



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 5, May 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.512

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

To Calculate the Specific Heat Capacity of Water

Mrs. Charuta Amol Puranik

Lecturer in Physics, Department of Science, Bharati Vidyapeeth Institute of Technology, Navi Mumbai,

Maharashtra, India

ABSTRACT: Concentrated solar energy (CSP) system use general thermodynamic cycle to supply electricity and thus the system efficiency is especially determined by the working temperature of heat transfer fluid (HTF). Organic-based HTFs were firstly used for this application. However, this has limited the working temperature of CSP around 300 °C since these organic material starts to decompose below 400 °C. Typical liquid salts are thermally stable to high temperatures (500~600 °C). Using these salts as HTF can significantly increase the working temperature and as a result the system efficiency also can be highly enhanced. For instance increasing working temperature from 300 °C to 500 °C can simply increase Carnot efficiency from 48% to 61%. Moreover, these salts are eco-friendly and using them as HTF can reduce the potential environmental cost caused by the traditional HTF. These salts even have very low vapour pressure which will reduce the potential mechanical stress on the pipe / storage system caused by using the traditional HTF.

Recently a binary liquid salt ($\text{NaNO}_3\text{-KNO}_3$; also termed as “solar salt”) has been introduced and adapted within the most up-to-date CSP plants. This solar salt is additionally used as thermal energy storage (TES) medium. Extra thermal energy collected within the daytime is stored in solar salt and kept during a TES for later use. When electricity demand peaks (e.g., evening time) solar salt in TES provide thermal energy to continue electricity production. One among the main challenges to use solar salt as HTF / TES is its high melting point at 220 °C. This has the potential risk of crystallization during a pipe / storage system during a harsh condition (e.g., rainy season) and can end in high maintenance & operation costs for extra freezing protection system. Adding $\text{Ca}(\text{NO}_3)_2$ to solar salt can dramatically decrease the melting point (down to 120°C). However, this ternary salt mixture has relatively low thermo-physical properties. Doping this material with oxidized nanoparticles can improve these properties. Nanofluids are liquids doped with nanoparticles. They need to be proposed for giant enhanced thermo-physical properties. The low thermo-physical properties were highly enhanced by doping with nanoparticles (19 to extend by I Chronicles nanoparticle concentration by weight). The results of this study are going to be useful to develop advanced HTF / TES material for CSP plants. This may also be applicable for other heat HTF applications like heat , nuclear energy, and other energy generation technologies using thermodynamic cycle.

I. INTRODUCTION

Thermal phenomena are at the idea of power line current rating. The temperature reached during the time in several points of the cable, especially at the interface between conductor and insulation, determines the cable lifetime, along side other ageing factors thanks to the characteristics of the materials [1,2]. Power line design for a given application has got to be administered accurately, because any issues that appear within the cable during its operation could lead on to failures. The occurrence of failures requires expensive maintenance, with the creation of joints (or junctions) that break the physical cable continuity and make the cable more vulnerable during successive operation [3]. When a cable is installed, the precise evolution in time of the present that the cable will carry, as well because the characteristics of the external environment, can't be known beforehand. For this purpose, the definition of the present rating of the cable has got to come from general hypotheses on the cable operation for a given cable layout and sort of installation. The present rating (also denoted as ampacity) refers to the utmost current at which the cable can operate without exceeding the temperature limits for the insulation material. Thereby, the determination of the present rating requires formulating a heat transfer problem, during which the thermal properties of the materials, the warmth sources inside and outside the cable, and therefore the mechanisms of warmth dissipation are modelled and evaluated [4]. The time-variable nature of the warmth sources, along side the possible changes occurring in the outside environment during the time, make the determination of the present rating a

time-dependent problem. This problem is additionally indicated as dynamic cable rating, and consists of the determination of the utmost permissible current loading of the cable during the time. Dynamic cable rating involves an iterative method for continuous calculation of the conductor temperature by considering the history of the present loading, alongside with the parameters and thermal conditions of the cable and therefore the environment [5]. The history are often considered by storing data for various periods (e.g., hourly data stored at six hours, one day, and at some point plus one hour in [6]). With today's real-time monitoring systems, gathering data during the cable operation is simpler than within the past [7]. Distributed temperature sensing enables data gathering in 10 to 30 min [8] at different locations along the cable.

Nevertheless, extended monitoring of the temperatures along cable lines remains a really expensive task, not supported also by the very fact that failures could appear at any location. For this reason, monitoring is usually restricted to those points (including cable junctions). The utilization of appropriate thermal models to represent the general picture of the temperatures at different points of the cable lines, as well as within the soil and on the external surface, is then fully justified. Investigating the thermal behaviour of electrical cables requires cross-competences from many domains, like thermal sciences and EE. Well-structured research lines are in progress, handling different objectives. For cable rating purposes, structured results are presented in books like [9,10]. The precise aspects associated with increasing the cable rating in several conditions are addressed in [11]. Life cycle management of power cables is reviewed in [12]. Most of the research work administered on power cables refers to underground cables, and in some cases to overhead cable lines, while submarine transmission cables are designed for dedicated applications. More recently, various applications to power cables located within the water have emerged, especially for sizing cables connecting offshore wind farms [13,14]. Concerning the thermal properties of the soil (without addressing the presence of power cables), recent reviews are presented in [15]. Furthermore, for future time horizons, the evolution of the warmth sources is additionally uncertain. Advanced thermal and electrical models are needed to enable better exploitation of the power cables during installation, operation, and emergency situations. These models need to be exploited to execute several simulations supported different operational scenarios. However, to the authors' knowledge, there's no recent review that addresses at an equivalent time multiple aspects of soil modelling, thermal assessment models, current rating calculations, advanced effects of the electrical quantities on the cable rating, and advanced applications like forecasting of the present rating, providing both an artificial view on the concepts and trends that emerge from recent publications.

The contribution of this paper is to review the thermal models of underground cables by indicating the evolutions occurred, ranging from basic models with general hypotheses, towards the adoption of more detailed specifications to deal with practical cases. especially, historical aspects are summarized, both concerning the mathematical thermal models and therefore the methods to simulate the warmth transfer in the cables, also as within the external medium. Various contributions presented in recent years are highlighted. Analytic expressions are presented for easy cable installation types. At an equivalent time, indications on articles that address more complex cases with metal components, ducts, conduits, oil cooling, back-fill, and more elements, are provided by pointing to specific references. The literature on soil properties (based on thermal sciences) is addressed with the one resulting in formulations of cable ratings in several conditions (which also exploits EE aspects), to supply a wider view on the researches ongoing within the respective domains.

II. SPECIFIC HEAT CAPACITY OF WATER

The world's climate system doesn't respond fully and immediately to externally applied forcing. This lag time has allowed the talk about the effect of human activities on climate to travel on longer than it might have if everything we did were instantly noticeable. for instance, when a particular amount of additional CO₂ is added to the atmosphere, the warming effects on the air, land, and ocean take a while to be fully realized. albeit there was how to feature heat on to the world, it might still take time for the temperatures we measure to extend. during this activity, we'll conduct an easy experiment to watch the precise heat capacity of water. By doing so, we'll be ready to gain some insight about the lag time of the climate system's response to external forcing.



The specific heat capacity (C_p) of liquid water at temperature and pressure is approximately $4.2 \text{ J/g}^\circ\text{C}$. this suggests it take 4.2 joules of energy to boost 1 gram (or 1 milliliter if you'd rather consider the equivalent volume of 1 gram of water) of water by 1 degree Centigrade . this is often actually quite large. the precise heat capacity of water vapour at temperature is additionally above most other materials. Here may be a table of the precise heat capacities of varied materials:

Table 1. Specific heat capacity of an assortment of Earth materials

Material	$C_p(\text{J/g}^\circ\text{C})$
liquid water	4.2
air	1.0
water vapor	1.9
granite	0.8
wood	1.7
iron	0.0005

Note that none of the opposite materials listed above compared to water's ability to soak up heat. (Nitpicker alert: Water doesn't have the very best known heat capacity. the warmth capacity of pure hydrogen gas at temperature is $14.3 \text{ J/g}^\circ\text{C}$, consistent with the CRC Handbook of Chemistry and Physics. Pure H_2 isn't an enormous player within the Earth's climate system, though.)

The high C_p of water is why "a watched pot never boils!" this is often also the most reason the climate is slow to reply to external changes. it's lucky for us that the ocean has the power to soak up tons of warmth before its temperature rises appreciably. The flip side of this is often that when an external source of energy is removed, the ocean is similarly slow to reply. Its temperature won't begin to decrease directly. Within the next activity, we'll observe this phenomenon.

III. CONCENTRATED SOLAR POWER

Solar thermal technologies are supported the concept of concentrating the radiation from the sun which produces steam or hot air by which generation of electricity is established following the thermal power cycles. Mirrors with high reflectivity or sometimes glass serve the purpose of concentration. Line focusing and point focusing are the 2 systems which are used in concentrating the solar energy from the sun. These systems use only the direct radiation from the sun in focusing the energy. Line focusing system features a low concentration factor and may achieve only low temperatures. they typically operate at pressure's starting from 80 to 120 bar and therefore the temperature of the steam which will be achieved ranges about 350 to 550 °C. the purpose focusing systems considerably have a better concentrating factor and may reach up to 600 °C to 1200 °C and their operating pressures are usually 1 to twenty bar [3]

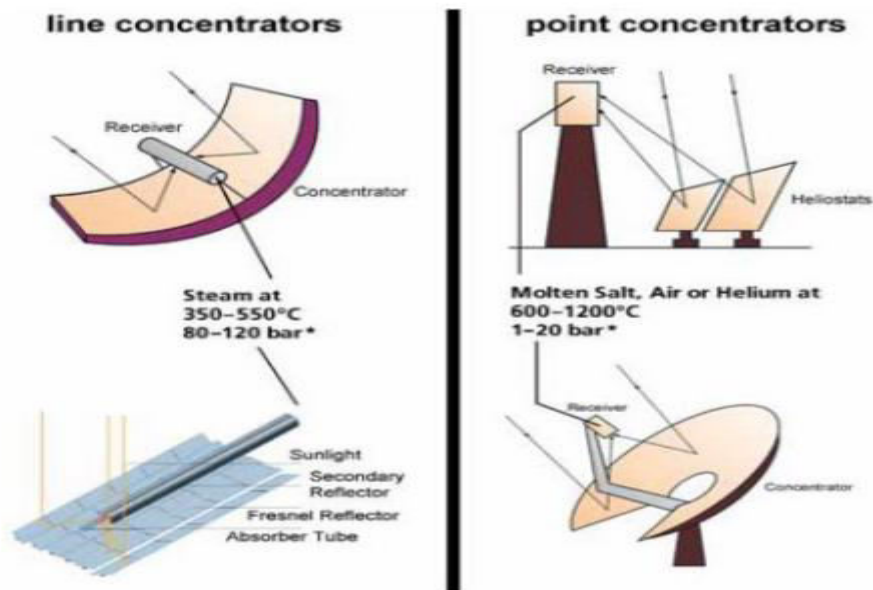


Figure 1. Technologies for concentrating solar radiation

The Solar thermal power plants constitute the subsequent major parts concentrator, receiver, storage / transport system, and therefore the power conversion device. The economic success of a thermal power station depends on its storage capacity [4]. Designing a storage system is a complex part thanks to issues associated with its design and warmth transferring capacities. Storage systems that are to be considered should have the capacity to be operated between 300°C to 390°C [5]. The fabric to be selected for the transfer and storage hence must possess certain enhanced characteristics as in high thermal conductivity (K), good heat transfer co-efficient (Cp), less corrosive to the warmth exchanger, cost efficient, high flash point, high heat of vaporization and fewer thermal decomposition [6].

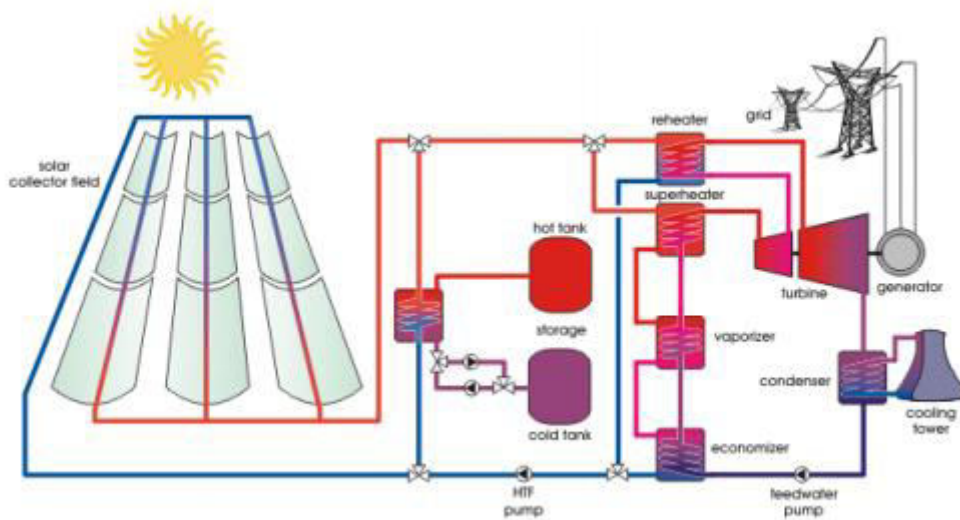


Figure 2 Schematic diagram of a steam cycle power plant with a parabolic trough collector and thermal energy storage

The chosen material for the Thermal Energy Storage (TES) is to be thermally stable, less reactive with the medium, feasibility to be stored in a container, high resistance to cyclic thermal loading and low cost. A heat transfer fluid is often utilized for this application. Heat transfer fluids in conventional system may heat to ~ 500°C which can be used as a data-storage medium or maybe as a channel to store the heated fluid. The thermal energy data-storage medium can later be used to obtain the specified electricity.

IV. METHODS DISCUSSION

Figure 1 illustrates the water CP(T) data, experimentally measured and evaluated by means of recent MD simulations at ambient pressure, under different conditions. Specifically, the figure reports data measured in bulk water (in the range 236 < T < 300 K, thus including the supercooled regime, confined water, ice Ih, LDA, HDA and therefore the cited simulation studies with the TIP4P/2005 model potential. However, although both the 2 mentioned MD studies report a maximum in CP(T) within the same temperature interval (220–230 K), there are some discrepancies about their values that would be related to the shortage of an entire equilibration within the data especially for the runs at rock bottom temperatures (below 170 K). As are often observed, for confined water, some CP(T) data coming from different experiments and during a very large temperature region (80–300 K, i.e., well inside the no man’s finish up to the region of the amorphous ice), are reported. especially, we report the studies of water confined in: (i) silica gels with pore sizes in the range of 1.1–5.2 nm: (ii) cylindrical MCM nanopores with different sizes within the range of 1.4–4.2 nm. More precisely, the Figure 1 data affect silica gels—CARIACT—(1.1, 3, 6, 12, and 52 nm pore sizes) and MCM nanotubes coming from previous (1.4, 1.6, 1.8 nm) and new experiments (1.8, 2, 2.2 and 2.4 nm). New data were acquired by using an equivalent experimental procedure and conditions reported in ref [15]: an equivalent heating and cooling rate of 12 K/h. the precise heat of water during a silica xerogel matrix (with a rather narrow distribution of pore sizes and a mean dimensions of about 2 nm), is additionally reported for comparison. The line and red data points deal with the CP(T) of ice Ih. The illustrated data come from two different experimental techniques: adiabatic method and therefore the usual differential scanning calorimetry (DSC). especially, the new data were acquired with this last technique (the same previously used for MCM samples, hydrated after an entire drying working with a Perkin–Elmer DSC 8500. the



warmth capacity of the water within the pores springs by subtracting, from the warmth capacity of the sample, the contributions of the excess water. the primary method has been just developed to account for the precise properties of a glass because it ages, and it is often wont to separate the properties of water round the surface from those of the internal one. It is, however, surprising to ascertain the agreement between the CP(T) data of confined water and people of the MD simulations.

The specific heat experiments on glass-forming materials are made during a thermal cycle: first, the sample is cooled ranging from the liquid stable phase toward, and below, its estimated glass transition temperature. then, the sample is heated returning to the start line. because it is documented, the rate of the cooling and heating phases usually must be an equivalent so as to possess reproducible and comparable data. The illustrated data affect the CP(T) during the heating phase. the precise heat values in 257–273 K aren't reported (could not be derived due to the massive fusion contribution which must be subtracted from the observed values).

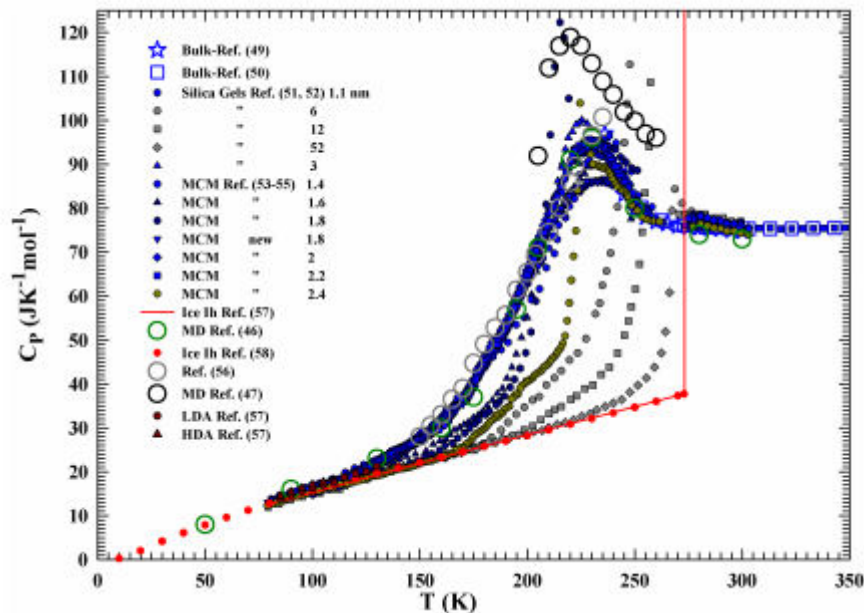


Figure 1. The CP(T) data measured, at the ambient pressure, in bulk, confined water and those obtained by the two mentioned MD simulation studies. Specifically, the bulk water data cover the range 236 < T < 350 K (thus including the supercooled regime), whereas confined water data are measured under different confining materials with various pores in the range 80 < T < 300 K. The figure also reports data of ice Ih 10–273 K, of LDA and HDA.

V. CONCLUSION

The electricity production and therefore the reliability of the plant are thus far worse than the expected. Additionally, the prices are much larger than what was planned. The real-world experience thus casts considerable doubts on the amount being proposed for the CSP ST technology by expert panels and therefore the literature. The CSP ST plant technology remains very faraway from the standards of conventional power plants within the power industry, where the particular costs and performances are usually on the brink of the planned values. More experience must be gathered to properly develop a technology that appears to be still in its infancy. Having said that, there are certainly many development trends being sought that albeit not game changers can make the CSP ST technology far more competitive a minimum of vs. other renewables, wind or solar photovoltaics. As actual numbers are very faraway from plans, we analyze of these technology updates being sought with the due skepticism. the present trends within the development of CSP ST installations are reviewed. Improvements are being looked for efficiency of plant, installation cost, life-span and operation cost. Materials and manufacturing processes, design of solar field and receiver, including fluids, cycle and materials, optimal management of daily and seasonal operation of the plant, new TES concepts, integration of solar plant with thermal desalination, integration of solar plant with CCGT installations and eventually, specialization and regionalization of the project specification, are the key areas of progress of CSP ST technology. While it's expected that CSP ST installations will grow considerably within the next few years, there's not yet a far better solution all-inclusive



than the utilization of MS as RF and TES fluid, with classic solar field heliostats and receivers, driving a water/steam superheated Rankine cycle steam cycle. Manufacturing may be a major keyword to hide the various alternatives that are presently under study at different stages of development may only progress slowly, taking advantage of world experiences requiring time instead of simulations or laboratory experiments. Cost of plants aren't expected to scale back drastically, albeit convergence on few selected designs of heliostats and receivers might be beneficial to their improvement and price reduction, with manufacturing of components in large scale and significant feed-backs from world operation expected to be a serious driver of the developments.

REFERENCES

- [1] "Solar Thermal and PV Efficiency Breakthrough – Stanford Solar Energy Researchers Make Big Claims". [2] Manning, Paddy (10 October 2009). "With green power comes great responsibility". Sydney Morning Herald. Retrieved 2009-10-12.
- [3] Hans Müller-Steinhagen and Franz Trieb. "Concentrating Solar Power – A review of Technology" (2004).
- [4] Advanced Thermal Energy Storage Technology For Parabolic Trough by Rainer Tamme, Doerte Laing, Wolf-Dieter Steinmann.
- [5] Development Of A Molten-Salt Thermocline Thermal Storage System For Parabolic Trough Plants by James E. Pacheco, Steven K. Showalter, William J. Kolb.
- [6] Thermochemistry of ionic liquid heat-transfer fluids by Michael E. Van Valkenburg, Robert L. Vaughn, Margaret Williams, John S. Wilkes.
- [7] "Assessment of A Molten Salt Heat Transfer Fluid In A Parabolic Trough Solar Field" by D. Kearney.
- [8] Moens, L., Blake, D. M., Rudnicki, D. L., and Hale, M. J., 2003, "Advanced thermal storage fluids for solar parabolic trough systems," J. Sol. Energy. Eng. Trans. ASME, 125, pp. 112-116.
- [9] "Physical properties data compilations relevant to energy storage", G.J. Janz, C.B. Allen, N.P. Banal, R.M. Murphy and R.P.T. Tomkins.
- [10] "Thermal Conductivity of Nanoparticle – Fluid Mixture", Xinwei Wang, Xianfan Xu and Stephen U.S. Choi, Argonne National Laboratory.
- [11] Donghyun Shin and Debjyoti Banerjee "Effects of silica nanoparticles on enhancing the specific heat capacity of carbonate salt eutectic", IJSC, 2010. [12] Buongiorno, J., "Conventional transport in nanofluids", ASME J. Heat Transfer. 128:240- 250, 2006
- [13] Gilman, Paul, et al. Solar advisor model user guide for version 2.0. National Renewable Energy Laboratory, 2008.
- [14] Kearney, D., Herrmann, U., Nava, P., and Kelly, B., 2002, "Evaluation of a molten salt heat transfer fluid in a parabolic trough solar field," Proceedings of the National Solar Energy Conference, Solar 2002, Reno/Sparks, Nevada, June 2002.
- [15] Moens, L., Blake, D. M., Rudnicki, D. L., and Hale, M. J., 2003, "Advanced thermal storage fluids for solar parabolic trough systems," J. Sol. Energy. Eng. Trans. ASME, 125, pp. 112-116.



**Impact Factor:
7.512**



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details