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PREVENTING FUEL evaporation from RESERVOIR USING COMBINATION OF NANO-FIX ANTICOR™ + RE-THERM™

If isothermal storage of petroleum products becomes possible or the temperature fluctuations of gas space and the surface of the oil are significantly reduced, it is possible to completely eliminate breathing loss.

During summer diurnal temperature of reservoir gas space reaches 30 ... 40%, and temperature of oil surface changes by 10 ... 15 ° C.

The simplest and cheapest way to reduce daily fluctuations is painting of reservoirs and installation of protective screens. More

complex and expensive methods are thermal insulation, irrigation of reservoirs and underground placement. Painting of reservoirs is permissible in any conditions as a method of controlling fumes and to protect a tank against corrosion. The color of reservoir paint has a significant impact on how much tank walls heat up and consequently on the oil contained in a reservoir.

Gasoline, under the same conditions stored in tanks which are painted in different colors, has the following temperatures: aluminum color - 11,5° C; gray - 14,6° C; minium - 16,6° C, green - 22° C, black - 30° C, i.e. petroleum products stored in tanks painted in bright colors with better reflectivity are much less prone to daily fluctuations in temperature. White has the highest reflectivity. When gasoline is stored in a horizontal white tank, the loss due to evaporation is half that of aluminum paint which is a common color for tanks at tank farms. Furthermore, white paint lasts for 3-4 years while aluminum (AL-177) lasts only 1.5 - 2 years.

Shielding is ensured by planting deciduous trees near the reservoirs, as well as placing reservoirs under awnings. In southern areas reflective insulation of reservoirs is used which consists of a roof, a screen and side walls mounted at a distance of 0.1- 0.5m from reservoir walls. The use of shielding helps to reduce the loss of petroleum products by a factor of 2-3.

Reservoir surfaces can be insulated with the use of materials with low thermal conductivity, such as foam glass, foam, cinder and fiberglass. However, the high cost of covering materials should be taken into account . Further, they need to be protected from rain and the overall level of control of the technical condition of the reservoir surfaces reduces.

The most popular method to deal with fuel evaporation from a reservoir and overheating of low-temperature energy materials is often the method of thermal insulation with the use of a standard set of materials: classic insulation materials (rock wool, polyurethane, polystyrene, etc.) and a casing made of galvanized steel.

This method is quite out of date; it does not meet high standards of energy efficiency and has a number of negative aspects:

- A complex and time-consuming process of installation, requiring highly skilled workers;

- Large storage capacities are required;

- High cost of materials and labor;

- Inability to protect the upper portion of a reservoir;

- Significant weight of insulation and the effect of the sail;

- The inability to exercise control over technical conditions of the reservoir walls while it is in use;

- The complexity of maintenance jobs;

- Corrosion of metal under insulation;

- Low rate of thermal reflection of solar radiation;

- Lack of protection from condensation;

- Vulnerability of insulation to moisture;

- Low fire safety;

- Accelerated aging of insulation material and rapid decline of its thermal characteristics;

- Susceptibility to looting or vandalism

With the adoption of federal, regional and local programs on energy saving new innovative solutions for thermal protection of reservoirs are required, and such solutions exist.

Innovative thermal protection systems have been used for these purposes for a number of years in many countries. One such system is the method of coatings developed and produced by the company "Innovative Technology" (Russia). The system consists of two coatings: **NANO-FIX ANTICOR™** and **RE-THERM™. NANO-FIX ANTICOR™** is a single-component anticorrosive primer for rust.

NANO-FIX ANTICOR™ primer offers a new approach to corrosion protection represented by a complex chemical interaction of molecules with components of the oxides of iron and atoms of a metal lattice. **NANO-FIX ANTICOR™** is composed of a nano-sized silica sol and alyumozol (boehmite). Addition of a nano-sized sol into **NANO-FIX ANTICOR™** contributes to significant reduction of the amount of organic binder while maintaining elasticity of coating, and to a substantial increase in degree of adhesion to various surfaces, as well as to the cohesive strength of the coating. At the same time **NANO-FIX ANTICOR™** practically doesn't shrink due to the high percentage of solids contained in it, and it is highly heat-resistant. Its operating temperature ranges from -70C to +230 C. The primer has the ability to penetrate cracks and pores of metal while suppressing corrosion that has already begun. Thus solid chelate complexes containing a polymeric component of the primer form on the

surface of the metal and effectively protect it from external exposure. This mechanism allows the primer to firmly bind up to 100 microns of rust.

The excellent anti-corrosion qualities of **NANO-FIX ANTICOR™** minimize efforts spent on preparation of metal surfaces for painting, especially in hard to reach areas. The use of primer eliminates costly blasting of corrosion products from metal surfaces prior to painting.

RE-THERM™ is a single-component water-based liquid thermal barrier coating consisting of a combination of silicone and ceramic microspheres that effectively reflect heat and sunlight.

In addition to the "mirror" effect the material has a low coefficient of thermal conductivity, which does not fluctuate during operation. The coating is eco-friendly, leaves no waste, is vandal-proof and is of no interest to looters as it is lightweight and resistant to dynamic effects. It is fireproof during both installation and in operation. The coating is as easy to apply as ordinary paint, can be applied by any means and does not require highly skilled workers. An average coating thickness varies between 1.5 and 2 mm, an average flow rate is 1.5 liters per 1m2, the weight of material is 0.55 - 0.6 kg / liter. A modified version adopted for winter conditions is also available, resistant up to -20° C.

All materials and production are certified.

The main advantages of using a NANO-FIX ANTICOR™ and RE-THERM™ coatings in combination are:

- Minimum amount needs to be stored and protected;

- Ability to carry out work (from cradles) without scaffolding;

- Minimal preparatory work necessary, including elimination of expensive sandblasting;

- Minimal cost of work and rapid return on investment;

- Complete absence of damage to the environment at the time of application of coating and in the course of operation;

- Great service life without change in performance;

- Significant reduction in the total weight of thermal protection, reducing the load on the foundation;

- Minimum load on the top of a reservoir;

- Easy control of the state of welds and other elements of reservoir;

- Complete protection against corrosion;

- Water proof, resistant to temperature drops and ultraviolet rays.

It should be noted that classical thermal insulation due to its heat resistance only slows penetration of thermal energy from solar radiation into the reservoir while **RE-THERM™** coating almost completely reflects thermal radiation preventing heat energy from penetrating the reservoir and heating up its contents, and not allowing it to cool or freeze in winter.

An example of application of a similar coating system produced by Pemex Oil (Mexico).

After a thorough analysis of this system the specialists focused on opportunities for reducing maintenance costs by using a combination of coatings: **Effective Primer** and **Liquid heat shield.**

This innovative coating system provided excellent insulation and corrosion protection and allowed an almost complete replacement of standard techniques including such labor-intensive and costly methods as sandblasting. Through the use of a thermal protection system a reservoirs service life could be extended from 4.5 to 10-15 years, and over a ten-year period the savings add up to $300 million.

Maintenance costs were significantly reduced, so much so that the problem of evaporation faded into the background because of the ten-fold savings from the elimination of a number of maintenance procedures on the tanks. The increase in maintenance intervals saved much more money.

Example of labour saving due to the use of an innovative coating system on a reservoir with a capacity of 80 thousand barrels:

- Reservoirs are repainted every 4-5 years;

- The cost of labor and materials for repainting one reservoir is approximately $65 thousand;

- Innovative coating system allows to effectively increase repainting interval by 2 – 2,5 times, up to 10 years;

- Savings on labor costs and materials for 10 years increase by 1 - 1.5 times;

- Savings on every reservoir range from $65 thousand to $97 thousand over a period of 10 years;

- For instance, for 3000 reservoirs, the total savings over 10 years would range between $195 and $300 million;

- Total savings over 10 years from application of Effective primer + "Liquid heat shield" in order to prevent evaporation of fuel and corrosion of reservoirs range between $ 213 and $ 322.5 million;

- Given the cost savings from reduced evaporation and increased interval between repainting, the payback period will be no less than 3.2 years or 68%.

The following cases are among most prominent examples of the application of the system of coating:

- Reservoirs and distribution pipelines transporting oil, fuel, liquefied hydrocarbons;

- Reservoirs and distribution pipelines transporting low-temperature energy sources;

- Non-technological equipment used to prevent overheating

from thermal radiation.

Comparing a "new" system to a "traditional" one, here is a brief summary of their dissimilarities:

- Traditional: cumbersome, expensive and time-consuming;

- New: eco-friendly, cost-effective and energy-efficient.

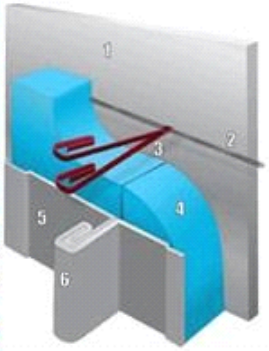
Today, a similar technology is successfully used by various companies around the world. Many world-renowned companies added innovative technology into their standards for production processes and energy efficiency. Russia still has a long way ahead of it, and innovative materials produced by "Innovative Technology" would greatly contribute to its progress down this path.

APPENDIX

A comparison of the two types of insulation installation

1. Affixing mineral wool insulation layer with metal pins.

Insulation layer could be affixed with pins onto vertical and horizontal surfaces with large radius of curvature and onto flat surfaces (reservoirs used for storing oil and oil products, accumulating hot water, reservoirs for drinking water, and for industrial purposes including fire, metal trunk chimneys, and other large equipment). Pins for fixing the insulation layer can be inserted (if brackets for pins are provided) or welded.



Construction:
1 – Wall of reservoir
2- Anchor Band
3 – Staples
4 – Mineral wool
5 – Steel lining
6 – Folded joint

2. Coating with liquid heat-shielding materials.

Coating with liquid heat-shielding material could be used on all types and configurations of surfaces similar to conventional paint.

A comparative analysis of methods:

Method of thermal insulation of reservoir walling with mineral wool slabs:

1. Anti-corrosion treatment of a reservoir wall
2. Mounting of brace fixtures.
3. Applying 2 coats of paint on reservoir walls
4. Installation of thermal insulation boards.
5. Hydro, steam, mineral wool.
6. Mounting of brace.
7. Mounting of the cover layer.
8. Two final coats of paint on reservoir
9. Installation and dismantling of building timber.

An average service life of mineral wool insulation is about 5 years, during which the insulation properties invariably deteriorate and may even deteriorate during storage and installation.

Using NANO-FIX ANTICOR ™ + RE-THERM ™ for thermal protection of reservoirs

1. Anti-corrosion treatment **NANO-FIX ANTICOR™**
2. **RE-THERM™** coating

Expected **RE-THERM™** service life is 15 years with no change in performance.

Notes

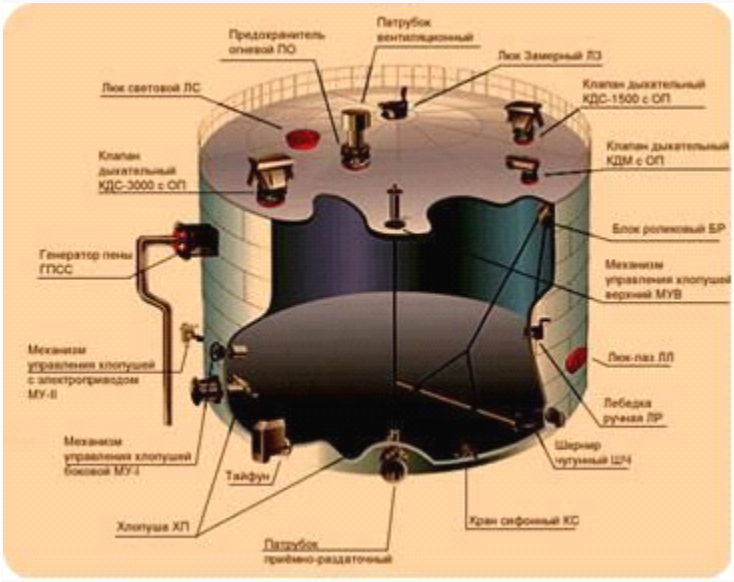
Insulation of industrial equipment, in addition to the energy saving, made it possible to run technological processes within given parameters, to create a safe working environment for production, to reduce the loss of volatile oil stored in reservoirs, and to store liquefied gases in insulated storage containers.

When choosing insulation material, strength and deformation characteristics of the isolated object should be calculated and allowable load on bearings and other elements of insulated surface should be taken into account. So, while isolating vertical steel water, oil or petroleum products' storage reservoirs, the bearing capacity of insulation shall not exceed 32-34 kg/m2.

Fire safety requirements are defined by the rules of technological design of relevant industries subject to SNiP 41-03-2003 "Thermal insulation of equipment and pipelines". For

industries such as gas, petrochemical, chemical, and fertilizer production, administrative rules allow use of only non-combustible materials and slow-burning insulation. When selecting materials, flammability of thermal insulation layer and protective coating should be considered, as well as characteristics of insulating structures in fire in general.

Fire hazard rating of insulating structures along with other factors depends on the heat resistance qualities of the protective coating and its mechanical strength under fire exposure. **Non-combustible fibrous insulating materials, under certain conditions, can absorb combustible substances (petroleum products, oil etc.), which in turn may affect an object's flammability potentially allowing it to catch fire, which its design should also account for.**



Looking at this picture you can clearly determine that new heat insulation system is more convenient for installation and operation.

Durability of heat insulation depends on design features and operating conditions, including the location of the isolated object, mode of equipment operation, environment and the intensity of mechanical effects. Durability of insulation as a whole is largely determined by the durability of the protective coating.

When designing foundations for containers significant savings

could be achieved with **RE-THERM™**: its weight is significantly less than of conventional insulation structures, thus it doesn't weight heavily on the foundation.

Questionnaires are used to determine thickness of insulation layers of each object, and a technological solution and individually modified **RE-THERM™** are produced based on the answers provided.