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CHINA GROUND SOURCE ENERGY

Heating with Ground Source Energy to Realize the Beautiful China Dream

Shallow Ground Energy is an Optimal Energy Option in Promoting New-type Urbanization and Rural Modernization

Ground Source Energy Building--
New Orientation for Building Industry

Knowledge Sharing

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The magazine has many columns, mainly including Current Focus, Policy Advices, Development Forum, Exclusive Interview, Hotspot Info, Project Showcase, Knowledge Sharing etc..

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Article layout shall include title, full names of writer(s) and employer(s), postal code, abstract, key words, body text, notes and bibliographic references.

Contributions shall be sent as separate attachments to emails. Please also make sure to send writers' biographies, address, contact numbers etc in the email, so that editorial responses and sample issues can be delivered timely.

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Heating With Ground Source Energy To Realize The Beautiful China Dream

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In face of new development and in view of new demand of the people, the 18th CPC National Congress in China calls for the country to "construct beautiful China and realize sustainable growth of the nation, while striving for green, circular and low-carbon development". By now, the Single-well Circulation and Heat Exchange System as an indigenous technology in China has been fully industrialized, which has made it possible for ground source energy to become a substitute energy in providing heating for buildings of various functions by districts. The system can help to achieve clean heating free of pollution and emission, and realize energy recirculation and low-carbon development. Broader application of the system can help the country to reduce pollution and realize the beautiful China dream.

Heating areas and the related energy consumption

Most part of China locates in the Temperate Monsoon Climate Zone, and therefore, under the result of Monsoon, most areas in the country are cold in winter and hot in summer. As such, a major cause of energy consumption in buildings is for heating and cooling.

I、Heating areas and populations

Heating areas in China can be grouped into two kinds, namely heating regions required by government policies, and other heating regions also with actual heating needs.

1、 Policy Heating Regions

Policy heating regions refers to the regions and districts where heating facilities are mandated and heating services are subsidized by the government. As ruled by the Ministry of Construction, heating areas include Northern China, Northeast China and Northwest China where the average temperature of more than 90 days in normal years are lower than 5℃. The geological demarcation of policy heating and non-heating areas in China is along the Qinling Mountains and Longhai Railway. It is required that standard room temperature in heating seasons shall reach to 16-18℃. By 2011, the population living in the policy heating areas has reached to 400 million with 200 million in the urban areas. In 2010, heating floorages in urban areas of the policy heating region has been 8.8 billion m^2 and the annual energy consumption arrived 150 million tons standard coals taking 7% of the country's annual total and 40% of the energy consumption of urban buildings nationwide.

2、Other Heating Regions

The above-mentioned heating policies was promulgated in 1950s when the country was still underdeveloped, and therefore was designed to cover a fairly limited area merely to meet minimum rather than comfortable living and working need of the people. According to experts of China's Ministry of Health, brainwork efficiency may retard in rooms of lower than 15℃ and long-time stay in rooms of less than 12℃ may cause cold injuries. In reality, strong cold snap in winter can also affect areas south to the Qinling Mountains, such as Guangdong and Guangxi provinces. Winter temperature in south of Guangdong Province may drop to below 0℃ and cold injuries are not rare seen in southern cities like Shenzhen. To address the basic living need of people and in line with the scientific development approach, it is asserted by experts and scholars that the Yangzi River Basin area also needs heating in winter. The area covers most part of East and Central China and part of Southwest China, with a total population of 400 million and a total floorage of 19 billion m^2 in 2010.

Generally speaking, regions that actually require heating in China include not only the Northern part of the country but also part of East, Central and Southwest China. Population with actual heating need reaches to 70% of the national total, taking up about 75% of the entire building floorages in the country.

II、Energy Consumption of Heating for Buildings

According to statistics, urban floorages that need heating in China are around 35 billion m^2. In 2011, energy consumption for heating has reached to 150 million tons of standard coals (exclusive of heating consumption in rural areas, the same below) in policy heating regions and 100 million tons in non-policy regions. Adding the two up, the total annual energy consumption of heating for buildings in the country was 250 million tons of standard coals. Taking into account of the heating consumption in rural areas, the national total energy consumption in heating was around 400 million tons of standard coals.

Currently, the urbanization pace of China is around 1% each year. That is to say, in the upcoming years, there will be an increase of 10 million urban population each year. In addition, with constant improvement in per capita income, per capita living space and people's working conditions, it is estimated that urban floorages throughout the country will increase by another 20 billion m^2 by the year of 2020. In the meantime, people are asking for warmer rooms for living and working. Adding all factors together, it is fair to say that despite of various energy conservation measures adopted in the heating industry, energy consumption of building will continue to grow.

Air pollution resulted from heating

Presently, coal remains as the major fuel used for heating in the northern part of China. Coal burning releases massive harmful gases and particles containing SO_2 and other chemicals. Various preventative measures to curb such air pollution have been put into use, including use of high-grade coal, installment of dust remover, upgrading boilers, and improving combustion method etc.. However, since most of the boilers are scattered, small-scaled and low efficient, pollutions caused by boilers is still severe, as evidenced in the fact that air quality in the northern part of China is far worse in winter than other seasons. Besides combustion pollution, coal burning also cause pollutions in coal storing, residue handling and vehicle emissions for coal transport.

Nowadays, coal-burning boilers stand as the major source of pollution in the populous areas of North China and East China. As pointed out in a study published in the Proceedings of the National Academy of Sciences by experts from China, US and Israel, compared with people living in the southern China, the average life span of those in the northern part is 5.5 years less as a consequence of air pollution. This leads to a value lost of as high as 100 trillion yuans in the labor market. Besides being harmful to human health and damaging to buildings and plants, severe air pollutions also contains China's pace in opening-up and foreign capital utilization, stain its international image and affects many events of international influence. For example, before the 21st century, heating in Beijing relied mostly on coal-burning boilers. The serious pollution in winter to a certain degree affected Beijing's bidding for Olympic Games. As such, Beijing municipal government decided to ban all coal-burning boilers in the city. With improved air quality, Beijing's bidding for Olympic Games succeeded.

Burning coals may also affect surrounding areas and lead to wide polluted areas. In the beginning of the 21st century when Beijing has banned the use of coal-burning boilers, such boilers were still popular in many of its surrounding areas, especially the rural suburbs, and Hebei Province where industrial pollution was also rampant. Therefore, in 2012, air quality in Beijing was still under serious affect of coal burning. In 2012, Deputy Mayor of Beijing Mr. Hong Feng pointed out that in the composition of PM2.5 in Beijing, 16.7% was caused by coal burning and 24.5% was blown in from surrounding areas which was mostly generated by coal burning as well. As such, about 40% of PM2.5 in Beijing is resulted from coal burning.

Coal-fired boilers pollution is also rampant in medium and small-sized cities. In windless days, the smoke and dust produced by boilers often makes people suffocating. Entering into the 21st century, a lot more medium and small-sized cities started to reveal the serious problem of poor air quality.

Heating is life necessity for residence of northern China, and therefore shall be reliable and guaranteed

As economics rules, when the price elasticity of a certain produce is less than 1, then the produce can be defined as a life necessity. In the 21st century, coal price in north China has grown by 200%, from 300-400 yuan per ton to 1000 yuan, while coal consumption kept expanding. This means the price elasticity of coal is very low and therefore it is a life necessity for the people. In southern China, prices of heating energies such as natural gas, fuel oil and electricity have been rising, but the energy consumption of heating has been increasing. It is therefore, fair to say that in the 21st century, the southern part of China, especially in the Yangzi and Pearl River Basin areas that is economically more developed, heating has become a life necessity.

In cities, heating as a life necessity features non-substitutability, non-exclusiveness, commonality and non-profitability, which attribute it as quasi-public goods. Such natures make heating-related products and services fall in between public and private sectors. China's Contract Law classifies the Supply Contract of Heating under the same regulation of the Contract of Electricity, Water and Gas. Heating industry belongs to public utility and infrastructure sector. Thus, in order to avoid repetitive works, normally only one heating center is designed for one heating district, and therefore attains certain nature of regional monopoly and big-sized infrastructure projects. It is for sure that heating provision project bears to be of huge capital input and long return period and completed by enterprises of certain scale and under supervision of government. Since heating is a must for residence in the northern China and carries a huge weight on people living quality, it has been listed as a priority industry by the national government in infrastructure sector. With the rapid development of urban construction, heating industry as an important aspect of public services and utilities, has direct impact on people's living standard, city images, air quality and environment in urban areas, and has been an industry attract top attention from city governments.

Heating services is a life necessity of special importance, therefore shall be constant, seamless and more importantly reliable. Problems in heating system may lead to huge impact on city operations, production and livings. In recent years, due to lack of safeguarding measures along with gradual scale expansion of heating enterprises and equipments, problems of majority heating failure in cold winters caused by break-down of pipelines and equipments have resulted in enormous consequences on people's livelihood. In order to prevent such problems from happening again, it is required that heating enterprises should be equipped pre-warning system and strong capability in providing non-stop services, including systematic maintenance and reparation for equipments. At the same time, a rapid-response rescue team is also necessary that can help to solve problems immediately so as to ensure the reliability and stability of urban heating service.

As a nature of life necessity produce, heating service won't decrease. In the background when air condition and quality becomes a key concern, urban heating in the future can only develop toward low-carbon and more environment-friendly. In order to achieve growth in output and reduction in pollution at the same time, heating enterprises really need to apply certain technology that can help them to constantly expand heating production and reducing energy consumption and pollution. Urban heating technology and method shall be reformed to meet the need.

Ground source heating helps to enhance life quality and protect ecology, therefore shall be greatly promoted

In contrast to all the current heating technologies, ground source energy heating is technology that can achieve clean and pollution-free heating via traditional equipments and pipelines and at the similar cost. That is to say, it can ensure sufficient heating service and reduced air pollution at a cost acceptable to consumers. Being highly efficient and environmentally friendly, the heating technology of ground source energy has been well acknowledged by relevant authorities in China in the 21st century. In 2011, the twelfth five-year plan of national development made it clear that China shall forcefully promote the utilization of ground source energy. In five years' time, floorages heated by ground source energy shall reach to 350 million m^2. In 2013, four ministries in the central government have jointly issued a document saying that by 2015, utilization scale of ground source energy shall be no less than 20 million tons of standard coals and at the same time a fairly complete industrial system shall be established for ground source energy utilization including resource evaluation, development and utilization technology, key machinery manufacturing, and industrial services etc.. By 2020, the total utilization scale of ground source energy shall reach to 50 million tons of standard coals and a fairly refined development and application technology as well as industrial system shall be mature.

Since 2012, pollution haze composed mainly of PM2.5 has become a major concern of the Chinese people, as well as the national government. Abating air pollution has become a priority task of many northern cities in China. The pollution-free technology of heating with ground source energy has once again attracted wide attention and gradually become a primary option for urban heating.

In China, ground source energy heating only become popular after 21st century. Early this century, ground source energy heating was mainly used for heating for individual buildings. Though it was good for demonstrating the technology to the general public, individual application is not incorporated into the overall urban planning and systematic arrangement. Moreover, since enterprises of various sizes are involved concurrently, such individual application incurred many problems including diverse equipment varieties, and poor maintenance services. In recent years, many cities have developed some industrial parks and energy conservation demonstration parks that mainly rely on heating of ground source energy. Applications in such parks proved that the ground source energy heating technology can be massively applied for district or regional heating as well. To reduce heating cost, the equipment manufacturing, system integration, production of spare parts, and maintenance services are all localized. Training of technicians are also carried out in local areas so as to ensure timely and effective maintenance and preparation services. Demonstration parks are built by energy companies to use ground source energy to provide heating for compositive building complex as a way to popularize the knowledge and to prove the superiority of the system of being user friendly, reliable, energy conservative, environment friendly, comfortable and economical. Construction of such demonstration parks can be carried out in cooperation with real estate developers with the energy company providing designs and engineering support.

Construction of industrial parks and demonstration parks involves huge investment and strict criteria, therefore only enterprises of competent strength and fairly large scale can undertake and effective guarantee its smooth operation.

Popularizing ground source energy heating can help to realize the beautiful China dream

In recent years, the Single-Well Circulation and Heat Exchange Technology has realized industrialized development. In 2012, Beijing municipal government endorsed the Engineering Standard and Code of Single-Well Ground Source Energy Collection Well via Circulation and Heat Exchange. The technology has been applied in various architectures in 28 cities and provinces in China. Some applications have been operating for more than ten years up to now. The technology also has been used and well acknowledged in the US and Mongolia. Being very advanced and reliable, the technology gained certified endorsement and policy support from many ministries and governmental departments including the National Development and Reform Commission.

Based on comparison study of current heating technologies, the most realistic route for China to eliminate pollutions caused by heating production is to popularize the application of district heating with ground source energy. In recent decade, aiming at solving pollutions created by coal-fired boilers, the heating authorities and companies in China have introduced in a lot of new heating technologies, mainly including gas heating, electricity heating and ground source energy heating. As for gas heating, limited supply and high cost of natural gas, added by its expensive storage charge, gas heating is not highly possible for massive popularization. As for electricity heating, though the technology is very mature, the high cost and energy consumption makes it difficult to be popularized throughout the country.

Among all the currently available clean heating technologies, Ground Source Energy Heating which has been widely utilized in other countries is the only reliable and mature technology that can be applied to realize clean heating in both urban and rural areas in China. In urban areas, the large-scale ground source energy heating station that employs synthesis techniques has already been fully capable of substituting traditional heating system in China, to provide reliable and clean heating service to cities. If the technology can be popularized in North China, it can help China realize the China dream better.

Beside heating in winters, ground source energy application can help to lower energy consumption in summers as well. If it is widely applied in southern cities of China, it can not only reduce energy consumption and pollution, but also effectively drag down power loading of peak times in both winters and summers, thus to safeguard production, life and work of people even in certain extreme weather conditions.

To wrap up, it is true that the ground source energy application technology is an emerging industry of heating-cooling integration, which is applicable to all kinds of architectures that require cooling and/or heating. In China, earlier popularization of the technology and systems will help realizing the beautiful China dream at an earlier date. ■


Fuyuan Dongli Villas

SiJi Xiangshan Community

Knowledge Sharing

By Nicole Zhang

Importance of Shallow Ground Energy in Future Building Industry

Currently, the world energy crisis is exacerbating, with increasingly lessened reserves and growing demand. Energy price has been persistently high. In the background when the world energy supply structure is transforming, energy conservation in building industry becomes a necessary root ahead. The important task is to reduce utilization of non-renewable energies such as oil and natural gas by implementing scientific and rational energy conservation measures to achieve sustainable development.

Energy consumption in buildings takes about one third of the national total in energy consumption. Heating is the largest shareholder in the energy consumption mix of building industry. The developed countries have attached great importance to energy saving in the construction industry and implemented a series of measures and regulations to improve energy conservation and efficiency in buildings. In China, it is important to popularize energy efficient buildings with same comfort level. The construction cost of such buildings is normally 10% higher than traditional buildings. But with high energy efficiency, operational cost of such building is 60% less. A most important technology to achieve energy conservative buildings is the utilization technology of shallow ground energy in providing heating, cooling and domestic hot water. It is a successful way to achieve social, economic and environmental benefits with least consumption of energies, a practical implementation of the scientific approach of development, namely constructing ecological cities, promoting circular economy and build conservative society in order to achieve sustainable growth, and a scientific means to realize graded utilization of energies.

In northern part of China, energy used for heating takes more than 65% of the total building energy consumptions. And the figure in certain regions even reaches to 90%. Therefore, there are enormous potentials for energy conservation in buildings. To improve energy efficiency in buildings, it is crucial to replace traditional heating and cooling method with shallow ground energy-powered heating and cooling system in reference to the experience of advanced economies.

Using shallow ground energy to produce heating and cooling for buildings is a very mature technology. The Single-well Ground Energy Collection Technology, being a highly advanced and innovative technology in the world has boosted the development and utilization practices of shallow ground energy to a new stage, urged the world's energy specialist to rethink the value and importance of shallow ground energy. Having strived for seven years for the development and application of the technology and system, the HYY Company contributes greatly in opening a new chapter in the record of shallow ground energy utilization.

Using shallow ground energy to produce heating and cooling for buildings is a system technology that can save all the coals, oils and gases consumed by traditional heating methods while providing quality heating and cooling for buildings by consuming a small amount of electricity (efficiency ratio can reach 4). And it is a green and environmental friendly technology that is free from any pollution and emission. The construction and installment cost is similar to the cost of traditional central air conditioning system. Excluding subsidies by government, the operation cost of shallow ground energy system is lower than that of heating with natural gas, coal gas, electricity, and similar to that of coal-fired heating. Shallow ground energy is by far the only renewable energy that can be applied in large scale to replace traditional energies in producing heating and cooling for buildings and the application technology is therefore, of high commercial value as a highly advanced technology in realizing pollution-free heating and cooling for modern buildings.

Up to now, governments at various levels in China have set/ are setting up relative policies and regulations in support of greater application and development of shallow ground energy in constructions' heating and cooling systems. It is believed that with the progress of time, the shallow ground energy will surely grow into a primary heating and cooling energy in future, so as to contribute to the realization of sustainable development, happy livelihood and ecological civilization.

HYY Ground Energy Heat Pump System

HYY Ground Energy Heat Pump System uses ground energy as a substitute of conventional energies to produce heating, cooling and domestic hot water for peoples, and is therefore called as "a strong competitor to replace traditional heating and cooling methods in the 21st century". When used for heating, a majority of its thermal power comes from shallow ground and by consuming 1 unit electric power it can produce a thermal output of more than 4 units. When used for cooling, the system saves about 50% electricity for the same cooling effect compared with average air conditioners. Meanwhile, the system if applied to 1 million m^2 can reduce water consumption by 12000 tons per day. Moreover, the operation of the system is entirely free from any forms of pollution and emission and combustion process. Therefore, it stands out as the most secure and reliable heating and cooling system that is also highly effective in energy conservation and environment protection.

1、System Composition

The HYY Ground Energy Heat Pump System is composed of three major parts: energy collection system, energy escalation system and energy release system. The Energy Collection System takes the Single-well Ground Energy Collection Technology as the core technology and stands as the fundamental precondition for safe, effective, economical, stable, consistent and reliable operation of the Energy Escalation System. The key equipment in the Energy Escalation System is the ground energy heat pump. The HYY Heat Pumps of various kinds are manufactured in line with the Codes of System Design and relevant national rules and regulations. The Energy Release System is basically the same as that of the traditional air conditioners.

2、Major Equipments in the System

Major equipments contained in the HYY Ground Energy Heat Pump System Integration are Ground Energy Heat Pump (or Energy Escalator), circulating water pump, hydraulic balance valve, domestic hot water devices, energy collection equipments etc.. Backup equipments are mainly for wired or wireless transmission, recording and handling of operation data.

SHALLOW GROUND ENERGY

Is an Optimal Energy Option in Promoting New-type Urbanization and Rural Modernization

KEY WORDS

Shallow ground energy, New-type urbanization, Rural modernization

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Shallow ground energy is also called as low-grade geo-thermal energy. It refers to the thermal energy lower than 25℃ stored inside the earth within a certain depth under the ground surface (normally from the constant zone to 200 meters underground). It is, as part of geo-thermal energy mainly a result of solar radiation and earth core heat. Stored in the shallow ground of the earth, such energy exists at all places and all times. Powered with small amount of electricity and by means of heat pump technology, such energy can be collected and utilized, as well as transformed into high-grade thermal energy that can be used to provide heating and cooling for buildings in a manner free of emissions and less costly. According to the statistics from the HYY Company, heating with shallow ground energy can save 60-70% of energy as consumed by traditional heating methods with 30-40% lower operational cost. Application of shallow ground energy can be traced back to remote antiquity when human ancestors used caves as shelters against coldness. Even to this day, after great economic growth and social progress, caves or cellars for dwelling and storage remain as an important mode of life and production for people to attain natural energy. Thanks to the invention of heat pump technology, the low-grade shallow ground energy can be upgraded; and thanks to innovations in energy collection technology, shallow ground energy can be effectively extracted. With the help of the single-well technology accomplishing pumping and rejecting in the same well that was indigenously developed by the HYY Company, the application of shallow ground energy can be carried out in a manner that is economical in space occupation and water loss and free of pollution and geological impact. In general, shallow ground energy, being inexhaustible and forever constant and with its collection and application unconstrained by natural conditions stands out as a vital force among all renewable energies.

The first half of the 21st century will be a time for great development in China's new-type urbanization process. This is a systematic engineering. To accomplish this unprecedented undertaking, top-down reforms are necessary, such as reforms in household registration, land administration, education and medical care systems and more importantly sufficient energy support is also needed. With acceleration of urbanization, energy demand is expanding in an unprecedented way. As shown in official statistics, by reaching 70% urbanization level of the advanced economies, urban population in China will have to increase by 260 million. As such, assuming there are three members in each household, there will be 87 million new household; while assuming average housing area for each household is 100 m^2, additional residence floorages for incremental will be 8.7 billion m^2. As required in the Standards on Energy Consumption of Residential Buildings in Beijing, criteria for heat consumption in houses is 20.6W/ m^2 while coal consumption is 12.4kg/ m^2. That means the urbanization will lead to an increased consumption of 107.466 billion kg. Together with the new energy demand created by new rural development, the total energy demand after realizing new-type urbanization will be twice over the current demand.

Modernization in agriculture is a basic necessity for realization of China Dream. Agricultural modernization includes modernization in machineries, electronics, chemicals, water facilities, improved seeds and equipments. Quite obviously, agricultural modernization also needs enormous energy supply, especially in its industrialization and mechanization. Without sufficient energy supply, modernization in agriculture would only be a blow in air. During the agricultural modernization process in western countries, they have unanimously opted to achieve it in a way that is highly costly and intensively oil consuming. With enormous outputs and returns generated by "oil agriculture", serious pollutions have also come along.

As suggested in the study results carried out by the China's Academy of Social Sciences, driven by the new-type of industrialization, informatization, urbanization and agricultural modernization, China's demand in energies and other key mineral resource will maintain its constant upward trend. It is estimated that during 2011-2035, the growth rate of energy demand in China will be 2.23%, much higher than that 1.9% as projected by the International Energy Agency (IEA) in the scenario of new policy. In 2012, energy consumption in China topped the world by taking 20% of the world's total. In the upcoming 20 years, average expansion rate of energy consumption in China will be around 4.5%, driving the total demand to its climax in 2030-2035.

While energy demand multiplies, stricter criteria on energy conservation, emission reduction and environment protection are implemented. The two are paradoxical contradiction. The solution is to develop and utilize renewable energies, to intensively reduce energy burning activities. By renewable, it means the energy is recyclable, sustainable and inexhaustible, such as solar power, wind power, biomass, terrestrial heat energy and ocean energy etc.. Being environmental friendly, the renewable energies are often wide spreading and feasible for local development and utilization. Solar power is a direct result of solar radiation. Biomass power is a chemical energy stored inside plants and transformed from solar light power via photosynthesis process. Wind power is produced by wind driven generators that take advantage of wind, an air movement caused by different atmosphere temperatures as results of solar radiation and therefore different air pressures. Hydro power is achieved via water falls which transform gravitational potential energy of waters into kinetic energy. Terrestrial heat energy comes from the earth core and solar radiation and can be utilized for power generation and heating. Ocean power mainly comes from movements caused by lunar and solar attractions such as tides, waves and ocean currents. Energy development strategy of all countries in the world is common in calling for low-carbon, clean and ecological development via energy diversification and effective utilization. The focus of new energy strategy is to lower coal ratio in total energy consumption, stabilize oil demand, forge ahead natural gas and new energy development and gradually reduce utilization of fossil energy. It has been a general concensus for both governments and the peoples to fortify development and utilization of new energies.

However, among all the new energies, shallow ground energy is just a little brother. When new energies are alluded to, they tend to include mainly solar power, wind power and hydro power. Public awareness of shallow ground energy is barely skin deep. Some scholars even smeared it as a pseudoscience. Some official documents have made very blurred remarks on the shallow ground energy and even confused the shallow ground energy with the deep ground geothermal energy. In view of these, it is more than necessary to popularize public awareness of this new energy especially its unique role in promoting new-type urbanization and agricultural modernization.

The new-type urbanization in China shall be guided by the principle of putting people first, coordinating urban and rural growth, striving for economical and intensive development, creating ecological and livable environment, and pursuing harmonious development. It shall feature coordinated and balanced development among large, medium and small-sized cities, townships and new-type rural communities. The so called "new-type" of China's urbanization process means to realize infrastructure integration and public service equality between rural and urban areas without sacrificing agriculture, ecology and environment. British economist George Patton found out in his research that a proper size of a small city should be at 25000-50000 population. Moreover, according to a survey on 90 plus small cities in 6 counties of Jiangsu Province, those with 30000-40000 population ranked the top in terms of economic performances. As such, we assume that a new-type of small city is populated with 30000 people, or around 10000 households. If each household lives in 150 m^2, the total floorage will be 1.5 million m^2 in one small city. In normal geological conditions, one energy collection well for ground energy utilization can heat and cool 5000 m^2. That means 300 wells will suffice the heating and cooling need of one small city. Supposing 30% of 60000 small cities to be constructed in China or 18000 small cities will use shallow ground energy for heating and cooling, the application will cover 27 billion m^2. Taking into account that heating service charge in Beijing is 30 yuan per square meter, and ground energy heating saves 75% of power consumption, the application will save 81 billion yuans in one year. As power consumed by the system is transmitted by power grid, the application of shallow ground energy for heating and cooling will not produce any pollution to local environments.

Shallow ground energy also has an important role to play in agricultural industrialization and protected agriculture. Protected agriculture is a modern agriculture featuring highly effective production of plant and animals by controlling environmental conditions (such as temperatures). It includes protected planting and protected breeding. Protected agriculture so called in Europe and Japan is often referred as Controlled Environmental Agriculture in US. In 2012, the areas taken by protected agriculture in China has taken 85% of the world's total, with 95% covered by Polyethylene greenhouse films. The output of protected agriculture is 3.5 times greater than out-door planting. With merely 40% of the world's arable land, protected agriculture is of special importance to the country. Major facilities used in the protected agriculture are environmentally secured greenhouses and animal houses.

As early as beginning of 1980s, the suburb areas of Beijing have started to develop protected agriculture with greenhouses of higher cost. In summer times, the greenhouses were covered by shade nets, while in winters by blankets. When cold snap arrives, the greenhouses were surrounded by fires to keep them warm. Some had to build a small house inside as heaters to warm up the greenhouse. And some pour water before cold snap attacks to warm the house with heat released by water

when freezing. Various means and methods have been tried to maintain a moderate temperature inside the greenhouses. But none of them can achieve ideal effects and some even leads to harmful impacts on plants. However, if heated by shallow ground energy, greenhouses can fully achieve an ideal and constant temperature throughout a year, not only good for plantation and husbandry, but also free of any negative effects.

Studies carried out by Australian Vegetable Association (the leading organization in this regards in Australia), an organization with more than 9000 members planting vegetables and potatoes indicate that shallow ground energy is not only a clean energy for heating, but also a conducive factor in promoting vegetable growth. "By applying the shallow ground heating technology, temperature inside greenhouses can be kept at 18℃, which is ideal for growing vegetable. In addition, heating with shallow ground energy is highly cost-effective, since it helps to transform 1 kilowatt power into a heat output equivalent to 4 kilowatt."

The very first large-scale application of shallow ground energy for heating in Beijing was the greenhouses for flowers in the Beijing International Flowers Port. This is an important venue in the 7th China Flowers Expo and therefore listed as a major construction projects by Beijing Development and Reform Commission. The project with a total investment of 260 million yuans and a land area of 6000 mu, includes 42 greenhouses of 220000 m^2 with total heating load reaching 46000 kilowatt for seedling and floral induction. By using shallow ground energy for heating, the International Flower Port realizes zero emission and low energy consumption in all its works including cultivating, planting and researching of flowers. As calculated by competent authorities, heating with shallow ground energy in the International Flower Port consumes 60% less power than elecIric boilers, and 50% less coal than coal-fired boilers and its operational cost is just 60% of traditional air conditioning systems.

Moreover, industrialization of agriculture asks for a large-scale logistic industry, to which shallow ground energy system has strong comparative advantages in offering low and constant storage temperature as needed by agricultural produces. It is especially good for preserving fresh produces such as vegetables, fruits, meat products etc.. in an environmental way different from using chemical preservatives which often achieve poor effect in preservation and harmful impact on human health.

To wrap up the above said, shallow ground energy is truly an ecological, cheap, constant and green energy that can be applied in urbanization construction and agricultural development. It is proved by factual practices and applications that "inexhaustible ground source energy makes life more comfortable with easy heating and cooling". Ground source energy is an optimal substitute energy for coal in heating and an important force in curbing smog. Presently, the most important thing is to improve general awareness of its features, advantages and significances in energy conservation and emission reduction, so as to progressively promote its applications in production and livelihood-related sectors. The government shall also fortify its incentives and supports through policies and actions to promote the development and application of ground source energy. ■

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Ground Source Energy Building

NEW Orientation for Building Industry

WU Desheng
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Executive director of the Institute of refrigeration China
Deputy director, senior member of Architectural Society of China HVAC branch

Electro Mechanics ---
a Late Comer with Huge Contributions in Building Industry

The development of science and technology gave rise to electro mechanics, and the evolution of building industry channeled electro mechanics into the building industry. It entered the industry nearly one hundred years ago, tens of thousands years later than civil engineer, but it has made remarkable contributions to the development of building industry.

The first major contribution:

In ancient China of vast land, there were no standard buildings that could be accepted in both north and south of the country where outside temperatures varied a lot. With constant increase in human activities, including politics, region, sports and business, building industry were trapped into a deadlock in meeting up with the increasing need of the people for more comfortable room temperature and physical conditions. To answer the call, electro mechanics joined the building industry and helped the sector smatter the deadlock with air conditioning technology. Before electro mechanics were developed, even the royal family found it hard to get through summers in Forbidden City and had to build its Summer Retreat in some cool places to escape sizzling hot. With the help of air conditioning technology, building temperatures become adjustable to meet different needs. Taking the Great Hall of the People as an example, the room temperature can remain constant throughout the year. The ventilation facilities and air conditioning systems enable the building to offer comfortable experience and forever fresh air to 10000 people at the same time. The dining hall in the Great Hall of the People can accommodate a banquet of 5000 people.

The second major contribution:

After electro mechanics entered and boosted the development of building industry, the rapid expansion of its applications has led to new problems. Then, electro mechanics stood out and contributed greatly to energy conservation, emission reduction and low-carbon development, ushering the building industry back into the track of creating more welfares for human civilization and progress.

Modern building industry in China reached its peak time after the inception of reform and opening up policy. However, at that time, building industry in developed countries has already passed the climax and started its downward trend. As such, due to the late start and very different national and resource conditions, there was no best practice that China could copy and learn in developing its building industry as well as construction codes on energy saving, emission reduction and low-carbon development. The practitioners in the sector have to make pioneering efforts in developing new and advanced technologies that best suit China's national condition. It has always been gratifying and encouraging to see that many outstanding scientific and technical results, products and theories have been developed and applied in China with numerous successful practices. Up to now, China has been ranked among the leading countries in electro mechanics development in the world. It is believed, electro mechanics will make even greater contributions to the growth of building industry in China.

History and Nature of Building Industry

Building industry has evolved for thousands of years. Ancient caves for human beings should be its originator, as confirmed in the historical record of Youchao people. In the long history of its development, the building industry has made numerous glories. There are relics, remains, theories and practices which are blessing treasuries and great prides of practitioners in nowadays' building industry.

People working in the building industry may not be more than those involved in agriculture, but its beneficiaries are by no means less. People need foods as well as dwellings. When enough food is no longer an issue, housing receives the most attention since it may incur a higher economic burden on a family than enough food. Housings may differ in their technology contents and local conditions. Moreover, building industry is closely related with urban planning and public utilities as well as national and economic development in the country. Therefore, it is fair to say that building industry is truly an industry of the widest reach.

As President Xi once pointed out, "it is justified for the people to long for more comfort living conditions and beautiful environment". "People's wish for a better life is the goal we strive for". What a proud for us, the practitioners in the building industry!

Being fully aware that the development of building industry in recent three or four decades, we have also witnessed many problems, such as excessively high market share taken by foreign companies and unfair treatment on Chinese companies and practitioners in designing fees, design cycle and assessment criteria. In many cases, in order to address massive and various needs, building construction tends to sacrifice its scientificness. Building industry in China has been developing step by step for nearly four decades, though certain steps were rough and careless.

After years of ups and downs in China's building industry, and at a time when China is speeding up urbanization process, it is believed that building industry is embracing a new spring of blossoms.

Ground Source Energy Buildings ----
New Orientation for Building Industry

Electro mechanics is applied to construction sector aiming at actively creating favorable environment and surrounding that meet the need of human beings by installing and utilizing special equipments, machineries or new energies. In the process of constructing buildings, civil engineering is the pre-runner with the mission is to best utilize natural favor such as sunshine and ventilation etc. to achieve ideal experience for people in the building. As such, civil engineering is also defined as a passive way to create building environment. Modern construction industry started to introduce electro mechanics and let it make the finishing touch in a construction.

With development of modern technology and in a view to protect the Earth, the ideology of erecting green buildings and structures has become a general consensus and professional ethnics in the modern building industry.

The Third Plenary Session of the 18th CPC National Congress has once again reaffirmed China's position to undertake more international responsibility by calling for utmost efforts in achieving green building industry in the country. It is widely acknowledged that in construction sector, a reasonable division of labor between civil engineer and electro mechanics shall be using passive means first and active measures next. This is also deemed as a construction rule for people to fully utilize natural endowments, conserve energy utilization and reduce energy consumption in erecting healthy and comfortable buildings.

To promote scientific construction and practice the new ideology, there are still many obstacles. For example, many professionals or outsiders still regard electro mechanics not as necessary part to buildings but as a crowning touch, and therefore when judging a building they care more about its external artistic effect and little about its mechanical and scientific contents. Some current awards to architectures and evaluations on buildings is lack of professional opinions from mechanic experts. In feasibility studies, some constructions fail to complete energy consumption study. All these practices are as ignorant, partial and backward as if in food contest no nutritionist is invited for comments.

In today's building industry, energy efficiency is rarely found to be an indicator of quality structure. Most indicators are still related to the artistic features of buildings and sometimes even connected with some superstitious interpretations. All these show that the building industry in China is still at its initial stage of development.

I believe, the development direction and objectives that we practitioners inside the industry are striving for is to enhance the weights and importance of building environment and energy efficiency in the sector.

It is encouraging to witness that buildings emphasizing its mechanical contents has emerged. The Ground Source Energy Buildings using indigenous patent technology will make even greater contribution to the development of China's building industry.

As employees and practitioners in this industry, we are proud to see that roads toward realizing the dream of building a stronger China are readily lighted.■

Extract Shallow Ground Source

Energy and Utilize Heat Pump Technology to Produce Heating in Winter and Cooling in Summer

SHEN Mengpei
Senior counselor of the State Council

Serial 2

Using heat pump technology to utilize shallow ground source energy

Heat pump system can produce heat equals to 4kw/hour electricity by consuming just 1kw/hour to extract heat from shallow ground source energy, therefore achieve energy conservation.

As we know, certain substance can change its form in normal temperature. When changing from liquid to gas, it absorbs lots of heat; whereas changing from gas to liquid, it releases heat. Freon is what we normally use as a coolant, such as the Freon 134a in refrigerators.

Heat Pump Unit is composed of four parts: compressor, evaporator, cooler and expansion valve. The four parts are connected by cooper pipelines to formulate an enclosed circulation system as shown in the Chart 3.

Freon 134a as a coolant circulating in the heat pump unit flows into the evaporator through expansion valve. With low pressure in evaporator, Freon 134a transformed into gas from liquid at temperatures around 2–3℃. During the transformation, the Freon absorbs in a great amount of heat from underground water in evaporator. After heat is extracted away, the underground water is lowered from 15℃ to 10℃ and then injected back to the underground. The gasified Freon after being compressed by compressor into high temperature and high pressure enters into the high–pressured cooler. In high temperature (60℃–70℃) , the Freon transforms again from gas into liquid and releases the heat which warms the circulating water from 40℃ to 50℃ in heating system so as to provide heating for buildings.

To reverse the process, the heat pump unit can also provide cooling for buildings as shown in the Chart 4.

Chart 3

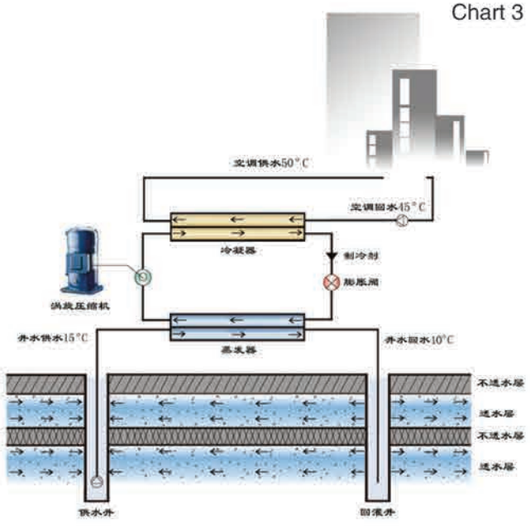
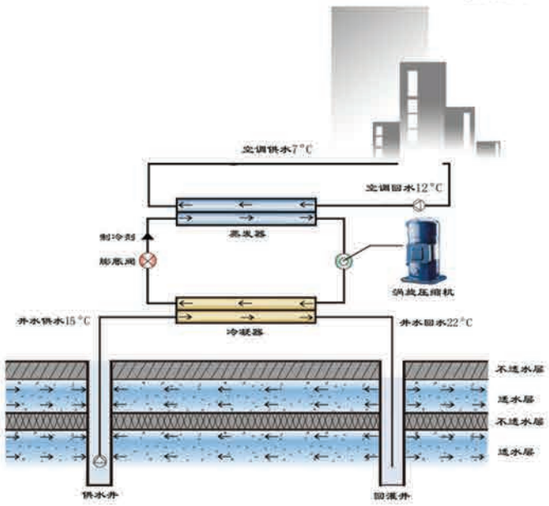


Chart 4



There are hundreds of ground source heat pump enterprises in Beijing. And only some enterprises have been highly devoted to the research, development, improvement and escalation of heat pump technology throughout the years, in order to constantly raise working efficiency of heat pumps and overall efficiency of heat pump system so as to achieve high effectiveness in energy conservation. In addition, the companies have been exerting efforts to improve adaptability of the technology and enabled a wider application of the heat pump technology. Ever Source Science and Technology Development Group (HYY Company) is the one that has been constantly pursuing innovation and making diligent efforts in R&D of the heat pump technology. After years of study and research, the Company has now ranked into a leading position in the sector of energy efficiency and conservation. Some of its study results and achievement have reached the international advanced level. The ground source energy heat pump heating and cooling system developed by the Company is composed of energy collection system, energy escalation system and energy discharge system.

Energy escalation system is the heat pump unit. According to compressors' type, the system can be classified into piston pump, screw pump and vortex pump. And in line with different application conditions, the Company has developed soil source pump, drainage water pump, sea water pump, and recovered industrial residue heat pump system. Among these, the vortex pump is advantageous in high efficiency, low noise, long life span and maintenance–free. With modularized design, it can greatly reduce energy consumption of building in partial load status. Being free of maintenance, it can substantially drag down the management cost. Industrialized vortex pump works as shown in the Chart 5.

Chart 5

Energy discharge system is the indoor terminal system. There are many different types of terminals such as fan coil unit, ductwork, floor heating and traditional heating radiators etc.. Fan coil and ductwork heating are classified as central air conditioning system that can be used to provide heating and cooling. Floor heating and traditional radiators can be used only for heating. Comparatively speaking, floor heating is more energy conservative since the water temperature it requires is relatively lower.

Resurgent Water Heat Pump Project for Heating and Cooling in Olympic Village

The Resurgent Water Heat Pump Project for Heating and Cooling in Olympic Village uses the reclaimed water from the Qinghe Water Treatment Plant as heat source to provide heating and cooling by applying the heat pump technology. Heating floorage in the Olympic Village is about 413,000 m^2, among which 380,000 m^2 are apartment and 33,000 m^2 are public areas. The cooling load during the match days is 28.748 megawatt and 19.048 megawatt in non–match days. The designed temperature of in/out water is 7℃/12℃ at the terminals, and 5℃/12℃ in the machinery unit. The project was completed at the end of June 2007 and went for test operation in August for cooling and in November for heating, with all operational parameters reaching the designed level. During the Olympic Games in 2008, the system has accomplished highly smooth and secure operation and managed to maintain the room temperature constant at 22℃ for more than 120 days from May to September in 2008. The project received no complaint during the Games but highly remarked by the athletes. Up to now, the system has been operating for 3 heating seasons and 2 cooling seasons with no complaints and fully saturated the heating and cooling needs of the residences in the village. The heat energy extracted and used by system from reclaimed water is equivalent to around 3000 tons per year standard coal, equivalent to 7200 tons/year CO2 reduction, 123 tons/year NOx and SO2, 4 tons/year CO and 33 tons/year dust. The annual energy efficiency ratio of the system reaches 3.44.

As a fairly advanced technology, the air conditioning system with water source and ground heat pumps applied in China shall be followed and monitored continuously for further refining.

Heat pump system is a new-type utilization of energies in using low-grade heat energy to produce heating and cooling for buildings. Compared with conventional energies such as coal, gas and oil that are normally used for heating and cooling, the heat pump system can realize pollution-free, highly effective and conservative production of heating and cooling. Therefore, broad application and development of heat pump system will help China to further optimize its energy structure, promote graded utilization of different energies and enhance energy effectiveness.

Some application projects using heat pumps to provide heating and cooling in Beijing have encountered certain problems in water rejection, low energy efficiency ratio and comparatively shorter service life etc.. All these problems show that it is necessary for the Heat Pump companies in Beijing to strive for further improvement in the technology. We believe, the water source/buried pipe heat pump system is an air condition engineering with fairly high technology content. It requires not only applicable hydro and geological conditions and qualified well completion techniques, but also rational and scientific calculation of pumping and rejection water ratio, and regular maintenance of rejection system. Only with reinforced management, could the system achieve the goal of conserving energy and protecting environment; otherwise, it may cause enormous lost of underground water. These are urgent issues to be tackled.

In the list of major project (2008) of Beijing Municipality, there are ground source and water source heat pump projects as well as water heat pump project using reclaimed water as source. As "Green Olympic Projects", the heat pump projects won its fame as combustion-free, emission-free and waste-free. After the completion of these projects, comprehensive evaluation works were much needed to timely sum up experiences and good practices of heat pump projects. In June 24th, 2007, I submitted a report to Vice Mayor of Beijing, Mr. Chen Gang, named "To Standardize Heat Pump Application in Beijing and Carry out Comprehensive Technical Evaluation on Heat Pump Projects in 2008". Vice Mayor Chen then instructed the 2008 major project office of Beijing to actively support me to carry out evaluation on water source heat pump projects. Several inspectors of the 2008 major projects were experts in the water heat pump area and they volunteered to participate in the evaluation. However, when 2008 projects were completed, they were handed over the employer and therefore we could not accomplish a comprehensive evaluation.

In 2009, the HYY Company undertook a renovation project of ground source heat pump system in Beijing People's Procuratorate and achieved very good results. In the National People's Congress in 2010, Mr. Mu Ping, Chief Procurator of Beijing proposed to hold an evaluation seminar on the renovation project of ground source heat pump undertaken by the HYY Company. On March 11th, 2010, specialists and experts in the area were invited to heed the HYY report on the project design, engineering and operation, review certain documents and raised comments and questions, to which the HYY Company responded accordingly.

After the meeting, President of HYY Company, Mr. Xu Shengheng told me that ever since its establishment in 2000, the HYY Company has been devoting to research and development of the ground source energy collection technology as well as the promotion of heat pump system with the collection technology as the core. He felt he was greatly enlightened by the seminar and he started to reflect the importance of the ground source heat pump technology. He has spent ten years in developing and promoting the technology and he was confident that this would become a substitute energy for heating, a technical breakthrough in China's new energy utilization, a future trend of energy conservation in buildings. He sincerely hoped that I could organize some experts in the related disciplines (geology, energy, heating, ventilation, hydraulic engineering, and economics etc.) to make comprehensive evaluation and assessment on energy collection efficiency, operational cost, cost effectiveness and service cycle of the system, identify deficiencies, sum up good practices and experience in system design, engineering, procurement, operation, maintenance and management, and formulate standardized code of operations and management .

Although the ground/water source heat pump came into being in 1950s and it has been applied for heating and cooling for more than fifty years, it is still a new comer in China. More and more people began to realize its superiority in energy conservation and many city governments started to call for wider application of the system to produce heating and cooling for buildings. However, due to lack of adaptability study, some applications in some regions or buildings unveiled some problems. It was time for a good sum-up of practices and experiences and for a complete formulation of standardized operation codes in the sector.

In order to refine the evaluation on ground/water source heat pump technology, we also invited Mr. Hu Jian, Chairman of Beijing Nirvana Resort Hotel to comment on the projects. He stated that as a new and advanced application technology, the ground/water source heat pump air conditioning system shall be managed by professional technicians in the starting up period, so as to facilitate the professionals to take note of various lessons and experiences and improve the system at a later stage. That is to say, after installment, the air conditioning system of ground/water source heat pump shall be managed by the research and development units and after technical assessment is finished, it can be trusted to others. I agree with Mr. Hu Jian's view. In technologically advanced economies, the ground/water source heat pump technology has been very mature. No matter what, it is still necessary to sum up lessons and experiences, identify deficiencies in the application and find ways to correct the situation. Especially for those early applications, various kinds of problem started to emerge, which could only be solved if managed by professionals. ■


Nirvana Resort Beijing

CONTROL SMOG! And Realize Combustion-Free Heating in Rural Area

"Smog" became a key word of the time in 2013.

DAI Qi
Admin Director of Ever Source Science & Technology Development Group Co., LTD.

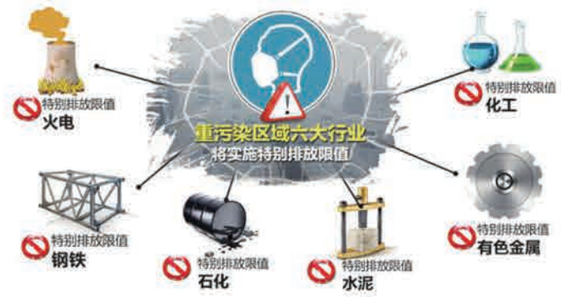
What is smog? It is a polluted status of air and a general description of excessively high content of suspended particles in the air. PM2.5 (particles with diameter less than 2.5 micron as an aerodynamic equivalence) is "culprit" of smog. There are many different causes that lead to smog, including vehicle emissions, industrial discharge, construction dust, garbage incineration and even volcano eruptions etc.. Smoggy days are often a synthesis result of complex pollutant sources which vary among different regions.

Smog can be extremely harmful since it severely exacerbates air quality. It can cause many inconvenience to peoples' daily life, but more importantly it may greatly affect human health, easily evoke heart disease and respiratory sickness and substantially increase attack rate of infectious diseases.

Statistics shows that in the top 500 cities in China, merely less than 1% of the cities can enjoy air quality that meets the quality standard of the World Health Organization. Meanwhile, in the ten most polluted cities of the world, seven are in China. On January 4th, 2014, smog weather was firstly alluded as a disaster of 2013 in the report by the National Disaster Relief Office and the Ministry of Civil Affairs.

In February 2014, President Xi during his site visit in Beijing pointed out that to curb smog and improve air quality, the top priority task shall control PM2.5 by taking substantial measures including reducing coal burning, curtailing vehicle increase, restructuring industries, strengthening management, carrying out synthetic control and improving rules of laws etc.. It is also necessary to identify key areas, tighten index appraisal measures, reinforce law enforcement and supervision, and implement accountability system in real earnest.

Reducing coal burning as a measure of top priority shall by no means be neglected. Coal burning for heating in rural areas has a great say in PM2.5. Taking Beijing as an example, as shown in studies, in the PM2.5 emissions in Beijing, 40% is caused by coal burning. In 2011, rural heating in Beijing consumed 4 million tons coal, taking about 15% of annual coal consumption in Beijing, i.e. 26 million tons in total. Moreover, rural heating are mostly done by small-scaled boilers of low energy efficiency. These boilers directly discharge smoke and dust to the air at a very low altitude without any means to extract dust, smoke or sulfur before emission. Added with other factors, the small boilers produce much more dust and smoke when burning than medium and large boilers. By weighted calculation, coal burning in rural areas of Beijing lead to about 9% of air pollution in Beijing.



Viewing from the survey data in 2012, during heating seasons, the air quality in outer suburb areas and downtown of Beijing was better than its outskirt areas from time to time. It further proves that coal-fired heating in rural areas does compose a major factor of pollution. Therefore, an earlier solution is needed to ease air pollution in Beijing. In 2013, Beijing Municipal Government claimed to cut back coal consumption to 15 million tons by 2015 and 10 million tons by 2020. To achieve the target, not only fuels used for industries, power generation and urban heating shall be replaced, but also the heating method in rural areas.

Ground Energy Heating Devices (split-type ground energy heat pump for individual household users) is a new-type air conditioning technology product indigenously developed by the HYY Company to tackle problems incurred by coal heating in rural areas. The device uses the clean and renewable shallow ground energy as the source energy for heating and cooling, and provides independent heating and cooling for single rooms or households. As such, it can offer ensured heating for every rural household, replacing coal burning boilers and thus effectively eliminating air pollution problem. The technology relies on the single-well energy collection system for circulation and heat exchange to take advantage of naturally accumulated underground energy to improve human welfares.

The technology is also a forceful support to Beijing' s endeavor in constructing new-type countryside by replacing medium and small-sized coal-fired boiler with heating measures that utilize clean energies as required by the policies already established by Beijing Municipal Government in a bid to curb air pollution. By now, the technology has been successfully applied in many coal transformation projects in suburban Beijing, including Mujiayu of Miyun, Baibeihe of Huairou and Mapo of Shunyi. The technology has the following features and advantages:

1. Highly effective in conserving energy: direct circulation of fleuron to provide heating helps to enhance the overall energy efficiency of the devices.

2. Handy to operate: the device can be switched on and off independently as needed. It is easy to operate by individuals and requires less technical training.

3. Much reduced capital investment: There is no need for setting up machinery rooms and massive thermal insulation works, therefore, greatly reduced the initial investment.

4. Easy to install: the master engine is compact, exquisite, convenient and space-saving. In the new buildings under construction, after the main public pipelines and sub-line are built, the machine set can be installed according to the need of each household so as to realize independent room heating. In renovation projects, machinery set with split-type heat pumps is more applicable.

5.Independent measurement: Every device can be attached with a meter to realize measurement by rooms. Thus, each company or household can pay for what it has consumed, making measurement simple and fair. By installing meters in each household, it is conducive to forge the dwellers to form a good habit of conserving energies.

6. Highly reliable: Flexible design and layout of the system and machineries make it easy for maintenance and replacement. When one unit goes wrong, it won' t cast any effect on others.

Presently, coal consumption for heating in rural areas of Beijing reaches to around 4.3 million tons per year involving more than 1.43 million households. If all these coal-fired heating were substituted by the Ground Energy Heating Devices, it could have saved all the 4.3 million tons of coal, reduced CO2 emission by 10.75 million tons and SO2 by 0.29 million tons. The emission reduction result is equivalent to an entire layoff of 66,000 taxis in Beijing for three years.

To sum up the above, the Ground Energy Heating Device developed by the HYY Company is a proper way to replace current coal-fired heating in rural Beijing with clean heating free of pollution and emissions. It is a strong support to Beijing' s efforts in reducing PM2.5 and lowering fossil energy consumption since it saves more than 70% energy compared to heating with electric boilers. The device and technology shall therefore be forcefully promoted and widely applied.

Smog control shall start with combustion-free heating in rural areas. The indigenous patent technology of the HYY Company is ready to serve the general public and retrieve blue sky and fresh air for all. ■


Zhang Zi Dao project

Tightening Efforts to Develop Ground Source Energy

an interview with Wang Bingchen Counselor of the State Council

Reporter: Jin Xiaoping

In 2005, Mr. Wang Bingchen, Wu Xuemin, Shen Mengpei and Shi Dinghuan as four couselors of the State Council, have jointly proposed to the State Council to develop and utilize ground source energy to fight against energy shortage and challenges in the country. The proposal aroused great attention and Mr. Zeng Peiyan, who was Deputy Prime Minister at that time also made important remarks and instructions on the proposal. Presently, the Planning Department and Environment Department of the Ministry of Land and Resources together with the China Geological Survey are carrying out studies on exploration and development of clean renewable ground source energy. Days ago, the writer interviewed the author of the proposal, Counselor of the State Council Mr. Wang Bingchen.

In Mr. Wang's words, ground source energy in China is abundant and wide spreading. In face of the tension in energy supply, it is of great value and broad prospects for China to develop and utilize ground source energy as a clean and renewable energy. According to statistics, ground source thermal energy stored within 2000 meters deep underground in major sedimentary basins in China equals to the total heat output of 1371.1 billion tons/year standard coal equivalent (SCE) and the exploitable ground source thermal energy can reach 422.7 billion tons year SCE. In Beijing alone, areas that are applicable for ground source energy development and utilization reaches to 2372 km^2, with an estimated exploitable volume of 108.71 million m^3/year. In Tianjin, the ten areas defined as thermal anomalous regions with an area of 2328 km^2 boast an exploitable volume of 50.88 million m^3/year ground source thermal energy. The current survey shows that in terms of exploitable amount, the Southwest part of China boasts the most ground source thermal energy, followed by North China and Central South region. Up to now, more 3000 places have been identified with 2748 places being measured with actual output. The thermal power released equals to 7.5 million tons of SCE. As such, it is fair to say ground source thermal energy is of great potential for development and application.

Mr. Wang Bingchen recalled that as early as 1950s, China's first Minister of Geology Li Siguang had already pointed out that it would be far from enough for China to solve its energy shortage problem by relying mostly on oil and coal. He had actively advocated for development and application of ground source heat energy, proposed to explore underground thermal treasure, and visited Tianjin to assist ground thermal energy exploration and development. In mid 1950s, China carried out a survey on the naturally exposed hot-spring geothermal resources. In early 1970s, survey and exploration on concealed geothermal energy was done. And in early 1980s, a productive geothermal power plant was launched. Ever since then, with the further improvement in exploration technology, China further strengthened its efforts in developing and utilizing ground source thermal energy that is comparatively high-temperature. The application of ground source thermal resource was also greatly expanded to many sectors and thus formulated a bunch of new industries related to geothermal resources, such as heating industry, greenhouse cultivation, aquaculture, spa resort and tourism etc.

Mr. Wang also analyzed the latest development trend of ground source thermal energy in the background of market economy.

1. More efforts and focuses have been given to the development of ground source thermal energy in non-anomalous regions. Heat pump technology has become a necessary means to achieve graded application of ground source thermal energy, utilization of low-grade ground source energy and reclaimed water heat energy.

2. Utilization of ground source thermal energy in oil fields has aroused more and more attention. In the post-exploration period, there is always more water than oil in the field and efforts shall be turned to development of ground source thermal energy.

3. More importance is put on synthesis utilization of ground thermal resources so as to enhance performance and efficiency.

4. More scientific approach to balance collection and reinjection so as to achieve sustainable utilization of ground source thermel energy.

5. Promoting scale development to improve the overall economic performance of applications of ground source thermal energy.

6. Development plan and project management are becoming more unified and standardized. Blindly irrational development and exploration were prevented to rationalize the development activities and protect ground source thermal energy.

Mr. Wang emphasized that despite of high importance attached to the application of ground source thermel energy, there are still many problems that need to tackle.

1. Administration system shall be further straightened out. Administration and management on ground source thermal energy by Chinese government are still weak and there are many redundant rules in some regions. Supervision on scientific exploration and rational utilization of ground source thermel energy is far from enough. Up to now, only Beijing and Tianjin have set up special government supervisory agencies in this regards, but still no unified national rules or regulations is in existence for administration and management of ground source thermal energy.

2.Prospection and evaluation are comparatively underdeveloped throughout the country. Presently, large-scale prospection and exploration are not in place in most part of China. Therefore, the statistic of national total reserve of ground source thermal energy is merely an estimation. Prospection and evaluation work lags behind resource development in the sector. In regions where prospection level is low, ground source thermel energy development involves more risks and challenges.

3. Development and utilization level of ground source thermal energy is low, therefore leads to serious loss of resources. Among all the hot springs in China, only 36% is developed and utilized and most of it just goes down in drain. Besides, some heating service providers can only realize a 20-30% utilization ratio of heat resources. Precious geothermal resources have been wasted.

4. Development and application technology of geothermal resources are still limited and equipments are still underdeveloped for exploration of deep energy. Drilling techniques of more than 3000 meters depth well are not yet mature.

5. Distribution of geothermal wells are excessively concentrated in certain places, which endangers sustainability of the resource and also imposes more risk of surface subsidence.

6. Exploration and prospection of geothermal energy is woefully inadequate. Since 1990s, the national government merely has made any substantial investment in this regards, which has severely restraint the sector from further growth.

As such, Mr. Wang Bingchen suggested the following:

1. Further refine the management and administration system, strengthen rules of laws, conduct unified management throughout the country by the competent authorities of state-owned land and resources, stipulate national regulations on geothermal resource management, reinforce supervision on the development and application activities, and perfect relevant legislatives, so as to promote an earlier establishment of the automated supervision and data-base management system in geothermal energy development.

2. Strengthen prospection and evaluation of geothermal resources, and find out the accurate status of development of geothermal energy application. As for those exploration projects underway, accurate evaluation shall be assessed on the exploitable amount. Based on improved and profound survey, China shall define areas that are most suitable for geothermal energy utilization.

3. Double the efforts on developing geothermal resources in North and Northeast China as well as the Central West China. In the post-exploration oil field, more efforts shall be put to extract heat from underground water for applications.

4. Improve planning of geothermal energy and enable local governments to compose the geothermal energy development plan in line with local reality and needs.

5. Further advance the geothermal industrial growth by means of scientific and technological breakthroughs. R&D in geothermal energy development and application shall be reinforced. Technical standards on exploration, development and application of geothermal energy shall be promulgated as soon as possible.

6. More incentives shall be put into place to encourage rational development and utilization of geothermal energy. The national budget shall earmark funds to support survey and prospection of geothermal resources, establish special fund or venture capital to develop geothermal energy. The incentive shall be applied to stimulate more social investment and attract foreign capitals into the geothermal utilization. ■

(The article was originally published in "China's Mining News", Feb. 21, 2006)

Yangbajing Geothermal, Tibet

REGIONAL ENERGY PLAN And the HYY Distributed Power Station for Cooling and Heating

Key words
Regional Energy, HYY Ground Energy Heating and Cooling Power Station

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China's economic development in recent decades has further sharpened the contradiction between energy supply and economic need. The comparatively coarse mode of economic development has tied the economy with increasing energy consumption. As coal dominates the traditional energy mix, increasing energy consumption has led to constantly worsening environment. In eastern China where economy is relatively more developed, declined air quality and rampant smog has severely affected lives and health of the people.

Energy loss and environment damage are often irreversible. In recent years, Chinese governments at different levels began to attach more importance on energy conservation, emission reduction and environment improvement. GDP growth is not the only index to measure development any more. Meanwhile, urbanization is also no longer a simple process of expanding big cities. Many new areas or communities with specific functions come into being surrounding big cities. These areas and communities have contributed to the overall sustainable and sound economic development and helped to reduce economic dependence on energy and excessive damage on environment.

In current urban planning system, energy is mainly consumed for cooling, heating and power supply. In some large scale regional development projects, regional energy plan is often neglected. However, energy conservation shall be pursued at the planning and designing stage in constructing buildings, since a energy conservative plan is the foundation for achieving the results.

Generally speaking, when discussing energy development, it mostly means to saturate consumption demand. Since provision of power, gas and heating are often planned separately when designing the power load of buildings, energy load tends to be overestimated. At the beginning when lodging ratio of buildings is low, energy supply is much greater than demand. In order to be profitable, energy suppliers will take incentive measures such as lower price to stimulate demand and encourage residence to use more electrical devices. Whereas, when more people move into the building, the designed power supply can no longer meet the need. The supplier will then expand the supply capacity and increase facilities to beef up supply. Once supply is raised, a new round of stimulus will be adopted to create more demand. Such process circulates. As consequence of this vicious spiral, energy waste and irrational energy consumption are forged into being.

In order to realize a regional energy plan that is truly energy effective and emission abating, it is necessary to introduce new clean energy and advanced application technology that can suffice the heating and cooling needs of regional buildings.

The HYY Distributed Power Station for Cooling and Heating (hereinafter referred to as Heating/Cooling Station) is based on the HYY patent technology of Single-well Circular and Heat Exchanging Ground Energy Collection System to utilize the renewable shallow ground energy as the core energy in combination with other clean energies such as electric power or geothermal energy to provide heating, cooling and domestic hot water for urban constructions.

Heating and cooling station sends lukewarm water (15℃) to the heating/cooling devices installed for users, so as to provide the users with hot water (50-55℃) for heating and cool water (7-12℃) for cooling. The heating/cooling station is a new model in heating and cooling production that features pollution-free, energy-conservative and multi-functional. Besides, such stations are easy to build requiring low complementary conditions and small land occupation. Its operation is highly reliable and does not incur any extra load on urban grid, any new need for public facilities. The station is also highly flexible to address varied demands. It, therefore, stands out from its peer technologies and products both home and abroad with apparent technological advantages.

Advantages of Distributed Ground Energy Heating/Cooling Station:

1.The main energy used by the Station is the renewable shallow ground source energy, and the collection technology of shallow ground source energy is the Single-well Technology.

2.The station ensures no pollution and no greenhouse gas emission to local environment.

3.It can take advantage of local energy condition to realize graded and highly efficient utilization of thermal powers and by utilizing residual heat of thermal power generation.

4.It is planned and engineered in concurrence with local infrastructures. The flexible modular configuration makes it adaptable to different construction cycles and thus ensures high efficiency of investment and operation.

5.It is equipped with intellectualized controlling system to secure smooth and reliable operation, and is capable of conducting household-based heat metering at low operational cost.

6.The total cost of equipments is similar to the input of traditional public heating facilities and its operation cost is the same as heating with other existing renewable energies.

The HYY Heating/Cooling Station can be applied to various areas

North China Region

North China is the region with the most population that needs heating service in China and also with fairly wide demand for cooling service. In this region, it is the urban agglomeration of Beijing, Tianjin and Tangshan cities that is most densely populated and highest in personal incomes. Currently, it is the region that the HYY Company has the most presence with a lot of marketing channels and application projects. It is also the most competitive region for the clean heating industry in China. During the twelfth five-year plan, urbanization process in this region will keep its rapid pace and therefore the region still enjoys big market potentials for further development.

Northeast China

Among the three provinces in Northeast China, Liaoning is the most populous one with most densely distributed cities and highest income levels. The major market in the regions is for heating.

Southwest China

Southwest China being rich in natural resources, used to be the earliest region in China in developing and utilizing natural gas. The region will generate more demand for integrated application.

In this region, size of city conglomerations is comparatively small and people's average income level is also much lower than other regions. Plus, it is not a policy heating area in China, namely heating is not mandated in China's policy. However, heating demand in the north of Sichuan and Chengdu is growing. Besides, cooling in summer is greatly needed as well.

Lower-Middle Reaches of Yangtze River Basin

The lower-middle reaches of the Yangtze River Basin is economically the most developed region in China with the highest average person income and living standard. Meanwhile, it also boasts the highest power prices and the sharpest energy constraints. Average temperature in the region is around 28℃ in July and 3℃ in January. Cooling in summer and heating in winter have long been a basic necessity for people.

In the region, cities along the River and the sea are often densely populated. In Shanghai, Jiangsu and Zhejiang alone, the urban population has reached to about 100 million. It is therefore, a region with the most potential for energy conservation and application of shallow ground energy heating and cooling system, an areas with the most input in energy conservation and a key zone for the Company to carry out forceful market exploration during the twelfth five-year plan period. ■

References:

Wang Zhao, Gui Lin, Regional Energy Plan of Civil Architectures, May 2014.

Long Weiding, Important Steps in Managing Energy Conservation of Buildings ---- HVAC in Regional Energy Plan of Architectures, March 2008

Latest Progress and Development Trend of Ground Source Heat Pump Technology

——Academic Paper Abstract by Mr. XU Wei

President of Building Environment Protection and Energy Conservation Institute, China Academy of Building Research

I. Key Features.

● China has vast area of land, and can be classified into five major climate zones. Its northern area requires heating while southern part asks for cooling. And most regions show needs for both heating and cooling.

● With multiple climate zones, it is unavoidable for China to develop diversified types of heat pumps for ground source energy utilization, so as to make it possible to carry out different applications suitable to buildings in different needs and conditions.

● Technology lays the foundation while industrialization facilitates the application; government provides guidance and market makes the choice.

● Learn the experience and good practice from Europe and North America and innovate and develop in line with Chinese national reality.

● Start by small scale followed by scale demonstration, then large area application.

● Initial investment of the system is roughly the same as or a little bit higher than traditional heating systems, but the operational cost is much lower.

▲Water source heat pump: initial investment is about 300–400 yuan/m^2; Buried loop–line heat pump system: initial investment is about 350–450 yuan/m^2.

▲If it is used for single purpose of heating or cooling, the initial investment is more than traditional system, but if used for both heating and cooling, it equals to the combined cost of a cooling unit and a fuel–fired boiler or centralized heating.

▲Ground source heat pump: initial investment is lower than that in other countries.

II. Latest Highlights

● Latest Development in International Ground Source Heat Pump Sector:

▲CO2 Heat Pump Unit in combination with buried–type loopline heat exchanger system, to realize better performance. (Japan: SANDEN);

▲Desiccant air–conditioning system in combination with heat pump system (Japan: Hokkaido University, Nagano Katsunori)

▲Vertical Pipeline Group Response Test (Sweden, Chalmers University of Technology).

1. Carry out TRT experiments on each buried pipeline under identical conditions to evaluate parameters including heat exchange performance and thermal resistance.

2. Repeat the TRT test after 2–3 weeks with conditions remain unchanged to compare heat exchange performance and thermal resistance of the same pipeline.

3. Conduct TRT experiment under the same condition for 250–300 hours on each buried pipeline.

4. Monitor how temperature respond to changes in heat inflow.

▲Application of ground source heat pump in snow melt of lead rail (Germany)

● Latest studies on ground source heat pump technology in China:

▲Heat–exchange modeling and study of buried pipeline heat exchanger;

▲Research on simulation model of transient condition in summer;

▲Research on dynamic simulation model of heat pump device and spare parts;

▲Study on substitute substance for refrigerant in heat pump cooling system;

▲Research on joint application development of ground source energy with other resources, such as solar power, hydro power;

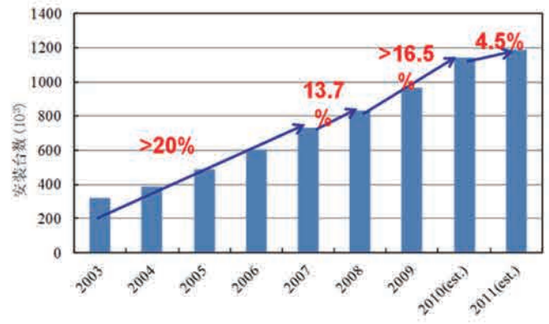
▲Design and engineering of ground source heat pump system;

▲Study on the economic performance and operational characteristics of ground source heat pump system;

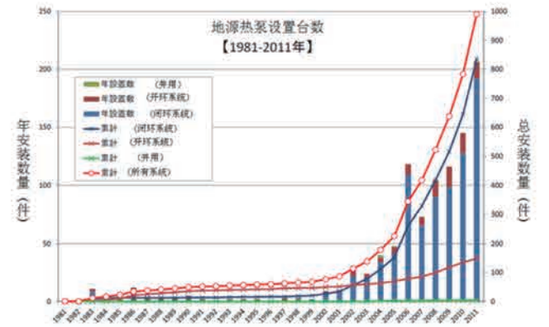
▲Study on the overall operational efficiency in terms of technological and economical matching performance of ground source heat pump system and buried heat exchanger technology;

▲Experimental research on physical property and thermal conductivity of soil. ■

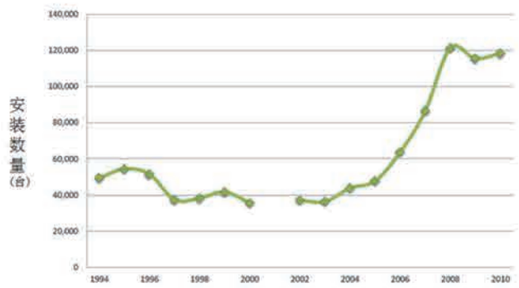
● Recent development trend of ground source heat pumps installation in Europe



● Changing curve in ground source heat pump installation in the world ---- Japan



● Changing curve in ground source heat pump installation in the world ----US



Symposium held by the Specialized Committee on Development and Utilization of Ground (Thermal) Energy under Beijing Association of Promoting Energy Conservation and Environment Protection in HYY Company

By Jason Wang

On the morning of April 18th, 2014, the Symposium on "Opinions on Implementing Policies to Further Promote Ground Thermal Energy Development and Heat Pump Utilization in Beijing" was held by the Specialized Committee on Development and Utilization of Ground (Thermal) Energy under Beijing Association of Promoting Energy Conservation and Environment Protection in the meeting hall of the HYY Company. Vice Chairman Ni Wenju and Deputy Secretary General Zhou Yifan of the Beijing Association of Promoting Energy Conservation and Environment Protection, Head of Specialist Group Wang Bingchen and Chairman Xu Shengheng of the Specialized Committee on Development and Utilization of Ground (Thermal) Energy, Director Xu Wei of the Institute of Building Environment and Energy Conservation under China's Academy of Architectural Science, Yan Lihua head of the Energy Division of Beijing Development and Reform Commission attended the symposium together with representatives from more than 30 companies.

Deputy Secretary General Zhou Yifan chaired the symposium and introduced guest speakers and leaders. Director Xu Wei briefed everyone on the Study Report "Latest Development and Trend of Ground Source Energy Heat Pump Technology". The Report elaborates in good details of the progress, features and problems of ground source energy heat pump technology in 2008–2013. In the several years after 2008, the ground source energy heat pump developed very rapidly in China. In terms of national policy, in 2009, the Ministry of Construction and the Ministry of Finance started to promote and subsidize construction of demonstration cities and counties that use renewable energies. By now, 36 cities and 92 counties have been awarded the title of demonstration cities and counties of renewable energy. In 2012, Ministry of Construction and Ministry of Finance launched the special program of promoting the development of National Green and Ecological Cities by providing subsidies. Since then, some provinces and cities including Beijing, Ningbo, Zhejiang and Henan have promulgated their policy on promoting new and renewable energy development. This is a very encouraging news for the application and promotion of ground source development and utilization. Director Xu Wei also shared with the audience on the latest focus and technology development of ground source heat pump technology in the world, and analyzed the development trend of ground source heat pump market in Europe, US and Japan in recent years. He made a systematic review on the evolution of ground source heat pump and an accurate and authoritative judgment on future market. As Director Xu Wei said, ground source energy has been included in the 12th Five-Year Plan of National Development as one kind of renewable energy. In the upcoming 7 years, China will accomplish 295 million m^2 application of ground source heat pump system for heating and cooling. Supposing the average investment is 350 yuan for each square meter, the total investment is estimated to reach 103.2 billion yuan.

The second speaker was Yan Lihua, head of Energy Division of Beijing Development and Reform Commission. She elaborated on the documents issued by Beijing government-- Opinions on Promoting Ground Energy Development and Applying Ground Source Heat Pump System in Beijing, and made meticulous analysis on its key development areas, major tasks and incentive measures etc.. Ms. Yan said, in terms of policy support stipulated in the Opinion, newly built heat pump heating project with reclaimed water, residual heat and soil source energy can be entitled with 30% capital subsidy; newly built geothermal heating projects can enjoy 50% capital support; transformation project of changing existing coal/oil fuel-fired boilers heating into heat pump heating can get 50% financial support. In terms of projects application, the rule is to apply locally, i.e., application is submitted to local county and district and the competent authority is responsible for reviewing. In terms of approval, heat pump heating projects using reclaimed water, residual heat and soil are approved by the competent investment authority in local county or district; geothermal heating projects and transformation projects changing coal/fuel fired boilers heating into heat pump heating are approved by investment authority in the municipal government; new project shall be applied together with the construction and real development project.

Chairman Xu Shengheng indicated that what the shallow ground source energy application can achieve is the combustion-free heating for buildings as a key measure to radically eradicate smog. With further development, shallow ground source energy utilization in proving heating and cooling for buildings, as an emerging industry can help to greatly accelerate the process of upgrading and reforming conventional heating industry, and therefore contribute significantly to our common efforts in nurturing a enjoyable living environment for all.

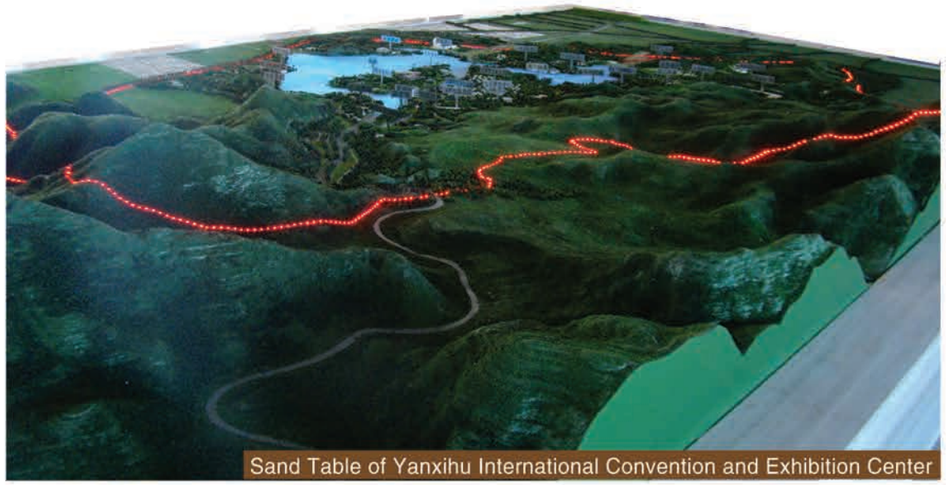
Deputy Chairman Ni Wenju in his speech proposed that the participating companies to the meeting shall reinforce efforts in the following four aspects. 1. take full advantage of the current preferential policies in market promotion; 2. constantly strengthen technological explorations and innovations so as to achieve more scientific breakthroughs and development; 3. be persistent and dauntless in providing good services; 4. strengthen communication and give full play to the role of professional experts and the role of the Special Committee as the bridge to connect enterprises, academicians and governments.

In the final session, leaders from the Specialized Committee on Development and Utilization of Ground (Thermal) Energy, Mr. Wang Bingchen, Head of Specialist Group, Director Xu Shengheng and Deputy Director Ni Wenju made closing remarks respectively and express thanks to speakers, leaders and all the participants of the meeting for coming and contributing to the successful convention.

Mr. Wang Bingchen, in his speech, pointed out that the bi-monthly magazine "China Ground Source Energy" as a professional publication on relevant knowledge popularization, scientific R&D achievements and new sectoral trend in shallow and deep ground thermal energy development and utilization has completed its first issuance in March this year in Hong Kong. The magazine functions as a demonstration and popularization platform in letting the world know the development and application practices of ground source energy in China. Mr. Wang also expressed appreciations to the HYY Group for its financial sponsorship and personnel support to the magazine.

Mr. Wang said in the future the Special Committee shall reinforce its effort to take full use of the advantages of its members to forge synthesis in developing and industrializing indigenous technologies and products. Taking the HYY Single-well Energy Collection technology as an example, it was officially appraised by professional panels in 2005, calling it as a heat power collection device in soil source heat pump system featuring a completely enclosed circulation of water media. As no water is consumed in its operation, the system casts no impact on underground water quality, water flow status and geological structure in its surrounding areas. Moreover, the technology is applicable to various geological conditions. Since 2001, it has been used to more 3.2 million m^2, with applications all over Beijing. Even in regions of tough geological conditions, the technology system has been successfully operated to serving 300,000 m^2. This is new technology that further solidifies the position of renewable ground source energy as the primary and reliable substitute energy for conventional energies. The technology is proved to be mature, energy effective, water conservative and environmental friendly, and therefore, deserves greater efforts in popularization and broader application. ■

Photo of Meeting


Sand Table of Yanxihu International Convention and Exhibition Center

PERFORMANCE TEST REPORT

On the Single–Well Heat–Exchange System for Ground Energy Collection in the Yanxihu Conference Center of Huairou District Beijing

By Yang Mingzhong and Wang Xuezhi
(Ever Source Science and Technology Development Group Co. Ltd. (HYY Company), Beijing)

[Abstract]: Analyze parameters and conduct performance test on a selected application project of single–well heat–exchange system for ground energy collection

[Key word]: Shallow–ground thermal energy, single–well system, ground source heat pump, performance test

Introduction

Single–well heat–exchange system for ground energy collection can collect ground source energy in a highly effective way that is of no harm to the natural distribution of underground water and minimum reliance on underground water flow. It prevents the underground water from being polluted and avoids disastrous problems such as collapse of driving well caused by sand movement and water loss and structure damages caused injection well plugs. Single–well heat–exchange system for ground energy collection is an indigenous patent technology of China and therefore there is little practice that can be learned and referred to in the world in terms of statistical and analytical methodologies and software models. The article is a case study on performance test and stands as a practical evaluation of performance of single–well system and viable verification and analysis methodology.

1. Objective

The objective of the test is to evaluate the heat exchange performance of the single–well system.

Test parameters include: outlet water temperature, injection water temperature, return water temperature, circulating flow, injection pressure on the source collection side and outlet water temperature, injection water temperature, circulating flow and water quality on the terminal user side.

In order to assess the performance of the single–well collection system, calculation and analysis have been made based on comparisons of operational parameters acquired by changing physical properties of the collection well.

2. Test Observer and Date

Observer: Test Team of the Ever Source Science and Technology Development Group Co.Ltd.(HYY Company)

Technical Adviser: Flood control and Water Resources Research Institute with China University of Mining (Beijing)

Test Date: July 21st, 2013

3. Test Environment

3.1. Ground Energy Collection Well under Test

3.1.1. Single–well heat–exchange well for ground energy collection.

(1) location: Huairou District, Beijing

(2) Serial No. HYY–YXH–02

3.1.2. Parameters of the Collection Well

The HYY ground energy collection well can be classified into two types in terms of construction structures, namely collection well with energy storage grains and that without energy storage grains. The geological structure of the project site is composed of three layers, i.e., artificial accumulation layer, quaternary sediment layer and Jurassic volcanic rocks layer. Based on such geology, collection well with energy storage grain is selected.

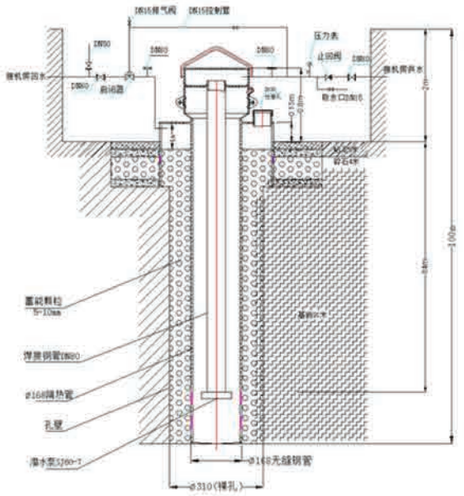
Collection well with energy storage grain is equipped with waterproof layer, isolation mask, and energy storage grain (including upper and lower clapboards).

Circulating water is pumped out by the submersible pump in water pumping area at the bottom of isolating tube, enters into heat pump unit to release or absorb heat and then return to high–pressure water injection area at the upper well. Afterwards, the water flows across the ring–like space filled with energy storage grains down into the water pumping area, enters the isolating tube through its perforated part at the lower end, and gets pumped out by water pump. Circulating water accomplishes its heat exchange process by moving downwards in the ring–like space filled with energy storage grains.

Technical Parameters of Well: depth – 100m, diameter of the hole – 310 mm, diameter of isolating tube – 168mm, energy storage grains – 5 – 10 mm, and static water level is 28.5m.

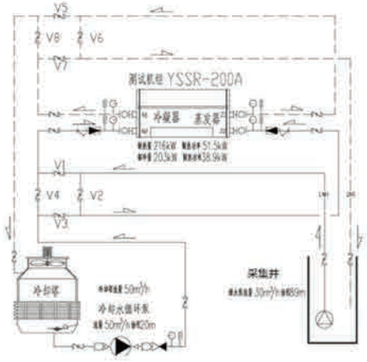
The ground energy collection well is designed, engineered and tested for acceptance in line with the Beijing local standards, namely "Engineering and Technical Standards of Single–Well Heat Exchange Energy Collection System" (DB11/T935–2012).

3.1.3. Collection Well Unit



3.2 Working Rationale of the Test System

As shown in the following chart, the test system consists three parts: ground energy collection well, machinery unit and cooling tower. By switching the handle, the system can be switched between cooling mode and heating mode so as to saturate different working situations as requested by the Test. Taking cooling mode as an example, the source side is the collection well connected with evaporator of the machinery unit, and the terminal side is the cooling tower connected with condenser of the machinery unit. The test monitors the inflow and outflow water temperatures of evaporator and condenser separately. Ultrasonic flow meters are used to monitor the circulating flow on both sides of the evaporator and the condenser.



3.3. Test Equipments and Software

Temperature: Automatic Thermograph RHLOG–DSZJ–W

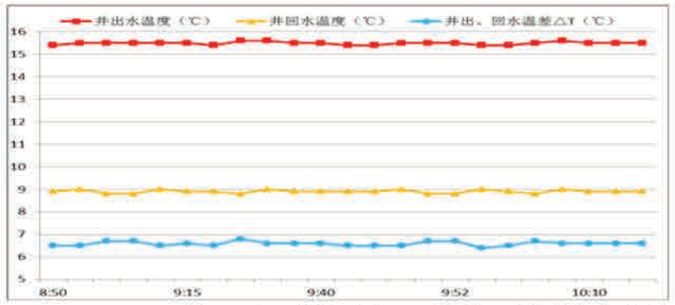
Flow: Ultrasonic Flow Meter HUF2000–F1A2D

Water Quality: FA2004N–Type Electronic Auto–balance (SYS–1), Atomic Absorption Spectrophotometer (SYS–3), F50A–Type Acidometer (SYS–2), 25mL Acid Burette

Data Analysis Software: HW–03–12

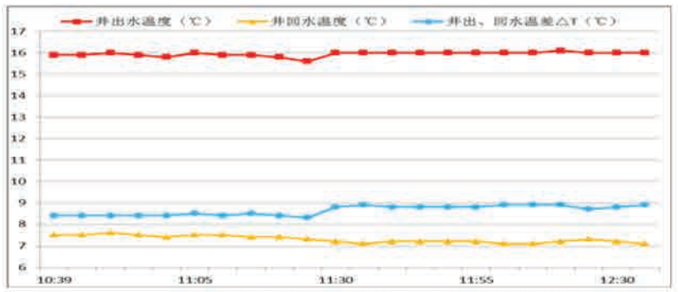
4. Test Result

4.1 Working Condition 1: Injection Pressure ±0MPa, Circulating Flow: 22.6m³/h



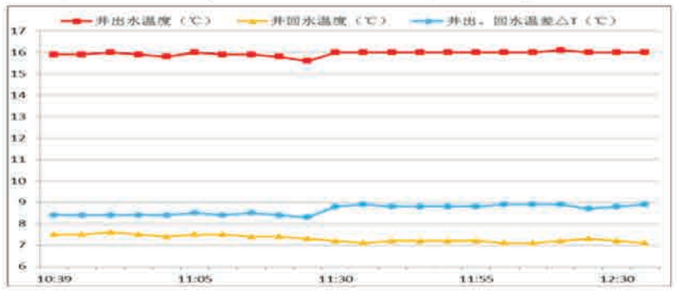
Temperature of Water Inflow and Outflow of the Collection Well
(Working Condition 1)

4.2. Working Condition 2: Injection Pressure≤0MPa, Circulating Flow 14.2m³/h



Temperature of Water Inflow and Outflow of the Collection Well
(Working Condition 2)

4.3 Working Condition 3: Injection Pressure 0.13MPa, Circulating Flow 30.5m³/h



Temperature of Water Inflow and Outflow of the Collection Well
(Working Condition 3)

4.4. Underground Water Quality

Sand Content	Total Hardness(mg/L) Calculated by $CaCO_3$	Iron(mg/L)	pH Value (dimensionless)	Visible Substance	Odor & Taste
<1/ 200,000	210	0.05	7.2	None	None

4.5. Data Analysis

Test Parameter	Condition 1	Condition 2	Condition 3
Temperature of Outflow （℃）	15.5	15.9	15.6
Temperature of Inflow（℃）	8.9	7.3	9
Temperature Difference（℃）	6.6	8.6	6.6
Circulating Flow（m³/h）	22.6	14.2	30.5
Injection Pressure(MPa)	±0	≤0	0.13
Thermal Power (kw)	173	142	233

1. Test Well (HYY–YXH–02): Minimal Circulating Flow is 14.2m³/h; Temperature Difference between in/out circulating water flow is 8.6℃; thermal power is 142kw;

2. Test Well (HYY–YXH–02): Maximal Circulating Flow is 30.5m³/h; Temperature Difference between in/out circulating water flow is 6.6℃; thermal power is 233kw;

5. Evaluation and Comments

1. Design, engineer and test reception of the ground energy collection well are all in conformity with the "Engineering and Technical Standards of Single–Well Heat Exchange Energy Collection System" (DB11/T935–2012) in Beijing. The performance of the collection well has reached to the designed level and its operation in the project site is reliable and mature.

2. In the water test, sand content meets the criteria of ≤1/ 200,000 and all the other parameters show the water quality reaches Category III. In the breakdown, iron content meets the criteria of Water Category I, and total hardness meets Category II.

3. Water Production and Injection Capacity of Aquifer are the anchors for stable and reliable operation of the ground source heat pump. Water production capacity of per unit of drawdown is positively relevant to the transmissibility coefficient of aquifer. The bigger the transmissibility coefficient, the higher the well capacities in water production and injection are. As calculated with the "Hydrogeological Parameter Calculation Software", the average permeability coefficient of the geology is 8.98m/d and the depth of the aquifer is above 200 meters.

4. The test also shows that increase of circulating flow would lower the water difference as a result of the insufficient cooling capability of the cooling tower in the test system.

5. The distance between different wells shall be kept reasonable to avoid any mutual impact among wells in water temperature and flow.

6. In Working Condition 3 as the injection pressure is 0.13MPa, with entirely closed loop, a sealed well head can secure a maximum injection pressure of 0.40MPa.

7. Single–well heat–exchange collection well of ground energy can well realize 100% water injection with no change in water quality and water position. Water is used merely as a media to transport thermal energy. Therefore, the single–well collection system has successfully tackled the problems of injection difficulties, ground water recession and cross–contamination. It boasts high thermal efficiency, small space occupation, easy maintenance, and is totally free from water loss, water pollution, and potential geological harm. It is therefore, a safe, effective and reliable shallow–ground source energy collection technology. ■

Standing column well ground heat exchange system