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SUPERFINE HEAT INSULATION

Economic justification of tank insulation using liquid ceramic thermal insulation coatings of the Bronya series.

liquid ceramic thermal insulation of the Bronya series

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In energy saving, great importance is given to improving the thermal protection of equipment and structures.

A special place in solving this problem is given not only to new construction, but also to the operated fund of technological equipment and structures, the thermal characteristics of which do not meet modern requirements.

Thermal insulation of industrial equipment, in addition to energy-saving functions, provides the possibility of carrying out technological processes at specified parameters, allows you to create safe working conditions in production, reduces losses of easily evaporating petroleum products in tanks, allows storing liquefied gases in isothermal storages.

This presentation allows you to make sure not only of the profitability of the insulation of equipment with the help of liquid thermal insulation Bronya, compared with traditional methods of insulation, but also to show the benefits in energy saving and operating costs.

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We will calculate for a standard tank of petroleum products according to SNIP 2.04.14-88.

Initial data:

- Energy carrier: fuel oil
- Coolant temperature: 20 °C;
- Ambient temperature: -25 °C;
- Tank diameter: 27 m;
- Tank height: 18 m;
- Energy carrier volume (70% of the tank volume): 7211 m^3;
- Permissible loss of energy carrier temperature: 5 °C.

Calculations.

1. Calculation of heat losses during coolant cooling.

$$Q = \Delta T \cdot C \cdot v \cdot V \cdot k = 0,21 \cdot 0,521 \cdot 860 \cdot 7211 \cdot 1,16 = 787062 \text{ W},$$

where: ΔT - Coolant cooling at - 0.21 °C;
C is the heat capacity of the coolant 0.521 kcal/kg °C;
v is the volumetric weight of the coolant 860 kg/m^3;
V - The amount of coolant 7211 m^3;
k is the conversion coefficient of kcal/h to Watts.

2. Calculation of the surface area of the tank.

$$S = \pi \cdot d \cdot H + \frac{\pi \cdot d^2}{4} = 2672 \text{ м}^2,$$

where: π is the number Pi 3.14 ...;
d - the diameter of the tank 27 m;
H - the height of the tank 18 m.

3. Determination of permissible heat losses.

$$N = \frac{Q}{S} = \frac{787062}{2672} = 294,56 \text{ W/м}^2,$$

where: Q is the heat loss for cooling 787602 W;
S is the total surface area of the tank 2672 m2.

4. Calculation of heat losses from the tank.

4.1. Without thermal insulation.

$$q = \frac{t - t_o}{\left(\frac{1}{\alpha_{вн}} + \frac{\delta_{из}}{\lambda_{из}} + \frac{1}{\alpha_{н}}\right)} = \frac{20 - (-25)}{\frac{1}{15} + \frac{0}{0{,}001} + \frac{1}{35}} = \frac{45}{0{,}067 + 0 + 0{,}029} = \frac{45}{0{,}096} = 468{,}75 \text{ W}/м^2$$

where: t is the temperature of the energy carrier 20 °C (initial data);
t_0 - the ambient temperature -25 °C (initial data);
$\alpha_{вн}$ - coefficient of thermal perception with a wall of 15 W/m^2 °C SNiP 2.04.14-88;
$\alpha_{н}$ - the coefficient of heat transfer from the wall in the ambient air 35 W/m^2 °C SNiP 2.04.14-88;
$\lambda_{из}$ - thermal conductivity coefficient of thermal insulation Armor 0.001 W/m °C;
$\delta_{из}$ - insulation thickness 0 m.

Conclusion: Heat losses in a non-insulated tank exceed the permissible norms. It is necessary to perform thermal insulation of the tank.

4.2. Thermal insulation Bronya (normalized layer).

$$q = \frac{t - t_o}{\left(\frac{1}{\alpha_{вн}} + \frac{\delta_{из}}{\lambda_{из}} + \frac{1}{\alpha_{н}}\right)} = \frac{20 - (-25)}{\frac{1}{15} + \frac{0{,}001}{0{,}001} + \frac{1}{35}} = \frac{45}{0{,}067 + 1 + 0{,}029} = \frac{45}{0{,}096} = 41{,}05 \text{ W}/м^2$$

where: t is the temperature of the energy carrier 20 °C (initial data);
t_0 - the ambient temperature -25 °C (initial data);
$\alpha_{вн}$ - coefficient of thermal perception with a wall of 15 W/m^2 °C SNiP 2.04.14-88;
$\alpha_{н}$ - the coefficient of heat transfer from the wall in the ambient air 35 W/m^2 °C SNiP 2.04.14-88;
$\lambda_{из}$ - thermal conductivity coefficient of thermal insulation Armor 0.001 W/m °C;
$\delta_{из}$ - insulation thickness 0,001 m.

Conclusion: Thermal insulation Bronya with a thickness of only 1 mm, allowed reduce heat losses by 7 times in relation to the required.

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4.3. With thermal insulation Bronya (energy-efficient layer).

$$q = \frac{t - t_o}{\left(\frac{1}{\alpha_{вн}} + \frac{\delta_{из}}{\lambda_{из}} + \frac{1}{\alpha_н}\right)} = \frac{20 - (-25)}{\frac{1}{15} + \frac{0{,}002}{0{,}001} + \frac{1}{35}} = \frac{45}{0{,}067 + 2 + 0{,}029} = \frac{45}{2{,}096} = 21{,}47 \ \text{W}/м^2$$

where: t is the temperature of the energy carrier 20 °C (initial data);

t_0 - the ambient temperature -25 °C (initial data);

$\alpha_{вн}$ - coefficient of thermal perception with a wall of 15 W/m² °C SNiP 2.04.14-88;

$\alpha_н$ - the coefficient of heat transfer from the wall in the ambient air 35 W/m² °C SNiP 2.04.14-88;

$\lambda_{из}$ - thermal conductivity coefficient of thermal insulation Armor 0.001 W/m °C;

$\delta_{из}$ - insulation thickness 0,001 m.

4.4. With mineral wool (normative layer).

$$q = \frac{t - t_o}{\left(\frac{1}{\alpha_{вн}} + \frac{\delta_{из}}{\lambda_{из}} + \frac{1}{\alpha_н}\right)} = \frac{20 - (-25)}{\frac{1}{15} + \frac{0{,}05}{0{,}055} + \frac{1}{35}} = \frac{45}{0{,}067 + 0{,}91 + 0{,}029} = \frac{45}{1{,}005} = 44{,}77 \ \text{W}/м^2$$

where: t is the temperature of the energy carrier 20 °C (initial data);

t_0 - the ambient temperature -25 °C (initial data);

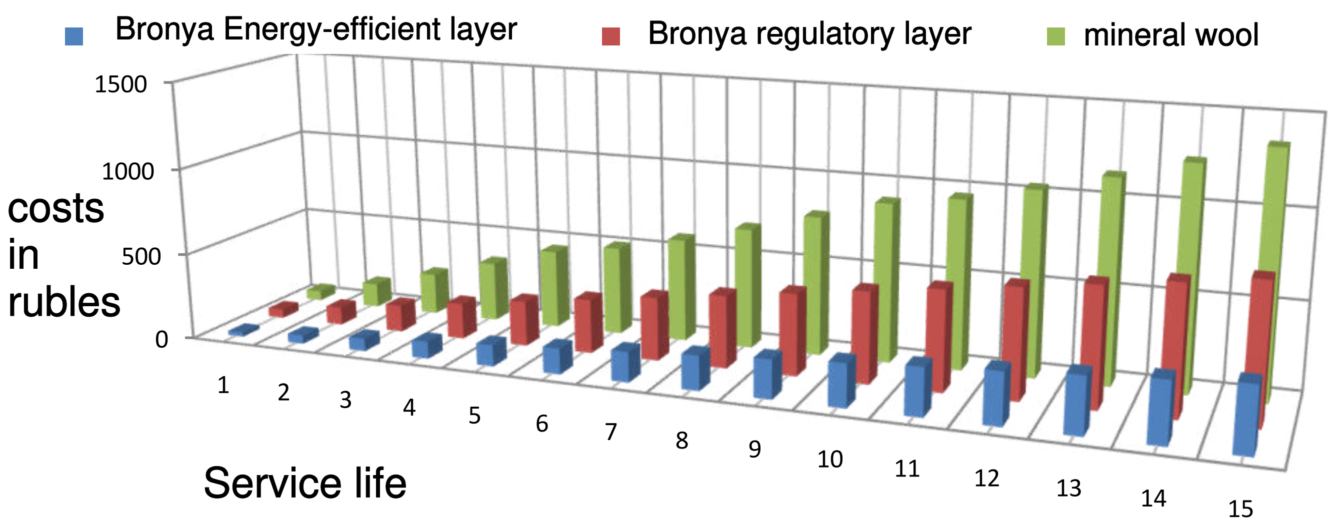
$\alpha_{вн}$ - coefficient of thermal perception with a wall of 15 W/m² °C SNiP 2.04.14-88;

$\alpha_н$ - the coefficient of heat transfer from the wall in the ambient air 35 W/m² °C SNiP 2.04.14-88;

$\lambda_{из}$ - thermal conductivity coefficient of thermal insulation Armor 0.055 W/m °C;

$\delta_{из}$ - insulation thickness 0,05 m.

The schedule of expenses for heat loss from 1 m2.



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Comparative table of economic efficiency

When using mineral wool and ultrathin thermal insulation Bronya as a thermal insulation material, using the example of tank for storing petroleum products. Calculations are made for 1 m2 the tank is calculated at the cost of 1 Gcal /hour - 1480 rubles.

Table 1.

	Mineral wool 50 mm (regulatory layer)*		Bronya 1 mm (standard layer)*		Bronya 2 mm (energy-efficient layer)	
Year	Heat loss Gcal/h / rub **	Thermal insulation device	Heat loss Gcal/h / rub **	Thermal insulation device	Heat loss Gcal/h / rub **	Thermal insulation device
1	0,038/56,24	1310	0,035/51,8	350	0,018/24,64	700
2	0,057/84,36		0,035/51,8		0,018/24,64	
3	0,066/ 97,68		0,035/51,8		0,018/24,64	
4	0,071/105,08		0,035/51,8		0,018/24,64	
5	0,074/109,52		0,035/51,8		0,018/24,64	
6	0,038/56,24	1310	0,035/51,8		0,018/24,64	
7	0,057/84,36		0,035/51,8		0,018/24,64	
8	0,066/ 97,68		0,035/51,8		0,018/24,64	
9	0,071/105,08		0,035/51,8		0,018/24,64	
10	0,074/109,52		0,035/51,8		0,018/24,64	
11	0,038/56,24	1310	0,035/51,8		0,018/24,64	
12	0,057/84,36		0,035/51,8		0,018/24,64	
13	0,066/ 97,68		0,035/51,8		0,018/24,64	
14	0,071/105,08		0,035/51,8		0,018/24,64	
15	0,074/109,52		0,035/51,8		0,018/24,64	
Total for 15 years	3,85/1358,64	3930	0,53/777	350	0,27/369,6	700

*The calculation of the thickness of thermal insulation is given according to the normalized density of the heat flow through the insulated surface (according to SNiP 2.04.14-88, SNiP 41-03-2003).

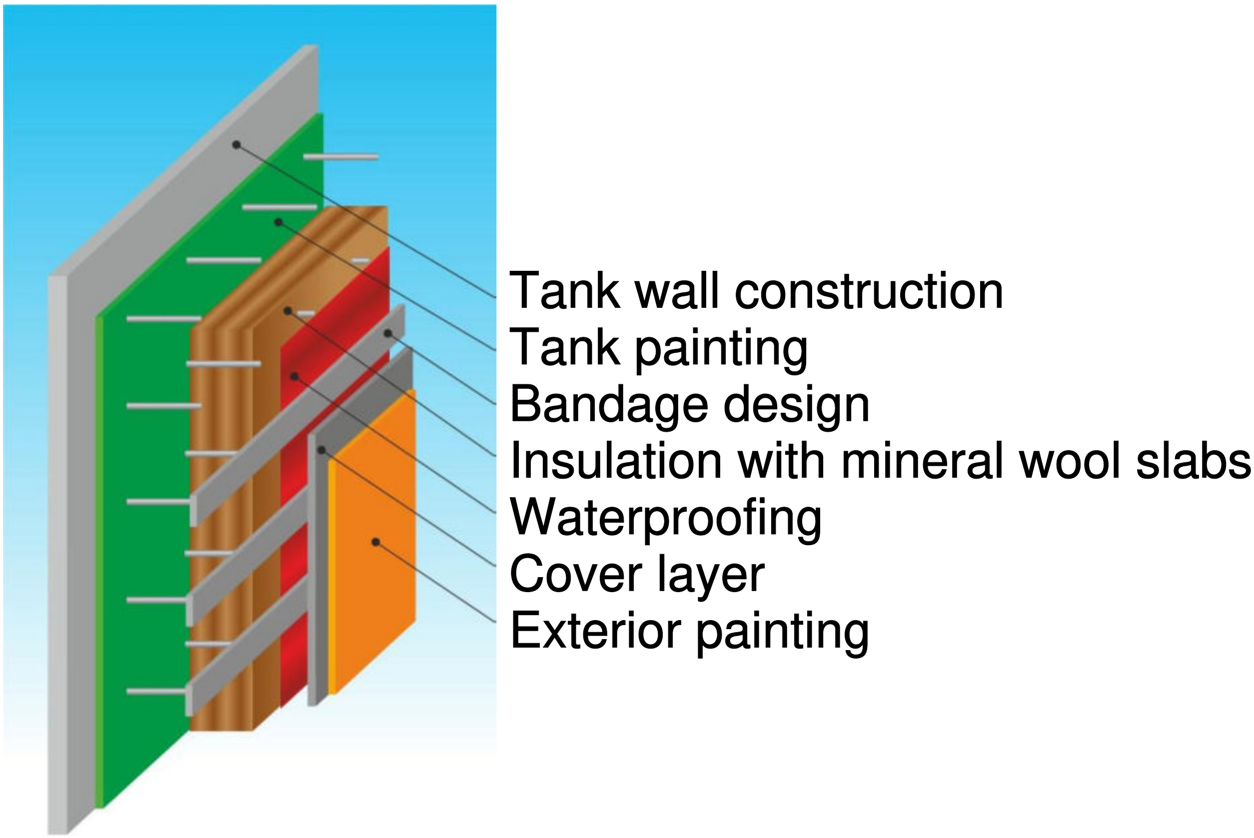
** the calculation took into account that every year the thermal insulation properties of mineral wool deteriorates by 50% (according to various sources from 50 to 280% per year)

Comparative analysis of various methods of insulation:

Option 1.

Performance of thermal insulation of enclosing structures of reservoirs with mineral wool:

1. Anti-corrosion treatment of the tank;
2. Installation of bandage fasteners;
3. Painting the tank in 2 layers
4. Installation of mineral wool;
5. Waterproofing of mineral wool;
6. Installation of the bandage;
7. Installation of the cover layer;
8. Finishing painting of the tank in 2 layers.



Standard method of tank insulation

Table of expenses for materials and work on insulation of reservoirs with mineral wool

Table 2.

Items of expenditure	The amount	Units of measurement
Anti-corrosion treatment	50	rub / m2
Painting of the tank wall in 2 layers.	150	rub / m2
Mineral wool slabs	280	rub / m2
Metal crate (mounting system)	380	rub / m2
Hydro- vapor barrier	100	rub / m2
Cover layer (galvanized sheet)	200	rub / m2
Finishing painting of the tank in 2 layers.	150	rub / m2
total cost of materials	1310	rub / m2
Cost of work	1310	rub / m2
Total costs	**2620**	rub / m2

The warranty service life of thermal insulation made of mineral wool is 5 years, after this period the material is stratified and crumbles down the structure. To replace the insulation, work is required on disassembly of the structure, replacement of elements and new insulation.

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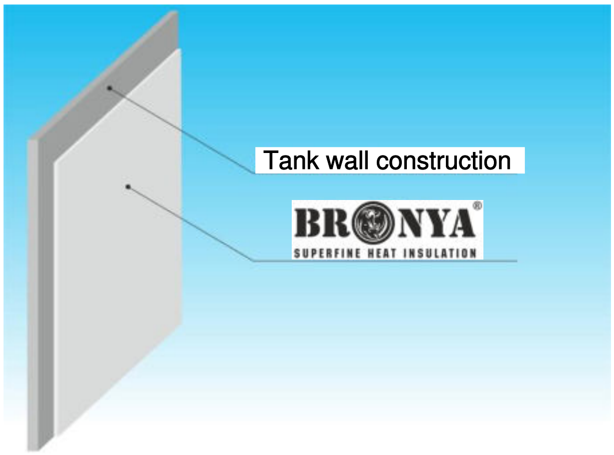
Option 2.
Implementation of anticorrosive and thermal insulation of enclosing structures of tanks with liquid thermal insulation of the Bronya series:
1. Anticorrosive and thermal insulation treatment of tank walls.



Anticorrosive and thermal insulation treatment of tank walls with liquid thermal insulation Bronya.
Table of expenses for materials and work on the insulation of tanks with ultrathin thermal insulation Bronya

Table 2.

Items of expenditure	The amount	Unit. change.
Anti-corrosion and thermal insulation treatment	350	rub. / m2
Total cost of materials	350	rub. / m2
Cost of work	250	rub. / m2
Total costs	**600**	rub. / m2

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