Application of Natural Gas Distributed Energy in Oil & Gas Drilling Project

AMICO GAS POWER CO., LTD

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1. Company Introduction

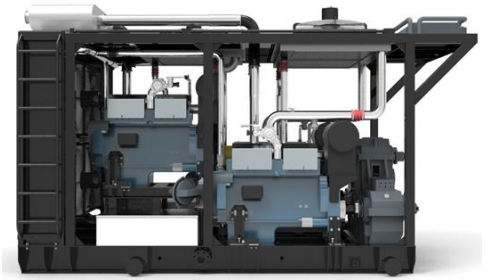
- Amico gas power co., ltd. founded in 2005, with registered capital 20 million. Committed to R&D, production, sales and distributed energy service of natural gas engine, generator set and power units. The products are mainly used in oil and gas fields, chemicals, engineering power, bridge and road energy supply, shopping malls, hospitals, hotels, data centers, and the gas power generation in industrial biogas, waste, sewage treatment fields.

1. Company Introduction

Main Business Cover:

- R & D of natural gas engines: More than 50 types natural gas engines have been developed, with more than 200,000 units used in the vehicle market;
- Natural gas power equipment R & D, production, sales and service: more than 20 types of natural gas generating units and power units have been developed, with power covering 18kw to 4500kw. In recent years, more than 500 sets of our products are served in different fields. Regarding to the natural gas generator set for drilling rigs, has become the only equipment supplier in China that meets the load characteristics of electric drills, through years of concentrated development and application verification of hundreds of wells due to the special characteristics of working conditions and use conditions.

Gas genset for electric drilling rigs



Gas genset for mechanical drilling rigs

2. Gas Power Generator Set For Electric Drill Rigs

1000kW Natural Gas Genset—AMC1000GFJ6-4PN3J

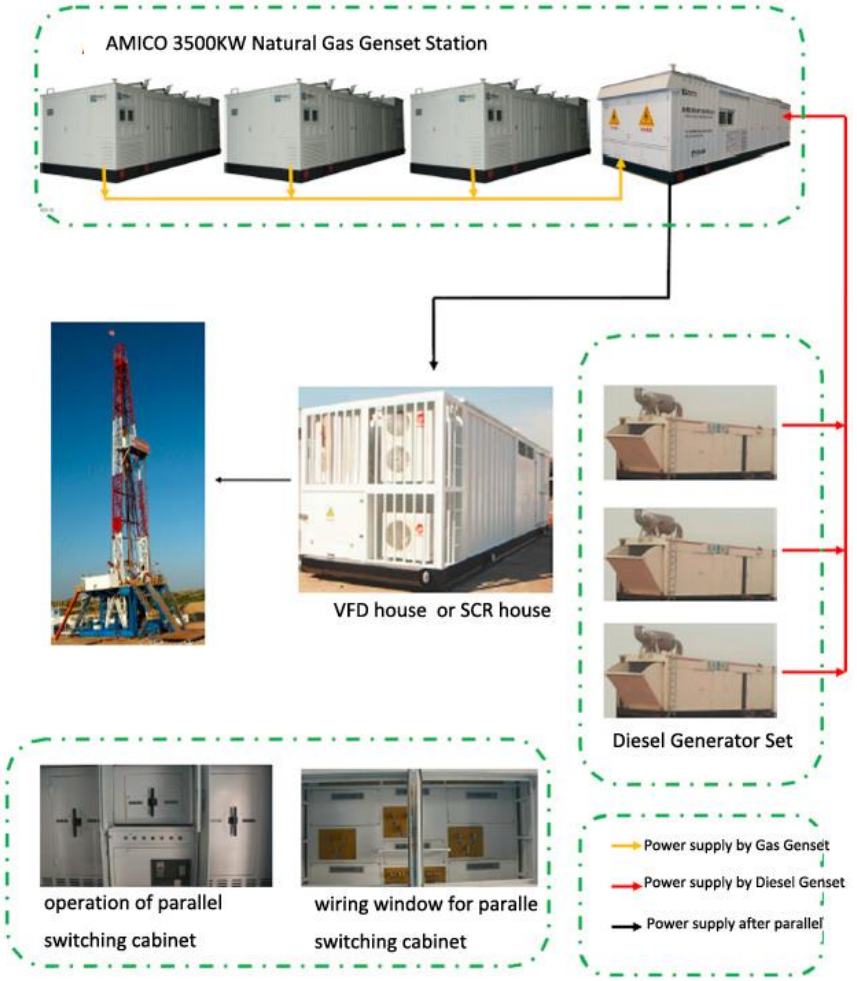
- Suitable to 90, 70, 50, 40 electric drilling rig systems: equipped with 600V main power generator set;
- Main specifications: Voltage: 600V, Frequency: 50Hz, PF:0.8;

2. Gas Power Generator Set For Electric Drill Rigs

Products Appearance Layout

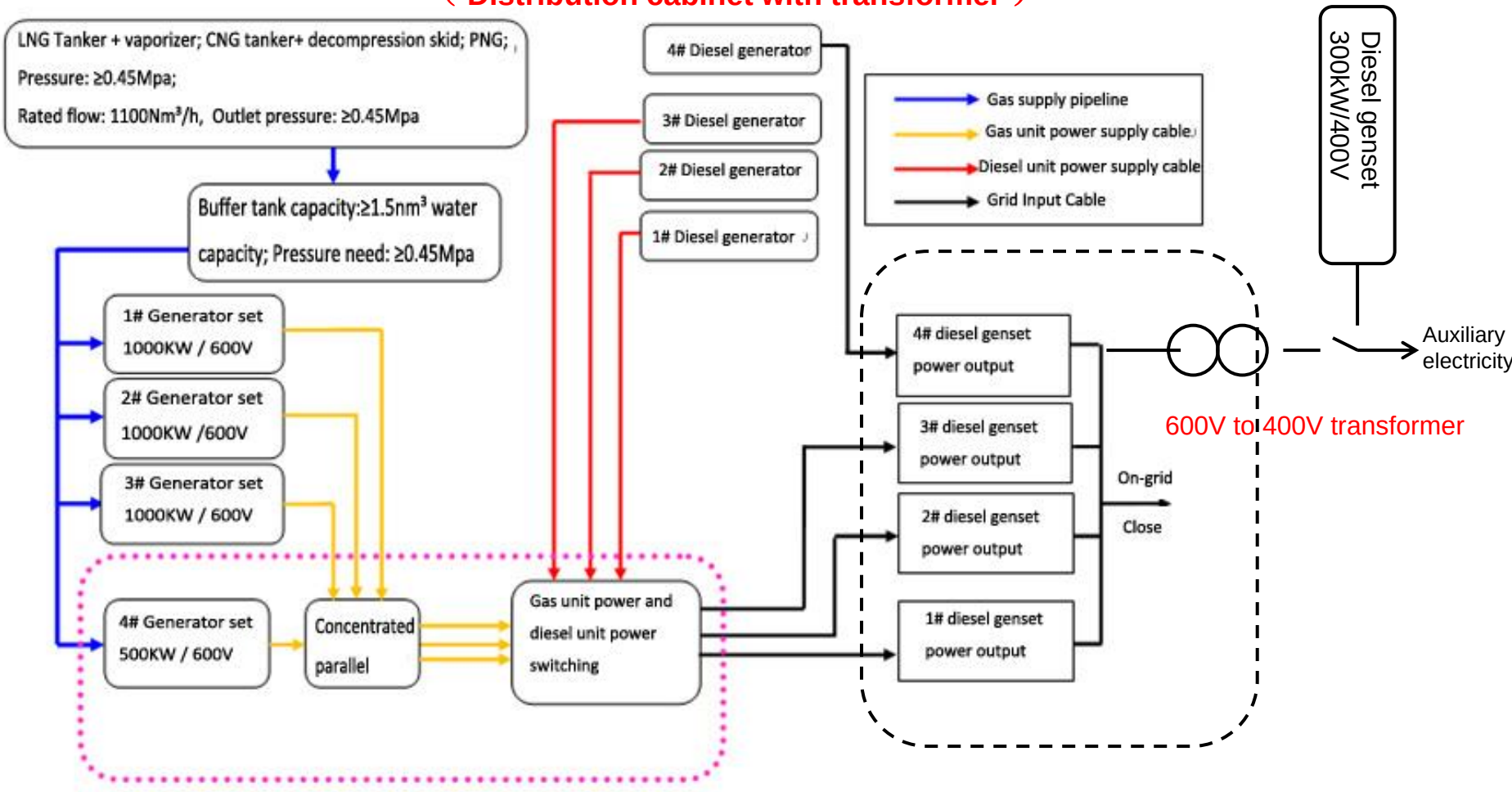
2. Gas Power Generator Set For Electric Drill Rigs

- Suitable to 70, 50, 40 electric drilling rig systems: equipped with main power generator set;
- Natural gas main power generation station configuration: 3 sets (4 sets) of 1000kW natural gas generating set + 1 set of 500kW centralized parallel natural gas generator set; total power capacity of 3500kW (4000kw), flexible online unit capacity selection range: 250kW ~ 4000kW (interval 250kW);
- Main specifications: Voltage:600V, Frequency: 50Hz, Power factor: 0.8; For detailed specification, please refer to "Technical datasheet of Main Power Gas Generator Sets for Drilling Rigs"
- Features: high stability, high dynamic response, high economy, one-key start, parallel operation, delivery, one-key shutdown; low failure rate, low operating cost.



2. Gas Power Generator Set For Electric Drill Rigs

3500kW gas power generating flow chart
（Distribution cabinet with transformer）



2. Gas Power Generator Set For Electric Drill Rigs

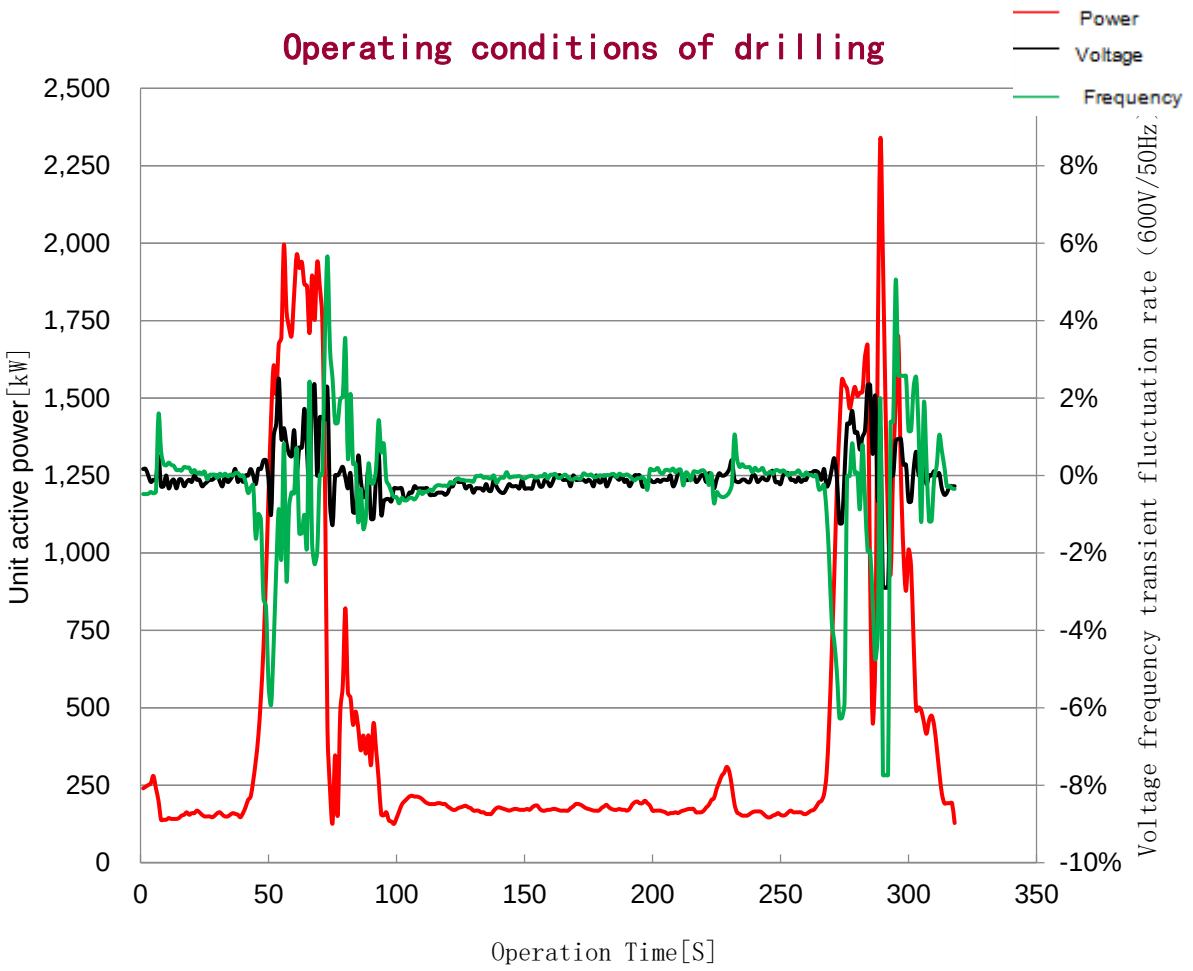
The 1000kW natural gas generator set consists of 4 pcs 250kW natural gas generators, which can achieve independent starting, interlocking and parallel operation, freely adjusting the use power according to the working conditions, and outstanding on fuel economy. Natural gas genset can be grid-connected with well onsite diesel generator set and free switching.

Internal structure

3. Electric drill rigs performance and references

Onsite Response Test

The picture on the right is the actual measurement chart when a 70-rig start drilling, requiring the driller to operate according to the diesel engine's operating habits: quickly operate the throttle. The load for two times drilling starts from 200kW to 2000kW, the frequency transient fluctuation rate is within -8% ~ + 6%; the voltage transient fluctuation rate is within -3% ~ + 3%;



3. Electric Drilling Rigs Performance and Applications

3.1 Match Rig Load Characteristic Test Parameters

Frequency transient fluctuation : -8%~+6%

Voltage transients : -7%~+7%

Working Condition		Load Characteristics
Tripping operation	Trip out	Well depth1536m，200-1100kW，Maximum Impact: 900kW； Well depth4378m，300-2000kW，Maximum Impact:1700kW；
	Drill down	Well depth1536m，280-1080kW，Maximum Impact:800kW； Well depth4378m，300-1250kW，Maximum Impact:950kW；
	Lift up hook block assembly	300-1100kW
Drilling	Drilling	single pump（Well depth5029m），Steady load:1680kW；Maximum Impact:1300kW； single pump（Well depth5372m），Steady load:1620kW；Maximum Impact:1200kW； double pump（Well depth2871m），Steady load:2150kW；Maximum Impact:1700kW；
	Redressing	single pump（Well depth5029m），Steady load:1650kW；Maximum Impact:800kW； single pump（Well depth5372m），Steady load:1550kW；Maximum Impact:840kW； double pump（Well depth2871m），Steady load:2150kW；Maximum Impact:670kW；
	Making a connection	single pump（Well depth5029m），Steady load:260kW；Maximum Impact:1350kW； single pump（Well depth5372m），Steady load:；Maximum Impact:1200kW； double pump（Well depth2871m），Steady load:450kW；Maximum Impact:1700kW；

3. Electric Drilling Rigs Performance and Applications

3.2. AMICO product Performance Technology Level Comparison

The highest grade of natural gas generator set GB/T 22343-2008 is G2, but the corresponding electrical indicators can not meet the main power supply requirements for drilling. Especially in the transient response index, it is necessary to refer to the performance index of the original Carter diesel generator set. The electrical performance index of the Amico gas generator set is far superior to the national standard G2 level.

Parameter		Performance Level		Amico Generator	Electric Drilling
		G1	G2	Test Data	Power Supply System Requirements
Frequency drop δf /%		0～8	0～5	0～5	0～5
Steady-state frequency band β/%		≤2.5	≤1.5	≤1	≤1.5
Relative frequency setting descending range δf /%		≥（2.5﹢8 f ）			
Relative frequency setting rise range δf /%		≥﹢2.5			
(for rated frequency) Transient frequency deviation	Sudden power reduction δf /%	≤﹢18	≤﹢12	≤﹢6	≤﹢8
	Sudden power increase δf /%	≤﹣25	≤﹣20	≤﹣8	≤﹣10
Frequency recovery time t_r/s		≤10	≤5	≤2.5	≤3
Relative frequency tolerance band a /%		3.5	3	3	3
Steady state voltage deviation δU /%		≤±5	≤±2.5	≤±1	≤±1.5
Transient voltage deviation	Sudden power reduction δU /%	≤﹢35	≤﹢25	≤﹢7	≤﹢8
	Sudden power increase δU /%	≤﹣25	≤﹣20	≤﹣7	≤﹣8
Voltage recovery time t_r/s		≤10	≤6	≤1	≤2
Voltage imbalance δU /%		1			

3. Electric Drilling Rigs Performance and Applications

3.3 Application Statistics of Electric Drilling Rigs (Partial application)

S/N	Specification	Generating capacity kW	Running time/h	Total power generation/kwh	Gas consumption /10,000Nm³	Form of power
1	3×1000kW+Concentrated parallel	3000	8946	7514640	250.7	600V main power
2	5×750kW+Transformer	3750	5214	4418865	158.6	400V L 600V main power
3	4×1000kW+Concentrated parallel	4000	6458	5166400	174.8	600V main power
4	3×1000kW+500kW Concentrated parallel	3500	2311	1860355	64.7	600V main power
5	3×1000kW+500kW Concentrated parallel	3500	2400	2016000	69.8	600V main power
6	3×1000kW+500kW Concentrated parallel	3500	2290	1803375	61.7	600V main power
7	3×1000kW+500kW Concentrated parallel	3500	2109	1734653	57.8	600V main power
8	3×1000kW+500kW Concentrated parallel	3500	2145	1636635	56.5	600V main power
9	3×1000kW+500kW Concentrated parallel	3500	2340	1850940	63.9	600V main power
10	3×1000kW+500kW Concentrated parallel	3500	2086	1890959	63.3	600V main power
11	3×1000kW+500kW Concentrated parallel	3500	1760	1293600	43.8	600V main power
12	3×1000kW+500kW Concentrated parallel	3500	1640	1216880	40.9	600V main power
13	3×1000kW+Concentrated parallel	3000	1820	1277640	44.1	600V main power
14	3×1000kW+500kW Concentrated parallel	3500	1705	1473973	49.5	600V main power
Note: The above data is some information we obtained based on the data when we checked the service. Because most of the data involves commercial confidentiality, customers require confidentiality and cannot be published.						

3. Electric Drilling Rigs Performance and Applications

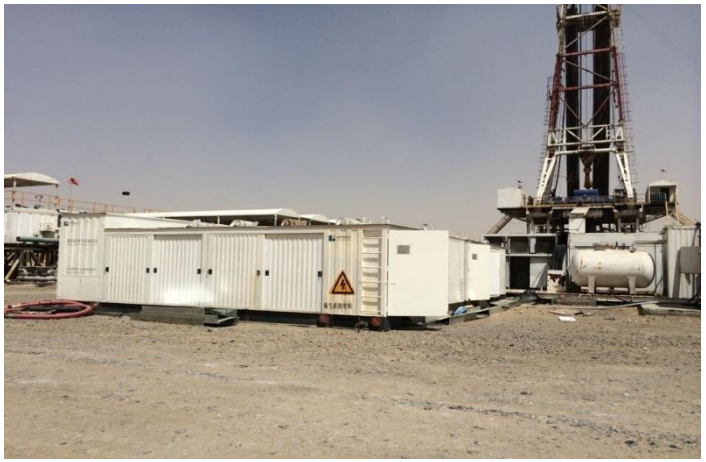
3.3 Application Statistics of Electric Drilling Rigs(Partial application)

The actual drilling power is 1310kw (the load is a turntable and a mud pump). The stand-alone power is 121kw, and a total of 11 units are started to ensure that the drill is lifted and handled in special conditions. At this time, the load rate is 47%, which can be increased.

On the left, the gas consumption during operation, the real-time data is 414.76 standard natural gas, and the gas-electricity ratio: 1310 / 414.76 = 3.16, that is, 3.16 degrees at a load rate of about 47% can be produced by 1 Nm3 natural gas.

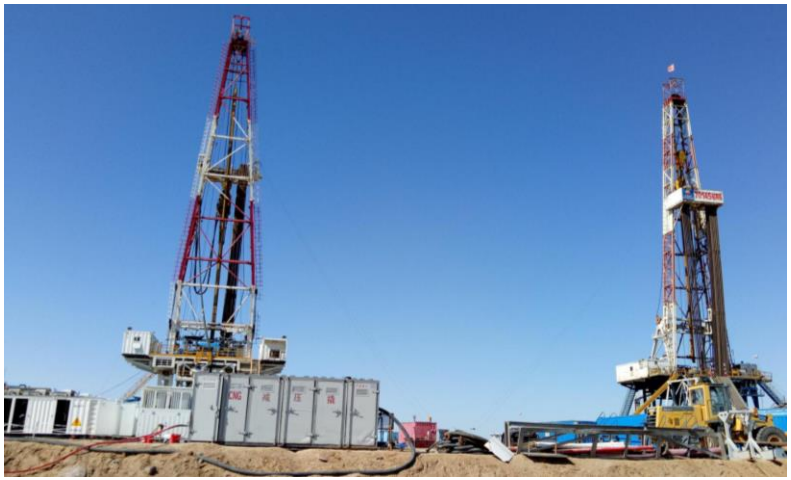
3. Electric Drilling Rigs Performance and Applications

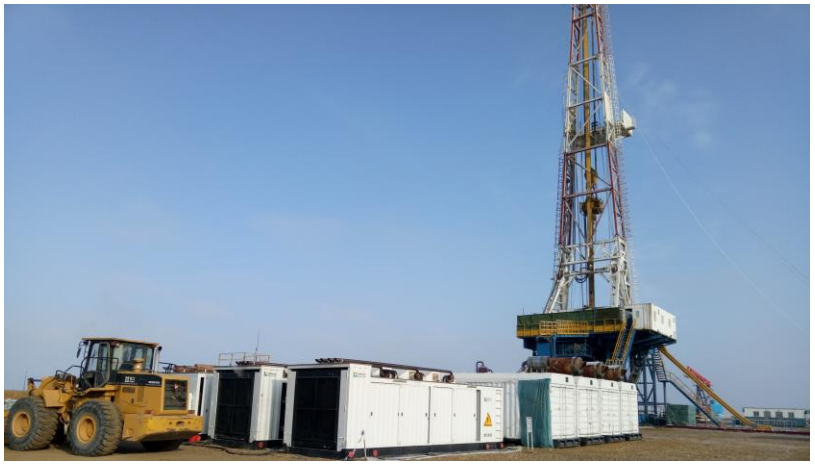
Drilling Applications in Tarim Oilfield and Inner Mongolia



3. Electric Drilling Rigs Performance and Applications

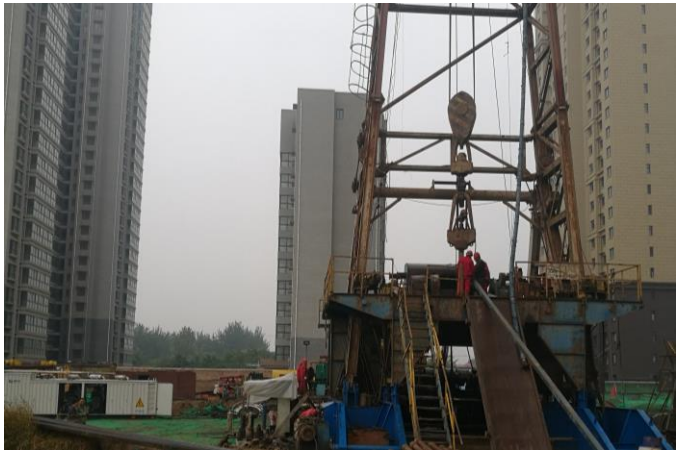
Oilfield Drilling Application Case in Karamay, Xinjiang





3. Electric Drilling Rigs Performance and Applications

Applications in South Sichuan Shale Gas Drilling and Shaanxi Geothermal Well



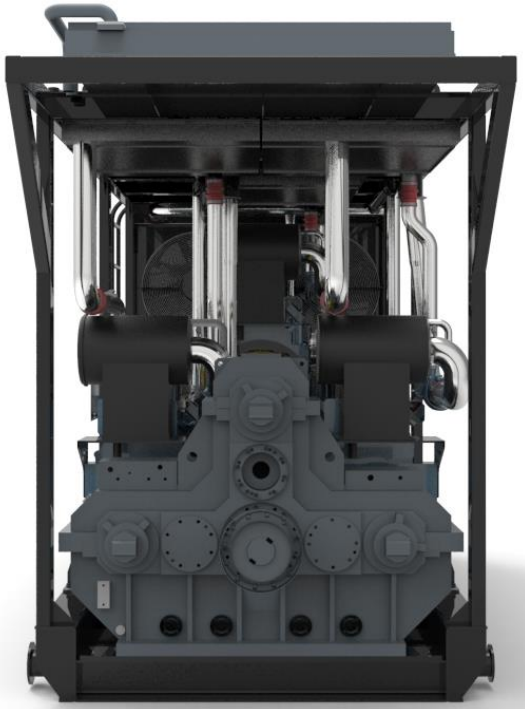
4.Gas Engine Modules for Mechanical Drilling Rigs

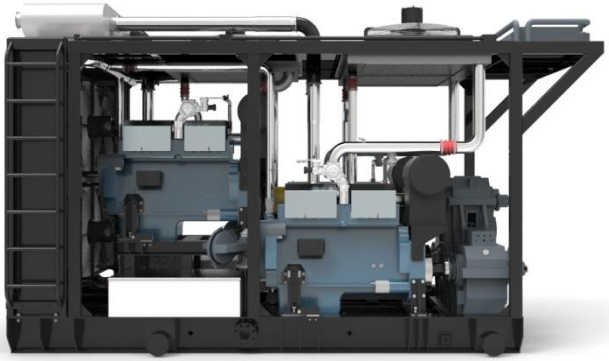
810kW Natural Gas Engine Modules——AMC810DF-3PN

- Applicable to 1000HP, 1500HP,2000HP, mechanical drilling rigs: Replace 12V190 diesel power engine;
- Main technical parameters: rated speed 1300rpm, rated power 810kW；

4.Gas Engine Modules for Mechanical Drilling Rigs

Generator Outline Structure Diagram





4.Gas Engine Modules for Mechanical Drilling Rigs

➢ 810kW Gas Power Engine Structure

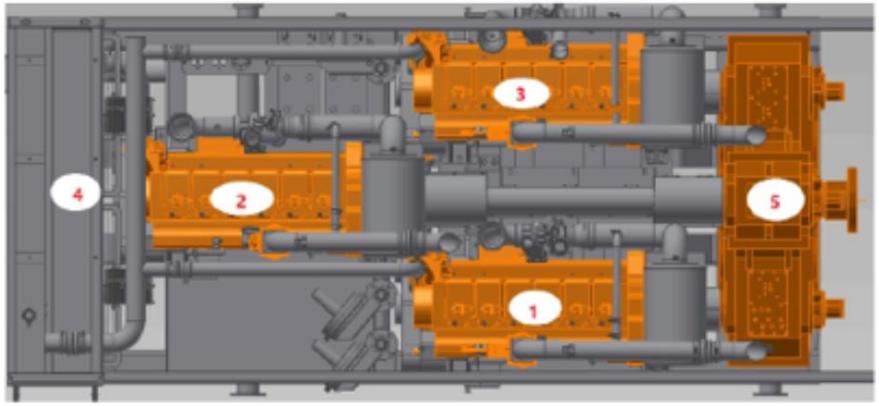


Figure 2-1:Top view layout of generator

1. 1# engine 2. 2# engine 3. 3# engine 4. Cooling water tank 5. Parallel gear box

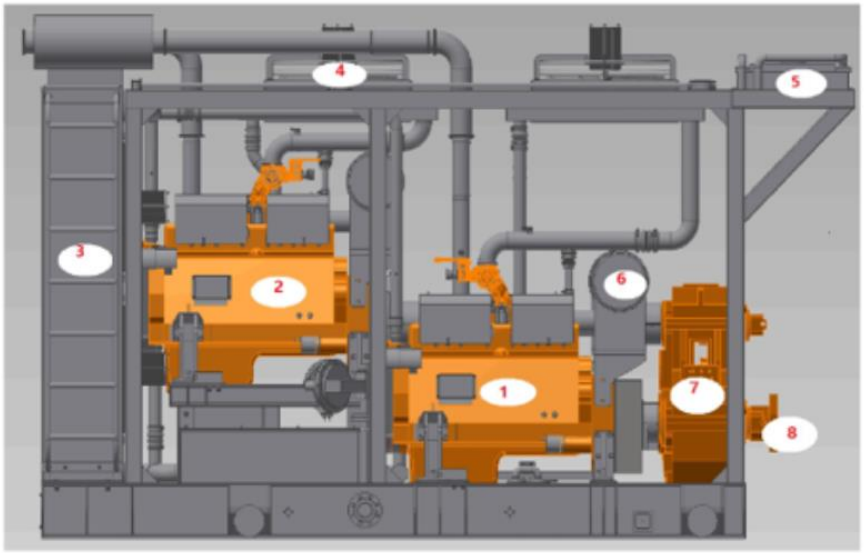


Figure 2-2: Side view of generator

1. 1# engine 2. 2# engine 3. cooling water tank 4. Intercooler and fan

5. Oil cooler and cooling fan 6. Air filter 7. Parallel gear box 8. Gearbox output

Structural features:

The installation interface is the same as that of the diesel engine;

Universal chassis, suitable for cart platforms with a shaft height of 640mm-760mm;

Intelligent closed cooling system, reducing the power consumption of the cooling system by more than 50%;

Two sets of centralized control platforms to meet the control needs of the machine and driller's room;

5.Mechanical drill rigs performance and application

Performance comparison between 810kW natural gas engine and 12V190 diesel engine

Performance parameters of 12v190 diesel engine		
Output Speed	Torque	Power
rpm	N·m	kW
800	5000.0	418.9
850	5200.0	462.9
900	5400.0	509.0
950	5600.0	557.1
1000	5650.0	591.7
1050	5675.0	624.0
1100	5700.0	656.6
1150	5725.0	689.5
1200	5750.0	722.6
1250	5775.0	756.0
1300	5770.0	785.5

Performance parameters of 810kW natural gas engine			Torque margin of 810kW natural gas engine
Output Speed	Torque	Power	
rpm	N·m	kW	%
800	7026.9	588.7	40.54
850	7586.4	675.3	45.89
900	7514.0	708.2	39.15
950	7321.6	728.4	30.74
1000	7114.0	745.0	25.91
1050	6912.6	760.1	21.81
1100	6484.6	747.0	13.77
1150	6365.4	766.6	11.19
1200	6176.5	776.2	7.42
1250	6015.4	787.4	4.16
1300	5947.4	809.7	3.08

Features：

- The power performance is better than that of diesel engine in the range of all working condition. In particular, the low speed stage has sufficient torque reserve, and the ability of power system cope with complex working conditions is improved. The efficiency of drilling is guaranteed.
- High response remote throttle, met the power demand of load for tripping in and tripping out and speed changing condition, the rate of speed governing can over 200rpm/s.

5.Mechanical drill rigs performance and application

Products operating in Xinjiang and Inner Mongolia

6. Client of Oil Field

Client of oil field：

CNPC Xibu Drilling Engineering Karamay Drilling Co.,Ltd.
CNPC Xibu Drilling Engineering Zhundong Drilling Co.,Ltd.
CNPC Greatwall Drilling Engineering Xibu Drilling Co.,Ltd.
CNPC Greatwall Engineering No.1 Drilling Co.,Ltd.
CNPC Greatwall Engineering No.2 Drilling Co.,Ltd.
CNPC Bohai Drilling Engineering Co.,Ltd.
Sinopec Jianghan Drilling Co.,Ltd.
Sinopec Huabei Drilling Co.,Ltd.
Sinopec Xibei Drilling Co.,Ltd.
Xinjiang Beiken Energy Co.,Ltd.
Xinjiang Zhengtong Petroleum and Natural Gas Co.,Ltd.
Xinjiang Petrolor Energy Services Co.,Ltd.
Bazhou Zhaoshi Drilling Co.,Ltd.,etc.

7. Case Analysis-Benefit

1. Economic benefit measurement（Based on the data of south Xinjiang gas instead of diesel project, it is for reference only. Subject to gas price and electricity consumption, please adjust by yourself.):

Drilling rig gasification project investment and annual operation cost details:

Project	Amount （Ten Thousands/0.01million Yuan）
Investment in one lump sum for the Project:	545
Annual spare parts consumption and maintenance costs：	30
Annual personnel salary, employee welfare funds, administrative expenses：	40
Annual fuel cost：	324
Total annual operating expenses：	394

The specific calculation details are as follows：

1. Service provider related cost and benefit calculation：
Measuring by one well was drilled in 3 months, 3 Wells was drilled in one year, with an average daily electricity consumption of 20,000 degrees and a settlement price of 1.3 yuan/kw.h.
Annual electricity consumption：3×30×3×2=5.4 million kW（Ten thousands kW）
The average generating capacity of natural gas generator set is 3kW. H /Nm, so the annual natural gas consumption is 540÷3= 1.8 million Nm^3 .
The on-site price of natural gas is 1.8 Yuan /Nm^3, so the annual natural gas fuel cost: 180×1.8= 3.24 million Yuan.
Total annual operating cost: 30+40+324= 3.94 million Yuan.
Annual settlement service fee: 540×1.3= 7.02 million Yuan.
Service provider annual operating profit：702-394=3.08 million Yuan.
Equipment recovery cycle：545÷308=1.8 year/20 months（This calculation does not include taxes, income taxes, etc.）
2. Cost and benefit calculation of drilling company:
According to the field test of natural gas engine and generator set, the consumption ratio of natural gas to diesel is 1.125Nm3/L.The diesel density is 0.84kg/L, the average generation capacity of natural gas generator set is 3kW. H /Nm^3, and 5.4 million KW of electricity needs to consume diesel:
180÷1.125×0.84×10=1344 ton
Corresponding diesel cost: 1344×6500 Yuan/ton = 8.73 million Yuan.
The labor cost and maintenance cost of operating diesel generator set by drilling company is close to that of gas generator, which is 600,000 Yuan.
Drilling company annual cost savings: 873 -- 702 + 60 = 2.3 million Yuan.

7. Case Analysis-Benefit

2. Environmental Protection Benefit：

- Environmental benefit analysis basis: according to the 2000HP mechanical drilling system, the average load is 1000kW, the single well operation time is 60 days, calculate the diesel power system and gas power system emissions;
- Diesel power emission level: currently, there is no mandatory implementation in China, and the actual emission is worse if calculated according to the European standard emission level;
- Gas-power emission level: calculated according to engine emission test index; Reaching the IV emission level of China;

Systems	Emission Level Comparison (g/kw.h)			
	CO	HC	Nox	PM
Diesel power system	5	1.3	9.2	0.54
AMICO gas power system	1.5	0.41	3.3	0
	Total emissions per day (g/day)			
Diesel power system	120000	31200	220800	12960
AMICO gas power system	36000	9840	79200	0
	Total emissions per well (kg/well)			
Diesel power system	7200	1872	13248	777.6
AMICO gas power system	2160	590.4	4752	0
AMICO gas power system	5040	1281.6	8496	777.6

7. Case Analysis-Benefit

3. Social Benefits：

- Particulate emission reduction benefits: after using natural gas power equipment, particulate (PM) emission reduction rate of each well is 12960g/ day, reducing air pollution; This emission reduction can make the air quality level of 8.64 square kilometers from clean to heavily polluted;
- Social and economic benefits of emission reduction: the impact of pollutants on the environment is very complex, and the impact on human beings and ecology is more and more serious, which has been paid more and more attention in recent years. Pollution control is difficult and costly, which can be reflected by the environmental economic value of different pollutants. For example, the environmental economic value of NOx is 31,500 / ton, each well emission reduction NOx 8.5 tons, the environmental economic value of 267,800, the social contribution is huge.

①：Refer to *Policy Research and Demand of Natural Gas Power Generation in the 13th Five-year Plan Period* (planning and statistical information department of China electricity council)

8. Advantage and Disadvantage compare to Diesel Power Generation and Grid Power

1. Comparison of gas power generation with diesel power generation：

- Better economy, fuel cost saving rate of 30-50%.
- It is the general trend to achieve better environmental benefits and reduce emissions of carbon smoke particles.
- Gas-fired power generation is more economical in winter.

2. Comparison of gas power generation with grid power generation：

Better flexibility, no block restrictions:

- Capacity free choice, not limited by the network capacity.
- The equipment is mobile and does not waste investment or leave idle.

Thanks !