LOAD LEVELING AND COP STABILIZATION USING HEAT ACCUMULATORS FOR GROUND-SOURCE HEAT PUMPS

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Annotatsiya: Yer osti geotermal issiqlik manbalari asosida ishlovchi issiqlik nasoslari zamonaviy muqobil energiya tizimlarining muhim yo‘nalishlaridan biriga aylanib bormoqda. Bunday nasos tizimlari atrof-muhitga minimal darajada ta’sir etadi, tabiiy resurslardan oqilona foydalanishni ta’minlaydi hamda issiqlik va sovitish ehtiyojlarini samarali qondirish imkonini beradi. Geotermal issiqlik nasoslari energiya samaradorligi jihatidan an’anaviy isitish va sovitish tizimlaridan ancha ustundir. Ushbu nasoslar yer ostida mavjud bo‘lgan doimiy issiqlik zaxiralaridan foydalanadi va muntazam haroratda ishlaydigan, ishlab chiqarishda sezilarli tejamkorlik ko‘rsatkichlariga erishish imkonini beradi. Yer osti qatlamlaridan olinadigan issiqlik nafaqat isitish, balki issiq suv ta’minoti va hatto sovitish maqsadlarida ham keng qo‘llanadi. Biroq, bu turdagi tizimlarning samarali ishlashi uchun yuklamani tekislash va COP (issiq-foydali ish koeffitsienti) ko‘rsatkichini barqarorlashtirish muhim ahamiyat kasb etadi.

Kalit so‘zlar: yer osti geotermal issiqlik nasoslari, issiqlik akkumulyatorlari, yuklamani tekislash, COP ko‘rsatkichi, energiya samaradorligi, barqaror ishlash, zamonaviy issiqlik tizimlari, issiqlik energiyasi, ekologik xavfsizlik, optimal boshqaruv.

Аннотация: Тепловые насосы на основе подземных геотермальных источников тепла становятся одним из важных направлений современных систем альтернативной энергетики. Такие насосные системы оказывают минимальное воздействие на окружающую среду, обеспечивают рациональное использование природных ресурсов и позволяют эффективно удовлетворять потребности в отоплении и охлаждении. Геотермальные тепловые насосы значительно превосходят традиционные системы отопления и охлаждения по энергоэффективности. Эти насосы используют постоянные запасы тепла, имеющиеся под землей, и, работая при постоянной температуре, позволяют добиться значительной экономии на производстве. Тепло, извлекаемое из подземных пластов, широко используется не только для отопления, но и для горячего водоснабжения и даже охлаждения. Однако для эффективной работы

таких систем большое значение имеют балансировка нагрузки и стабилизация показателя COP (коэффициента полезного действия).

Ключевые слова: геотермальные тепловые насосы, тепловые аккумуляторы, балансировка нагрузки, показатель COP, энергоэффективность, устойчивая эксплуатация, современные системы отопления, тепловая энергия, экологическая безопасность, оптимальное управление.

Abstract: Heat pumps based on underground geothermal heat sources are becoming one of the important directions of modern alternative energy systems. Such pump systems have a minimal impact on the environment, ensure rational use of natural resources, and allow you to effectively meet the needs of heating and cooling. Geothermal heat pumps are much superior to traditional heating and cooling systems in terms of energy efficiency. These pumps use the constant heat reserves available underground and, operating at a constant temperature, allow you to achieve significant savings in production. Heat extracted from underground layers is widely used not only for heating, but also for hot water supply and even cooling. However, for the effective operation of such systems, load balancing and stabilization of the COP (coefficient of performance) indicator are of great importance.

Keywords: ground source geothermal heat pumps, heat accumulators, load balancing, COP indicator, energy efficiency, sustainable operation, modern heating systems, thermal energy, environmental safety, optimal management.

INTRODUCTION

One of the main problems with modern geothermal heat pumps is the significant change in energy demand over time. That is, the Heat need of air or building is not the same, the space or season changes, even according to different hours of the day. This leads to a decrease in energy efficiency in commercial and residential buildings, insufficient use of thermal resources. And heat accumulators play an important role in solving this very problem. In systems, the application of heat accumulators can accumulate at times of excess heat energy, and in circuits with increased demand, be continuously released, resulting in smoothing of the load. Such an approach, firstly, provides continuous and stable working conditions for the heat pump, and secondly, helps to maintain the efficiency – COP indicator of the pump at a maximum and consistent level. Heat accumulators are widely considered a heat storage device. With them, it will be possible to temporarily maintain part of the energy and return it to the system when there is a need at the right time. The presence or absence of batteries significantly affects the operating points of the heat pump, general efficiency indicators, uniform distribution of loads and, of course, the duration of the device's service. By integrating such accumulators into the system, energy loads can be approximated to their mean in time. This, in turn, guarantees stable and

economical operation of the equipment structure, preventing the operation of the heat pump compressor or other main units to the constant “start-stop” mode.

MATERIALS AND METHODS

Smoothing the load directly affects the efficiency of the system. The greater the difference between the maximum load and the minimum load in heat pumps, the lower the performance of the system. This leads to excessive energy consumption, premature failure of equipment parts, low efficiency of use. While smoothing the loads that occur with heat accumulators gives geothermal heat pumps a new life in many ways. The system stores thermal energy in the accumulator if it is in excess, while heat is transferred to the system by the accumulator when the need for heat increases dramatically. In this way, the heat pump is constantly ensured to work in the “optimal” mode, at a stable COP indicator.

The COP indicator is the main efficiency parameter of heat pumps. The fact that it is stable and high directly affects the effective functioning of its system. COP is defined as the ratio of the released thermal energy to the received electrical energy. If the heat pump operates at full load, constant and optimal temperatures, the COP indicator will be higher, that is, the energy efficiency of the system will increase. But the system will quickly fade or have to start more often after short-term, high-end loads, as a result of which the COP indicator will decrease, energy consumption will increase, and the stability of the system will decrease. Heat accumulators in such situations maintain the operating parameters of the heat pump in moderation, perform the role of a “buffer” to changes in loads, and as a result, the COP indicator is maintained at a consistent and stable value. Batteries for geothermal heat pumps are a category of technologies that are vital to life. With these devices, thermal energy is often accumulated during low load hours and released during maximum demand. They can have different volumes and structures, and the advantages always pay off – saving on energy and costs, prolonging the life and efficiency of heat pumps, and the main thing is the constancy of the COP indicator. Batteries "smooth" the temperature parameters and operating cycle of the heat pump, reducing the damage caused by short-term high loads to the system and equipment components.

RESULTS AND DISCUSSIONS

The importance of stable loading and COP indicator can be explained more clearly on the example of underground geothermal heat pumps. Naturally, the energy resource obtained from an underground heat source is kept almost the same all year round. But the need for users changes significantly in hot and cold seasons, between day and night, or even for hours. This causes energy “waves”, surpluses, or deficient loads in the system. Accumulators allow subterranean heat to be released optimally and uniformly, and energy to be stored during low load hours; by doing so, the overall load will be flat, and the heat pump will always operate on a COP indicator that meets optimal international standards. For high-quality and stable operation, it is necessary

to correctly integrate heat accumulators into the system, determine their size, take into account the desired location. The heat accumulator must have heat conductors, temperature sensors, an automatic control system and a pump supply unit with it. In this way, the maximum heat transfer from the battery is established, automatic control and control during the operation period. In the opposite case, excess eneria cannot be saved, the COP indicator does not come out stable, and the energy efficiency can fall significantly.

Smoothing the load and stabilization of COP using heat accumulators are important in the process of system operation. This approach guarantees many years of continuous and stable operation of heat pumps. In addition, these systems also benefit when special loads are dropped on thermal networks and there is a need to work flexibly on energy prices. Also, geothermal heat pumps have a high ecological value-they reduce the release of greenhouse gases into the atmosphere, eliminate the need for natural gas and coal as a boon, help maintain the microclimate in living and working areas in a state close to nature. For this reason, smoothing the load using heat accumulators for underground geothermal heat source pumps and ensuring COP stability is the basis of system readiness. With the help of efficient management and optimal tuning, such systems are able to reduce electricity consumption, reduce the cost of general operation, alleviate the difficulties in working hours, which are expensive. The foresight of this technology is evidenced by the fact that in a period when modern environmental and economic requirements are increasing even more, effective and cost-effective operation is more important than ever in sharp competition in the energy market. Heat accumulators take heat-related technologies to the next level and remain an important component of modern heating and cooling systems.

Underground geothermal heat source heat pumps should always be compact, reliable and environmentally friendly. Noticing and paying attention to the main factors that directly affect their performance has become an urgent issue in the modern energy sector. With the help of heat accumulators, it will be possible to ensure the efficient and reliable operation of these systems. Modern control technologies are harmonized with automated temperature sensors and heat exchangers, which provide the opportunity to accumulate thermal energy at any stage of time, release it at the right time, distribute it in accordance with the user's needs. This, in turn, significantly reduces the discrepancy between energetic high load and low load, ensuring that the heat pump's work is in fact at the highest COP indicator. In systems integrated with heat accumulators, the heat cycle is in equilibrium, eliminating short-time Light-Duty modes caused by excess energy losses and overload. Under the system, the savings losses caused by a sharp change in temperature are reduced. Optimal operating conditions are developed for each heat pump, in which, as a result of one whole

performance of all components and the accuracy of control, the possibility of maintaining COP at a high and stable level is created.

In the future, the issue of saving energy resources, maximum use of thermal energy, preservation of nature and the most efficient heat supply of population and industrial buildings is becoming relevant day by day. By smoothing the load with heat accumulators and stabilizing the COP indicator, it is possible not only to increase the efficiency of the system, but also to harmonize stability, environmental and economic aspects in competition in the heat energy market. This approach laid the foundation for a new stage in heat pump technology, accelerated technological progress, and made a significant contribution to reducing environmental impact.

CONCLUSION

In conclusion, smoothing the load and stabilizing COP using heat accumulators for underground geothermal heat source heat pumps is emerging as a modern, energy efficient, environmentally friendly and economically expedient solution. The operation of the system in a wide range serves the formation of advanced experiences in the world in terms of energy savings and rational use of Natural Resources. With the integration of batteries into the system, energy consumption is reduced, the heat pump life is extended, the COP indicator is kept stable. The main thing is that users are provided with stable and constant warm comfort, environmental and economic interests are harmoniously manifested, and maintenance and operation costs are reduced as much as possible. In this way, the technology of smoothing the load and stabilizing the COP using heat accumulators is expected to serve as a source of blessing and progress for future generations as well.

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