PERM NATIONAL RESEARCH POLYTECHNIC UNIVERSITY

The development of the thermoelectric energy generator for oil and gas pipelines electrochemical protection

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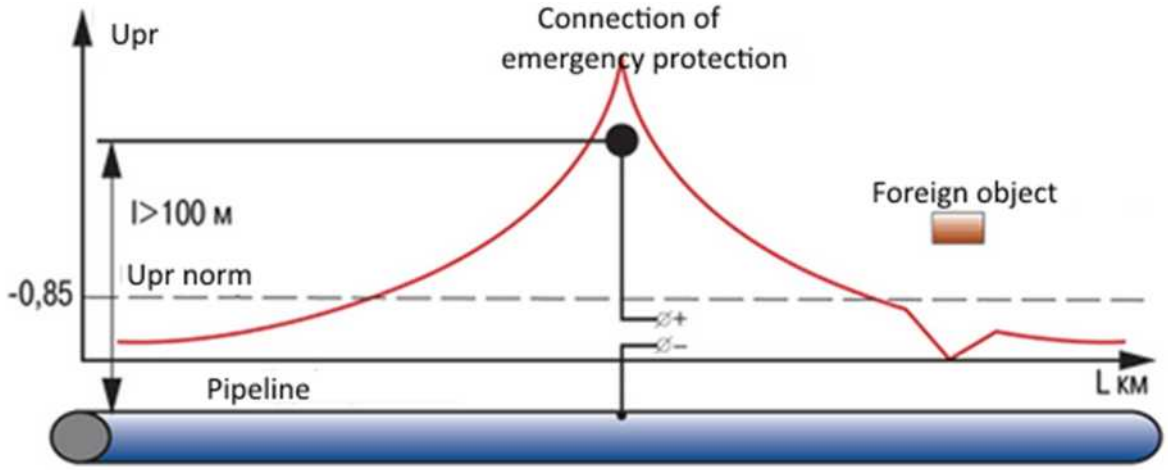
PROBLEM

Underground structures are subjected to intensive dynamic loads and adverse operating conditions. In deformation or damage places a corrosion arises. It leads to enormous costs of repair and maintenance.

SOLUTION:

The development of innovative high-tech protection based on electrochemical protection (ECP).



The principle of operation of ECP

When using the cathode current it may be substantially reduced corrosion propagation. The ECP of underground utilities significantly prolongs life and reduces the number of unscheduled repairs.

URGENCY

At present the "Gazprom" by the method ECP for protection pipelines uses:

diesel generators

- short maintenance intervals
- the high cost of maintenance and repairs in remote areas

steam turbine generators ORMAT

- the cost from 600 000 $
- included in the list of import substitution

Diesel generator

Steam turbine generators ORMAT

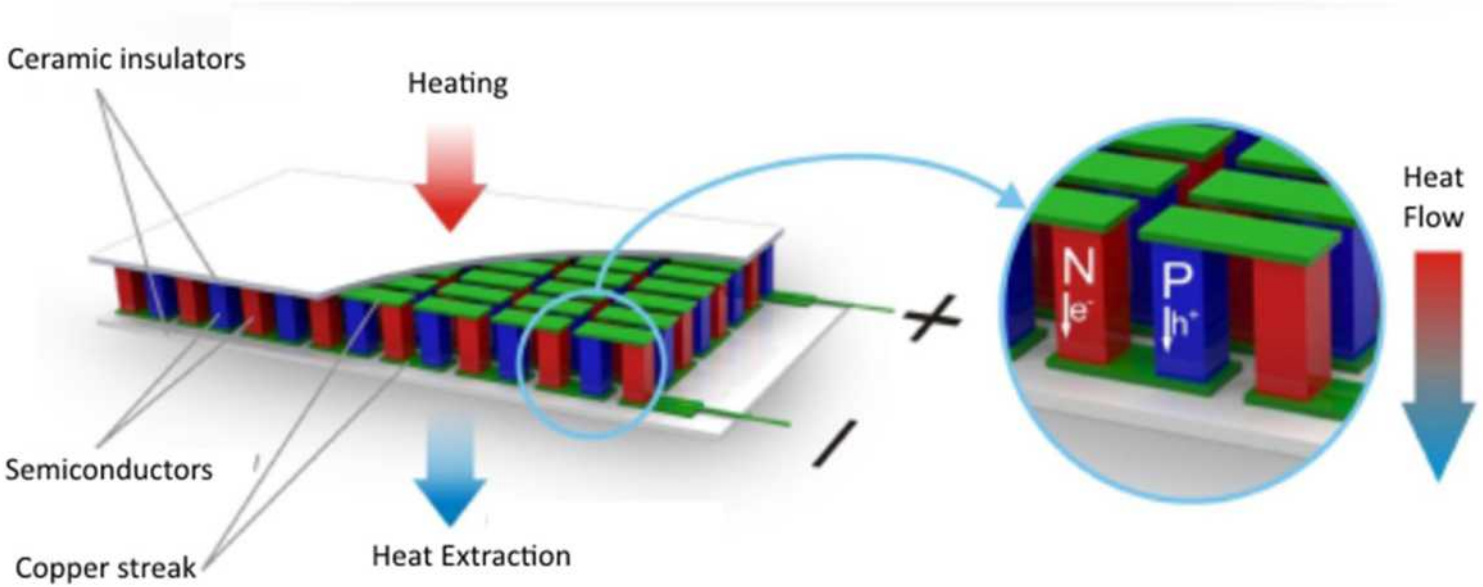
PROJECT GOAL

1) The development of the alternative power generator with low maintenance
2) The numerical calculations for the possibility of achieving the desired output characteristics estimation

The **thermoelectric energy generator based on the Peltier elements** is proposed.

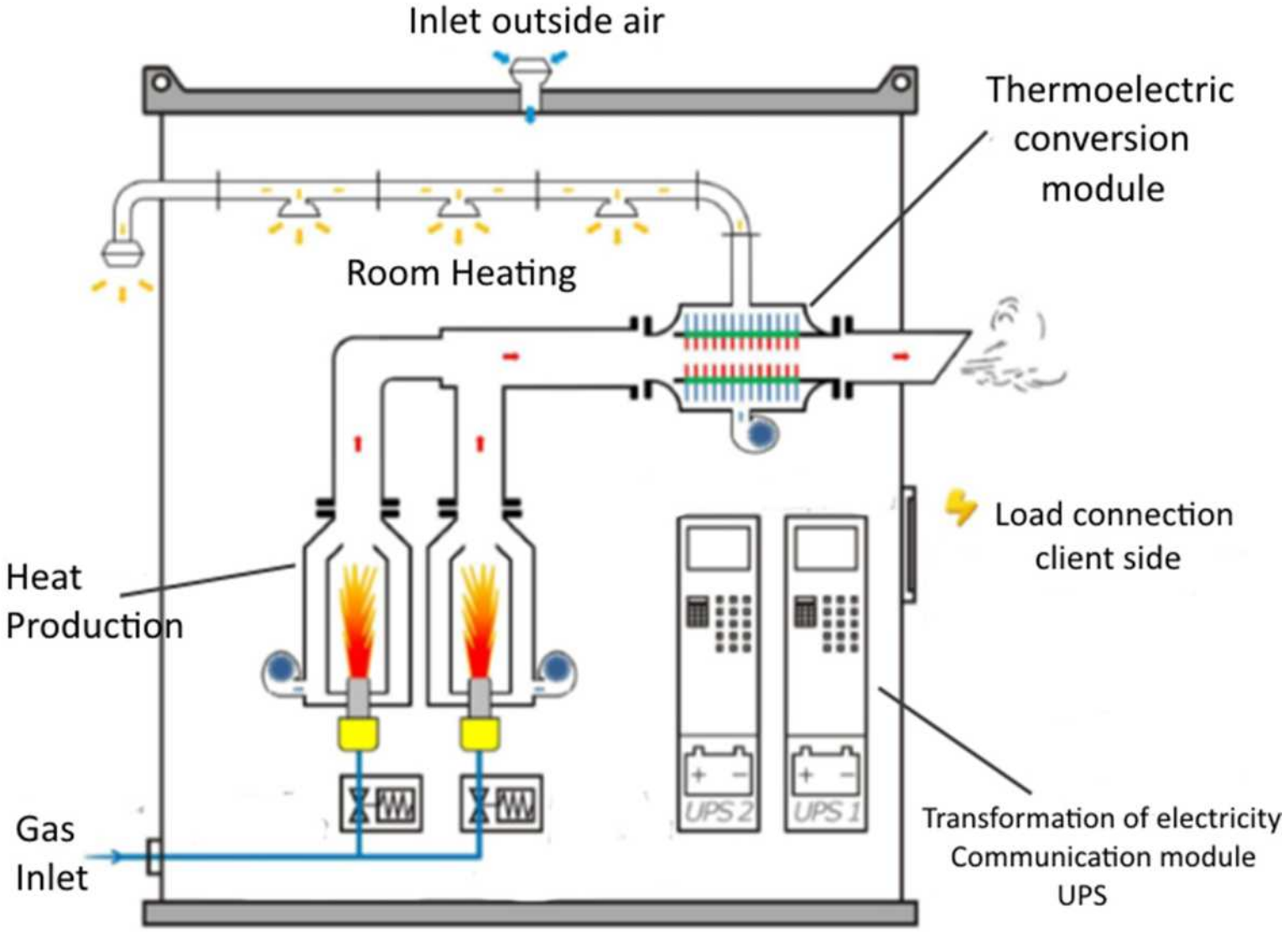
PELTIER ELEMENT

Peltier element is a thermoelectric converter the principle of which is the appearance of an electromotive force in a closed circuit of the semiconductor junction provided that the temperature difference in the site of contact.

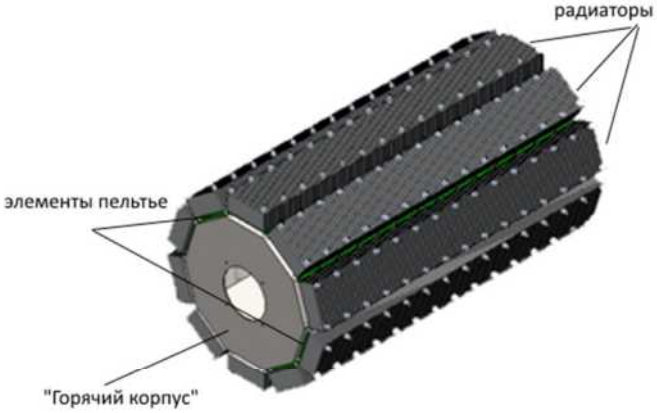


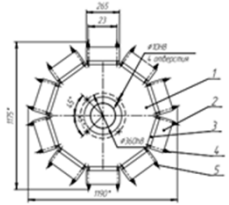
No moving parts ⇒ wear is minimal

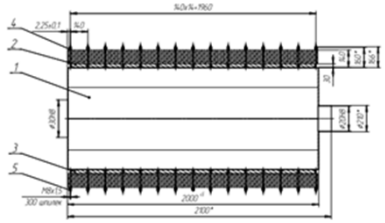
GENERAL CONSTRUCTION



CONSTRUCTION DEVELOPMENT

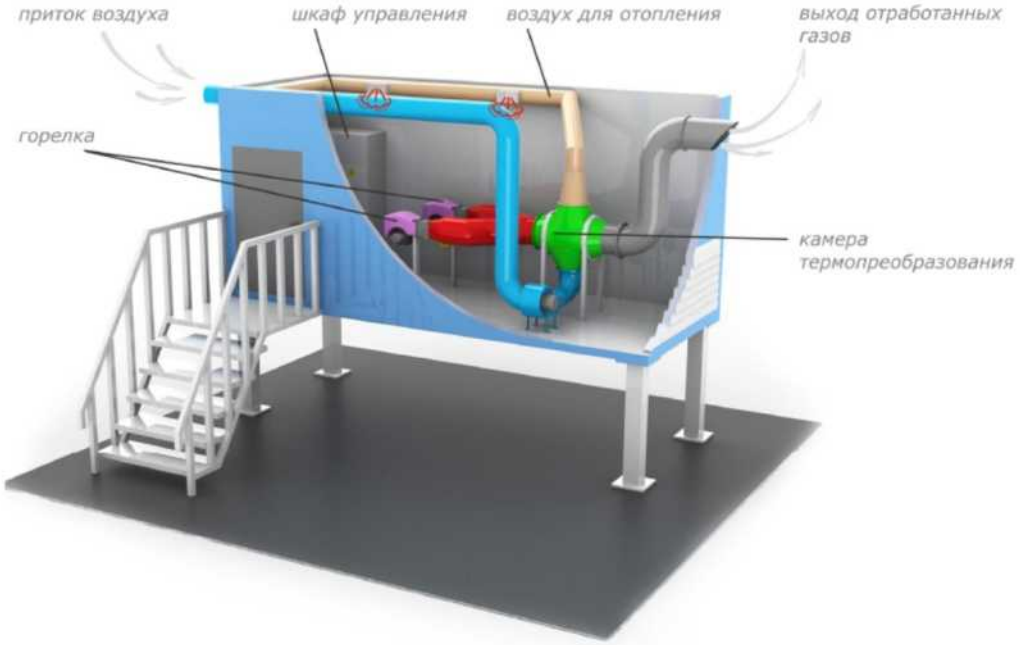






Termoconversion node

Exterior installation

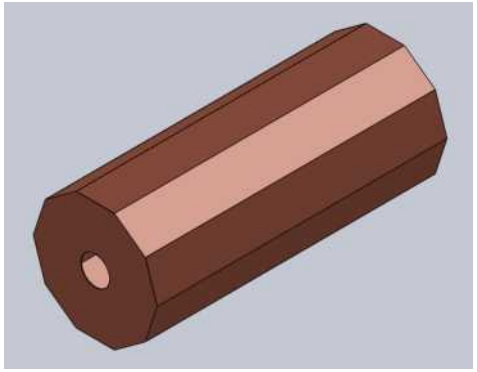


The project plan of internal layout

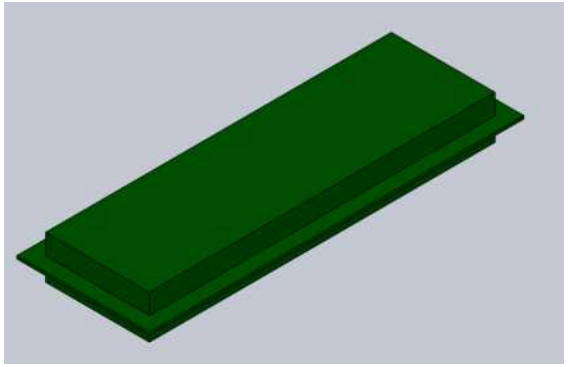
SOLID MODEL DEVELOPMENT

The model was developed using SolidWorks software package.

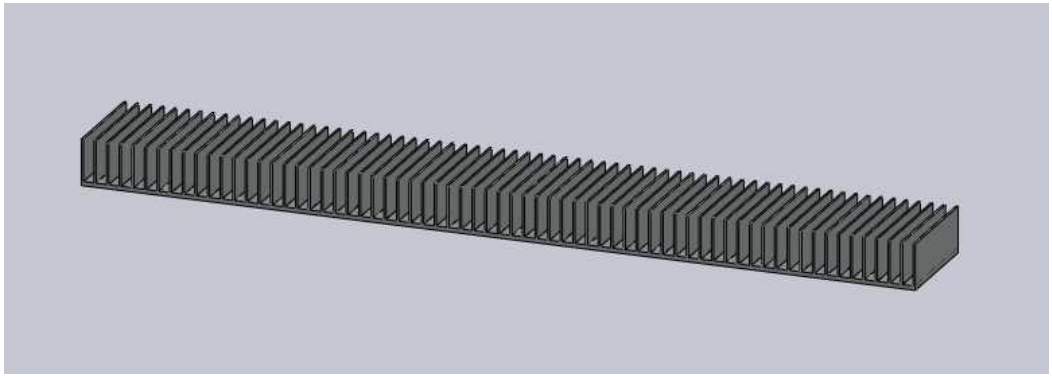
Hot housing



Termoconversion generator module

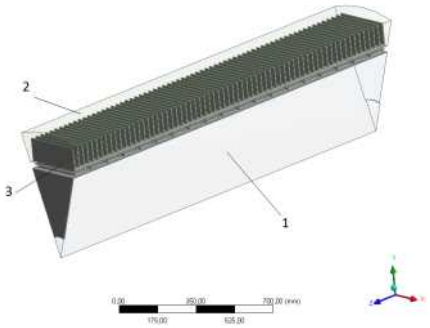


Cooling radiator

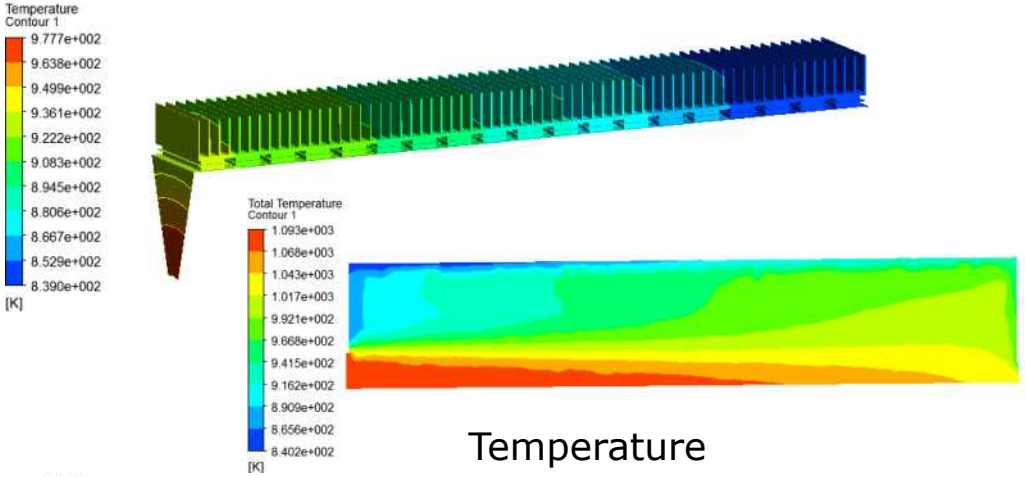


NUMERICAL CALCULATION

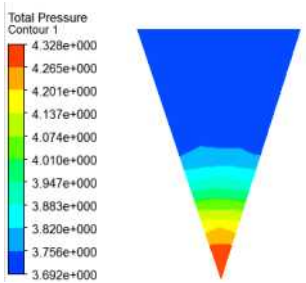
The calculation of the gas-dynamic characteristics of the object is produced using the ANSYS CFX software package



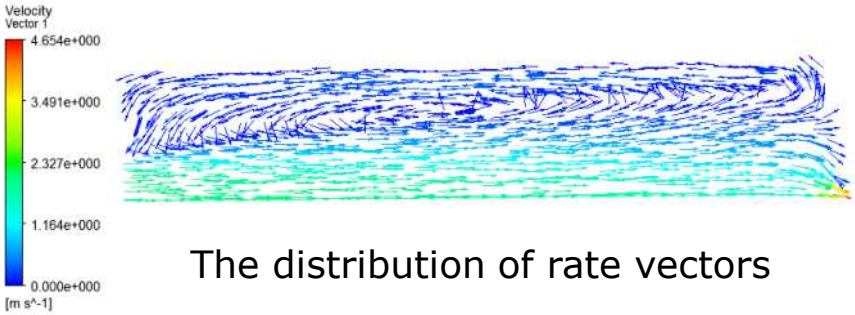
Calculation area



Temperature



Pressure



The distribution of rate vectors

The analysis of numerical experiments proved **the possibility of achievement of the necessary output characteristics**.

TECHNOLOGY COMPARISON

Parameter	TEG	Diesel generator	Steam turbine ORMAT
Power, kW	3-14	3-14	3.5
Service interval, h	30 000	8000	30 000
Fuel type	Gas, oil, fossil fuels, wood chips, steam *	Diesel	Gas, oil
Installation cost	Of 5 million ₽	Of 10 million ₽	600 000 $
Moving parts	Absent, minimal wear and tear	∞	Turbine wheel

RESULTS

- ✓ A principal design is developed
- ✓ The physical and mathematical models are developed
- ✓ The technique of numerical calculation of the gasdynamic and thermal characteristics is developed
- ✓ Numerical calculations of gasdynamic and thermal characteristics are carried out
- ✓ The thermoelectric generator prototype is erected

THANK YOU FOR YOUR ATTENTION!

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PROTOTYPE

The thermoelectric generator prototype was assembled to review the technology and to identify the most important factors that influence the output electrical characteristics.