilization of CMM to Make up the Heat Supply Gap of Coal-fired Boiler

- Small coal-fired boilers are banned nationwide in China. Some big cities and centralized polluted areas have completely stopped using coal-fired boilers below 10 tons/h. Coal mines also need to replace coal-fired boilers as soon as possible.
- Natural gas, methanol, diesel oil, electric heating and other energy are expensive. The use of alternative energy will increase the production cost and reduce competitiveness of coal mines. It can only be used as a short-term transition plan.
- The investment of heat pump and solar energy is huge, and its application is limited.

Oxidation Device Drives Air Compressor

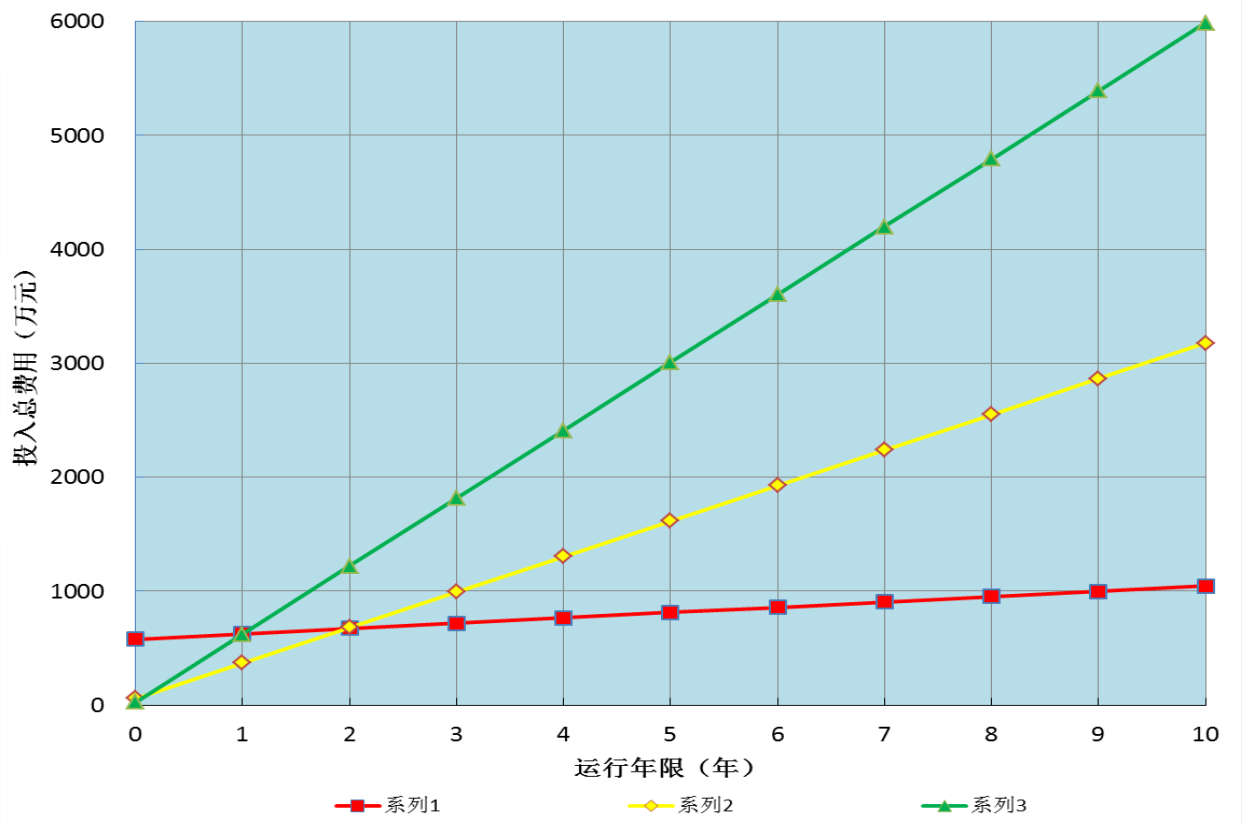


1-compressed air tank, 2-steam turbine, 3-A air compressor, 4-A motor, 5-B air compressor, 6-cut-off valve, 7-pressure transmitter, 8-check valve, 9-mixing fan, 10-mixer, 11-oxidation device, 12-waste heat boiler, 13-induced fan, 14-chimney, 15-cooler, 16-tank, 17-pump

Preferential Policies for CMM Utilization

- The central financial subsidy standard for coalbed methane (CMM) mining and utilization had been raised from 0.2 yuan/cubic meter to 0.3 yuan/cubic meter in 2016.
- The provincial government had raised the provincial financial subsidy standard for gas extraction by 0.05 yuan/cubic meter, reaching 0.1 yuan/cubic meter in 2015.
- CMM power generation implements the benchmark tariff policy, and the tariff standard is 0.509 yuan/kWh.

Economic Comparison of Different Fuel Heating Devices (2 Steam Tons/h)



oxidation device nature gas boiler electric boiler

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- In the whole life cycle, the total cost of the oxidation device is 17.3% of the total cost of the electric boiler.
- The total cost of the oxidation device is 32.9% of the total cost of the nature gas boiler.

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04 Part Four Application Cases

Gas Drainage at Liyazhuang Coal Mine

- November 28th, 2018, 12:00 a.m.
- Water-ring vacuum pump 2#, concentration 4.0%, flow rate(pure methane)14.27m^3/min, discharged to atmosphere.

2#风井地面瓦斯抽放泵站工作日志

日期：年 2 月 28 日

记录时间		负压	压差	混合流量	抽放浓度	纯流量	轴温	减速器温度	电机温度	电流	电压	泵房瓦斯	泵房温度	高水位	低水位	大气压
		Kpa	mmH2O	m³/min	%	m³/min	℃	℃	℃	A	V	%	%	m	m	Pa
0：00	人工	34	140	110.94	7.5	8.32	51	58	43	22	6264	0.04	11	1.1	2.4	93.3
	监测	28.5			4.6											
2：00	人工	34	140	110.94	8	8.87	51	58	43	23	6257	0.04	11	1.0	2.7	93.3
	监测	28.5			4.6											
4：00	人工	34	140	110.94	8	8.87	51	58	43	22	6264	0.04	11	0.9	3.0	93.3
	监测	28.5			4.6											
6：00	人工	34	140	110.94	8	8.87	51	58	43	22	6257	0.04	11	0.8	3.3	93.3
	监测	28.5			4.6											
8：00	人工	34	140	110.94	8	8.87	51	58	43	21	6264	0.04	11	1.2	2.1	93.3
	监测	28.5			4.6											
10：00	人工	34	140	110.94	8	8.87	51	58	43	22	6257	0.04	12	1.1	2.4	93.3
	监测	28.5			4.6											
12：00	人工	34	140	110.94	8	8.87	51	58	43	22	6257	0.04	12	1.0	2.7	93.3
	监测	28.5			4.6											
14：00	人工	34	140	110.94	8	8.87	51	58	43	22	6256	0.04	12	0.9	3.0	93.3
	监测															
16：00	人工															
	监测															
18：00	人工															
	监测															
20：00	人工															
	监测															
22：00	人工															
	监测															

主司机：刘西林　　副司机：安宁

2#风井地面瓦斯抽放泵站工作日志

日期：年 2 月 28 日

记录时间		负压	压差	混合流量	抽放浓度	纯流量	轴温	减速器温度	电机温度	电流	电压	泵房瓦斯	泵房温度	高水位	低水位	大气压
		Kpa	mmH2O	m³/min	%	m³/min	℃	℃	℃	A	V	%	%	m	m	Pa
0：00	人工	44	110	98.33	10	9.83	50	55	46	12	6433					
	监测	32.8			17.6											
2：00	人工	44	110	98.33	10		50	55	46	12	6426					
	监测	32.8			18.6	9.83										
4：00	人工	44	110	98.33	10		50	55	46	13	6433					
	监测	32.8			18.6	9.83										
6：00	人工	44	110	98.33	10		50	55	46	13	6426					
	监测	32.8			19.0	9.83										
8：00	人工	44	110	98.33	10		50	55	46	12	6426					
	监测	32.8			17.6											
10：00	人工	44	110	98.33	10	9.83	50	55	46	13	6433					
	监测	32.8			17.6											
12：00	人工	44	110	98.33	10	9.82	50	55	46	13	6323					
	监测	32.8			17.6											
14：00	人工	44	110	98.33	10	9.83	50	55	46	13	6323					
	监测															
16：00	人工															
	监测															
18：00	人工															
	监测															
20：00	人工															
	监测															
22：00	人工															
	监测															

主司机：刘西林　　副司机：安宁

Heat Demand at Industrial Square 2# of Liyazhuang

- Heat demand at industrial square 2# of Liyazhuang coal mine:

  Heating of Industrial Buildings 320kW

  Air intake shaft freezing prevention 4270kW

- At present, electric heating devices with 2100 kW rated output are used to replace the original coal-fired hot blast stove.

CMM Utilization Scheme of Liyazhuang Coal Mine

- Two WLCO 10/2.8-S2-95/70 oxidation devices are planned to be built, equipped with two heat exchangers with rated output of 1400kW. The purity of gas drainage is 8 m^3/min.
- At present, the gas is not fully utilized; reserve the installation location of 1-2 oxidation devices.
- The heat exchanger produces 95°C hot water as heat source. Two 1400 kW heaters are equipped. They can supply the heat shortage of existing 2100 kW electric heating devices, giving priority to the use of oxidation devices for heating.

Gas Drainage and Heat Demand at Ximing Coal Mine

- March 28th, 2019, 12:00 a.m, Water-ring vacuum pump 2#, concentration 2.1%, flow rate(pure methane)14.99m^3/min, discharged to atmosphere.
- Heat demand at Jijiagou industrial square of Ximing coal mine:

  Heating of Industrial Buildings 352kW

  Air intake shaft freezing prevention 4027kW
- At present, electric boiler with 700 kW rated output are used to replace the original coal-fired hot blast stove. There has serious shortage of heat supply at Jijiagou industrial square of Ximing coal mine.

CMM Utilization Scheme of Ximing Coal Mine

- Three WLCO 10/2.8-S2-95/70 oxidation devices are planned to be built, equipped with three heat exchangers with rated output of 1400kW. The purity of gas drainage is 12 m^3/min.
- The heat exchanger produces 95℃ hot water as heat source. Three 1400 kW heaters are equipped. It can fully meet the heating demand of Jijiagou industrial square.

Hand in Hand to Create a Better Future

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