

## “Storage of solar energy by application of thermally stratified phase change materials. Experimental research and optimization”

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### **Kopsavilkums.**

Saules kolektoru sistēmas ir kļuvuši par plaši izplatītu alternatīvu tehnoloģiju siltumenerģijas ražošanā un siltuma akumulācijas sistēmu izmantošana ir atrisinājusi enerģijas ieguves un izmantošanas periodu nesakritību. Esošajās sistēmās kā siltuma akumulācijas vide ir ūdens. Lai arī ūdens ir teicams darba šķidrums ar salīdzinoši lielu siltuma ietilpību un plašu pieejamību, tas nodrošina siltuma uzglabāšanu tikai fiziskā siltuma veidā. Lai palielinātu sistēmu siltumietilpību ir nepieciešams izmantot latentu siltumu, jeb siltumu, kas nepieciešams, lai materiāli mainītu savu fāzi. Šādus materiālus dēvē par fāžu pārejas materiāliem (PCM). PCM izmantošanas siltuma akumulācijas sistēmas tiek pētīta salīdzinoši sen, bet Latvijā šī tehnoloģija ir maz pazīstama. Latentā siltuma izmantošana sarežģī fizikālo procesu raksturošanu, tāpēc daudzi pētījumi aplūko dažādus paņēmienus, kā aprēķināt PCM izmantošanas lietderīgumu. Tikai pēdējos gados attīstoties datoru skaitļošanas jaudām, kļūst iespējams aprakstīt notiekošos procesus. Maģistra darbā tiek aplūkota dažādu PCM izmantošana saules kolektoru sistēmā vienlaicīgi, kas līdz šim nav plaši izpētīts, un noskaidrota PCM izmantošanas ietekme uz saules kolektora kopējo efektivitāti.

### **Ievads.**

Main aspect when solar thermal energy storage (TES) is considered is thermal storage capacity in form of sensible heat, latent heat or chemical energy. In case of solar systems, solar TES provide a solution for mismatch between energy supply and energy demand. Higher capacity reduces the size of the system and increases overall efficiency [1]. Water is used in almost every system as working fluid due to characteristics like nontoxicity, abundance, high specific heat and suitability for wide range of heating applications [2]. Since the temperatures that occur in solar heat storage is above 0 °C and below 100 °C, no phase change of water can occur and energy is stored only as sensible heat. Wide variety of phase change materials (PCM) have been created and accepted as suitable to make use of latent heat storage (LHS).

While use of phase change materials in latent thermal heat storage have been studied thoroughly, a lot less studies have been looking into use of different melting temperature phase change materials to enhance the efficiency of solar system. Solar systems in many cases are used in existing buildings where available space is limited. By increasing efficiency and energy density, it is possible to store more and take less space.

### **Mērķis.**

Aim of the work is to assess the use of multiple phase change materials with different melting temperatures on overall efficiency of solar thermal system.

### **Materiāli un metodes.**

The methodology to calculate the effect of PCM on solar system is to divide the volume of the tank into multiple layers and numerically describe physical processes in each of them. Energy balance for each layer or node consist of energy charge or discharge by upward/downward flow, heat flux through the internal heat exchanger, the thermal conduction to neighbouring nodes, the thermal losses through the tank envelope to the ambient and energy exchange between storage medium and PCM modules [3]. Since different PCM layers will melt at different periods, this is time dependent problem. Simulation of periods as long as whole heating season is available by using data acquired by existing solar systems.

### **Avoti:**

- [1] Y. Tian and C. Y. Zhao, “A review of solar collectors and thermal energy storage in solar thermal applications,” *Appl. Energy*, vol. 104, pp. 538–553, Apr. 2013.
- [2] A. Sharma, V. V. Tyagi, C. R. Chen, and D. Buddhi, “Review on thermal energy storage with phase change materials and applications,” *Renew. Sustain. Energy Rev.*, vol. 13, no. 2, pp. 318–345, Feb. 2009.

[3] J. Bony and S. Citherlet, "Numerical model and experimental validation of heat storage with phase change materials," *Energy Build.*, vol. 39, no. 10, pp. 1065–1072, Oct. 2007.