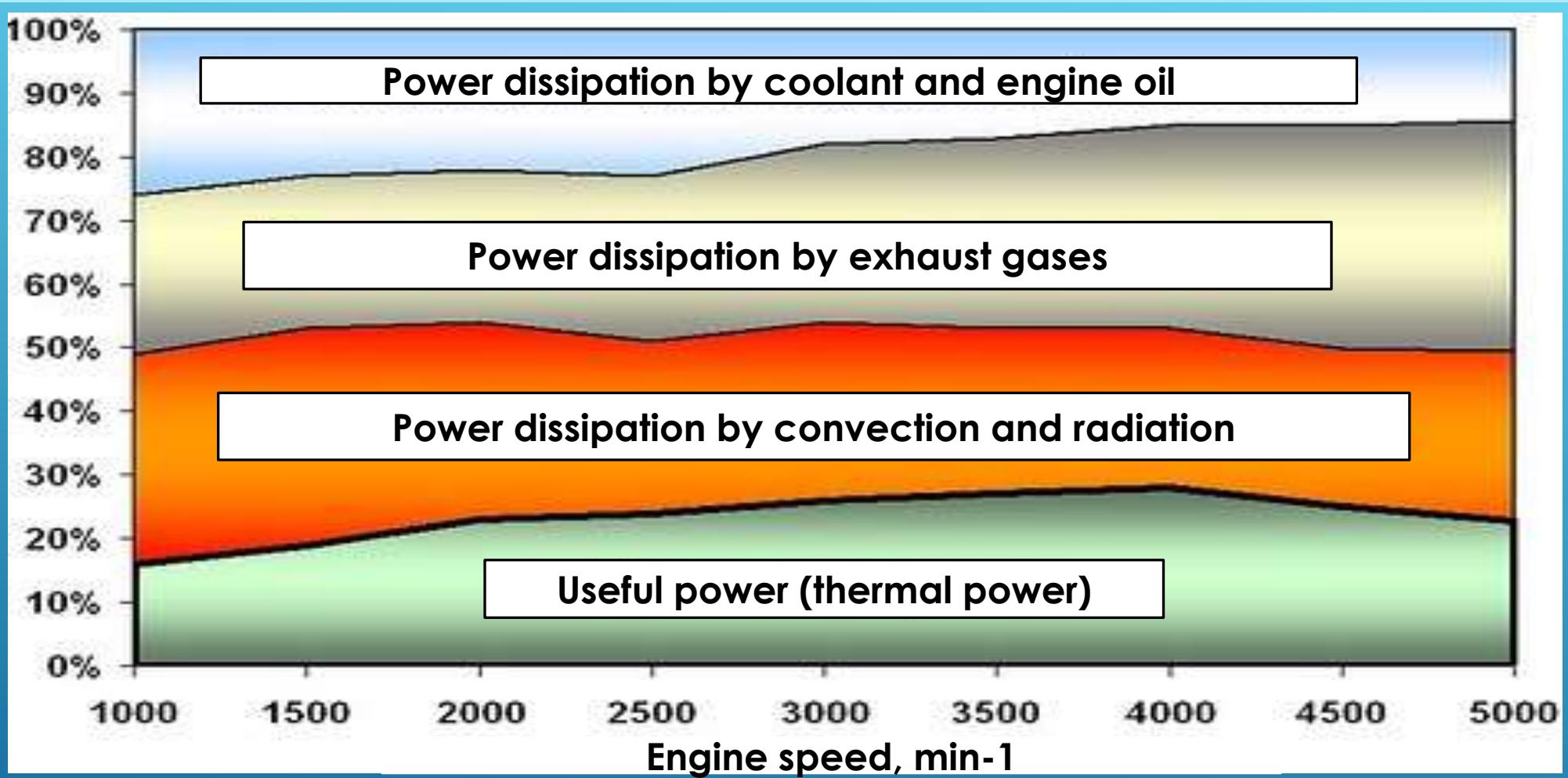
THERMAL PREPARATION OF STATIONARY AND TRANSPORT ENGINES WITH ACCUMULATED ENERGY

Speaker: Igor Gritsuk

Professor, SciD (Tech), Professor of the Department of Ship Technical Systems and Complexes

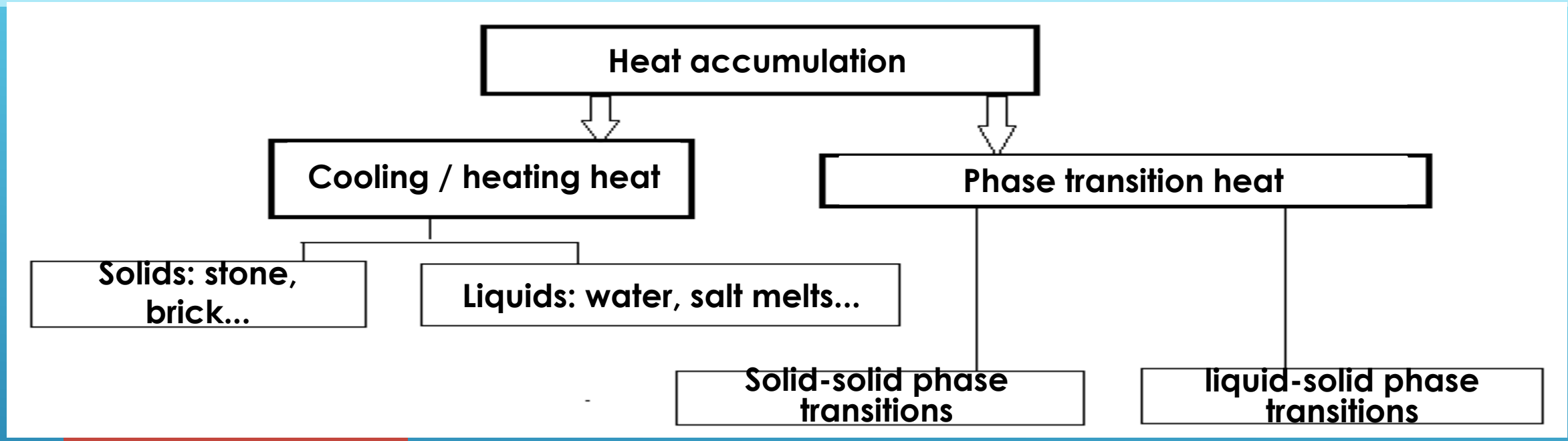
Kherson State Maritime Academy, Ukraine

Thermal preparation of stationary and transport engines with accumulated energy



Features of the distribution of components of the heat balance of a gasoline engine with injection

Thermal preparation of stationary and transport engines with accumulated energy



Cooling of 100 kg of water from 80 to 40°C

Q_1

≈

Crystallization of 100 kg of paraffin (T-3) at 54°C

Q_2

Cooling of 1 ton of brick from 80 to 40 °C

Q_3

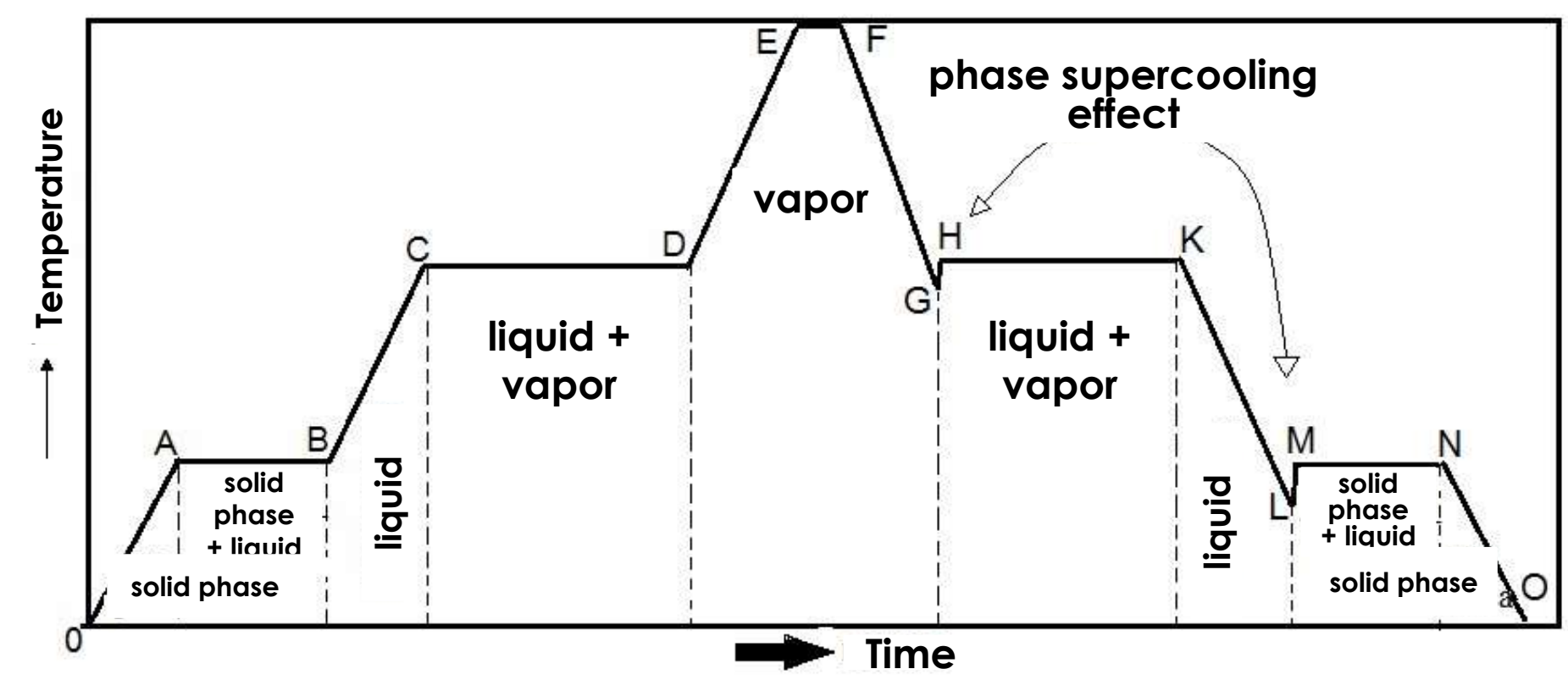
≈

Crystallization of 100 kg of Glauber's salt Na2SO4·10H2O at 32 °C

Q_4

Features of thermal accumulation technology in substances

Thermal preparation of stationary and transport engines with accumulated energy



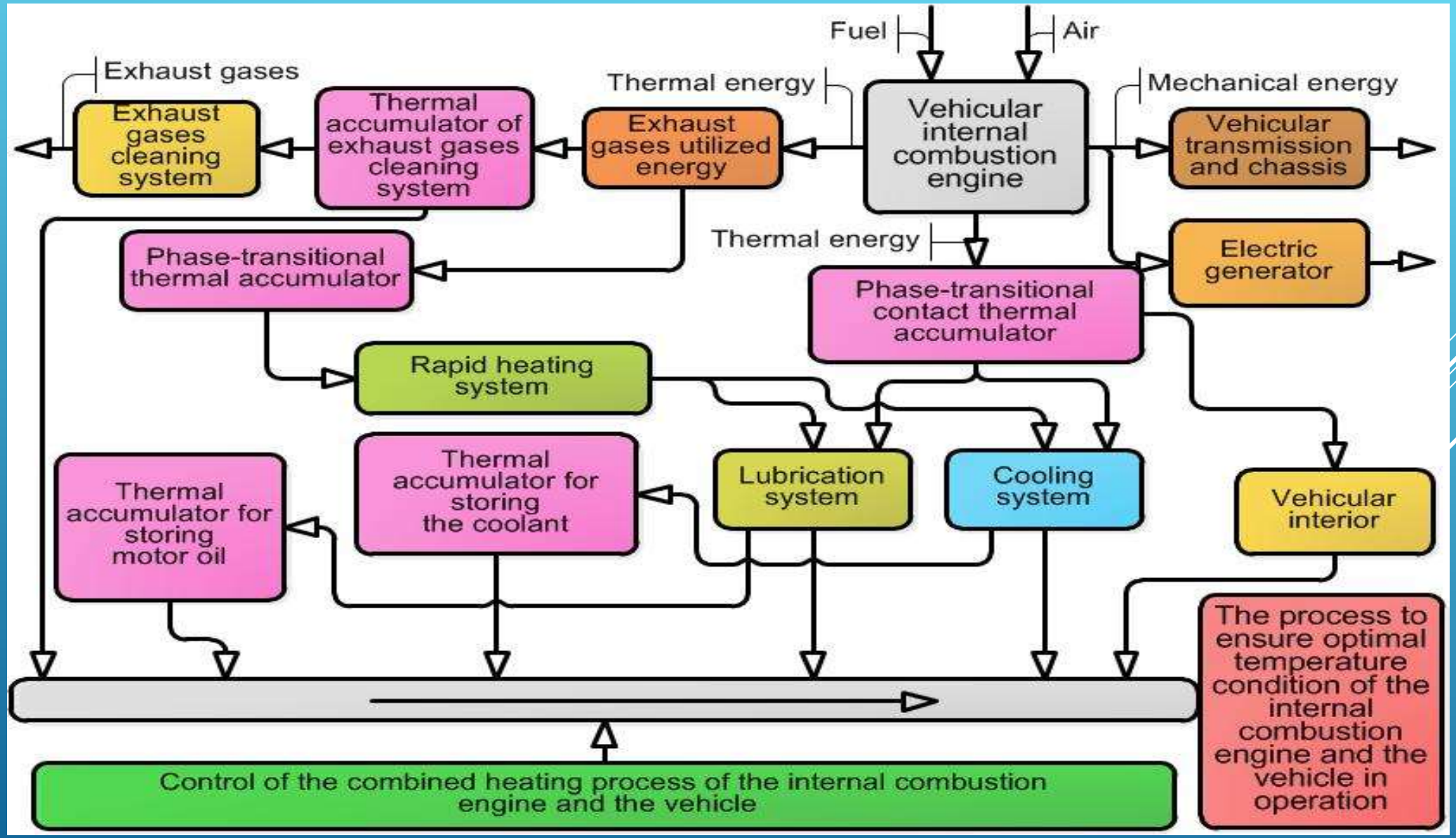
Temperature diagram of heating of a substance

The amount of heat transferred to the material during heating from point O to point E:

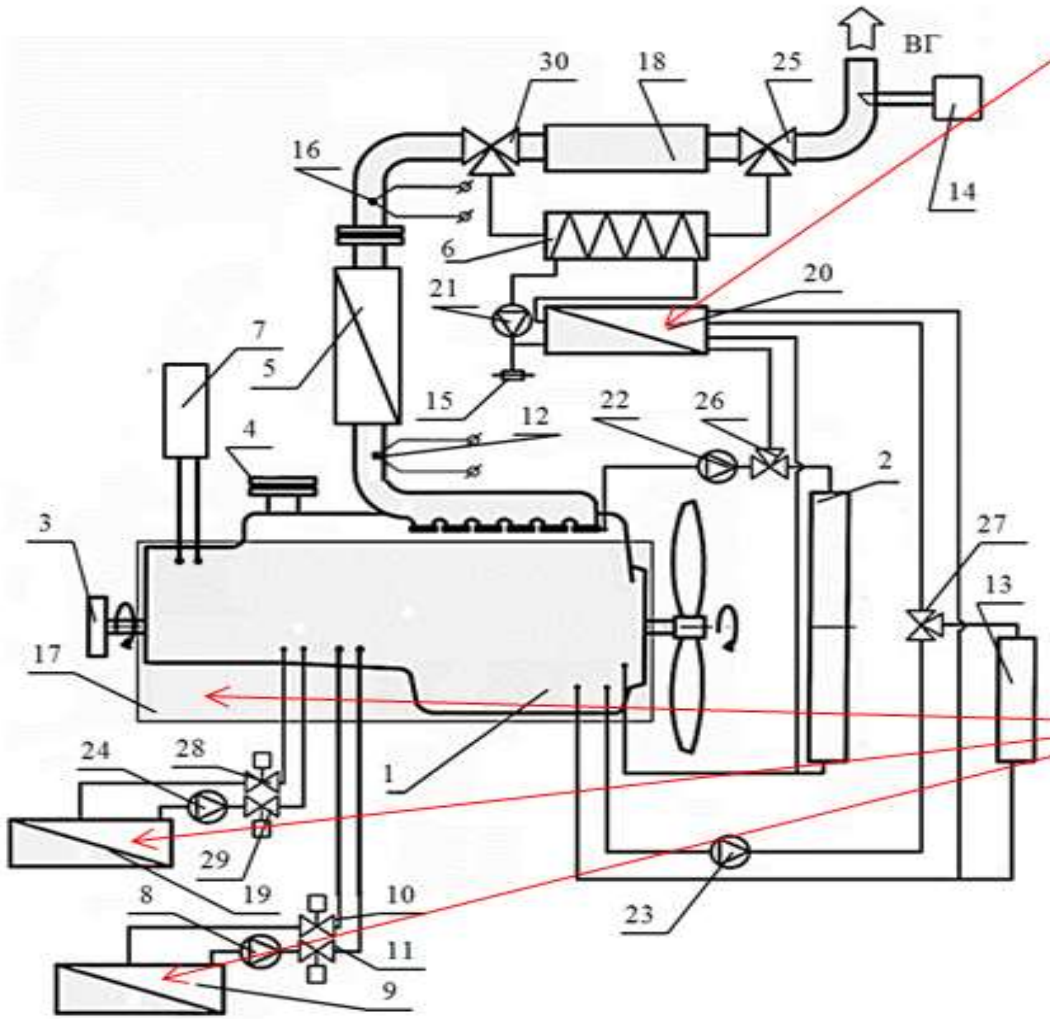
$$Q = m\left[\int_{T_O}^{T_A} C_{ps}(T)dT + q_t + \int_{T_B}^{T_C} C_{pl}(T)dT + q_i + \int_{T_D}^{T_E} C_{pv}(T)dT\right].$$

Thermal preparation of stationary and transport engines with accumulated energy

The formalized scheme of the combined heating system of the engine and the vehicle with the interaction of major energy flows and their conversion



Thermal preparation of stationary and transport engines with accumulated energy



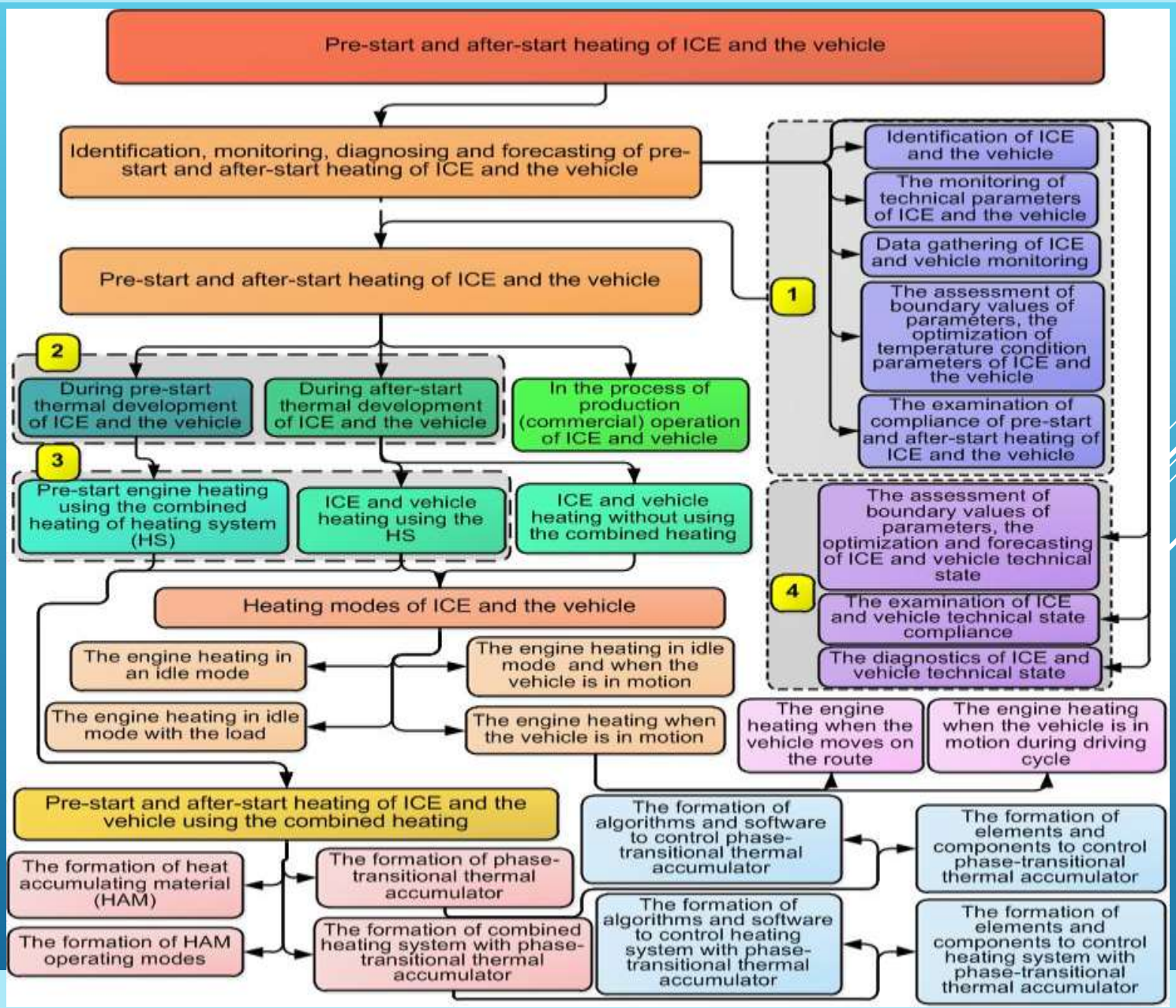
Title	Specification
Heat accumulating material properties:	high-density polyethylene
Density, kg/м³ ρ_s / ρ_l	925 / 800
Temperature of phase transition, K	408
Specific heat of phase transition, kJ/kg	230
Specific heat capacity, kJ/(kg·K), C_s / C_l	2.5 / 3.3
Thermal conductivity, WT/(м·K), λ_s / λ_l	0.25 / 0.04
Heat accumulating material weight, kg	18.5
Weight of thermal accumulator with HAM, kg	32.75
TA dimensions, mm	164x280x480
Thermal insulating material	double layer of polyethylene foam coated on both sides with layers of aluminum foil
TA frame material	stainless steel
TA heat exchanger material	brass
TA heat capacity, kJ/K	46.25

Title	Specification
Heat accumulating material properties (according to the relevant standards):	Paraffin - a mixture of high-molecular hydrocarbons C_{18}-C_{35}
State	Solid
Melting temperature, °C (K)	45-52 (318- 325)
Boiling temperature, °C (K)	350 (623)
Latent heat of melting, K	35
Specific heat of phase transition, kJ/kg	190
Thermal insulating material	double layer of polyethylene foam coated on both sides with layers of aluminum foil

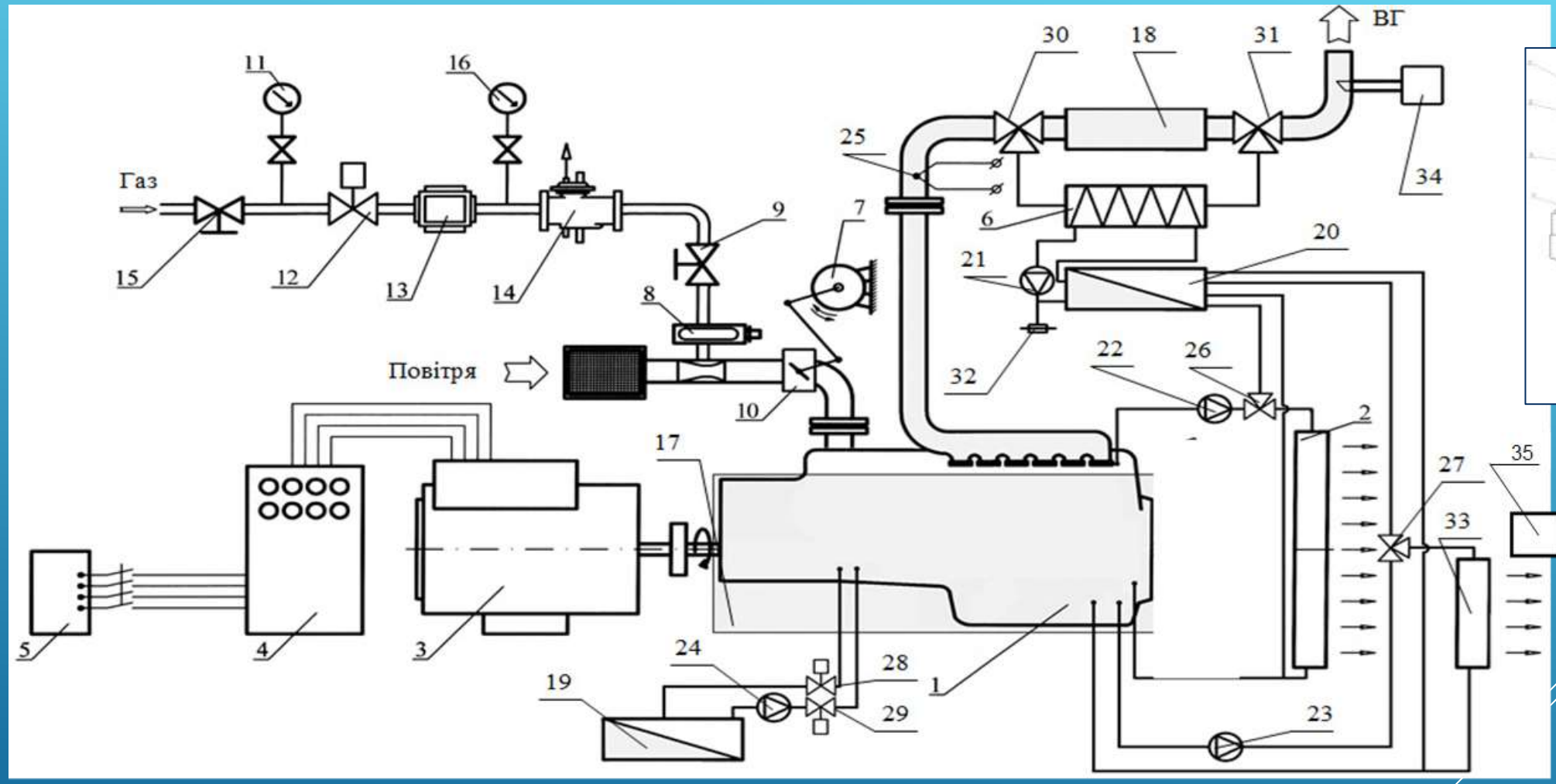
The scheme of the combined heating system of the engine and the vehicle and specifications of phase-transitional TA and its HAM

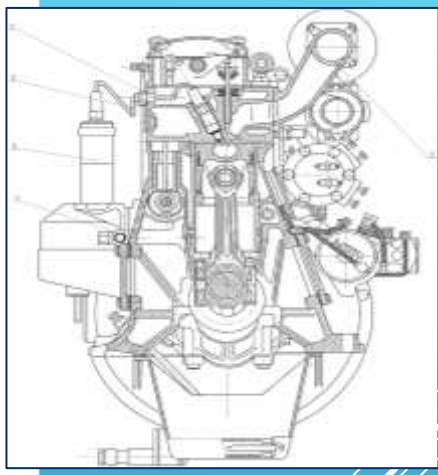
Thermal preparation of stationary and transport engines with accumulated energy

The system of pre-start and after-start heating of the engine and the vehicle in operation



Thermal preparation of stationary and transport engines with accumulated energy

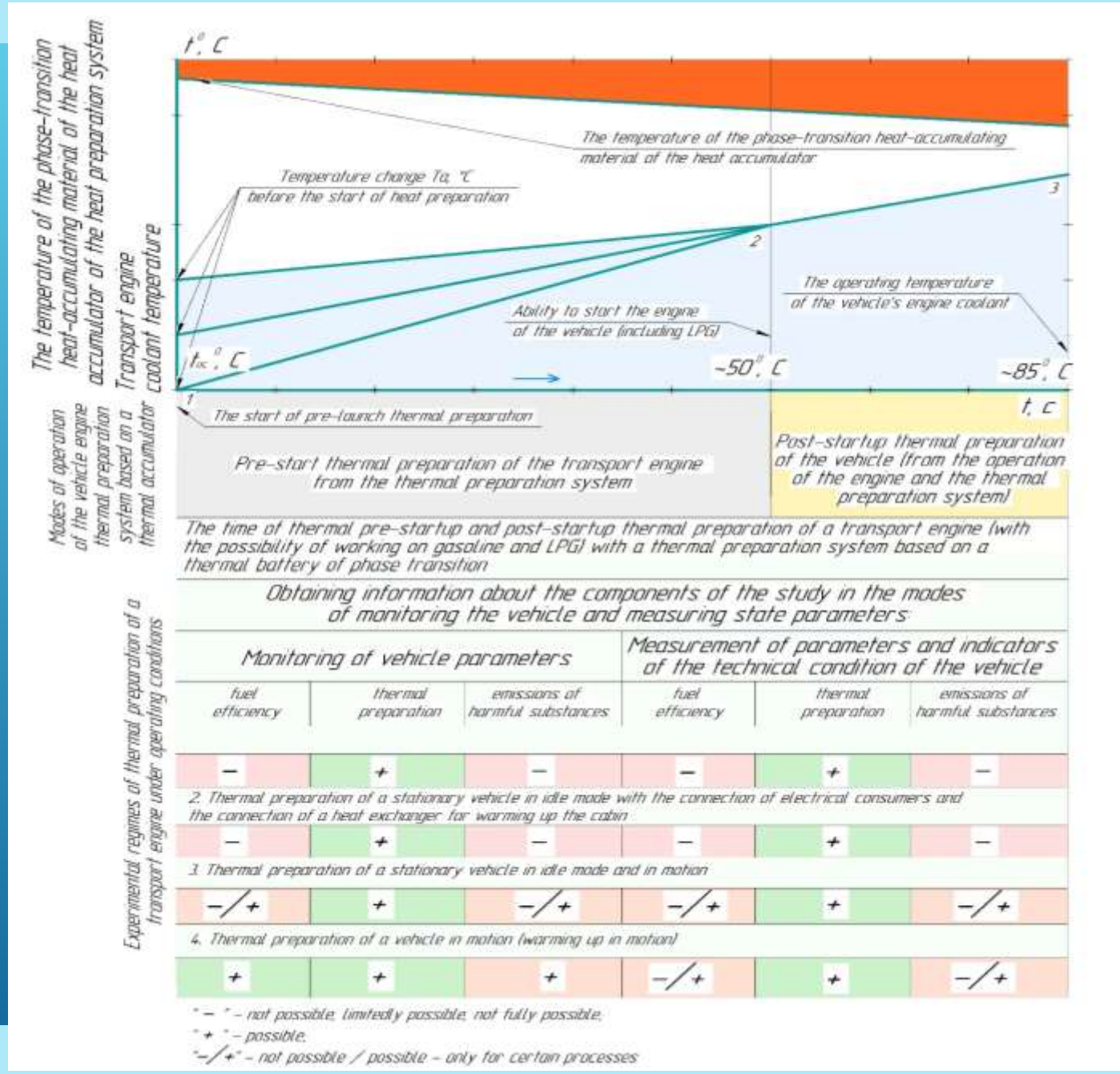




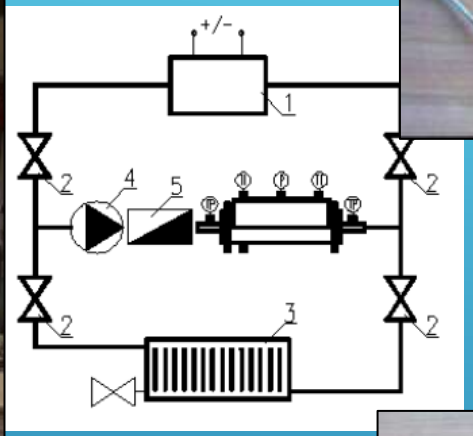
General scheme of the thermal preparation system using the accumulated energy of the experimental stationary gas engine 6FS 12/14 (K-159 M2)

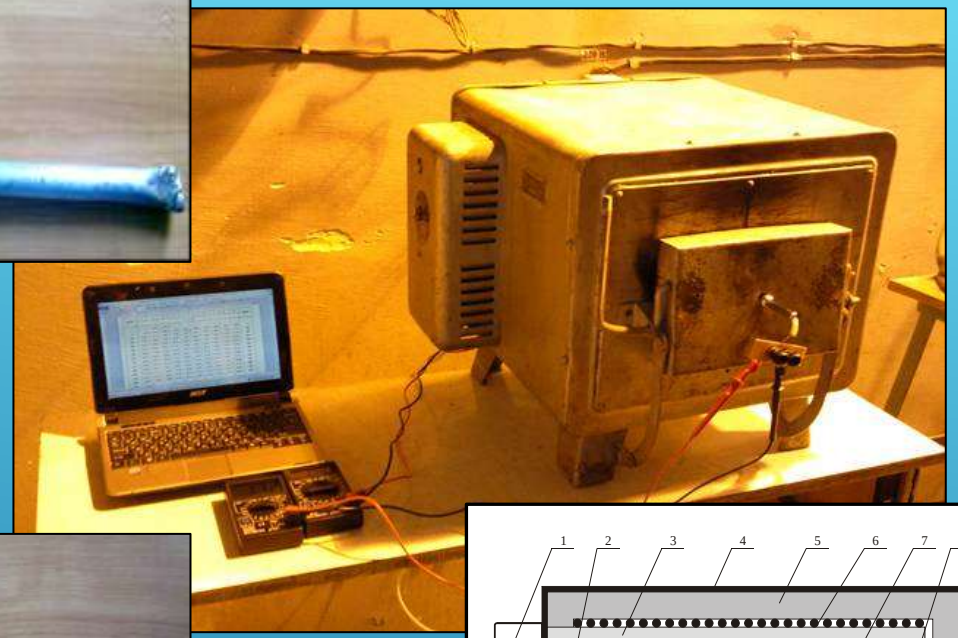
Thermal preparation of stationary and transport engines with accumulated energy

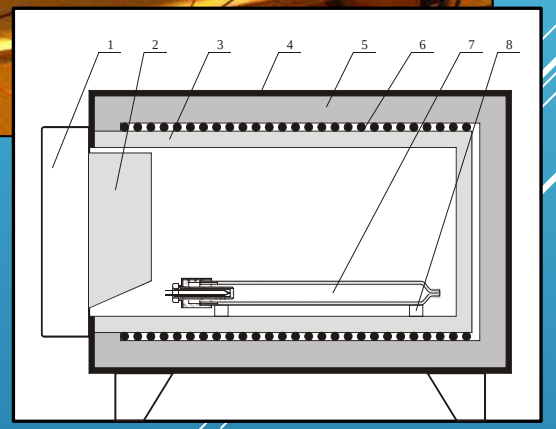
The thermal preparation cycle of a vehicle with an engine modified for operation on petrol and LPG, equipped with a thermal preparation system based on a phase-transition heat accumulator, under operating conditions with the justification of the implementation of experimental research and the approach to ensuring the thermal preparation processes of the vehicle in terms of fuel consumption and exhaust gas emissions



Thermal preparation of stationary and transport engines with accumulated energy

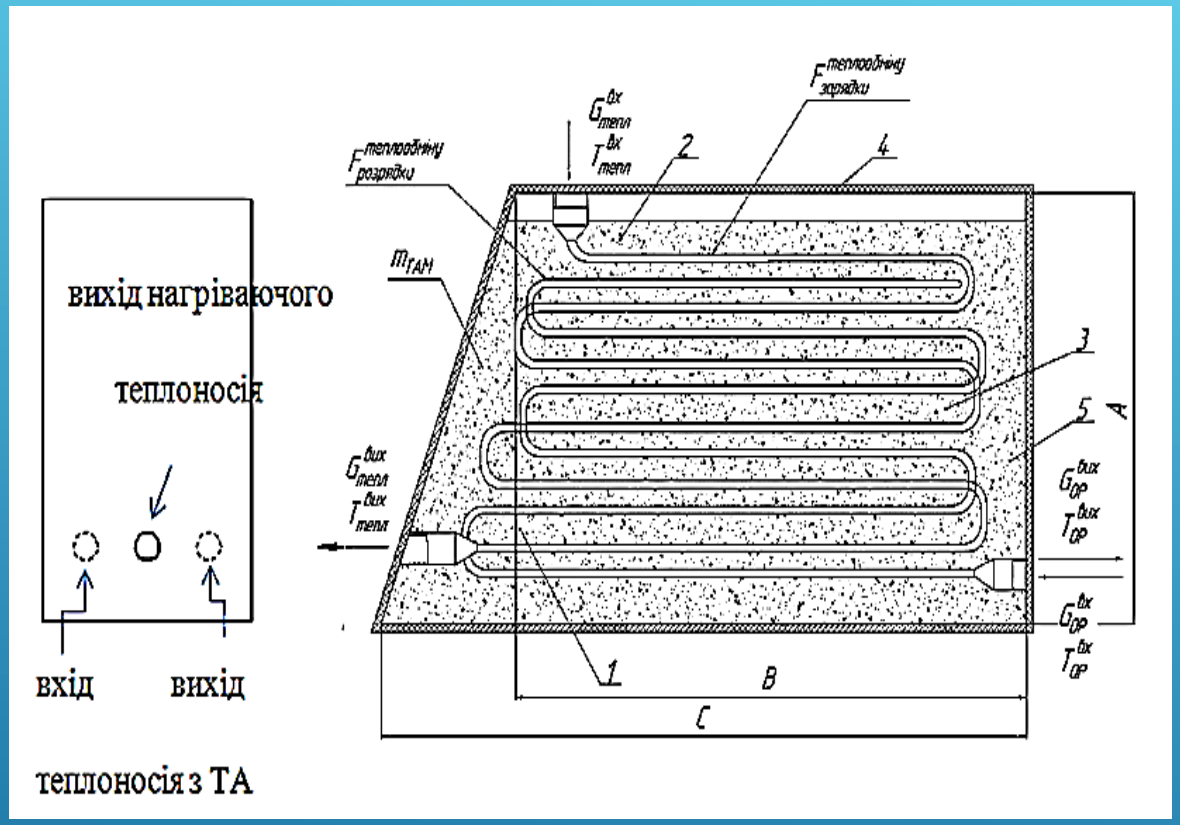






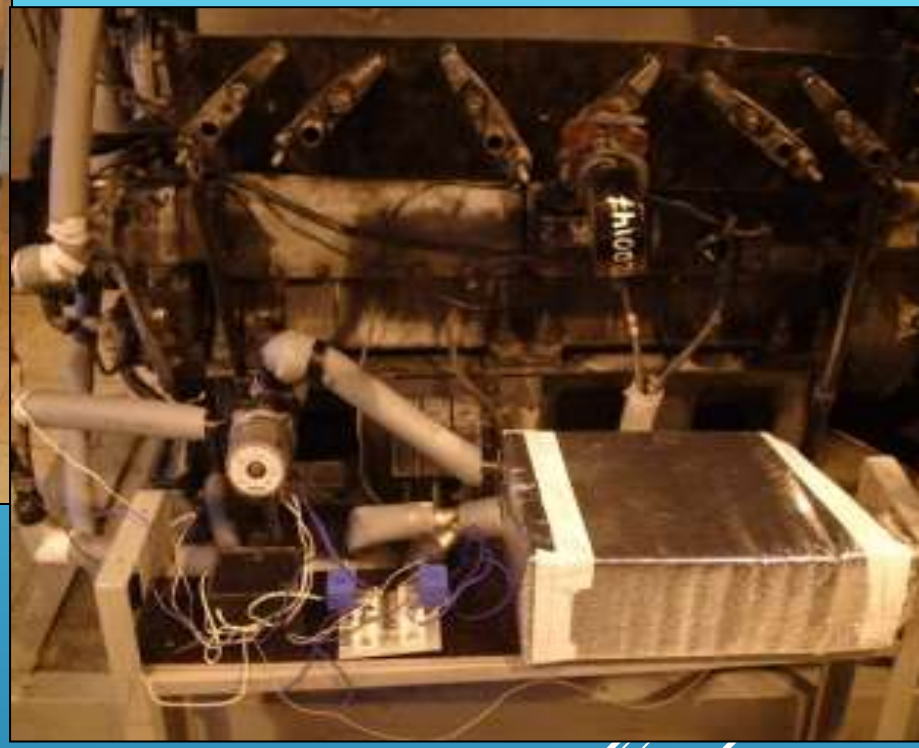
Laboratory installation for conducting experimental research: a) appearance of the laboratory complex for conducting the experiment; b) diagram of the location of the TAM capsule in the working space of the muffle furnace

Thermal preparation of stationary and transport engines with accumulated energy



Schematic diagram of the experimental thermal accumulator: 1, 2, 3 – thermocouple installation locations, 4 – thermal insulation layer TA, 5 – heat-accumulating material

Thermal preparation of stationary and transport engines with accumulated energy

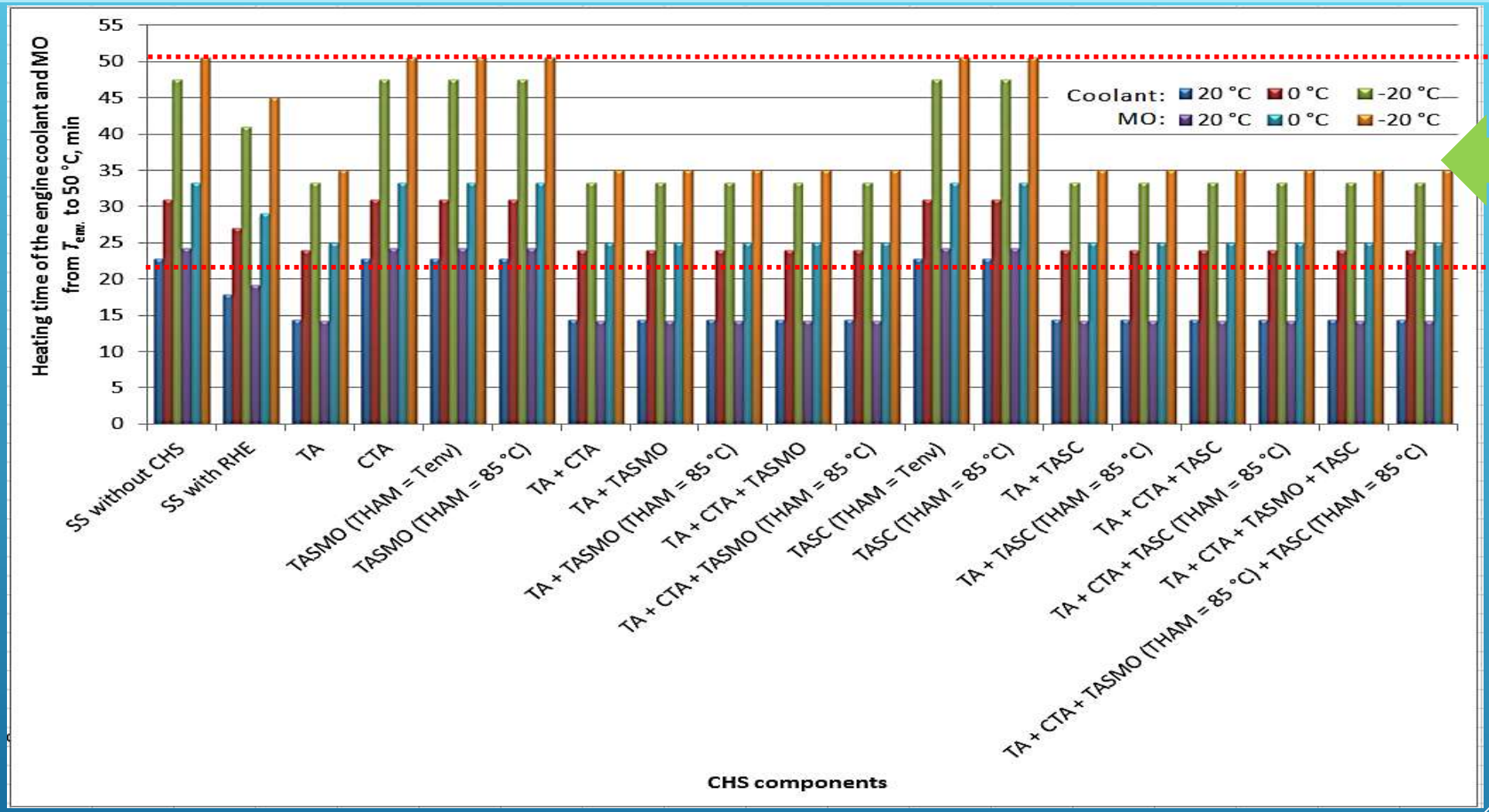


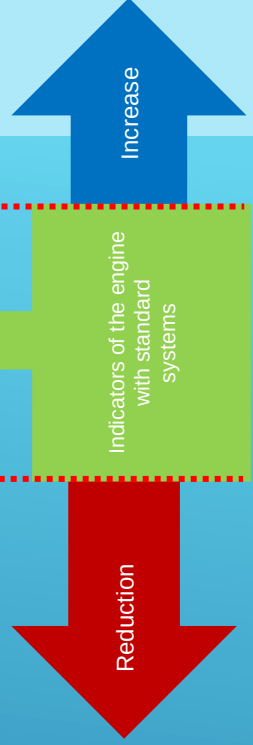
Motor installation for research into the thermal preparation system of 6FSN 12/14 and 6FS 12/14 engines: general view and elements of the thermal preparation system

Thermal preparation of stationary and transport engines with accumulated energy

A general view of a measuring complex to study the heating of the engine and the car interior with the HS and TA in pre-start and after-start heating

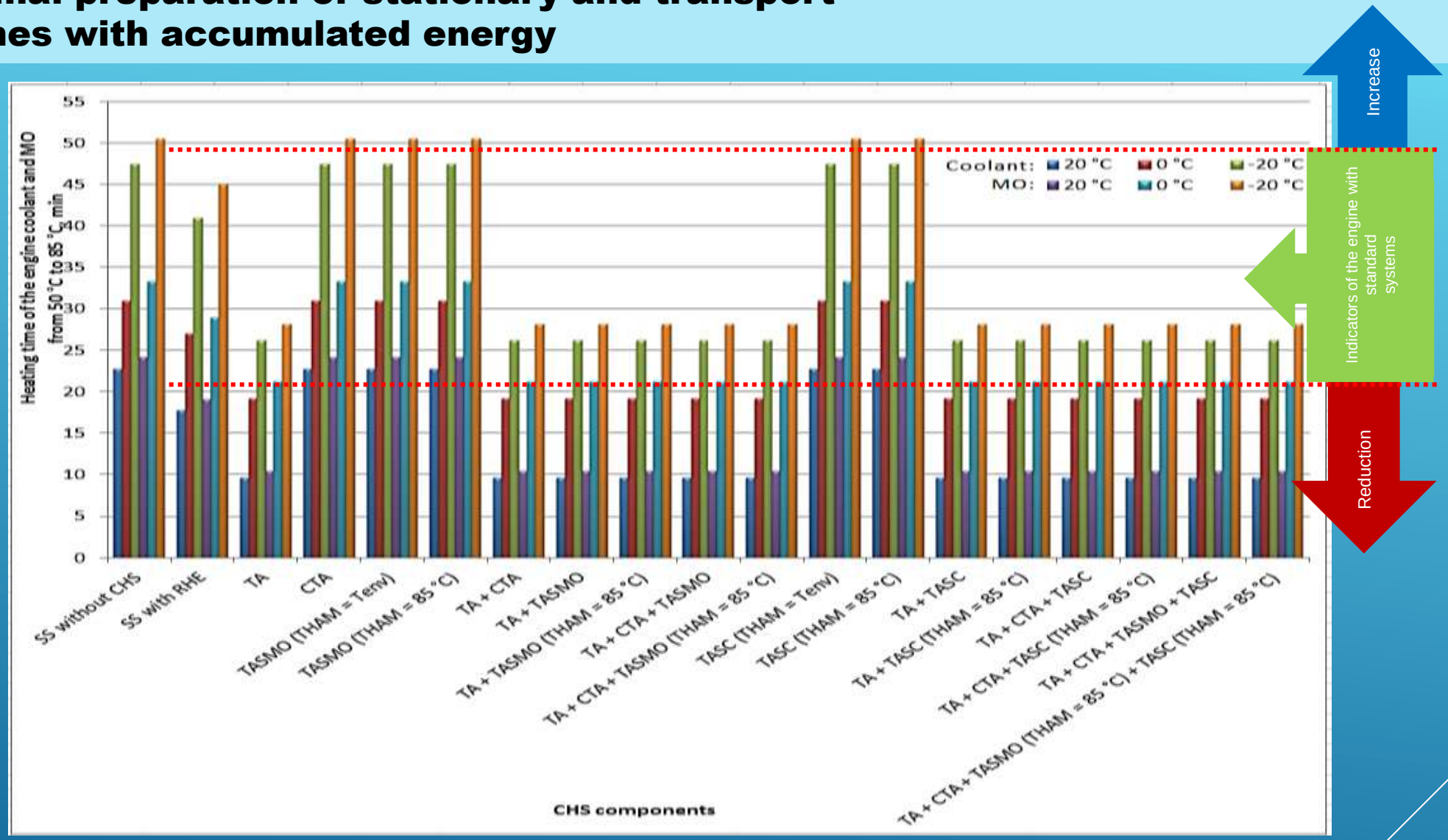
Thermal preparation of stationary and transport engines with accumulated energy





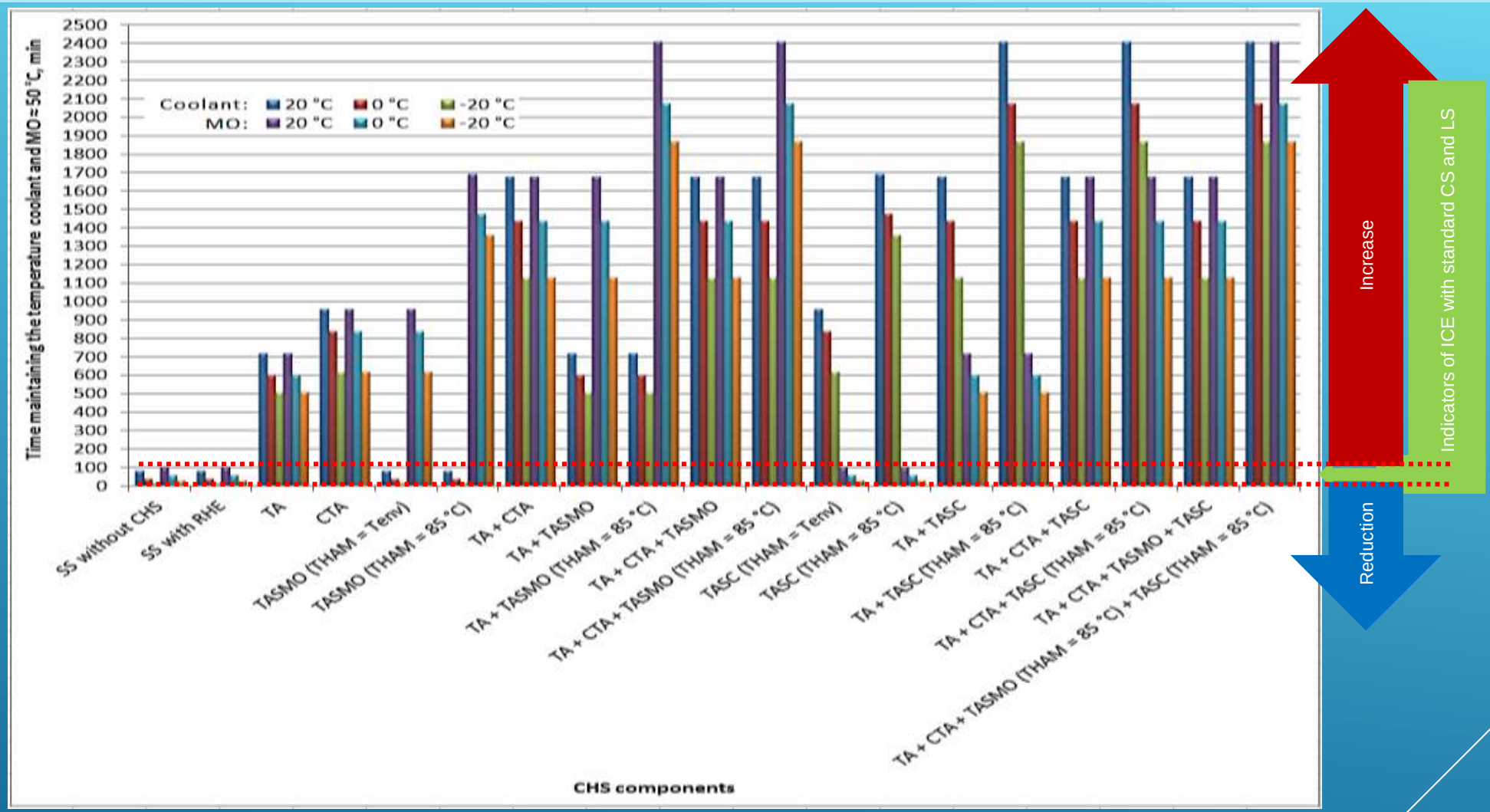
The influence of options of the combined heating system components on the heating time of the engine coolant and motor oil from Tamb. to 50 °C

Thermal preparation of stationary and transport engines with accumulated energy



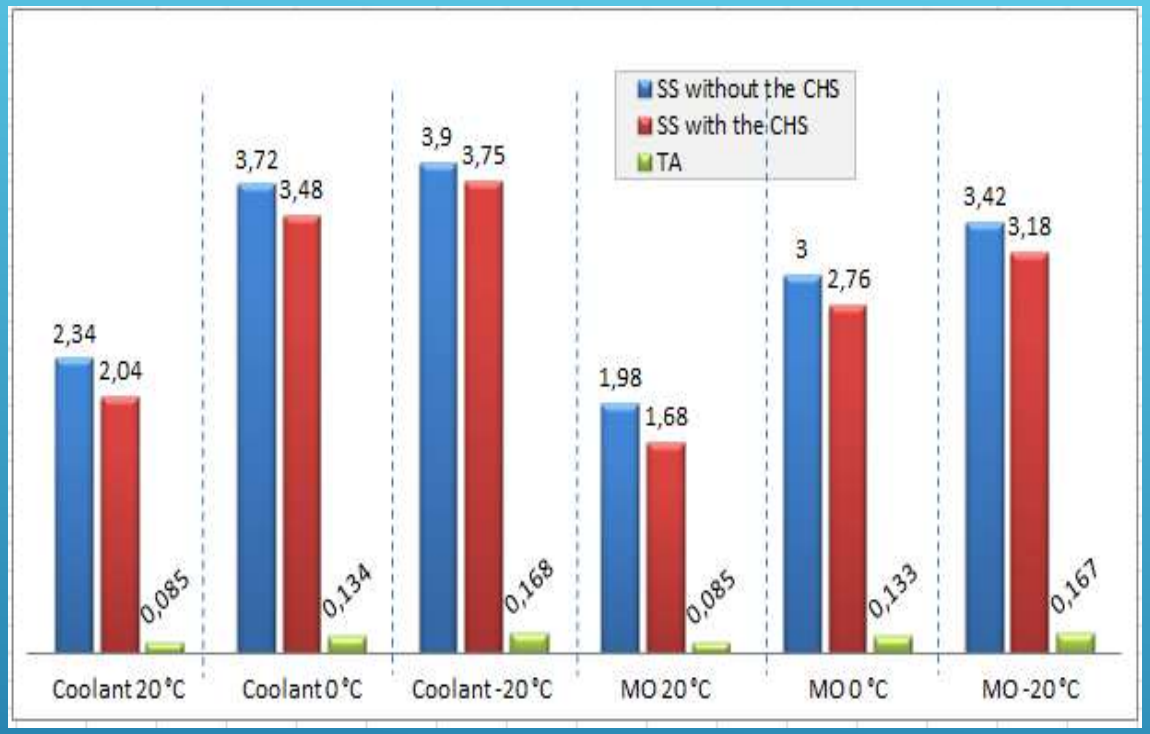
The influence of options of the combined heating system components on the heating time of the engine coolant and motor oil from 50 °C to 85 °C

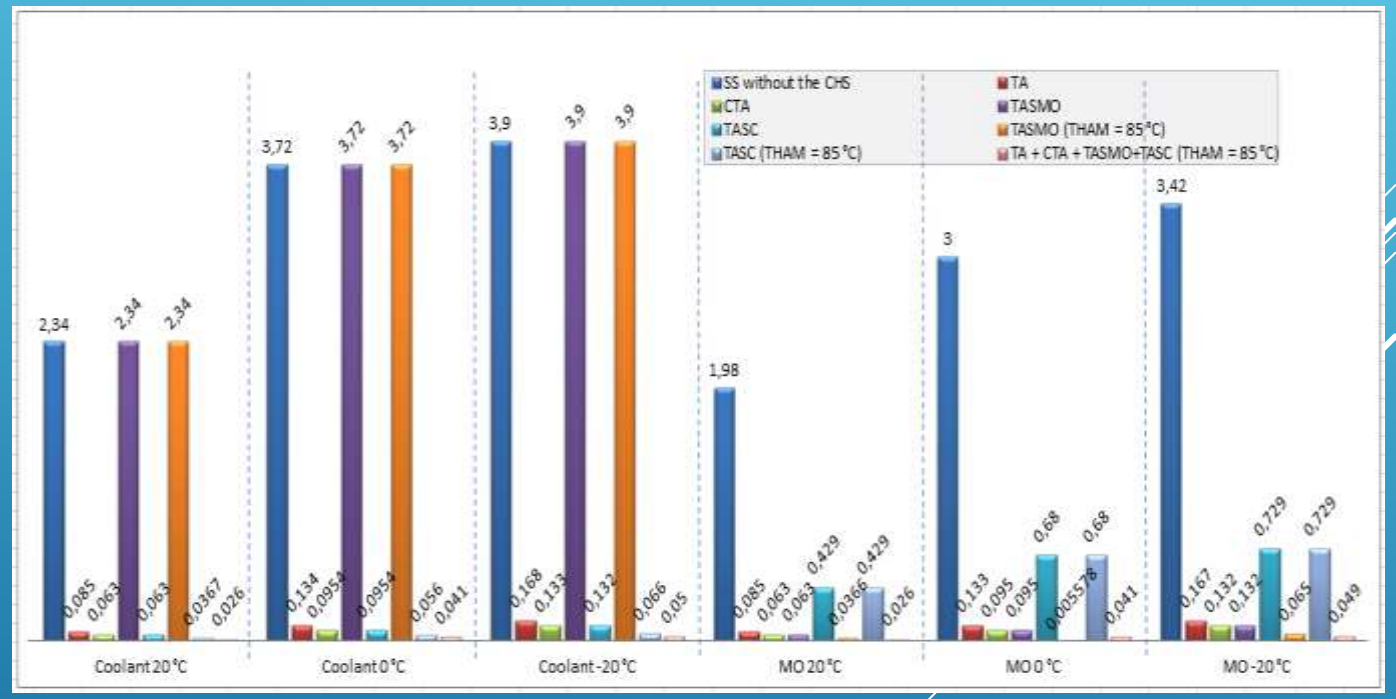
Thermal preparation of stationary and transport engines with accumulated energy



The influence of options of the combined heating system components on the duration of maintaining the coolant and motor oil temperatures within ≈ 50 °C

Thermal preparation of stationary and transport engines with accumulated energy





The results of investigating the influence of the CHS components on the coolant and MO heating time (a) and on the total time of the coolant and MO thermal development (b) in terms of fuel consumption (kg / h)

▸ Advantages of thermal preparation of stationary and transport engines with stored energy using thermal storage technology in materials

1. The use of a combined engine heating system with phase-transition heat accumulators for pre-start and post-start heating in cold operating conditions and to ensure the optimal temperature regime of the engine and vehicle is proposed.

2. The use of a combined heating system in an automobile engine for different ambient temperatures allows to significantly improve the duration of thermal development of the coolant and engine oil. This is possible with: pre-start and post-start heating by 22.9-57.5% and 25-57%, as well as with long-term storage from 9 to 92 times and from 6.2 to 61 times, without engine idling. The use of a combined heating system is usually effective for the pre-start and post-start thermal program of the vehicle engine and for its maintenance for a long time when it is not working in different climatic conditions. Features of the use of the components of the combined heating system and the technology of use are selected individually.

3. In order to ensure safety in terms of maintaining the OT of the engine and the vehicle, it is advisable to use the following options:
- heating from Tamb. to 50 °C - SS + RHE and phase-transitional TA;
- heating from 50 °C to 85 °C - SS + RHE and phase-transitional TA;
- maintaining the coolant and MO temperature within ≈ 50 °C when the vehicle is stopped – TA + CTA + TASMO (THAM = 85 °C) + TASC (THAM = 85 °C) and phase-transitional TA;
- by total specific indicators - TA + CTA + TASMO (THAM = 85 °C) + TASC (THAM = 85 °C) and phase-transitional TA.

To ensure the harmless environmental impact, it is expedient to use TAEGCS, TA + CTA + TASMO (THAM = 85 °C) + TASC (THAM = 85 °C) and phase-transitional TA. To ensure the transportation comfort, it is expedient to use any means of thermal development in the engine CS. The best of them are – the vehicle - TA + CTA + TASMO (THAM = 85 °C), the vehicle - TA + CTA + TASMO (THAM = 85 °C) + TASC (THAM = 85 °C) and phase-transitional TA. In order to ensure the engine capacity at its start, that is the ability to have the load on the engine immediately after its start, it is expedient to use TAEGCS, the vehicle - TA + CTA + TASMO (THAM = 85 °C) + TASC (THAM = 85 °C) and phase-transitional TA. In order to ensure specific efficient fuel consumption when maintaining the OT of engines and vehicles, it is expedient to use TA + CTA + TASMO (THAM = 85 °C) + TASC (THAM = 85 °C).

Thank you for your attention!

Speaker: Igor Gritsuk

Professor, SciD (Tech), Professor of the Department of Ship Technical Systems and Complexes

Kherson State Maritime Academy, Ukraine