International Journal of Smart Home
Vol. 8, No. 6 (2014), pp. 57-64
http://dx.doi.org/10.14257/ijsh.2014.8.6.05

Induction Power Transmission System Parameter Identification and Constant Current Control

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Abstract

Because the power systemload the randomness of the nature, power transmission of AC induction system has the low efficiency. In order to improve the transmission efficiency，the transmission efficiency influenced factors of the system is analyzed. Based on the current source power transfer system, DC/DC circuit for dynamic adjustment method is proposed. The method ensures that the transmission efficiency is the biggest.

Keywords: *AC induction power transfer; power transfer efficiency; Dynamic coordination*

1. Introduction

Since electric energy applied to production in life, transportation mode is wire transmission, electrical equipment through the plug and socket connectors with the contact of power grid to obtain the power, it is a traditional way for power transmission system. In this transmission mode, electric energy exist electric shock and friction or other problems.

In order to overcome these shortcomings and deficiencies, it urgent to find other methods of transmission of electrical energy, and AC induction electric energy transmission which is possible at this level has a good application prospect. AC induction electric power transmission technology is a comprehensive one of technology, this technology includes power electronic technology, electromagnetic induction principle, circuit theory knowledge, the modern control theory, and so on. Energy which passes magnetic field coupling of the primary side and secondary side circuit is provided to one or more electrical loads in non-contact transmission mode.

2. Presentation of Ac Induction Electric Power Transmission System

Based on AC induction electric power transmission system of the primary side circuits for parallel capacitor compensation and the secondary side circuit for series capacitor compensation, resistance is as the research object, and analyzed. Its principle diagram is Figure 1. Work process as follows: alternating current which is provided by power source is rectified and filtered, then the direct current V_{in} is achieved. The DC is converted into the high frequency alternating current by high frequency inverter circuits, then the high frequency alternating current was sent to a side compensation circuit, next the primary winding of loose coupling transformer converts the electrical energy into the magnetic field energy, the magnetic field can be launched and last is received by loose coupling transformer secondary side circuit. This process is non-contact power transmission.

ISSN: 1975-4094 IJSH

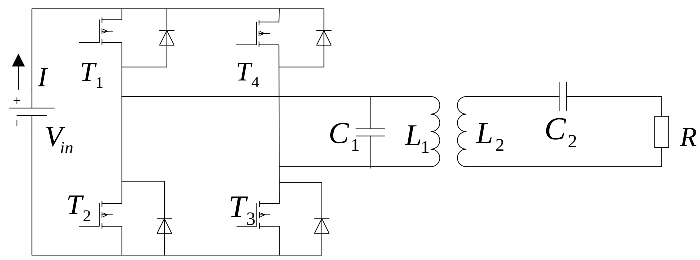

Figure 1. AC Induction Electric Power Transmission Schematics

In Figure 1, I refers to the current which provided by DC power; L_1 is a side winding and L_2 is the secondary side winding; C_1 is a side compensation capacitor of Loose coupling transformer and C_2 is the Secondary side compensation capacitor; R is the load (inductance and capacitance, resistance or a combination of the three kinds, This article only discuss the resistance) .

The construction of the system is shown in Figure 3. The function formula is derived in the condition of only considering the basic cycle of the rotation pendulum. In order to test the correctness of the control means, making experiment on the construction of system by applying the parameters in Table-1 and the changing rule of the adjusting process is shown in Figure-4. It can be inferred that as long as increasing the value of swing of rotary-arm, the rotation pendulum can be impelled to begin to vibrate from the static state. The vibration state can be controlled by the swinging of rotary-arm to great extent until the final mutual stable dynamic balancing state is achieved; when the rotation pendulum departures the balancing state under the help of the outside interference, rotary-arm can make the swing of inverted pendulum to reach the stationary dynamic balancing state through adjusting the swing and velocity.

In the AC induction electric transmission system, because of its own factors, Loose coupling transformer is described with mutual inductance model.

According to the mutual inductance model, when the primary circuit is parallel compensation and the secondary circuit is series compensation, the reflected impedance is:

$$Z = \omega^2 M^2 \frac{\omega^2 C_2^2 R + \mathrm{j}\omega C_2 (1 - \omega^2 L_2 C_2)}{(1 - \omega^2 L_2 C_2)^2 - (j\omega C_2 R)^2} \tag{1}$$

When the circuit is working in resonance, the nature of the reflected impedance is resistance, the equivalent impedance value is:

$$Z = \frac{\omega^2 M^2}{R} \tag{2}$$

At this time, the coupling parameter of the secondary circuit has not affected on the primary side resonant frequency.

For the same reason, when both sides are parallel compensation, the reflected impedance is:

$$Z = \omega^2 M^2 \frac{(1 + j\omega C_2 R)(R - \omega^2 L_2 C_2 R - j\omega L_2)}{(R - \omega^2 L_2 C_2 R) - (j\omega L_2)^2} \tag{3}$$

When the circuit is working in resonance, the equivalent impedance value is*:*

$$Z = \frac{M^2 R}{L_2^2} - j\frac{\omega M^2 L_2}{L_2^2} \tag{4}$$

Therefore, when the load of secondary circuit changes, the reflected impedance also change.

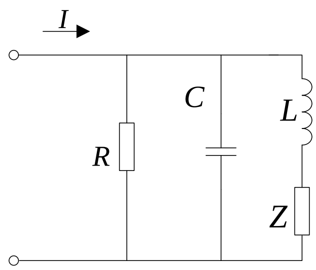

Figure 2. Reflection Impedance Equivalent Model

For RLC resonant circuit, parallel resonance conditions:

$$Y = \frac{1}{R} + \mathrm{j}\omega C + \frac{1}{\mathrm{j}\omega L}) = \frac{1}{R} + j(\omega C - \frac{1}{\omega L}) = \frac{1}{R} + j(X_C + X_L) = \frac{1}{R} + jX \quad (5)$$

When X=0, that $\omega_0 C = \frac{1}{\omega_0 L}$, the circuit is working in resonance.

Resonance frequency

$$\omega_0 = \frac{1}{\sqrt{LC}} \quad (6)$$

Power source does not transfer the reactive power to circuit when the circuit resonance. The inductance is equal to the capacitance in the size of the reactive power. Therefore at resonance, power is the largest in the circuit. So in order to make the system of the transmission power to achieve maximum, circuit is working in resonance.

Amplitude relationship:

$$I(\omega) = Y(\omega)U \quad (7)$$

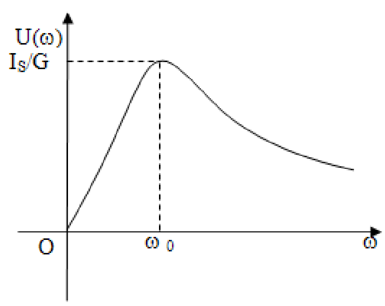

Figure 3. Voltage Curve in Resonance

Obtained by the voltage resonance curve, the voltage is the maximal when resonance, at this time ω= ω_0, when ω deviates from the ω_0,voltage drop down from the maximum IS/G.

So signals of different frequencies have different response in the parallel resonant circuit, the most prominent is on resonance signal on the response(the specific performance is to maximum of voltage),but the signal that is far away from the resonance frequency is suppressed(voltage value is small). This choice ability is called "selective" for different input signals.

Due to changing of secondary side circuit load, reflected impedance will also corresponding change, it makes the frequency deviate from the resonant frequency for the primary circuit and also makes the transmission power down. In order to solve this problem, when the responsible for the property of the circuit is change, it can change the primary circuit voltage to adjust the frequency of primary circuit according to selective curve, the frequency is close to the resonance frequency. And the change in voltage can be applied buck-boost circuit.

3. The System Frequency Stability Analysis

It has analyzed changing factors of the system frequency, the following discusses are about how to use buck-boost circuit to adjust the resonant frequency of the primary side circuit in dynamically.

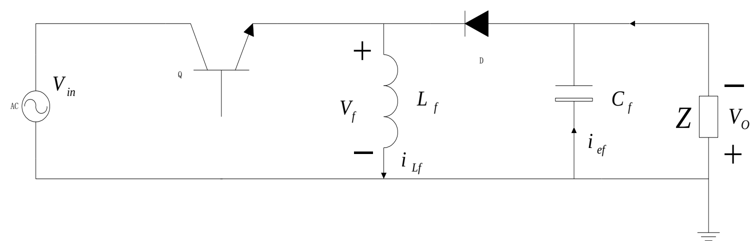

Figure 4. Buck-Boost Circuit Principle Diagram

V_{in} is the input voltage, Q is a thyristor, D is diode and Z is load, the buck-boost circuit is composed of Buck and Boost chopper circuit which are series connection ,the average output voltage can be higher or lower than the input DC voltage, thus the buck-boost circuit can flexibly change the voltage level, it can also change the polarity of the voltage, so buck-boost circuit is applied to circuit system needed for real-time change voltage. Figure 5 shows the waveforms.

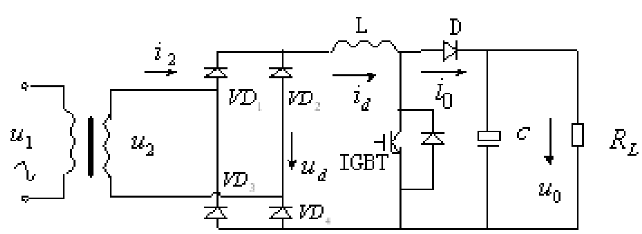

Figure 5. Boost Chopper

Because Bridge rectifier and Boost Chopper has the characteristics of simple circuit structures, high efficiency, low cost and so on, it is taken as a kind of regular changing circuit and popularly used in computer systems, Power Electronic Devices and any electric equipments. But this circuit also has its disadvantages: low factor of input power, dead district existing in input circuit, briolette cut , containing higher harmonics and so on, especially along with the increase of application, it can do harm to power supply system. Based on the analysis of regular changing law of regular boost chopper’s input circuit, this essay proposes a kind of improved circuit by high frequency Soft-switching technology and input circuit retroaction. To ensure amplifying the step-up ratio and improve the aberration phenomenon of input circuit as well.

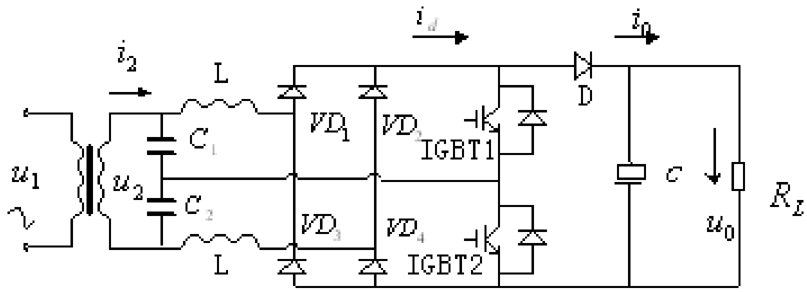

Figure 6.The Boost Chopper Improved

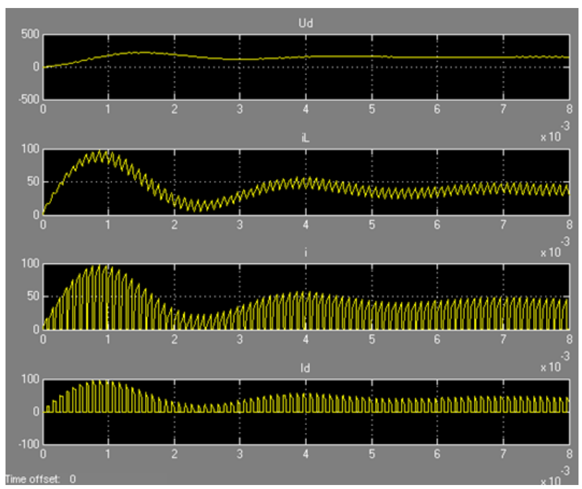

Figure 7. Buck-boost Circuit Waveform

Because there are different voltages resonance curve for the different resistances, when resistance changes, there is a way to adjust voltage by changing the working time of the thyristor, then voltage reaches the corresponding voltage resonance curve. As the resistance is constant, we can use climbing to realize the change of frequency, the principle is to measure a side circuit voltage at different times, this voltage is compared with the resonant voltage, if they are not equal, this voltage is compared with the voltage of the previous time, working time of the thyristor is controlled according to difference frequencies along the voltage resonant curve to close to the resonant frequency.

On the base of the tool software MATLAB7.0, through different illumination intensity, the output characteristic of the PV array is simulated. The results are as shown in Figure 4, from which we can see that, in a fixed environmental temperature, with the strengthening of illumination intensity, the maximum output power is also increasing by degrees in accordance with the exponential law, but the points of open circuit voltages corresponding to these maximum output powers hardly change which is in conformity with the characteristic relation as shown in.

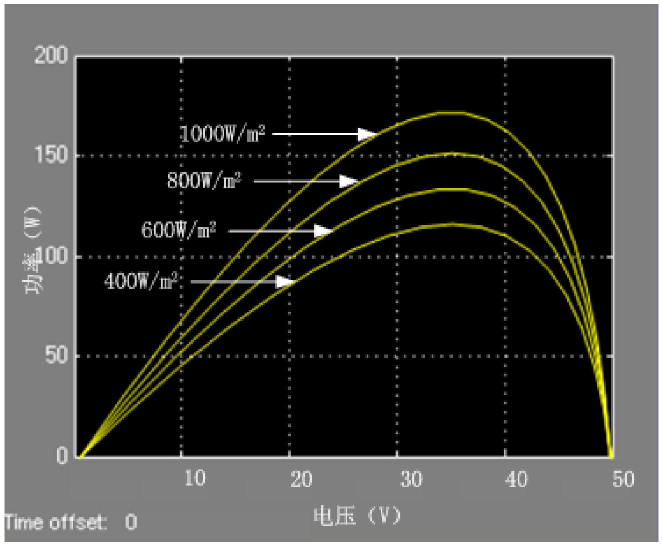

Figure 8. The P-V Curves of a PV Array with Different Illumination Intensity

A simulation experiment is also made towards the regulating characteristics of system on temperature, and the results are as shown in Figure 5 and Figure 6. It can be seen that, the temperature no matter starts from 0 or starts from a certain value, the system still own a preferable rapidity with a control time between 8-18s and a static error less than 3%, all of which show that the method designed has a relatively good practicability in solving the temperature control issue of solar energy calorific clothing.

4. Conclusions

This paper researches the power transmission system load in AC induction, according to the mutual inductance model, the secondary circuit load is converted into the primary side circuit. Then the expression of the reacted impedance is obtained, it shows that secondary side load impact on primary impedance. Analyze the influence factors of power transmission efficiency, circuit voltage is changed by the DC/DC converter circuit, application of the hill-climbing to regulate the circuit voltage in a side to achieve a dynamic adjustment of the side frequency. It makes electricity transmission power to achieve maximum efficiency. In this essay, the problem of enhancing solar azimuth tracking control is analyzed in detail, and PID-Fuzzy sectional control method is performed and designed according to the quantity of deviation value. Through stimulation experiment, it suggests that the above method can let electric eye holder track the transformation of solar position well, and it has many features, such as short accommodation time, fast response, overshoot, and small steady-state error, which has good guarantee to enhance photoelectric conversion efficiency. Moreover, this method can be adopted in all kinds of servo position fixing system, to enhance the performance index of system.

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