A Regional Smart Grid Pinch Technology

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Abstract. Based on smart grid area, heat-exchange network is used together with multi-energy analysing method. Also, pinch technology is optimized, considering many kinds of load, such as cold, heat, electric and illumination. What is more, KW is used in heat-exchange network, as a bridge leading to other kinds of energy. A regional smart grid pinch technology is proposed in this paper, which is also useful in many kinds of users, such as hospital, school, super marcket, community and so on.

Introduction

Remoulding the cascade of heat exchange network, is an effective method of energy optimization and utilization, via the basic idea of pinch technology.

The thoughts of pinch technology could originate from chemical industry production. In 1978, Linnhoff B etc. put forward the problem on heat exchange network in chemical production , and expounded the use of pinch technology to analyze and optimize exchange heat network.[1] The summary of the above method was carried out systematically in 1983.

The thought of pinch technology caused great repercussions, both in production and academic. In actual production, pinch technology was applied to a factory of polycyclic aromatic hydrocarbons by Feng Xiao, Wang Li, The isomerization of small unit energy consumption was analyzed, and put forward the integrated renovation plan, which recycled heat efficiently[2]. Aimed at the pressure-relief devices of oil refineries, the negative energy tache was dealt in energy analysis on preheating system of crude oil, based on the heat exchange network, and achieved good effects. Yu-lin Ge combined the process simulation technology, and the basic principle of pinch technology[3]. He analyzed atmospheric and vacuum distillation units, and implements the energy-saving renovation.

In terms of academic research, people have made many improvements to pinch point algorithm. A lot of equipment and complex process are left, after pinch technology analysis. To solve this problem, energy relaxation method is proposed by Su J L, etc. Mr. Galli etc[4]. In the light of the problem of HENS, changes was made in both pure counter flow heat and shell-tube heat exchanger .They solved the minimization problem of multi-pass heat network[5]. To deal with temperature cross problem in heat exchange network, Gulyani etc puts forward the fluid heat capacity coefficient and thermal efficiency coefficient, to optimize the heat exchanger network[6].

In this paper, from the perspective of electricity, comprehensive analysis of various forms of energy is no longer limited in the chemical production of thermal energy. Using the basic principle of pinch point method, the study of the basic characteristics of the fluid equipment and electric power is put forward a kind of smart grid area oriented energy analysis method.

Pinch Technology for Non-Fluid Equipment.

Introduction to Pinch Technology. Heat is exchanged between all kinds of equipment in chemical production or smart grid area . They can be seen as a network, which is called a heat exchange network more accurately. Effective analysis of heat exchange network, undertake energy exchange link, is the premise of optimizing the heat exchanger network energy consumption structure. The pinch point algorithm is a kind of effective analysis of heat exchange network algorithm[7].

The Process of Pinch Technology.

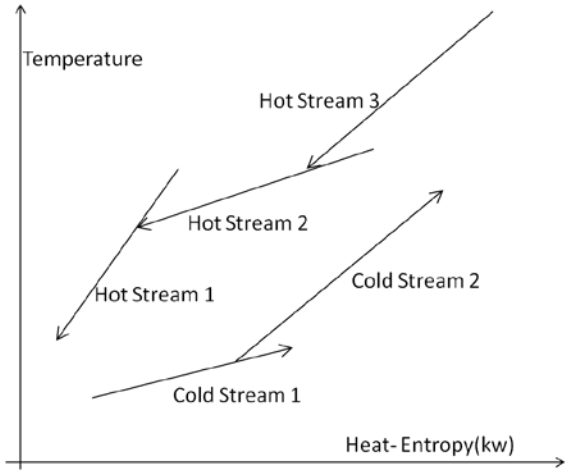

Fig.1 The initial T-H diagram

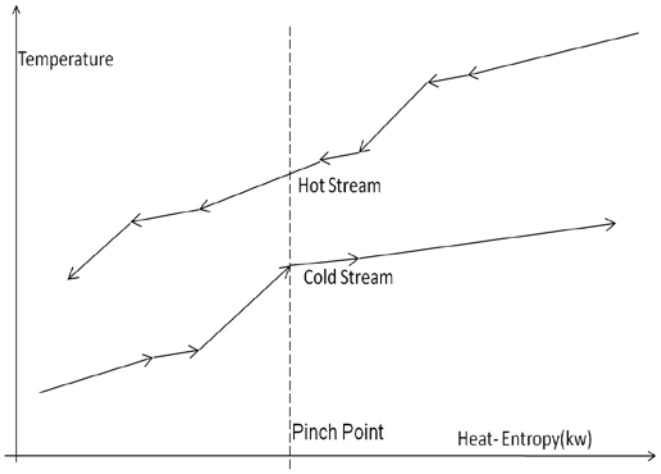

Fig.2 The simplified T-H diagram

The general idea of pinch technology is as follows. First map the area of temperature and enthalpy, and then integrated all kinds of data, such as heat transfer material flow rate and specific heat capacity, simplify the T-H diagram, finally calculate the pinch of T-H figure , analyse calculation results. Specifically, includes the following steps.

(1)map the initial T-H diagram. Temperature is set as the ordinate, and energy is set as abscissa. As shown in figure 1, measured in each process of the initial temperature and energy consumption, the initial temperature, enthalpy of figure. Figure lists in the process of chemical production in the three cold flow and the three heat flow. Because each of the material flow velocity, the different heat capacity, led to the different slope.

(2)the simplification of T-H diagram. The hot (cold) flow of 1 and 2 experienced from the changing process of temperature t1 and t2. Respectively in the process, energy consumption and, if these two hot (cold) flow is regarded as the same flow, so the new hot (cold) flow is the sum of original pieces.

(3)Similarly, hot (cold) heat capacity of flow 1 rate is FCR1, hot (cold) heat capacity flow 2 is FCR2. Is the heat capacity flow rate per unit time, the flow of fluid (gas) increase (decrease) unit (release) heat temperature needed. It can be thought of as the slope of the line in the figure from bottom. So, after the comprehensive heat capacity flow rate of cold (hot) flow follow the rule of the quadrangle, which is as the following formula:

$$FCR_{12} = FCR_1 + FCR_2 \quad (1)$$

Calculation process of the above, can be simplified temperature, enthalpy diagram, as shown in figure 2.

(4)Carries on the cold flow of translation. First of all, according the actual situation of the project, determine the heat transfer temperature difference. When the temperature difference is less than the difference between the cold flow and heat flux, heat transfer speed is very slow, having no feasibility in engineering. Determined, would be cold flow along the axis of the enthalpy H lateral translation. Cold flow and heat flux of minimum vertical distance of two points are called pinch. When the pinch point temperature difference is greater than the heat is wasted. When the pinch

point temperature difference is less than the heat cannot be. Only when achieve minimum temperature difference, the consumption of the whole system cannot be reduced any more.

The Application of Heat Exchange Network in Energy System.

Pinch point algorithm is widely used in chemical production. These scenarios of object are often one kind of fluid. Follow fluid full process, realize the exchange of energy. But in examining the system such as smart grid park, facing two questions. As shown in figure 3, one problem is that the area often exists in the photovoltaic power generation, wind power, gas and other kinds of energy structure. Traditional pinch point algorithm, cannot deal with clean energy. Another problem is that, in the smart grid, tend to have air conditioning, heating, lighting, mechanical load of the kinds of load. The characteristics of these devices is not liquid, the temperature in a short period of time can be regarded as a constant. We call these devices as fluid equipment. It can be seen that the energy consumption characteristics of fluid equipment in temperature, enthalpy cannot be represented in the figure. Therefore, for grid area contains the fluid equipment, through the energy exchange between the ideal fluid, can't solve the problem of energy optimization and utilization. Therefore, according to the characteristics of the fluid equipment, to pinch algorithm was improved, which can be applied to the smart grid park, it is essential.

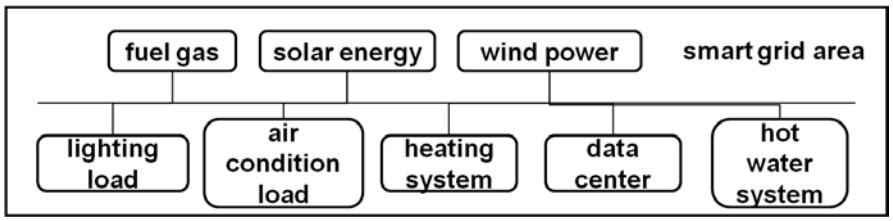

Fig.3 The common equipment of smart grid area

As an example of the solar water heater, winter or summer, sunny or rainy days, the efficiency of its capacity is different. Take the example of a data center server, the server for data calculation, but at the same time of calculation, heat is produced. However, the temperature of the server is a permission scope, namely 20 to 65 degrees Celsius are normal. For the heat exchange network, if the strict set the temperature of the heat production equipment for 50 degrees, and the bathroom water heater temperature need to be heated to 40 degrees Celsius, it will not be able to realize the heat exchange process.

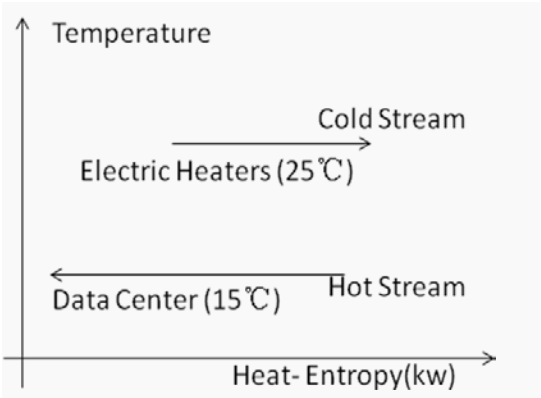

Fig.4 An Example of Non-Fluid Equipment

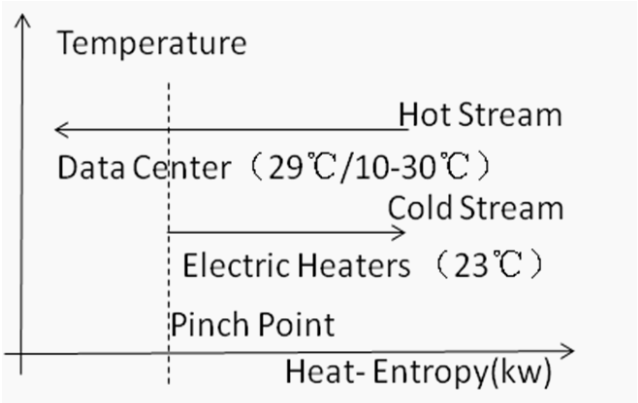

Fig.5 An optimizied T-H diagram of non-fluid equipment

In the face of the adjustable temperature of fluid equipment, and we make the following provisions:

(1) if the cold flow can accept the lowest temperature is higher than the room temperature, then with the lowest temperature identification cold flow; Or otherwise identify cold flow at room temperature.

(2) if the heat flux can accept the highest temperature is lower than the room temperature, then with the highest temperature identification of heat flow; Or otherwise identify heat flux at the room T-H diagram.

(3) temperature, temperature adjustable equipment should indicate the temperature adjustable range.

The rules set, mainly lies in the balance of feasibility and maximum energy saving heat transfer these two requirements. For cold flow, the temperature is too high, is not conducive to release more heat energy; Temperature is too low, and the feasibility of the heat transfer will cease to exist. According to the above regulations, T-H diagram of figure 5 can be optimized for the following form.

As shown in figure 5, the optimized temperature, enthalpy chart realized the cascade utilization of energy, reduce the energy consumption.

In this paper, the algorithm can find the theoretic optimal value of energy using in smart grid. Here the so-called "optimal value", means making the zone minimize the energy consumption through the pinch point. it doesn’t consider a multi-pass heat transfer under the premise of feasibility and actual construction.

Summary

This paper implements the pinch point algorithm for smart grid zone. The algorithm solved the fluid equipment extremum problem on cascade utilization of energy, electricity and other energy equivalent. Substitution algorithm is discussed, the use range of pinch point algorithm is broaden. Through the analysis of actual data, verify the feasibility of proposed algorithm in this paper, the cascade utilization of energy in the smart grid and the development of low carbon has a certain guiding significance.

Acknowledgements

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