A Summary of Research on Energy Saving and Emission Reduction of Transportation

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Abstract. Road transport is an important part of transportation, and road in the field of energy-saving emission reduction is a very important industry. According to the existing problems of road energy saving and emission reduction, this paper elaborates the domestic and international research on energy saving and emission reduction from three aspects: road network optimization, pavement material and pavement maintenance. Road network optimization may be overlooked, and the research content is still relatively preliminary; pavement materials mainly from the asphalt pavement temperature mixed asphalt technology research; pavement maintenance technology development is relatively comprehensive.

1. Introduction
In China, the long-term high carbon emissions from the transportation industry are among the highest sources of carbon emissions outside the energy sector and are the main source of carbon emissions. Road transport is the basic part of the transportation industry, also is a part of energy saving and emission reduction which can not be ignored, and its output value is high. We must vigorously carry out energy-saving emission reduction work. Many experts, scholars and scientific research institutions at home and abroad have done a lot of research on low-carbon technology, and put forward specific measures and policy recommendations. Comparison of international and domestic energy-saving situation, from the legal system, environmental protection and energy consumption in the current situation and so on. Based on the existing problems such as lack of resources, incomplete information, difficult implementation of laws and regulations, technical backwardness and other issues, focusing on technology progress of road network capacity, road materials and road maintenance.

Road energy-saving emission reduction in the field of specific problems reflected in the following aspects: First, the lack of resources. There is no general consensus on the importance of energy conservation and energy efficiency in terms of the current situation in our country. Based on the amount of per capita resources, we have to pay attention to energy conservation. Second, there is a lack of information on energy conservation and environmental protection, and statistics are not comprehensive. In the past for a long time, the energy-saving consciousness of the transportation industry is indifferent, the basic research is weak, and the energy-saving work of transportation has become a kind of subsidiary work which is dispensable in the production activities. Road transport energy-saving emission reduction industry in the basic sources of information and research work is too lacking, resulting in poor progress in energy conservation work. Third, regulations are difficult to implement. Policies and regulations on energy efficiency are imperfect. For a
variety of reasons, although China has promulgated and implemented the "Energy Conservation Law", but the implementation of difficulties. Fourth, we have outdated technology. For energy-saving technologies, there is technological backwardness field of road transport, embodied in the weak pace of energy-saving technology R & D capabilities and promote the use of energy-saving technologies mature slowly. Of course, China's road transport energy-saving emission reduction areas not only exist in these areas, there are more problems need to be found, more technologies need to improve and promote the application.

China's energy-saving emission reduction research work is steadily advancing. As a part of the transport industry, road transport industry can not be ignored, we will deepen the structural adjustment, change the growth mode, and strive to build their own, as soon as possible, we should build this industry to become resource-saving and environment-friendly industries.

2. Study on Energy Saving and Emission Reduction of Road Network

Since the reform and opening up, as a result of the rapid economic development and expansion of China's central cities, urban population and various types of vehicles increased significantly. The road traffic congestion is bringing a serious waste of resources and environmental pollution.

From the perspective of urban road network structure traffic energy consumption, it is feasible to reduce the energy consumption of urban road traffic system through reasonable signal control strategy. For road transport, the terrible road will lead directly to the vehicle fuel combustion is not enough. Thereby reducing combustion efficiency, increasing harmful gas emissions and pollutant emissions. Domestic experts and scholars generally believe that: Speed up the national highway, the main line and other road transport construction as the focus. We must strengthen the management and maintenance of the road to form an effective ability to improve the level of the road, increase the proportion of high-grade highway, strengthen the implementation of the national rural road construction plan in order to improve accessibility and improve road conditions in order to improve the efficiency of road network. Therefore, the Government should speed up the construction of highway infrastructure, improve road network capacity, but also to achieve the purpose of road energy conservation.

At present, the domestic road network optimization of energy-saving emission reduction model is the basic model of urban road traffic carbon emissions, but also based on low-carbon concept of urban road network structure optimization model. The former can take the road sections of the unit hours of carbon emissions, and then quantify the carbon emission indicators, so the carbon emissions data are estimated. The latter combines the maximum target of network capacity, establishes the objective function, and uses the example to carry on the computation verification, has verified the applicability of the model.

In order to realize the sustainable development of urban traffic, the author Lin Hongliang, Huang Xiaopeng and Yu Qiang et al. first studied the energy consumption law of urban transportation system, and then established the fuel consumption model and evaluation method[1]. In the study of Shan Jianlian et al., the research structure and land use have made significant progress based on the relationship between individual traffic demand and planning. Jia Shunping and others consider the traffic energy in urban traffic space on the basis of traffic travel model. In these studies, urban structural patterns and network layout characteristics have a crucial impact on urban transport systems that are committed to sustainable development. Jiang Zhizhe and Li Peizu take Hunan as an example, pointing out that road energy saving and emission reduction should improve road quality and technical level. Research shows that by improving the road conditions, improve the road network structure, can achieve the purpose of saving energy.

In the study of low-carbon ideas and low-carbon transport, urban traffic has become a scholar in the eyes of the problem, but the study of urban road network is always easy to be ignored. The combination of low-carbon ideas and urban road network research, is to adjust and optimize the road network at all levels of the proportion of roads and connections to achieve the purpose of reducing traffic carbon emissions research. Through the study we can see that the optimization of the road network structure has a greater impact on the smooth operation of road traffic and reduce road traffic carbon emissions. Therefore, making the low-carbon concept into the urban road network optimization, is a start, with great potential in the field, still to be in-depth study.
3. Study on Energy Saving and Emission Reduction of Pavement Materials

Resources and the environment increasingly into people's vision. Asphalt pavement construction and operation and maintenance have produced some environmental problems, which is also attracting widespread attention both at home and abroad. In the field of energy saving and emission reduction of asphalt pavement, it is an important research topic to establish scientific and reasonable quantitative analysis and evaluation system of energy saving and emission reduction.[1]

In the road construction and construction process should promote the warm mix asphalt technology and cold cooling technology, not only for energy-saving emission reduction is of great significance, but also to achieve sustainable development of strategic objectives. Asphalt cold fill material is conducive to environmental protection, such as the production and use of the process will not produce dust and potholes, and its finished products do not dissolve in water, do not pollute water resources.[2] Asphalt pavement regeneration technology research and development and application, in line with the sustainable development of transport requirements.[3] The application of this technology can not only increase the durability of pavement structure, but also more conducive to the protection of the ecological environment.

Most of the domestic road use asphalt pavement. In order to reduce the maintenance costs of asphalt pavement and the environmental pollution caused by the construction, China has been on the old asphalt concrete material recycling using a variety of renewable technology and equipment. The first choice for road management is: First of all, the relevant units of the old asphalt paving materials for recycling; Second, the unit on the road to re-cover and overlay.[4]

At present, on the asphalt pavement energy-saving emission reduction quantitative evaluation methods, domestic and foreign scholars, experts through continuous efforts, and achieved some useful results. The United States has formulated the analysis and evaluation system of environmental impact of highway construction project, and analyzed and evaluated its economic cost.[5]

Although the evaluation method is not strong in the evaluation results, the advantage is that the quantitative analysis of energy consumption and emissions of asphalt pavement is more comprehensive. Combined with the life cycle analysis method and subjective and objective evaluation methods, for the highway construction project, developed the US highway construction environment and ecological sustainable evaluation system. The evaluation method is insufficient in the scope of application is narrow, can not be extended to other countries and regions. The advantage is that the evaluation index can be quantified, the construction cost can be analyzed and the evaluation function of the analysis result is improved. The University of Washington's research team worked with the American CH2M HILL to analyze and evaluate the overall impact of the road environment from a sustainable development perspective.[6] Thus, the United States in the asphalt pavement energy consumption and emissions of quantitative analysis, although the relatively weak, but also a more comprehensive evaluation index system.[7]

In the quantitative analysis of the impact of road construction on the environment, although China has not yet practical application, but some researchers have put forward the quantitative evaluation method of the indicators, the corresponding research. In general, domestic and foreign research on this area for more than the actual situation of a region, does not have universal. China's asphalt pavement energy-saving emission reduction quantitative research is still a long way to go.

4. Study on Energy Saving and Emission Reduction of Pavement Maintenance

Compared with foreign countries, China's road management and maintenance work are starting late, and the development is lagging behind. Based on the advanced technology of foreign countries, combined with the actual structural characteristics, material properties, geographical environment, traffic conditions, climatic conditions and regional influence of the road surface in China, the R & D department should carry out research and development of the road management system suitable for China's actual situation and formulate corresponding Pavement conservation measures and strategies. Based on the asphalt pavement function theory, Sun Lijun and others put forward the preventive maintenance index system[8]. Zeng Feng to develop protection planning, cost theory, gray theory, and the introduction of highway maintenance strategy research; Through the use of short-term benefits - cost analysis, Zhi Jianming identified the timing of conservation and conservation programs, and made the gray theory is introduced into the road maintenance strategy research; And Yao Yuling, Ren Yong et al. Based on the life cycle benefit-cost study, to determine the best preventive
maintenance procedures for the life cycle cost of the best program\textsuperscript{[9]}. On the basis of research, the relevant units gradually standardized the conservation technology and conservation measures. For example, according to the actual situation in Shanghai, the municipal government put forward the "road asphalt pavement preventive maintenance technical regulations" to determine the asphalt pavement preventive maintenance standards and strategy selection methods and processes\textsuperscript{[10]}. The method is similar to the expert library method. In addition, the country carried out a large number of pavement conservation practical engineering applications, and the development of a number of pavement management system for conservation strategy development.

Foreign scholars are more focused on transport planning, transportation, sustainability research. There are some scholars have studied this, such as Zhang Shengrui on the road to a comprehensive and sustainable development of a comprehensive analysis. There are few studies on sustainable development in road maintenance. In the analysis of China's road traffic development model, Li Yang has proposed it, but did not focus on road maintenance; Yu Xiang believes that it should take the lead in reforming the existing management system and the sustainable development of road maintenance research, and the maintenance of the market-oriented operating mechanism, strengthen the budget of highway maintenance funds, and establish the concept of highway construction and protection. Cao Yunlong suggested that the life of the remaining road network to maintain a good distribution of the state, we must make full use of the concept of sustainable development.

In the last century, the United States faced a lot of road maintenance work. Therefore, the concept of preventive maintenance came into being, which is recognized by the majority of the road maintenance staff. Some scholars have studied the precautionary conservation measures, the decision tree and the decision matrix method are used for the selection of measures. This approach is now widely adopted. Because the principle of the method is to first calculate the efficiency of the measures taken and then select the most cost-effective conservation measures as the best conservation plan\textsuperscript{[11]}. Proposals for preventive conservation benefits have been proposed, and we are able to establish a well-established model of preventive maintenance\textsuperscript{[12]}. This method describes the calculation of the effect in the model in detail, gives the method to determine the effect weight coefficient, and quantifies the effect.

In 1997, Canadians, through the knowledge base, mimic the thinking of human experts, to provide scientific road maintenance measures, which is flexible pavement conservation knowledge expert decision-making system. Because the knowledge base is formed by a large number of conservation knowledge provided by experts in road maintenance, the basis of the choice of measures, reference and decision-making has a certain scientific nature. Neural network method has been used and confirmed that the method used to develop conservation strategies, and in the conservation strategy to develop a certain degree of superiority. Australian states first through the government allocated funds, and then develop the optimal plan to determine the road maintenance program, and finally chose the most appropriate conservation measures. This is similar to the US PMS asset management system. In New South Wales, the road transport sector has developed a strategic plan based on aspects of conservation needs, such as road system performance, road characteristics, road conditions and social welfare, including a five-year plan for basic conservation. Pavement maintenance management tends to be privatization, contract management, and statistical data show that this reduces maintenance costs.

5. Conclusion

Based on the reality that energy conservation and sustainable development has become the main theme, the road industry's energy-saving emission reduction has played an increasingly important role. Road energy-saving emission reduction technology, the transportation industry is an integral part. This paper is based on the current lack of resources, lack of information, difficult implementation of laws and technology and other issues, from the road network, road materials and road maintenance in several areas, from domestic and foreign respectively, elaborated on the energy saving and emission reduction technology research progress, in order to better understand the current status of energy-saving emission reduction research.
References

[1] YANG Bo. Study on Quantitative Analysis Method and Evaluation System of Energy Saving and Emission Reduction of Asphalt Pavement [D]. Chang'an University, 2012.

[2] LI Wen-zhong. Application of Cold-fill Technology in Asphalt Pavement Maintenance [J]. Heilongjiang Transportation Science and Technology, 2006, (06): 27.

[3] Li Yan-yan. Study on the Performance of In-situ Thermal Recycled PE Modified Asphalt Mixture [D]. Changsha University of Science and Technology, 2010.

[4] Wu Huiqing. Recycling of waste asphalt [J]. Sichuan Cement, 2015, (08): 139. [2017-09-13].

[5] Ren Zhaojun. Trunk road network National Economic Evaluation and socio-economic impacts [D]. Chang'an University, 2011.

[6] Yang Bo, Zhang Zheng-qi, Zhang Hui fresh asphalt pavement energy saving quantitative evaluation method [J] Highway and Transportation Research, 2014,31 (01): 32-38 [2017-09-14].

[7] XU Jian. Evaluation of energy consumption of asphalt pavement [J]. China Highway, 2016, (19): 76-77.

[8] YAO Hui-ning. Study on Expressway Pavement Management System Based on Preventive Maintenance [D]. Chang'an University, 2008.

[9] Shen Haisheng. Study on Nonlinear Fuzzy Evaluation and Preventive Maintenance of Asphalt Pavement Performance [D]. Anhui University of Architecture, 2015.

[10] Tang Li. Study on preventive maintenance cost model of asphalt pavement of expressway [D]. Chongqing Jiaotong University, 2012.

[11] Zeng Feng. Study and Technology Application of Asphalt Pavement Preventive Conservation Decision Method [D]. Harbin Institute of Technology, 2009.

[12] Li Lei. Study on Key Indicator System of Asphalt Pavement Preventive Maintenance [D]. Chongqing Jiaotong University, 2014.