Doc.No.：JNPJ-2017-057

# Hunan Shichun New Energy Co.,Ltd

Technical modification of oxygen hydrogen gas generator catalytic combustion for industrial boilers

**Third-party energy saving evaluation report**

Evaluation agency: Hunan Energy Conservation Evaluation Technology Research Center

Responsible person: Li Hesong

Date of preparation: October 19, 2017

# Field Evaluation Form

<table>
<tr><td>Apply Company</td><td colspan="4">Hunan Shichun New Energy Co.,Ltd</td></tr>
<tr><td rowspan="4">Project details</td><td>Name</td><td colspan="3">Technical modification of HHO generator catalytic combustion for industrial boilers<br>Third-party energy saving evaluation report</td></tr>
<tr><td>Boiler spec and Cost input</td><td colspan="3">Target company:Zhongshan Yihao Energy Co.,Ltd<br>Boiler spec:6tph chain grate boiler<br>Fuel:Coal<br>Cost:RMB10500/set including transport</td></tr>
<tr><td>Project installation content</td><td colspan="3">Boiler and PLC do not change and boiler operation keep same. Install 1 set hho machine near by boiler,feeding mixed oxygen and hydrogen gas into combustion chamber of boiler,part of hho is fed from primary air intake pipeline,and part of hho is fed from secondary air intake pipeline.</td></tr>
<tr><td>Fuel saving</td><td colspan="3">Total 640.08t coal will be saved per year</td></tr>
<tr><td rowspan="5">Project field details</td><td>Evaluation agency</td><td>Hunan Energy Conservation Evaluation</td><td>Field evaluation date</td><td>2017.6.17</td></tr>
<tr><td>Team Leader</td><td>Jiang Li</td><td>Contact number</td><td>0731-88830269</td></tr>
<tr><td>Members</td><td colspan="3">Zhou Hongfei and Luo Zhengyi</td></tr>
<tr><td>Field record</td><td colspan="3">HHO model:GTHO-6500, QTY:1 set，Manufactured in 2016，Steam pressure:0.6MPa，User:package factory<br>HHO gas is fed into combustion chamber from air intake pipeline,boiler steam flow,fuel consumption and electricity consumption have been record.<br>The flame is yellow-white, no smoke can be seen, and the ash burns more completely by on-site observation.Third parts including evaluator,seller and user are all on site,user are satisfied with the results of the hho machine and provided related electricity and fuel consumption,steam flow data before and after hho machine installed.</td></tr>
<tr><td>Conclusion</td><td colspan="3">After oxygen & hydrogen gases are fed into combustion chamber of the boiler, the hydrogen in the furnace ignites quickly in advance, the overall temperature of the furnace is increased, the radiation heat exchange in the furnace is strengthened, the CO content in the flue gas</td></tr>
</table>

| | | |
|---|---|---|
| | | and the carbon content in the ash and slag are reduced, energy saving, environmental protection, safety, high efficiency, and stable benefits. The operation of the 6t/h biomass(coal) chain furnace confirmed that the boiler unit steam energy consumption was reduced from 0.117tce/t to 0.103tce/t after using HHO generator, and the relative energy saving rate was 11.8%. The project saves 640.08 tons of standard coal annually. According to the 2017 biomass price, the static investment payback period is about 11 months. |

# Menu

# 1、Company and project profile

## （1）Company profile

Hunan Shichun New Energy Co., Ltd. is a high-tech enterprise focusing on zero-pollution, low-energy, high-safety hydrogen and oxygen energy technology, and specializing in hydrogen and oxygen energy. R&D, manufacturing, sales and project services of equipment, motor vehicle maintenance equipment, environmental protection equipment, welding and cutting equipment. The company's main products are used in automobile decarbonization, steel cutting and welding, garbage incineration, kiln catalytic combustion, hydrogen vehicles and other fields. They have been sold to most domestic provinces and exported to Asia, Africa, Europe and North America. The company's quality management complies with ISO9001:2015 quality management system standards, and its series of products have passed EU CE certification.

In line with the country ’ s energy-saving and emission-reduction green needs, the company extends its main technology—inverter power technology to the industrial field, and independently develops three-way catalytic cleaning machines, hydrogen-oxygen decarbonizers, hydrogen-oxygen cutting machines, and cutting machines that are used in the automotive field. , Combustion-supporting and welding integrated machine. In 2015, it independently developed a hydrogen-oxygen energy machine applied in the field of small and medium industrial boilers. After two years of pilot testing and industrialization, the hydrogen-oxygen energy machine has mature technology, finalized product design, safe and reliable on-site application, and significant benefits in energy efficiency and emission reduction. Specially entrusted the national energy-saving third-party organization—Hunan Energy-saving Evaluation Technology Research Center to conduct a third-party energy-saving evaluation of the comprehensive energy consumption, unit steam comprehensive energy consumption and annual energy saving after the application of hydrogen-oxygen energy machine to chain boiler The promotion and application of hydrogen-oxygen energy generators in the field of industrial boilers.

## （2）Technology process,investment and service condition

### ① Technology process

The burning coal enters the coal bunker through the conveying device. The coal in the coal bunker falls into the front coal hopper by its own weight, and then falls on the chain grate that moves forward slowly, and enters the combustion chamber through the gate. The height of the gate can be adjusted freely to control the thickness of the coal seam from 100 to 150 mm. Air enters from the partitioned static pressure chamber under the grate and intersects the direction of coal seam movement. The coal is heated by radiation in the furnace, and the preheating, drying, and burning are completed in sequence until it is burnt out. The ash and slag move to the rear with the grate, pass through the slag baffle and fall into the rear water-cooled ash hopper, and are discharged by the slag remover . The speed reducer drives the chain grate to rotate, so that the coal catches fire from the front to the end of the boiler. At the same time, when the chain turns to the bottom, the air cools down, which can protect the grate pieces from burning.

The combustion-supporting air is forced into the air preheater by the blower, and enters the segmented air supply bin under the grate after the temperature rises, and then fully contacts and mixes with the coal seam above the grate to carry out a strong combustion reaction. The way of heat exchange is to transfer heat to the water wall laid around the combustion chamber. Then the high-temperature flue gas sweeps through the slag tube, flushes the steam superheater horizontally and vertically, and then flows into the convection flue, flushes the boiler tube bundle horizontally along the fire wall, and transfers heat to the convective heating surface by convective heat transfer; temperature along the way; The gradually decreasing flue gas enters the tail flue, flushes the economizer laterally, transfers heat to the working fluid water in the tube by means of convective heat transfer, and then flows into the air preheating tube, and transfers heat to the outside of the tube to support combustion by means of convective heat transfer Air, the preheated air enters the furnace, which strengthens the combustion in the furnace. So far, the flue gas temperature has been reduced to the economical flue gas temperature, leaves the boiler body, is dedusted by the dust collector, and then discharged into the atmosphere through the induced draft fan, flue and chimney.

The feed water is sent to the economizer by the feed water pump through the pipeline. The water absorbs the heat of the flue gas in the tail flue in the economizer, and enters the upper drum after preheating.

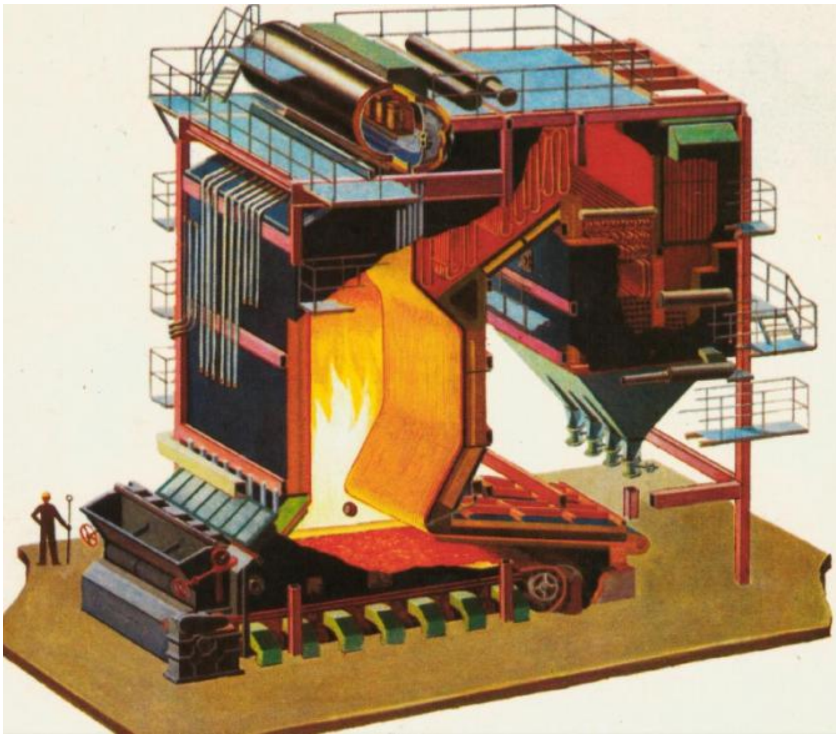


FIG. 1 Principle of chain boiler

The chain furnace consumes solid fuel and electricity to produce water vapor. The solid fuel combustion is mainly stratified combustion. The solid fuel combustion process is first to preheat and evaporate water, volatilize and analyze it, and then to burn fixed carbon. Volatilization analysis takes a long time, excessive air, and low furnace temperature, which cause volatile matter to be unable to burn normally and to be emitted in the form of black smoke, and fixed carbon cannot be burned normally to be discharged in the form of carbon-containing ash (usually the ash contains up to 10-20% carbon) . The actual average thermal efficiency of my country's small and medium-sized coal-fired industrial boilers is mostly less than 60%, and some hand-fired boilers are even only 30% to 40%. However, the operating efficiency of small and medium-sized coal-fired boilers in developed countries is generally close to 80%, which has huge energy saving potential. The thermal efficiency of the chain furnace is closely related to the capacity and coal burning conditions.

**Table 1 Average level of thermal efficiency of the first layer furnace (chain furnace) / %**

| Fuel Type | | CV/10K KJ.KG-1 | Boiler Volume D/t.h-1(MW) | | | | |
|---|---|---|---|---|---|---|---|
| | | | <1(<0.7) | 1-2(0.7-1.4) | 2-8(1.4-5.6) | 8-20(5.6-14) | >(>14) |
| Soot | II | 1.77-2.1 | 73 | 76 | 78 | 79 | 80 |
| | III | >2.1 | 75 | 78 | 80 | 81 | 82 |
| Meagre Coal | | >=1.77 | 71 | 74 | 76 | 78 | 79 |
| Non-soot | II | >=2.1 | 60 | 63 | 66 | 68 | 71 |
| | III | | 65 | 70 | 74 | 76 | 79 |
| Lignite | | >=1.15 | 74 | 74 | 76 | 78 | 80 |

The main body of the technical transformation is the DZL-6-1.25 chain boiler, which was delivered in 2016, with a rated steam flow of 6 tons/hour and a steam parameter of 0.6MPa saturated steam.

② **Project investment**

According to the invoice and contract for the purchase (including transportation) of the hydrogen-oxygen energy machine configured for the 6-ton chain boiler, the project investment is 105,000 yuan/unit, and there is no on-site installation fee.

③ **Usage condition**

In March 2016, Ezhou Huashuo Technology Co., Ltd., 4T boiler carried out the combustion-supporting energy-saving transformation of hydrogen-oxygen energy machine;

In May 2016, Wuhan Fenghe Industrial Park, a 1T boiler carried out a hydrogen-oxygen energy machine combustion-supporting energy-saving transformation;

In July 2016, Xiangxiang Jinlong Gelatin Co., Ltd., 4T boiler carried out the combustion-supporting energy-saving transformation of hydrogen-oxygen energy machine;

In 2017, Zhongshan Wansheng Boiler Equipment Co., Ltd. used the 1t ton thermal oil boiler of Zhongshan Lehua Food Co., Ltd., the 1t ton thermal oil boiler of Zhongshan Senmei Furniture Co., Ltd., the 6T boiler of Zhongshan Yihao Energy Co., Ltd. and Zhongshan Fuzhou Adhesives Co., Ltd. 6T heat conduction oil boiler undergoes the hydrogen-oxygen energy machine combustion-supporting energy-saving transformation. After the transformation, the emission reduction effect is significant, and the social benefits are obvious; the energy-saving effect is well received by users.

## 2、Field evaluation process description

### （1）Site evaluation organization and members

The project evaluation is carried out by Professor Jiang Li, Engineer Zhou Hongfei and Luo Zhengyi from the Hunan Energy Conservation Evaluation Technology Research Center. The evaluation team leader is Professor Jiang Li. The evaluation team conducted on-site investigations on the authenticity of the combustion-supporting energy-saving transformation of the 6-ton biomass chain boiler of Zhongshan Yihao Energy Co., Ltd., the calculation of energy saving, the energy consumption of the equipment attached to the technological transformation, the production situation, and the feasibility of technological transformation. Evaluation.

### （2）Schedule of site evaluation

After the evaluation team formally accepted the on-site evaluation tasks of the comprehensive energy consumption, unit product energy consumption and energy saving of the industrial boiler hydrogen and oxygen catalytic combustion technology reform project, it began to familiarize and understand the project related documents and standards. On October 17, 2017, the evaluation team, Professor Jiang Li, engineer Zhou Hongfei, and Luo Zhengyi arrived at Yixian Industrial Park in Zhongshan City to conduct on-site evaluation of energy consumption and energy saving of the 6-ton biomass chain boiler of Zhongshan Yihao Energy Co., Ltd. On October 19, the evaluation team completed the compilation and analysis of the industrial boiler operation data before and after the application of the hydrogen-oxygen energy machine. On October 20, it completed the preparation of the "third-party energy-saving evaluation report" and ended the on-site evaluation.

### （3）Field evaluation process

According to the "Guidelines for the Audit of Energy Conservation Projects" (Fagai Huanzi [2008] No. 704), "Methods for Determination and Monitoring of Energy Conservation", "General Principles of Energy Conservation Monitoring Technology" (GB/T 15316-2009), "Energy Consumption Unit Energy" General Rules for the Allocation and Management of Measuring Instruments (GB 17167-2006), General Rules for Comprehensive Energy Consumption Calculation (GB/T 2589-2008), and the client's "Feasibility and Benefit Analysis on the Application of Hydrogen Oxygen Energy Machines to Boiler Combustion", The entrusting party "A Kind of Catalytic Combustion Device for Kiln Furnace" (ZL2016 2 0164056.5, authorization date 2016.8.10) and relevant national standards, industry standards and equipment standards, etc., the evaluation team will implement the project's hydrogen-oxygen energy machine before and after the energy utilization, Energy consumption measurement and monitoring, production operation and other conditions are evaluated, and the operating parameters of industrial boilers using hydrogen-oxygen energy machines, third-party monitoring reports of boiler flue gas pollutant emissions, energy consumption metering equipment, and technical reform units provided May 2017 Data such as solid fuel consumption, power consumption and steam generation of industrial boilers that have been technically upgraded during the period from January to September and those that have not been technically upgraded during the period from January to

April of 2017 are objective, fair, and realistic. Energy consumption and annual energy saving.

Table 2 Energy saving evaluation process

| Date | Evaluation implementation content |
|---|---|
| Oct 13 | Evaluation invitation received |
| Oct 14 | Team members training |
| Oct 17 | Arrived at Zhongshan Yihao Energy Co.,Ltd |
| | Convene the first meeting attended by the client, the industrial boiler manager and the leader and members of the evaluation group to determine the project boundary and the calculation method of annual project energy saving |
| Oct 17 -18 | Site visit, energy-saving technology evaluation, industrial boiler and comparison industrial boiler production and comprehensive energy consumption data on-site monitoring |
| | On-site monitoring data collation and analysis, energy consumption, unit product energy consumption and energy saving calculation |
| Oct 19 | Form energy conservation evaluation conclusions and communicate with the client |
| Oct 20 | At the final meeting, submit an energy-saving evaluation report |

## 3、Site evaluation content

### （1）Project progress and HHO running

On March 13, 2017, the equipment manufacturer and the buyer signed a contract, stipulating a total project investment of 105,000 yuan (including installation and commissioning), and a GTHO-6500 HHO generator arrived at the project site on March 14, 2017.

March 15th to March 30th, 2017，GT-HO6500 installation finished。

April 1st to September 30th, 2017，GT-HO6500 start running on the boiler,keep daily record.

### （2）HHO generator investment

Total charges is RMB105000,No extra fee on installation.

### （3）The implementation of the content

① Boiler and PLC do not change and boiler operation keep same.

② Install 1 set hho machine near by boiler,feeding mixed oxygen and hydrogen gas into combustion chamber of boiler,part of hho is fed from primary air intake pipeline,and part of hho is fed from secondary air intake pipeline.

## 4、Energy-saving technologies and products adopted by the project

### （1）Technical principle or process characteristics

#### A、HHO generator structure

As shown in Figure 1, HHO generator includes a hydrogen-oxygen manufacturing system, a hydrogen-oxygen transfer system, a quantitative air supply system, a control system, and a combustion adjustment system. IGBT inverter power supply is also affected by the remote control system, the pressure automatic control system and the gas production automatic control system. The inverter power supply outputs specific electric energy to the electrolysis generator. The soft water is electrolyzed in the electrolysis generator into a mixture of hydrogen and oxygen. The mixed gas is converted into hydrogen and oxygen after four stages of water and gas separation. The hydrogen and oxygen pass through two stages of wet protection. After tempering, it enters the industrial boiler furnace through the conveying pipe to support combustion。

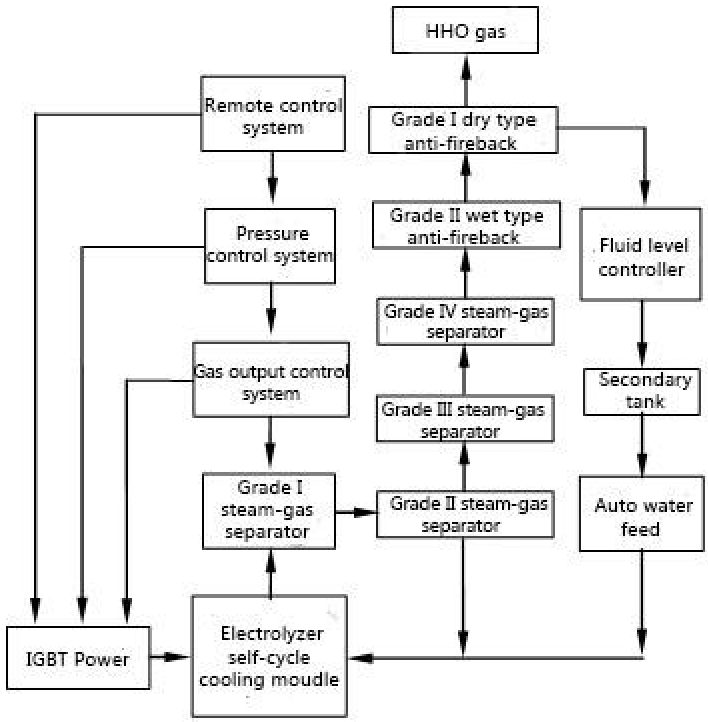



**Fig.2 HHO constitute and principle**

Key technology of HHO generator:

① The self-convection heat dissipation microporous jet generator structure can effectively reduce the water electrolysis temperature and increase the gas production rate;

② Multi-stage anti-tempering device composed of two-stage wet anti-tempering device and one-stage dry anti-tempering device;

③ The hydrogen pressure detection system overcomes the hydrogen penetration and hydrogen embrittlement in the traditional hydrogen pressure detection;

④ Adaptive inverter DC pulse electrolysis power supply, energy saving about 40% than traditional thyristor rectifier power supply;

⑤ The all-digital control system takes the embedded microprocessor as the core, with complete over-voltage, over-current, over-heat protection and self-diagnosis functions designed to achieve precise and reliable control. The device is connected to the Internet in 3G or WiFi mode, and has the function of remote monitoring of energy machine operation

**.B、Fuel saving principle of HHO generator**

Chain furnaces usually burn lump solid fuels (such as bituminous coal, anthracite or biomass fuel). Solid fuel combustion includes two parts: chamber combustion of volatiles precipitated by preheating dry distillation in gas phase air and laminar combustion of fixed carbon on the grate bar. Laminar combustion is dominated by the combustion reaction of fixed carbon on the grate. It is limited by temperature and oxygen diffusion rate. The fixed carbon burns slowly. Measures such as increasing the combustion temperature, evenly distributing the oxidant gas flow and extending the combustion time are usually taken to reduce solid ash Carbon loss in slag. Chamber combustion is usually dominated by the carbon monoxide combustion reaction, and the CO combustion reaction speed is slow. Generally, measures are taken to increase the combustion temperature, strengthen the combustible volatile matter-oxidant gas flow, and prevent the flue gas from flowing out of the high-temperature combustion zone too quickly. Reduce flue gas soot and CO emission losses. To improve fuel combustion efficiency, it is necessary to strengthen both laminar combustion and chamber combustion at the same time. More importantly, different strengthening measures should be taken according to the different proportions of laminar combustion and chamber combustion.

Biomass fuel has a low calorific value in the range of 3000-4000kCal/kg, volatile content 70-80%, fixed carbon 10-20%, and ash content about 10%. Combustion practice shows that biomass fuels and combustion devices have the following shortcomings: ① Poor quality, and ash containing alkali metal oxides will collide with the convective heat transfer surface of the furnace roof under the action of the flue gas high temperature thermal buoyancy force. After the combination of $Na_2O$, $SiO_2$ or FeO, the melting point is low and the slagging occurs due to melting, and the problem of convective heating surface deposition and slagging occurs. The flue gas has a high dust content and is easy to form slag outside the heat exchange tube, which reduces the heat transfer performance of the heat exchange tube. ② Similar to bituminous coal, a large amount of flue gas generated by the combustion of volatile matter will flow upward naturally, and the position of the combustion high temperature zone will move up (or even move to the flue), resulting in high CO and carbon black emission concentration in flue gas, and low thermal efficiency; ③ Flue gas content tar. Biomass fuel has low calorific value, low combustion temperature, easy to generate tar, easy to corrode metal equipment.

Comparing the combustion reaction mechanism of $H_2$, $CH_4$, and CO, it can be seen that $H_2$ has the lowest ignition point, the strongest ability to diffusely bind oxygen, the fastest combustion reaction speed, the easiest combustion reaction, the most exothermic combustion reaction, the most increase in flue gas temperature, and the propagation speed of combustion diffusion. The fastest, CO has the highest ignition point, the weakest ability to diffuse and bind oxygen, the slowest combustion reaction speed, and the most difficult combustion reaction. When $H_2$, $CH_4$, CO mixture gas and $O_2$ are in contact with combustion, the first $H_2$ combustion reaction occurs until one of $H_2$ and $O_2$ is completely consumed.

Multiple oxyhydrogen energy generators are arranged on the side of the chain furnace or in front of the furnace. The hydrogen and oxygen output from the oxyhydrogen generator is fed into the furnace through the air inlet of the combustion-supporting fan of the boiler through the combustion-supporting fan and primary air duct, and the remaining part is passed through the secondary air duct of the boiler Enter the furnace.

When the primary air mixed with hydrogen and oxygen meets the ignition source in the coal seam area, the hydrogen is the first to combine with oxygen molecules at the fastest speed to be quickly burned and consumed, and releases all heat at the combustion point, promoting CO and fixed carbon around the combustion point Rapidly heat up to the temperature above the ignition point. First, the coal seam interstitial CO and fixed carbon are ignited and burned in advance, which then triggers "synchronous combustion of all coal seams", which increases the volume of the coal seam that burns. The second is to increase the coal seam temperature and prolong the fixed carbon burning time. -The comprehensive heat transfer coefficient and heat transfer temperature difference of the water wall increase, and the heat transfer rate of the coal seam to the water wall increases. The combustion intensity per unit volume of the coal seam is increased, and the combustion efficiency of the coal seam is improved, which reduces the carbon content of the ash and slag. When the secondary air mixed with hydrogen and oxygen meets the ignition source in the gas phase space, the hydrogen is first combined with oxygen molecules at the fastest speed to be quickly burned and consumed, and all heat is released at the combustion point, prompting the rapid temperature of CO around the combustion point To the temperature above the ignition point, firstly, the CO in the gas-phase space is ignited and burned in advance, which prolongs the CO burning time and increases the gas-phase space temperature. The gas-phase space flame-water wall comprehensive heat transfer coefficient increases, the heat transfer temperature difference increases, and the flame-water wall The heat transfer rate increases, the second is that the adhesion of ash and jelly on the water wall surface is weakened and gradually falls off, the heat transfer rate of the water wall is enhanced, and the third is the increase in the combustion intensity per unit volume of the gas phase space, the coal bed combustion efficiency increases, and the flue gas The concentration of carbon black and CO emissions is reduced, which solves the problems of biomass chain boilers emitting black smoke, water-cooled wall slagging hindering heat conduction and tar emission.

When burning high volatile bituminous coal or biomass fuel, the combustion is mainly in the form of volatile compartments, and hydrogen and oxygen are mainly mixed into the secondary air duct. When burning low volatile anthracite coal, the fixed carbon layered combustion is mainly used, and the hydrogen and oxygen are mainly mixed into the primary air duct.

The hydrogen and oxygen are burned in the furnace to generate water vapor, which increases the volume content of triatomic gases in the furnace gas, increases the heat capacity of the furnace gas and the heat radiation heat transfer capacity of the high temperature furnace gas, and improves the comprehensive heat transfer coefficient of the heating surface of the boiler. The furnace temperature rises by 50～100 ℃ , which can accelerate the speed of coal seam volatilization analysis, the high-temperature cracking speed of long hydrocarbon chains, and the reaction speed of gas-phase space elementary combustion (H2, CH4, CO combustion). At this time, combustibles ignite and burn ahead of time. Extend the combustion reaction time and ultimately reduce the CO content of the flue gas.

The mixing ratio of hydrogen and oxygen in the hydrogen and oxygen maintains the best stoichiometric ratio, and has the best complete premixing conditions for the combustion reaction to occur, and it is prone to deflagration with extremely fast combustion reaction speed. Part of the hydrogen and oxygen output from the hydrogen-oxygen energy machine is mixed into the primary air duct, and the other part is mixed into the secondary air duct. This prevents the hydrogen and oxygen from being directly introduced into the furnace to support combustion without being diluted by the mainstream combustion air, and will not cause primary/secondary air. A deflagration accident occurred in the pipeline, static pressure chamber, coal seam in the furnace, and gas phase space because the local hydrogen concentration was within the deflagration concentration range. The mixing ratio of hydrogen and oxygen in the hydrogen and oxygen maintains the best stoichiometric ratio. The hydrogen combustion consumption always just consumes the external oxygen accompanying the hydrogen entering the furnace, and the oxidant conditions for the combustion of CO and fixed carbon in the furnace remain unchanged.

Mixing hydrogen and oxygen into the furnace to pre-ignite the hydrogen and oxygen to aid combustion and energy saving is different from the traditional method of spraying an appropriate amount of water vapor into the furnace to save energy. Water vapor is sprayed into the furnace, a small amount of pyrolysis reaction of water vapor occurs and a water gas reaction occurs when encountering C. One of the reactions is small and cannot be accurately controlled. Both of them require heat supply to reduce the overall level of the furnace temperature, and the energy saving benefits cannot be sustained. The project only retains the rapid combustion of hydrogen and oxygen and heats up in the furnace, moves the endothermic section of generating hydrogen and oxygen to the outside of the furnace, and maintains the overall level of furnace temperature to continue to rise. Hydrogen and oxygen are produced through electrolysis, which enhances the production of hydrogen and oxygen. Controllability. From 2015 to 2017, the practice of the hydrogen-oxygen energy machine shows that the sum of the power loss of the inverter power supply that produces hydrogen and oxygen outside the furnace and the electricity loss of the water electrolysis (standard coal), only the annual energy-saving benefit of the chain furnace with the hydrogen-oxygen energy machine (standard coal) More than 10% of coal), the energy saving benefit is obvious when the hydrogen-oxygen energy machine is applied to the chain furnace.

HHO generator integrates energy-saving and environmental protection technologies such as high-efficiency hydrogen production by electrolysis of water outside the furnace, early ignition of hydrogen and oxygen in the furnace, high-temperature combustion in the furnace, safe combustion of hydrogen and oxygen premixing, and simultaneous combustion of all coal seams in the furnace. The field application shows that the overall temperature of the chain furnace using the hydrogen-oxygen energy machine increases, the gas production is rapid, and the steam pressure rises quickly; the fuel saving rate is more than 10%; the ash and slag carbon content, flue gas, dust and CO emissions are reduced.

### （2）Technical and economic index

**Table 3 Comparison of technical and economic index of chain furnace before and after installation of HHO generator**

| Compared items | Before installation | After installation |
|---|---|---|
| Exhaust gas temperature/℃ | 275 | 248 |
| Ringelman Blackness/level | 0.8 | 0.5 |
| Flue gas CO emissions Concentration/mg.m-3 | 450 | 58 |
| Furnace flame color And transparency | Orange red | Yellow white |
| Boiler structure and operation adjustment method | Same | |

**Table 4 Technical and economic index of HHO generator**

| Items | Data | Items | Data |
|---|---|---|---|
| IGBT power effg./% | 86% | Input voltage/V | Three phases 380V±15% |
| Rated gas output/L.h$^{-1}$ | 6500 | Rated input volume/kVA | 27.5 |
| Capacity factor | 0.92 | Working medium | deionized water |

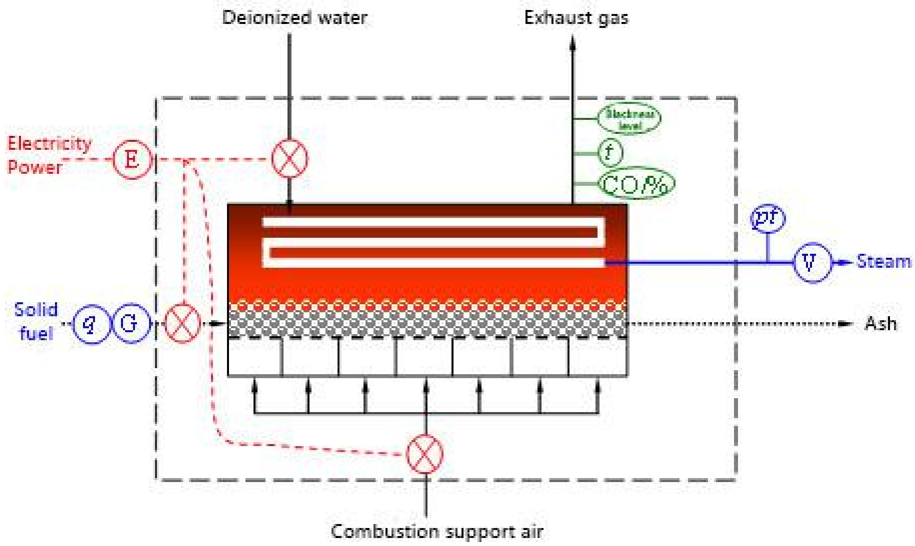
The test of the 6-ton biomass chain boiler of Zhongshan Yihao Energy Co., Ltd. shows that the boiler energy efficiency ratio can be increased from the original 4.8 to 5.3, the daily coal saving rate is about 12.5%, the flue gas dust volume is reduced by 80%, and the NO is reduced by 20%.

**Figure 3 Photo of combustion chamber in the chain boiler(HHO generator installed)**

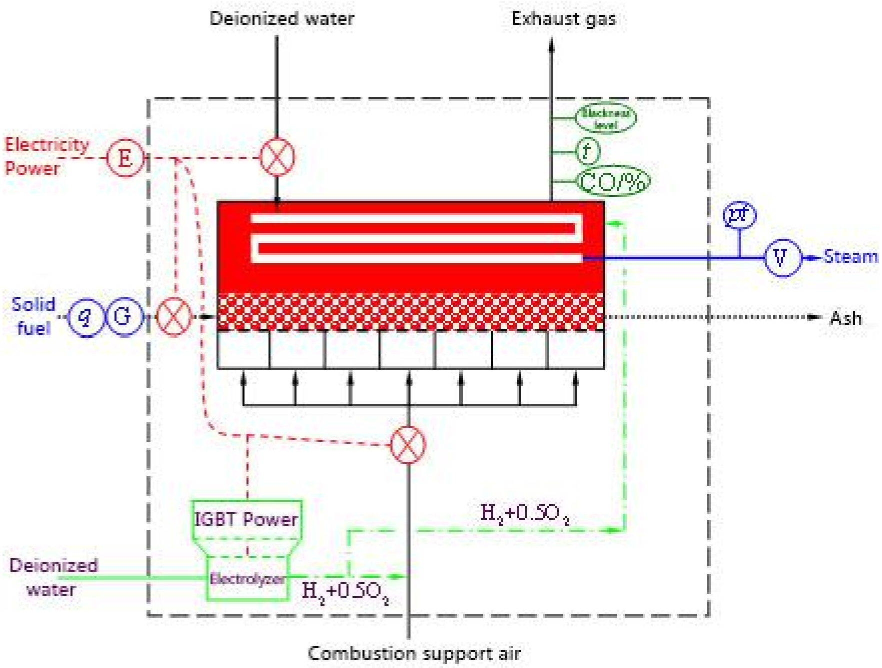
According to the third-party exhaust gas inspection report (GDTD17060468), after the flue gas of a 6t/h biomass chain boiler equipped with a hydrogen-oxygen energy machine is subjected to bag dust removal and water film dust removal treatment, the detection result at the 20m high exhaust gas outlet of the boiler is a particulate matter emission concentration of 11.3 mg/m3, SO2 emission concentration 13 mg/m3, NOx emission concentration 184 mg/m3, flue gas Ringelmann blackness level 0.5, meeting the emission requirements of "Boiler Air Pollutant Emission Standard" (GB13271-2014).

# 5、Fuel saving calculation

## （1）Desciption




a) Before




b) After

**图 4 Description**

**Table 5** Project production and energy consumption meters equipped

| Item | Instrument | Spec | Grade | QTY | Usage |
|---|---|---|---|---|---|
| 1 | Three - phase four - wire active electricity meter | DT862-4 | II | 1 | Measure electricity consumption |
| 2 | Steam flow meter | RDG | I | 2 | Measure steam flow |
| 3 | Calorimeter | IKA C2000 | - | 1 | Test fuel CV |

Analysis of Table 3 shows that the equipment and accuracy of measurement instruments for project production and energy consumption meet the requirements of the "General Rules for the Provision and Management of Energy Measuring Instruments for Units of Energy" (GB 17167-2006).

## （2）Calculation method of project annual fuel saving

The annual energy saving is calculated by the unit consumption method, which is calculated based on the changes in the rated capacity and the comprehensive energy consumption index per unit of steam. The specific process is as follows：

Accounting period,before installation:July 2015-April 2016

Accounting period,after installation:May 2017-September 2017

The total energy consumption tce before the implementation of the project = the biomass consumption of the chain furnace during the accounting period t × 0.5886 tce/t + the total power consumption during the accounting period 10,000 kWh × 1.229 tce/10,000 kWh

The low calorific value of biomass is 4120kCal/kg (see Annex 2), and the conversion factor for standard coal is calculated at 0.5886tce/t.

The total electricity consumption during the accounting period is the total electricity consumption of the chain furnace during the accounting period

Steam energy consumption tce/t = $\dfrac{\text{Total fuel consumption tce}}{\text{Total weight of steam t}}$

After the implementation of the project, the total energy consumption tce = the biomass consumption of the chain furnace during the accounting period t × 0.5886 tce/t + the total power consumption during the accounting period 10,000 kWh ×

1.229 tce/10,000 kWh

The total power consumption during the accounting period is (chain furnace + HHO generator)

$$\text{Steam energy consumption tce/kg} = \frac{\text{Total fuel consumption tce}}{\text{Total weight of steam t}}$$

Total annual steam production = rated capacity 6t/h × 24h/day × 330 days/year × 1000kg/t = 47520t/year

Annual energy saving of the project kgce = 47520t × (unit steam energy consumption tce/t before project implementation-unit steam energy consumption tce/t after project implementation)

**Fuel & Electric Power consumption summary and Gas steam output**

**Table 6 Summary of fuel consumption of chain furnace before and after using HHO generator(consumption exchange standard between wood and coal: 1t wood=0.5886tce coal)**

| Item | Before | | | After | | |
|---|---|---|---|---|---|---|
| | Month | Wood consumption/t | Exchange to Coal consumption/tce | Compared Month | Wood consumptio | Exchang e to Coal |
| 1 | 2017.1 | 222.21 | 130.79 | 2017.5 | 180.45 | 106.21 |
| 2 | 2017.3 | 197.21 | 116.07 | 2017.6 | 183.88 | 108.23 |
| 3 | 2017.4 | 224.86 | 132.35 | 2017.8 | 207.11 | 121.9 |
| 4 | —— | —— | —— | 2017.9 | 194 | 114.18 |
| Total | —— | 644.28 | 379.20 | —— | 765.44 | 450.52 |

**Table 7 Electric Power(E.P) consumption summary**

| Item | Before | | | After | | |
|---|---|---|---|---|---|---|
| | Month | E.P consumption/kWh | Exchange to Coal consumption/tce | Compared Month | E.P consumption/kWh | Exchange to Coal consumption/ |
| 1 | 2017.1 | 4484 | 0.55 | 2017.5 | 8882 | 1.09 |
| 2 | 2017.3 | 5247 | 0.64 | 2017.6 | 9922 | 1.22 |
| 3 | 2017.4 | 4893 | 0.60 | 2017.8 | 9033 | 1.11 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | —— | —— | —— | 2017.9 | 9063 | 1.11 |
| Total | —— | 14624 | 1.80 | —— | 36900 | 4.54 |

**Table 8 Gas steam output summary**

| Item | Before | | After | |
|---|---|---|---|---|
| | Month | Gas steam output/t | Compared Month | Gas steam output/t |
| 1 | 2017.1 | 1083 | 2017.5 | 1044 |
| 2 | 2017.3 | 1056 | 2017.6 | 1069 |
| 3 | 2017.4 | 1117 | 2017.8 | 1127 |
| 4 | —— | —— | 2017.9 | 1167 |
| | Total | 3256 | Total | 4407 |

**Data summary**

**① Project start before**

Fuel consumption summary = 379.20 tce+ 1.80tce

=381.0tce

Gas steam consumption summary = 381tce / 3256t

= 0.117tce/t

**② Project finish after**

Fuel consumption summary= 450.52tce + 4.54tce

=455.1tce

Gas steam consumption summary = 455.1tce/ 4407t

= 0.103tce/t

**③ Energy saving rate**

Energy saving rate = ( 0.117tce/t—0.103tce/t ) / 0.117tce/t×100%

=11.8%

**④ Annual energy save qty**

Annual energy save qty= 45720t × ( 0.117tce/t —0.103 tce/t)

$= 640.08tce$

**⑤ Summary of project energy-saving indicators accounting basis**

[1] Biomass fuel low calorific value test report, Guangzhou Energy Testing Research Yuan, 2017.5.19

[2] April to September in 2017 chain boiler steam production, biomass consumption and electricity consumption statistics, Zhongshan Yihao Energy Co., Ltd.

## 6、Report attachment

# 中华人民共和国财政部
# 中华人民共和国国家发展和改革委员会

# 公 告

2011 年第 66 号

财政部 国家发展改革委

关于第三方节能量审核机构目录（第一批）的公告

根据《财政部 国家发展改革委关于印发<节能技术改造财政奖励资金管理办法>的通知》（财建[2011]367 号）要求，财政部、国家发展改革委组织专家对地方推荐的第三方节能量审核机构进行了评审。现将目录（第一批）予以公告。

公告目录中的机构接受省级财政部门、节能主管部门委托，对节能技术改造项目、合同能源管理项目等独立开展现场审核工作，并对现场审核过程和出具的审核报告承担全部责任，审核费用由地方按有关规定支付。

附件：第三方节能量审核机构目录（第一批）

财 政 部

国家发展改革委

二○一一年九月二十九日

主题词：节约 能源 审核 机构 公告

附件：

第三方节能量审核机构目录（第一批）

| 序号 | 机构名称 | 联系人 | 联系电话 | 总部所在地 | 分支机构覆盖地区 |
|---|---|---|---|---|---|
| 20 | 湖南节能评价技术研究中心 | 黄伯云 | 0731-88879201 | 湖南 | |

**Member list of project energy conservation evaluation**

| | Name | Major | Title | Affiliation | Signature |
|---|---|---|---|---|---|
| Leader | Jiang Li | Thermal Engineering | Professor | Hunan Energy Conservation Evaluation Technology Research Center | |
| Member | Zhou Hong fei | Mechanical engineering | Engineer | Hunan Energy Conservation Evaluation Technology Research Center | |
| Members and liaison | Luo Zhengyi | Building environment And equipment | Master | Hunan Energy Conservation Evaluation Technology Research Center | |

# Project energy saving evaluation plan

(1) Evaluation preparation

According to the requirements of the commission and the characteristics of the technical transformation project, the evaluation tasks are clearly divided, and the team leader, liaison and team members are determined. The liaison and the client Hunan Shichun New Energy Co., Ltd. will conduct on-site evaluation time, methods, and arrangements. communication.

(2) Material review

Before October 14, evaluate the relevant materials of the energy-saving technological transformation project, determine whether the main body of the energy-saving transformation meets the requirements of the national general boiler equipment energy consumption and emission management documents, analyze whether the energy-saving measures taken by the client are reasonable and feasible, and clarify the focus of the on-site evaluation and problem. If the project is completed, whether there is any change in the construction content of the project.

(3) On-site evaluation

1) Implement the time and place of on-site evaluation.

2) The work division of the evaluation team: Professor Jiang Li, the team leader, is fully responsible for the on-site evaluation of the 6-ton biomass chain boiler of Zhongshan Yihao Energy Co., Ltd., focusing on the authenticity and rationality of the evaluation project, and organizing the discussion and finalization of the evaluation report. The team member, Hongfei Zhou, is responsible for the technical transformation verification, evidence collection and boundary drawing of Yushan Factory, evaluating the scientific nature of the transformation process, the rationality of equipment selection, and the accuracy of energy saving calculations. Associate Professor Ai Yuanfang is responsible for the scientific delimitation of the project boundary. Team member Luo Zhengyi serves as the liaison officer, responsible for contacting and

communicating with the client, and for verifying the investment in the Yushan Factory project, real-time steam flow readings, real-time energy consumption monitoring, and energy-saving calculations.

3) Collect data related to energy flow, material flow, and capital flow, verify and verify the obtained data to ensure the quality of the evaluation. Exchange opinions with the client on October 17 and start writing evaluation reports on October 18。