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Energy Performance and Controllability Study of Different Control Strategies in Chilled Water System

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Abstract

As we all know, how to achieve better energy savings has been mentioned on various countries' energy schedules. Public buildings as a large energy consumption. It's air conditioning system has a lot of energy-saving space, and air-conditioning chilled water system to optimize energy-saving control is an important measure to achieve energy-saving air-conditioning system initiatives. This paper mainly focuses on the control system of variable frequency pump in chilled water system. For the water pump control strategy, the secondary pump frequency control strategy is discussed, in order to obtain a better control strategy, in detail the current commonly used differential pressure control strategy. In this paper, five kinds of differential pressure control strategies are analyzed, and then the simulation model is simulated by the established mathematical model. The input energy consumption model of the inverter - motor - water pump micro - system is obtained and the simulation results are analyzed.

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Keywords: Chilled water system; Pressure control strategy; Energy performance

1. Introduction

Since the reform and opening up, the city has been developing rapidly. With the development and application of a series of advanced technologies,the direction of urban construction is becoming more and more modern,humanized and intelligent. However,with the rapid expansion of the scale of the city,exacerbated the degree of intensive urban construction,building energy consumption issues are increasingly concerned about.According to some test and research,in the concentrated air-conditioning system in the summer electricity consumption, public buildings have about 25% -30% of the electricity consumption, including cooling pumps and chilled water pump transmission and

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distribution, there are about 15% -20% of the electricity consumption in the transmission of various types of fans . It can be seen that it is very important to reduce the energy consumption of the water pump in the cold water system, which is also the hot content of the scholars' research.

Therefore, this paper introduces the differential pressure control strategy, and establishes the mathematical model of the total energy consumption of the water pump, and analyzes the final simulation results in detail. On the basis of considering energy consumption level, loop stability and reliability, the optimal control strategy is obtained.

Nomenclature

W	the useful power of the pump (kw)
W_{input}	total input power of the inverter - motor - water pump system(kw)
Q	the volume flow of the pump (m^3/h)
H	the head of the pump (kPa)
η_{pump}	pump efficiency (%)
η_{motor}	motor efficiency(%)
η_{VFD}	inverter efficiency(%)
q_{cc}	cold water coil load (kw)
q_{oa}	outdoor air supply load (kw)
q_{fan}	fan load (kw)
Q_w	chilled water system volume of water flow (m^3/h)
q_c	chilled water system total coil cooling capacity of all coils (kw)
C_{pw}	constant heat of water (J/(kg.℃))
$T_{w,out}$	return water temperature (℃)
$T_{w,in}$	water supply temperature (℃)
ΔP	the pressure drop of the system (kPa)
Si	the resistance coefficient of the competent i(i= Ⅰ， Ⅱ，Ⅲ，Ⅳ， Ⅴ) (kPa/(m^3/h)^2)
Qi	the volume of traffic in charge i (m^3/h)
$\Delta P_{1,d}$	the design pressure drop of loop 1 near the pump (kPa)
Q_t	the total flow of the system is designed (m^3/h)
$\Delta P_{1,min}$	the minimum differential pressure setpoint for loop *1* (kPa)

2. Differential pressure control strategy

In the past few decades, with the frequency conversion technology mature, variable frequency drive prices have been significantly reduced, due to its potential energy efficiency and technical reliability, more and more inverters used in the HVAC, including the water pump and fan control. At present, the chilled water system to control the frequency of the pump, which has pressure control, temperature control, flow control, valve position control and the formation of integrated control on the basis of. In this paper, the frequency control strategy for differential pressure control is introduced, and its control characteristics and control effect are discussed.

Near-end constant pressure differential control mode is the most commonly used in the differential pressure control mode. The pressure sensor is placed in the chilled water system near the water supply pipe of the pump. The VFD controller collects the differential pressure ΔP as it's input signal.

Near-end variable pressure control mode, is a kind of control method that has evolved in the control mode of the Near-end constant pressure differential control. Due to part of the load, there will be back-end users "over-current" problem, not only lead to frequent valve movements, but also go against to energy conservation.

Terminal differential pressure control ,in recent years, has been widely used, and achieved good energy saving effect. The control mode is that the differential pressure sensor collects the differential pressure value of the end loop as the control signal of the pump. When the load changes, the frequency change of the pump is maintained at the design pressure difference.