Energy Saving Analysis of No-load Loss of Electric Welding Equipment

Hailong Li1, Ke Liu2,* and Xiaodong Tan2
1 No.36, changqian 1st Road, Tiefeng District, Qiqihar City, Heilongjiang Province, China
2 794 Huanghe Road, Shahekou District, Dalian City, Liaoning Province, China

*Corresponding author

Abstract. In this paper, two types of electric welding equipment are studied. First of all, YD / k-505fl4 and bx3-500 type welding machines do not have the function of self power off in standby state. It is necessary to install an intelligent welding machine power saving system to control the power off of the primary side of the transformer under the no-load state of the welding machine, and then cut off the no-load loss of the welding machine. Secondly, yd-500-kr II series welding machine has the function of standby, delay and self power off. Due to the unreasonable setting of welding parameters, the uneconomical selection of welding cable and the unreasonable layout of welding machine, the overall energy loss of welding machine is large. Finally, weathering steel is used in the welding process design, and the performance, energy consumption and economic practicability of the material are analyzed.

Keywords: Welding machine; self-power off function; weathering steel material.

1. Introduction

China is one of the countries with insufficient energy resources and low utilization rate, and the energy strategy has gradually become a national strategy. In recent years, the state has issued many policies related to energy utilization rate, which is to improve energy utilization rate and reduce energy consumption rate. According to statistics, the steel used for welding structure in developed countries is more than 60% of its domestic steel output, while 40% in China. CO2 gas shielded welding technology is an energy-saving, efficient and high-quality welding process [1]. This method is widely used in automatic welding because of its advantages of energy saving, high efficiency and low cost. CO2 gas shielded welding has been widely used in advanced industrial countries. The electric welding machine is a large power consumption equipment in the enterprise, which has a large loss in no-load condition. The total loss is about 9% - 11.5% of the rated capacity. Under no-load condition, the power factor is about 0.1-0.3. Therefore, it is very important to configure the welding machine reasonably. Due to the increase of working pressure, parents spend less time accompanying their children, which will attract more attention from society. The market demand of accompanying robots will continue to increase, which makes the research in this area also attracted a lot of attention and attention[2]. In addition to the advantages of high efficiency, easy to carry and easy to operate, the disadvantages of modern welding power supply should be overcome in this paper: first, the no-load loss of the welding machine, that is, the utilization of electric energy; second, the welding process parameters of the welding machine, the use of reasonable welding process parameters can bring great economic benefits; finally, the use efficiency of the welding machine, that is, the Pollution of power grid[3]. In this paper,
according to different types of welding machine, we carry out different conservation of electricity design to achieve the effect of conservation of electricity.

2. Methods and Analysis of Saving Electricity in Welding Machine

2.1. Methods of Saving Electricity in Welding Machine

According to the working characteristics of different types of welding machines, power saving of welding machines is different\[^4\]. According to the energy loss sources of different types of welding machines, different energy saving solutions are proposed. The following types of welding machines are mainly used in this paper:

1) Saving electric energy of YD / k-505fl4 and bx3-500 type welding machines: this type of welding machine does not have the function of self power off in standby state. The power saving method is to install intelligent welding machine power saver to control the power off of the primary side of the transformer in no-load state, and then cut off the no-load loss of the welding machine\[^5\]; at the same time, because the primary side of the transformer is not electrified, the induced power on the secondary side is The voltage is zero, which eliminates the high secondary side voltage\[^6\]. In this way, the utilization ratio of the welding machine is improved and the unnecessary energy consumption is reduced\[^7\].

2) Saving electric energy of yd-500-kr II series welding machine: this kind of welding machine has a certain function of standby, delay and self power off. Through its in-depth analysis and research, it is found that it has a certain function of delaying the disconnection of the primary power supply of the transformer in the state to be welded, which can basically achieve no power loss in the period of welding intermittence\[^8\]; but at the same time, because of the welding current and welding voltage, etc. Because of the influence of factors, the total energy loss of this kind of welding machine is large\[^9\]. It is mainly because of the unreasonable welding parameter setting, the uneconomical selection of welding cable, the unreasonable layout planning of welding machine and so on.

2.2. Analysis of Power Saving of Welding Machine

1) Energy saving of YD / k-505fl4 and bx3-500 welding machines, which do not have self power off function in standby state. Using fluke-435 - II, the data of YD / k-505fl4 welding machine was collected from 07:20 to 07:50 in standby state, and the corresponding data was analyzed. The data collected are as follows:

![Figure 1. Input Voltage Waveform of Welding Machine in Standby Mode.](image-url)
From the data in the above figures, it can be seen that the input voltage and current of this type of welding machine are rated in the no-load standby state, and the pulsating DC output at the secondary side will remain at the set value all the time, which will bring huge power loss\(^{10}\). Not only that, from figure 2-1, in the standby state, the waveform of the input voltage can be seen, the sine wave shape distortion is very serious, and the histogram of harmonic content in Figure 2-3 clearly shows that the distortion rate is as high as 9.0\% (THD > 9.0\%). In this way, when a large number of similar welding machines are connected to the grid in standby state, it will cause grid distortion, power factor reduction, grid pollution and energy waste. The specific power loss model is as follows:

In this way, the data show that it is very necessary to install intelligent welding economizer for this kind of welding machine and its similar type. When the welding machine is in the standby state, the intelligent control and detection system of the power saver is used to cut off the power supply at the input side in time and effectively, so that the welding machine is in the power-off state; when welding
is needed, the welding rod and the weldment are short circuited, the intelligent processing system of
the power saver outputs the command of connecting the power supply in an instant, and the relay is
used to connect the input power supply, so that the welding machine can enter the normal working
state. This not only saves power, but also reduces grid pollution.
2) Saving electric energy scheme of yd-500-kr II series welding machine: the welding machine itself
has the function of standby, delay and self power off. In view of this kind of welding machine, the
energy-saving efficiency is mainly improved from the aspects of improving the management level of
process parameters and equipment.
The fluke power quality analyzer is used to collect data of the welding machine for a period of time,
and the results are as follows:

Figure 5. Voltage and Current Waveform of Welding Machine in Standby State.
It can be seen from the data in the above figure that under normal standby state, the voltage is rated
voltage and the current is basically zero (I < 1.0 / a). This shows that this type of welding machine
itself has an intelligent power-off detection system in standby state. In this way, the energy-saving
strategy of this type of welding machine is transformed into the optimization of welding process
parameters. The most reasonable welding current and welding voltage are selected through the
conditions of welding plate thickness, groove form and lapping mode of the welding machine, so as to
save energy.

3. Working Principle of AC Arc Welding Machine
Generally speaking, under normal condition, the working state of AC welding machine shows the
following characteristics: 60% of the time is in no-load state, 38% of the time is in real welding state,
and 2% of the time is in maintenance state. The electric energy consumed by the welding machine
must be consumed in 38% of the working time, and it will not be consumed in 2% of the time when
the power is cut off. The target of this equipment is the electric energy consumed by the welding
machine in 60% of the time when it is no-load. The main basis of the working principle of the
intelligent welding machine Saver is to detect that the welding machine is in no-load state and cut off
the primary power supply of the transformer; at the same time, when the welding machine returns to
the welding state, it can quickly close the power supply and work. The economizer is mainly
composed of automatic electrical signal detection, micro processing control circuit, AC control circuit,
etc. The automatic detection circuit will timely monitor the working state of the electric welding
machine. According to the working state of the electric welding machine, the controller will
automatically switch the power supply in time; when welding is needed, just follow the normal
welding operation, short circuit the welding rod and weldment, and the microprocessor will output the
power on command within 20ms, so that the welding machine can enter the normal working state.
When the welding machine is in continuous operation, the microprocessor will output the continuous
power supply command to keep the welding machine in continuous working voltage; when the
welding is stopped, the monitoring circuit will send the data to the microprocessor to output the stop
power supply command after calculation, and the controller will timely disconnect the working power
supply. In order to achieve the purpose of intelligent and human-oriented conservation of electricity.
4. Energy Saving Design of Welding Process (Parameters)

In this paper, the weathering steel is selected as an example to illustrate that it is also called atmospheric corrosion-resistant steel. It is a series of low-alloy steel between ordinary steel and stainless steel. The weathering steel is made of ordinary carbon steel with a small amount of copper, nickel and other corrosion-resistant elements. It has the characteristics of toughness, plasticity, forming, welding and cutting, abrasion, high temperature and fatigue resistance of high-quality steel[1].

The weathering resistance is 2-8 times that of ordinary carbon steel, coated. The installation capacity is 1.5-10 times of that of ordinary carbon steel. At the same time, it has the characteristics of rust resistance, corrosion resistance, life extension, thinning and consumption reduction, labor saving and energy saving. Weathering steel is mainly used in railway, vehicle, bridge, tower, photovoltaic, high-speed engineering and other steel structures exposed to the atmosphere for a long time. It is used to manufacture containers, railway vehicles, oil derricks, seaport buildings, oil production platforms and containers containing hydrogen sulfide corrosive medium in chemical and petroleum equipment.

After adding phosphorus, copper, chromium, nickel and other trace elements into weathering steel, the total amount of alloy elements only accounts for a few percent, reaching more than ten percent, so the price is relatively low. At the same time, the steel surface forms a dense and strong adhesion protective film, hinders the corrosion to spread and develop, protects the substrate under the rust layer, and slows down the corrosion rate[1]. The amorphous spinel oxide layer with thickness of 50 μm-100 μm formed between the rust layer and the substrate is dense and has good adhesion with the substrate metal. Due to the existence of this dense oxide film, the infiltration of oxygen and water into the steel substrate in the atmosphere is prevented, the development of corrosion to the longitudinal depth of the steel material is slowed down, and the atmospheric corrosion resistance of the steel material is greatly improved[1]. Weathering steel is a kind of steel system which can be used thinly, exposed or simply painted, and can make the products resist corrosion and prolong life, save labor and reduce consumption, upgrade and replace[1]. It is also a steel system which can be integrated into the new mechanism, new technology and new process of modern metallurgy to make its continuous development and innovation[1].

4.1. Methods of Saving Electricity in Welding Machine

Q550nqr1 high-strength atmospheric corrosion-resistant steel for welding is produced according to TB/t1979 atmospheric corrosion-resistant steel for railway vehicles. The delivery state is hot rolling and the thickness is different. Through alloying of Cu, Mn, Si, Al and simply adjusting part element content of ordinary low-carbon steel (Q235 steel), good atmospheric corrosion-resistant performance and comprehensive production can be produced without changing the production process of Q235 steel. Economical weathering steel with mechanical properties.

Copper contained in the steel can improve the strength and toughness of the steel, especially the atmospheric corrosion performance. The disadvantage is that it is easy to produce hot-shortness during hot processing, but the copper content is only 0.26% < 0.50%, which has no adverse effect on the solder ability of the steel, and the content of impurities such as s, P is low, and it is not easy to produce hot cracks. However, according to the carbon equivalent calculation formula recommended by the International Welding Society (IIW), CE = 0.41 is obtained, which shows that the base metal has a certain hardening tendency. In order to reduce the hardening tendency, preheating measures should be taken. Preheating can slow down the cooling speed of the welded joint, appropriately extend the cooling time, so as to reduce or avoid the quenching structure, and is also conducive to the escape of hydrogen. According to as / NZS 1554.1, the minimum preheating temperature of steel is 50 °C.

5. Conclusion

In this paper, the energy-saving technology of YD / k-505fl4 and yd-500-kr II series welding machines is studied. When a large number of welding machines similar to YD / k-505fl4 series are connected to the power grid in standby state, it will cause grid distortion, power factor reduction, pollution of the power grid, and energy waste. The intelligent control and detection system of the power saver is used to cut off the power supply at the input side in time and effectively, so that the welding machine is in power off state. When welding is needed, the welding rod and weldment are short circuited, and the
Intelligent part of the power saver is short circuited. The management system outputs the power on command in an instant, and uses the relay to connect the input power to make the welding machine enter the normal working state. This not only saves power, but also reduces grid pollution.

Yd-500-kr II series electric welding machine has intelligent power-off detection system when it is in normal standby state. In view of this type of welding machine, its energy-saving strategy is turned to the optimization of welding process parameters. Through the conditions of welding plate thickness, groove form, lapping method, the most reasonable welding current and welding voltage are selected to save energy.

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