INTERNATIONAL JOURNAL ON ORANGE TECHNOLOGIES
www.journalsresearchparks.org/index.php/IJOT e-ISSN: 2615-8140|p-ISSN: 2615-7071
Volume: 02 Issue: 12 | December 2020

Efficient principles for heat batteries

R.M. Makhmudov[1] - C.t.s.associate professor[1]
Z.I.Kholmurodova[2], Sh.A.Usmonov[3] -senior teachers[2,3]
S.Sh.Babanazarov[4] – teacher[4]

---***---

Abstract. The article deals with the important characteristics required in the design process of short-term and long-term heat batteries, as well as the heat physical properties of heat-collecting materials.

Keywords. Melting and solidification temperature, latent heat conduction ability, heat conductivity, cost, volumetric expansion coefficient from heat, short-term heat batteries, long-term heat batteries, spherical capsules.

Introduction

The aim of batteries adoption is to smooth out the operating contradictions arising from the uneven heat consumption, which in turn leads to costs [1].

The total cost of heat collection equipment is the sum of the energy storage and the required power costs.

The first is the heat storage tanks cost, heat storage materials, thermal insulation, etc., and the second is the heat storage and conduction devices cost in the accumulator, i.e. heat exchangers, pumps and so on. This means that both types of prices should be reduced as much as possible. In the long-term heat storage case, the value spent on heat energy collection is high [2].

In the short-term heat collection case, the work is different. An important factor here is power consumption, so it is important to focus on it. Energy-related costs can be somewhat higher than long-term batteries.

However, the heat collection equipment use has a specific effect. For example, long-term batteries are used 4 times a year, while short-term batteries are used 300 times a year, which is 74 times larger. Thus, energy-related expenditures have 74 times stronger impact on the useful energy cost per 1 kW/h. Considering the energy lost from them in long-term heat batteries, the appearance becomes more uncomfortable. Taking into account that these costs consist of the same thermal insulation, the heat loss is averaged in proportion to the heat collection time. If thermal insulation is improved, energy-related costs will increase. Thus, only the accumulated energy fraction can be used.

This requires a higher heat storage capacity that is higher than necessary, resulting in higher energy consumption. In addition, if we consider the effect on a solar device, for example, a large solar collector area is loaded with a higher temperature than when using a heat accumulator, and so on. In short, it is not advisable to predict the costs associated with long-term solar heat storage. The heat collection use in this type is possible only when the most economical systems and methods that do not require thermal insulation are created [3]. This will make the additional energy use more economical, even if it requires an additional device installation on the device in the near future.

However, this is not an optimal solution in growing energy problems. For this reason, research on the optimal possibilities of heat collection and further hitherto improvement known long-term heat collection systems is self-justifying.

The following parameters are most important for materials based on substances that change their state of aggregation (for the accumulation of latent heat energy) in short-term heat collection [4].

That is:

- Melting or solidification temperature;
- Hidden heat energy, $\Delta i_{эр}$;
- the heat conduction coefficient;
- Behavior in extreme cold;
- Density;
- Abrasive activity in relation to the wall material and the heating device of the surrounding container;
- Cost;
- Heat resistance;

- Toxicity;
- Coefficient of thermal (volumetric) expansion.

The first three above characteristics are in great importance because they determine the technical characteristics of the heat accumulator. The melting temperature of the heat-collecting material determines the operating temperature of the heat batteries, whereas at the melting temperature, heat accumulation and heat release occur in the heat batteries.

Excessive cooling is due to the fact that the accumulated heat energy release occurs at a temperature slightly lower than the melting temperature of the heat-collecting material.

In addition, the heat stored in the accumulator is at the same value, the higher the latent heat per unit volume of material used, the more compact the heat accumulator, resulting in a lower cost. The remaining characteristics should be taken into account when designing a real heat accumulator [5, 6].

Heat accumulation in substances that change their aggregate state can be placed in different shaped capsules (parallelepiped, cylindrical and spherical) and heat can be collected.

The heat collection system at the expense of latent in spherical capsules has several advantages and they are promising for the future [7].

These advantages include:

1. Possibility (probability) to shorten the heat collection and separation time due to good heat conduction. In this case, a substance use that changes its aggregation state with low thermal conductivity (e.g., polyethylene glycol and other organic substances). Air can also be used as a heat carrier.
2. Due to the spherical capsule shape, the heat batteries shape can be optional. In cylindrical capsule and shell types, the capsules size and heat exchanger should be selected depending on the heat batteries shape. This is the most important, allowing for easy reconstruction of heat batteries, turning it into a battery that runs on water, i.e. at the expense of heat capacity.
3. There is no need for spiral pipes and shell construction system.
4. High heat storage capacity is achieved due to the presence in the heat substance batteries that changes its aggregate state, which has a large volume.
5. The different balls diameters adoption allows easy change of heat collection and dissipation characteristics.
6. High heat accumulation efficiency and heat utilization can be achieved through the appropriate distribution and substances placement that change their aggregate state, dissolving at different temperatures, according to the tank height [8].

For example, by placing a high-temperature soluble material in the upper part of a heat accumulator and a low-temperature soluble material in the lower part of the accumulator, the heat-collecting capacity is increased by increasing the substances state change frequency. It is also possible to increase the heat collection rate and its release. We have revisited the main advantages of a spherical capsule heat collection system above. The disadvantage of this heat type collection system is that it is a bit complicated to make (prepare) the capsule and fill it with a substance that changes its aggregation state.

However, it is possible to organize large-scale production of a relatively simple capsule with a low cost. It should also be noted that heat batteries based on substances that change their aggregate state are based on heat capacity, i.e. when considering the water example, the following can be learned.

The object being compared is a commercially available battery with 500l capacity. The aggregate-modifying material adopted for comparison is a high-temperature soluble crystal hydrate $NaOH \cdot H_2O$. The main properties of this substance are given in the table below.

Table №1

Features	**Assignment**	**State**	**Numerical values**
Density	ρ	In a solid state In the liquid state	1748 $kg/м^3$ 1717 $кg/m^3$

Specific heat capacity	C_p	In a solid state In the liquid state	1510 $J/\kappa g^{\circ}C$ -
Hidden heat	$\Delta i_{эр}$		$259.5\cdot10^3 J/\kappa g$ $445.6\cdot10^6 J/m^3$
Melting point	$t_{эр}$		61 $^{\circ}C$

Table 2 shows the comparative characteristics of latent heat-based batteries with a heat capacity of water and a spherical capsule. When the amount of heat collected is the same 83800 kJ, the maximum water temperature in the accumulator is 70 $^{\circ}C$ and the minimum water temperature in the accumulator is 30 $^{\circ}C$. The thickness of the polyurethane coating as thermal insulation is 40 mm.

Table №2

Battery Features	Water	$NaOH\cdot H_2O$	Note
Capacity, in l	500	204	In a spherical capsule
The heat-collecting material weight, in kg	500	296	aggregate state modifier is 215 kg, water weight is 81 kg
Surface area, in m^2	3.78	2.08	For cubic shape
Lost heat. kJ/day	15084	8359	Ambient temperature 10 $^{\circ}C$
The maximum time that can run without recharging, per day	1.9	2.2	When heat consumption is 29330 kJ/per day.

When the battery volume is the same (500 l), the temperatures and thermal insulation are the same as before.

Table №3

Battery Features	Water	$NaOH\cdot H_2O$	Note
The heat-collecting material weight, in kg	500	726	Own unit with spherical capsule in the battery state modifier material weight is 528 kg, water weight is 198 kg
The amount of heat collected, in kJ	83800	205310	
The maximum time that can be used without recharging, per day	1.9	4.6	The heat demand per day is 29330 kJ/day

As can be seen from Table 3, the volume of a battery containing spherical capsules containing substances that change their state of aggregation when the same amount of heat is accumulated is twice less than the volume of an aqueous battery based on heat capacity, the heat lost in the first is only 55% of the heat lost in the second type of battery. In the spherical capsule batteries use, the heat loss calculation alone is sufficiently efficient in itself that the heat accumulated during the year reaches 2430700 kJ/year [9].

As can be seen from Table 3, at the same volume of heat batteries, the heat accumulated in the spherical capsules is 205310kJ. If this (29330 kJ/day heat loss 15084kJ/day) heat is used mainly for hot water supply, the service life of water in the accumulator due to the heat capacity is 1.9 days, in spherical capsule batteries - 4.6 days, the latter is 2.4 times larger than the former. The use of the last battery for 2-3 days on cloudy days is quite effective [10]. Hidden heat batteries with a spherical capsule are preferable to the short-term (unit-day) and long-term (unit-of-season) batteries currently available.

It is estimated that medium-season batteries will be created that will make life easier to use [11].

References

1. Sorensen B. Transformation, transmission and storage of energy. Educational reference guide / B. Sorensen-Dolgoprudny: Intellect.2011 p.296 .
2. Thermal energy storage in solar installations. A.C.Kalt Speicherung Thermischer Energie in Anlagen der Nutzung zur Sonnenenergie Oel+Gasfeuerung. 1980, vol. 25? № 11.637-641.
3. Khalaim N.T. Manufacturing of a heat accumulator with direct absorption of solar energy. SPARE project. Moldova Ru htm. 2006.
4. Varshavsky I. L. Energy storage substances and their use. Kiev: Nauk. Dumka. 1980.p240.
5. Kenasarin M.M., Karabaev M.K. Centralized solar heating systems with seasonal heat storage. Tashkent, Scientific Research Institute of Scientific and Technical Information and Technical and Economic Research of the State Planning Committee of the Uzbek SSR, 1987. p38.
6. Gritsyna V.P. Seasonal storage of thermal energy. Heat supply news magazine. № 05. (153) 2013.
7. Alekseev V.A., Malozemov V.V. Design of heat batteries. Study guide - Moscow: MAI, 2008.- p.86.
8. Saito T., Hirose K. Study of skryte heat accumulation using spherical capsules. Reito. 1983. V 58, № 672 p. 933-940.
9. Takahashi Yoshio, Abe Yoshiyuki and Ozava Takaeo. Development of special materials is the key to solving the problem of accumulating latent heat energy. 1982, V.23, № 213, p 61-67.
10. Beckman G., Gilly P. Thermal energy storage./Tran. from English under the red. of Doctor of technical sciences V.M. Brodyansky. - M.: World, 1987. p.272
11. Levenberg V.D., Tkach M.R., Golstrem V.A. Heat storage. Monograph.-Kiev: Technique, 1991.p.111