

# REVIEW OF ROAD GEOTHERMAL SNOW MELTING TECHNOLOGY

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## **Анотація**

*Для забезпечення руху транспорту зазвичай використовується механічне прибирання снігу або розсипання протиожедної солі, що має відповідні недоліки. Розглянуто принцип роботи дорожньої геотермічної технології танення снігу, детально розглядається стан досліджень геотермічної технології танення снігу та аналізуються деякі існуючі проблеми. Завдяки своїм перевагам в енергозбереженні та охороні навколишнього середовища, геотермічної технологія танення снігу матиме широкий спектр перспектив застосування.*

**Ключові слова:** геотермічні, дорожні, танення снігу, охорона навколишнього середовища.

## **Abstract**

*In order to ensure the traffic, mechanical snow removal or spreading deicing salt are usually used, but there are corresponding disadvantages. This paper expounds the working principle of the road geothermal snow melting technology, emphatically introduces the research status of the geothermal snow melting technology, and analyzes some existing problems. Due to its obvious advantages in energy saving and environmental protection, geothermal snow melting technology will have a wide range of application prospects.*

**Keywords:** geothermal, road, melting snow, environmental protection.

## **Introduction**

In high latitude areas, the long-term snowfall in winter has a great impact on people's travel and life. The problem of snow on road has been plaguing the traffic departments of various countries, which not only causes huge direct economic losses, but also increases the probability of traffic accidents[1, 2]. Therefore, many countries have attached great importance to the treatment of road snow, and have done a lot of research to explore a variety of methods to restrain snow on the road[3 - 6]. At present, the most important snow removal methods are mechanical snow removal and spraying of deicing salt. Mechanical snow removal equipment has the characteristics of high manufacturing cost, low removal rate, low work efficiency, very large power consumption, and unsatisfactory use effect. Spreading deicing salt is an excellent snow removal technology with good effect and low price. However, after many years of use, it has also caused serious damage to the surrounding ecological environment and infrastructure[7, 8]. Geothermal snow-melting technology is currently a hot spot of the researchers, because the earth as a heating body, continuously release heat energy from the inside to the surface, shallow soil geothermal resources is an important part of renewable energy, is a kind of abundant, high economic benefit, and won't produce any pollution of renewable energy[9 - 11].

## **Results of the research**

The road geothermal snow melting technology is to bury heat pipes in the road and extract the energy from the ground through the underground heat exchanger. After being lifted by the heat pump, the fluid with high temperature is conveyed to the pipes in the road by the pump. When the high-temperature hot fluid flows in the pipe, it transfers the heat to the road through convection, which makes the temperature of the road above 0°C, and the ice and snow on the surface will melt, thereby achieving the purpose of melting snow. In areas with insufficient geothermal heat, or areas with low snow melting efficiency, the summer heat storage function can be added[12]. In summer, the road circulating thermal fluid is used to transfer the strong solar radiation heat to the underground soil for storage, that is, underground energy storage; in winter, the circulating thermal fluid extracts heat to the road to increase the temperature and then achieve the purpose of snow melting[13, 14]. Therefore, the solar-geothermal road snow melting system can realize the cross-season heat storage utilization, greatly improve the energy utilization rate, and realize the seasonal energy storage reuse.

The geothermal snow melting system has the following characteristics: (1) Use stable and clean geothermal energy as heat source. The use of natural and rich geothermal energy, even in cold winter, can provide enough and stable quantity of heat[15]. (2) Stable snow melting performance. The use of constant low-temperature heat energy and the large specific heat capacity of the soil means that there is more heat that can be stored in the soil, which makes the ground source heat pump running with high efficiency for a long time[16, 17]. (3) Reduce operating costs. The use of cheap geothermal snow melting system greatly reduces operating costs. (4) Protect the ecological environment around the road. The use of geothermal snow melting technology can greatly reduce the use of deicing salt, even without the use of deicing salt at all, which will have a great effect on the restoration of the normal ecology of the waters, soil, animals and plants around the road.

Since 1992, under the joint funding of the U.S. Department of Energy (DOE), the Federal Highway Administration of the Department of Transportation (DOT) and the National Basic Research Fund, the HBT (Heated Bridge Technologies) project has been implemented to systematically study the problem of road geothermal snow melting[18]. During the five years from 1994 to 1999, five states in the United States carried out road thermal snow melting application demonstration projects to compare and explore the energy utilization and snow melting effects of circulating thermal fluid, heat pipe transfer, electric heating, fuel heating and other methods. With the special promotion of renewable energy from OECD (Organization for Economic Cooperation and Development) and IEA (International Energy Agency), NIRE (National Institute of Resources and Environment) of Japan built the first full-automatic road heat collection and energy storage circulating thermal fluid snow melting system in Edo, Japan in 1995, and achieved phased results[19].

Since 1998, Oklahoma State University (OSU) in the United States has carried out research work on road thermal fluid circulation snow melting technology, and established the world's largest road special experimental system in OSU. Combined with the local climate conditions, the pavement is used as a solar energy collection system, and the closed system of ground source heat pump with vertical hole underground heat exchanger is used to carry out the research of geothermal snow melting process. The research work mainly involves the heat transfer of ice and snow in porous media. The finite element method is used to solve the heat transfer process of the road, and the geothermal snow melting is simulated, analyzed and tested.

Researchers from Hokkaido University in Japan made a comparative analysis of the early ground energy storage and snow melting test projects in Japan. Studies have shown that the average ground heat collection rate can reach 36%, and seasonal changes in Hokkaido can achieve a basic balance between energy use and energy storage. The research conclusion points out that the road geothermal snow melting method is an energy technology with great development prospects. Although the initial investment is high and the technology is difficult, the use of natural renewable energy resources has significant energy saving effect, obvious advantages in environmental protection and rational utilization of resources, and is convenient for automation and timely treatment.

Senser used the computer to simulate the geothermal snow melting system of the airport runway, and designed a road heat pipe heating system based on response factor technology. The resulting algorithm proved to be highly efficient and accurate.

(1) Insufficient theoretical basic research, lack of effective combination of theory and practice. Should pay attention to the basic theoretical research of snow melting, speed up the determination of heat transfer coefficient of different roads, select appropriate heat transfer enhancement means, improve heat transfer efficiency, explore the mechanism process of road geothermal and mixed energy snow melting system, expand and improve the basic theory of road snow melting, balance the theoretical research and experimental engineering, and guide engineering application.

(2) Not integrated with road construction. Geothermal snow melting technology needs to be combined with road site construction technology, both of which are indispensable. In actual engineering, when burying heat exchange pipes, should consider the influence of pipe materials and concrete on the temperature field and heat exchange effect to minimize the unfavorable factors. This requires engineering organizers and technical personnel to be able to coordinate reasonably and make adequate technical and economic analysis.

(3) Under different cold and heat loads, the research on road geothermal snow melting system is not enough. In the snow melting system, the automatic monitoring and control system should be used to optimize the system, improve the operation mode, and maximize the efficiency of the snow melting system.

### **Conclusion**

Due to the advantages of energy saving and environmental protection, road geothermal snow melting

technology is suitable for ordinary roads, expressways, airport runways, etc., which has been paid attention by many countries and relevant organizations, but its practical application projects are few. The combination of basic theoretical research and actual engineering should be accelerated to determine the simpler design calculation methods that can be used by design units, manufacturers and other departments to promote the practical application of geothermal snow melting technology. With the continuous development of ground energy utilization research and application work, the concept of energy saving and renewable energy utilization continues to deepen, the continuous improvement of road materials and buried pipelines, the improvement of road construction technology, the development of road geothermal snow melting technology have great prospects.

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