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ABOUT THE PECULIARITIES OF PROGRESS IN THE WORKS TO CREATE THERMOELECTRIC RECUPERATORS FOR VEHICLES

The analysis of publications, patents, reports at scientific conferences related to the creation of thermoelectric recuperators for the utilization of heat from vehicles is carried out. Conclusions are made on the prospects for further development of such studies.Bibl. 148, Fig. 5.
Key words: thermoelectric generator, exhaust gas, heat recovery.

Introduction

General characterization of the problem.

The use of thermoelectricity for the utilization of waste heat in order to obtain electrical energy has been and remains the subject of interest of specialists dealing with thermoelectricity for the last almost three decades. Internal combustion engines (ICEs) of vehicles occupy a significant place among the sources of waste heat. Therefore, this interest is understandable, since, despite the efficiency of internal combustion engines, almost 2/3 of the thermal energy (Fig. 1) obtained from burning gasoline or diesel fuel is given to the environment, contributing to the thermal pollution of our planet.

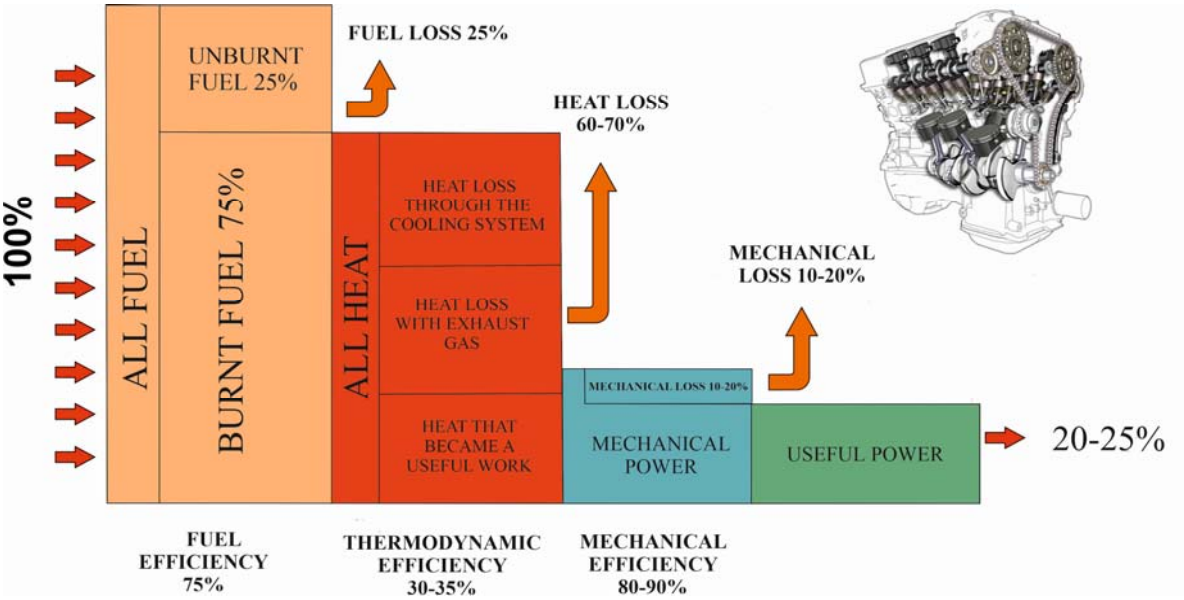

Fig. 1. Energy balance in the internal combustion engine.

The purpose of this work is to analyze the achievements and prospects in the field of thermoelectric recuperators for vehicles.

Progress in the works to create thermoelectric generators (TEG) for vehicles

The geography of research and development of TEG for vehicles covers most of the countries where thermoelectric studies are pursued. More than a hundred reports at many conferences were devoted to the results of such works (Fig. 2).

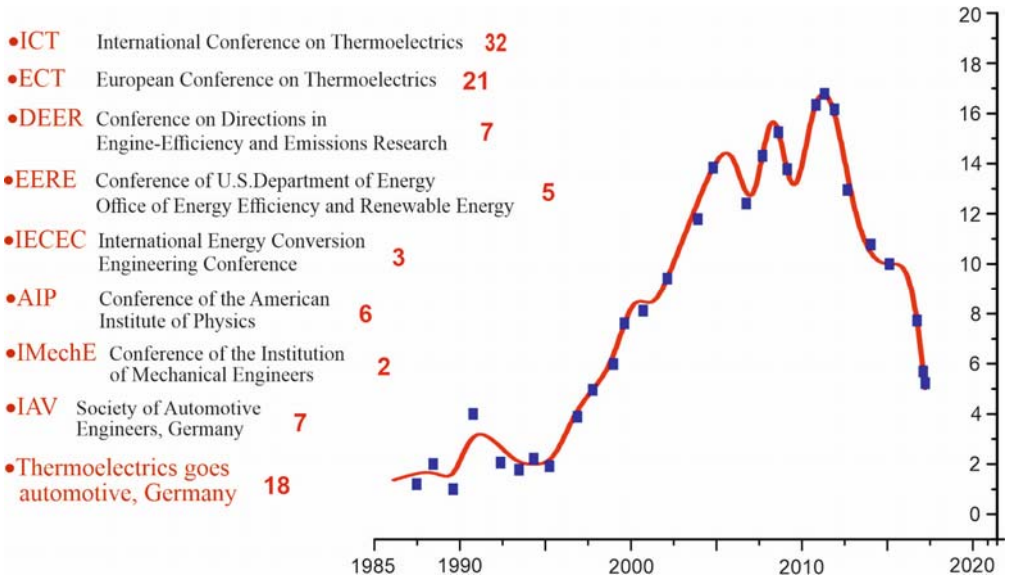

Fig. 2. The dynamics of growth in the number of reports at international conferences on TEG for vehicles [1 - 52].

It should be noted that the peak of research on such thermoelectric generators falls on 2010. After that, there is a decrease in the number of such works. Similar dependences are observed in the number of publications. Their maximum also falls on 2010 with a curtailment of activity in subsequent years (Fig. 3).

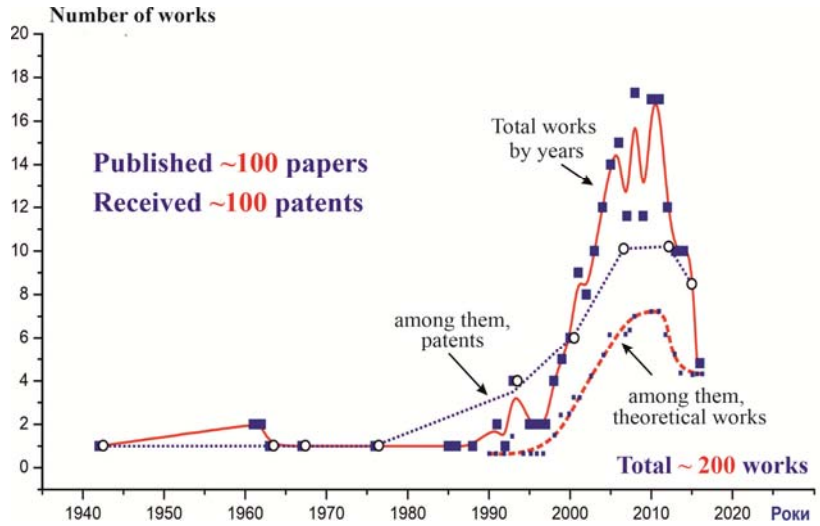

Fig. 3. Dynamics of TEG research activity for vehicles [53 - 148].

The rapid growth in the number of works from the 1990s to the 2010s was the result of hopes for the introduction of automotive thermoelectric generators. However, during this period, in most cases, the samples of generators were developed without proper theoretical justification, simply based on the experience of creating thermogenerators for other purposes - space, autonomous ground, underwater, and so on. About a hundred papers have been published and almost the same number of patents have been received. The result of these efforts was an increase in the power of generators for vehicles up to 1 kW (Fig. 4). Efficiency also increased (Fig. 5), but in the values 8 - 10 times less than expected.

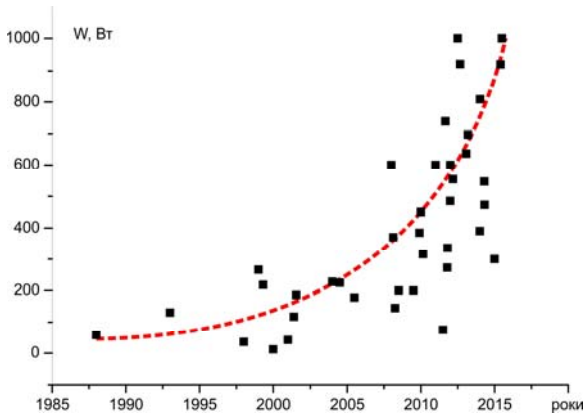

Fig. 4. Growth of TEG power for vehicles.

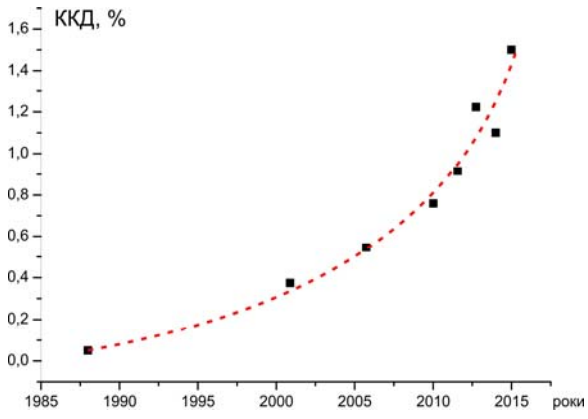

Fig. 5. Growth of TEG efficiency for vehicles.

Nevertheless, the results obtained provided important information about the possibility of using thermogenerators for the utilization of waste heat from vehicles. Let us consider the main ones.

1. It should be recognized that the development of generators for cars is one of the most complex, based on the requirements for them and their properties:
   - restrictions on weight and volume due to their shortage, especially on cars;
   - increased requirements for traffic shaking;
   - significant dependence of thermal power on time leading to increased requirements for the cyclic thermal resistance of generators;
   - lack of stability in electrical voltages and powers, which requires the use of special electronic means to overcome these disadvantages;
   - inefficient use of generators due to their predominant operation in the modes far from maximum power and efficiency;
   - low efficiency values, which cause the high cost of electricity received from generators;
   - restrictions on large-scale use of generators due to insufficient tellurium;
   - heat removal from generators and other problems.
2. The use of thermogenerators in other non-automotive vehicles - diesel locomotives, airplanes, and especially water transport, where the above problems and limitations are less significant looks more promising.
3. In general, progress in thermoelectricity leaves the dream of creating thermoelectric generators for transport vehicles not hopeless. Enthusiasts of this business hope that with a decrease in the cost of generators by 3 -5 times and the provision of their other specific properties, conditions will arise that are promising for their industrial use.

Such results make the idea of creating thermoelectric generators for mass production unattractive, so

many of the developers abandoned their further development. In addition, theoretical work led to an understanding of the complexity in the implementation of the idea of thermoelectric generators for cars and became the reason for the curtailment of work in this direction.

Based on these results, it is important in general to consider how promising are further studies in this direction and what real results should be expected in this case.

Conclusions

1. Nonoptimal research and development, when numerous experimental attempts were made without adequate theoretical justification, resulted in an excessive waste of resources and time.
2. The use of TEG on cars is one of the most complex applications of thermoelectricity. Primarily due to a non-stationary heat source, shock and vibration loads, size and weight limitations.
3. A new approach is necessary to consider thermoelectric generators for vehicles, where a thermoelectric generator and an internal combustion engine are jointly considered.

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ПРО ОСОБЛИВОСТІ РОЗВИТКУ РОБІТ ПО СТВОРЕННЮ ТЕРМОЕЛЕКТРИЧНИХ РЕКУПЕРАТОРІВДЛЯ ТРАНСПОРТНИХ ЗАСОБІВ

У роботі проведено аналіз публікацій, патентів, доповідей на наукових конференціях, що стосуються створення термоелектричних рекуператорів для утилізації відходів тепла від трансопртних засобів. Зроблено висновки про перспективи подальшого розвитку таких досліджень. Бібл. 143, рис. 5.
Ключові слова: термоелектричний генератор, вихлопний газ, утилізація тепла.

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О ОСОБЕННОСТИ РАЗВИТИЯ РАБОТ ПО СОЗДАНИЮ ТЕРМОЭЛЕКТРИЧЕСКИХ РЕКУПЕРАТОРА ДЛЯ ТРАНСПОРТНЫХ СРЕДСТВ

В работе проведен анализ публикаций, патентов, докладов на научных конференциях, касающихся создания термоэлектрических рекуператоров для утилизации отходов тепла от трансопртних средств. Сделаны выводы о перспективах дальнейшего развития таких исследований. Библ. 143, рис. 5.
Ключевые слова: термоэлектрический генератор, выхлопной газ, утилизация тепла.

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