Second Update on Activity C1 Design Tools and Models, Task 65 Solar Cooling Sunbelt Regions

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Abstract

This brief extended abstract reports about IEA Solar Heating and Cooling (SHC) Task 65 and Australia's engagement within the task. Australia has been contributing to Subtask C: Assessment and Tools. The additional findings from the literature on solar cooling system design tools and models are also presented.

Keywords: IEA; Sunbelt region; solar cooling; assessment; design tool

Introduction

IEA SHC Task 65 focuses on innovations for affordable, safe and reliable solar cooling systems. It is organised in four main activities/subtasks; the details may be found in Neyer and Jakob (2020). One of the issues identified is that commonly accepted appropriate methods and tools for benchmarking, assessment, and design for Sunbelt region are lacking. To address this issue, the main objectives of Activity C1 are (Neyer, 2020):

- to document the tools and their specific applications,
- to provide measured data for validation of the tools, and
- to adapt the selected ones for sunbelt boundaries.

The initial finding from the published literature about the solar cooling system design tools and models were presented in the last Asia-Pacific Solar Research Conference (APSRC) (Aye et al. 2021). The software tools applied in solar cooling system research found in the literature and their websites are shown in Table 1. Among these software tools, TRNSYS (Klein et al. 2020) was found to be the most applied in solar cooling research (Aye et al. 2021). We have reviewed the relevant TRNSYS documentation and components available for solar cooling system simulations were identified. The list of the components were presented to the experts in the Fourth Task Expert meeting held on 23 March 2022. The expert completed a partial list presented with the references. In this second update, TRNSYS components available for solar cooling system simulation are presented together with the references which they are implemented (Table 2).

In general, solar cooling system components are categorised into four processes: solar energy collection, cooling, distribution, and optional storage. Software tools are applied for estimating design parameters (by sizing tools) and predicting operational performance parameters (by simulation tools). It should be noted that the simulations tools could be used for design optimisations. Optimisations could aim for individual or combination of technical performance, financial performance, and environmental performance.

Table 1 Software tools applied in solar cooling system research

Software	Webpage
Ebsilon	https://www.ebsilon.com/
EES	https://fchartsoftware.com/ees/
EnergyPlus	https://energyplus.net/
FLUENT	https://www.ansys.com/products/fluids/ansys-fluent
gPROMS	https://www.psenterprise.com/products/gproms
IES	https://www.iesve.com/software
IPSEpro	https://www.simtechnology.com/CMS/index.php/ipsepro
MATLAB	https://www.mathworks.com/products/matlab.html
Meteonorm	https://meteonorm.com/
Sage	http://www.sageofathens.com/
TRNSYS	https://sel.me.wisc.edu/trnsys/

Conclusions

The additional findings from the available literature on the software tools applied in solar cooling research have been presented. Since TRNSYS has been the most widely applied software tool relevant to solar cooling system design, the components available have been identified. The potential for users to create or modify components, such as the components available in TRNSYS Extensions for Australian Solar Products (TRNAUS) should be noted. The next step is to complete the collection of the data on design software tools utilised in the industry for practical installations. If you wish to take part and contribute to this data collection, please contact us.

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Table 2. TRNSYS components available for solar colling system simulation.

Category	Component	TRNSYS Type	Source	Reference where implemented
Solar collector	Flat plate collector	Type 1: Quadratic Efficiency Collector	Std.	(Tashtoush, Alshare and Al-Rifai, 2015)
		Type 72: Performance Map Collector	Std.	(Uckan & Yousif, 2021)
		Type 73: Theoretical Flat-Plate Collector	Std.	(Fong & Alwan, 2013)
	Evacuated tube	Type 71: Evacuated Tube Collector	Std.	(Boero & Agyenim, 2020; Cascetta, Cirillo, Nardini and Vigna, 2018; Hang, Du, Qu and Peeta, 2013; Herrando, Simón, Guedea and Fueyo, 2021; Mehmood, Maximov, Chalmers and Friedrich, 2020; Plytaria, Bellos, Tzivanidis and Antonopoulos, 2019; Siddique et al., 2022; Ssembatya, 2013; Tashtoush et al., 2015; Thomas & Andre, 2012; Uckan & Yousif, 2021; Wu, Aye, Yuan, Mendis and Ngo, 2020)
		Type 538: ETSC	TESS	(Vasta, Palomba, Frazzica, Costa and Freni, 2015; Vasta, Palomba, Frazzica, Di Bella and Freni, 2016)
	Trough and concentrating	Type 30: Parabolic Trough Arrays	Std.	N/A
		Type 536: Linear parabolic concentrating solar collector	TESS	(Rossetti, 2018)
		Type 1245: XCPC Collector Model	TESS	(Uckan & Yousif, 2021)
		Type 1288: PTC	Non-Std.	(Cascetta et al., 2018)
	PV	Type 103: Basic Model – w/wo MPPT	Std.	N/A
		Type 190: Advanced Model – w/wo MPPT – w/wo Inverter	Std.	N/A
	PV/T	Type 50: PV-Thermal Collectors	Std.	(Calise, Dentice d'Accadia, Figaj and Vanoli, 2016; Calise, Figaj and Vanoli, 2017)
		Type 560: Combined PV/T Solar Collector	TESS	(Herrando et al., 2021)
		Type 562: Simple Glazed Or Unglazed PV Panel	TESS	(Park, Jang and Kim, 2021; Wu et al., 2020)
Cooling technology	Absorption	Type 107: Absorption Chiller (Hot-Water Fired, Single Effect)	Std.	(Herrando et al., 2021; Lugo & Garcia-Valladares, 2015; Mehmood et al., 2020; Plytaria et al., 2019; Uckan & Yousif, 2021; Vasta et al., 2015) Modified (Ssembatya, 2013)
		Type 117: Absorption Chiller	Non-Std.	(Boero & Agyenim, 2020)
		Type 676: Double-Effect Steam-Fired Absorption Chiller	TESS	N/A

Category	Component	TRNSYS Type	Source	Reference where implemented
		Type 677: Double-Effect Hot Water-Fired Absorption Chiller	TESS	(Calise, Libertini and Vicidomini, 2017; Hang et al., 2013; Rossetti, 2018; Siddique et al., 2022; Xu & Wang, 2017)
		Type 678: Double-Effect Direct-Fired Absorption Chiller	TESS	(Hang et al., 2013)
		Type 1005: Absorption with dynamic elements	Non-Std.	(Neyer et al., 2013) (Neyer et al; 2018)
	Adsorption	Type 909: Adsorption Chiller (Performance Map)	TESS	(Vasta et al., 2016)
	Vapor compression	Type 118: Air-Cooled Chiller	Std.	N/A
		Type 142: Water-Cooled Chiller	Std.	N/A
		Type 655: Air cooled chiller	TESS	(Thomas & Andre, 2012)
		Type 666: Water Cooled Chiller	TESS	(Mehmood et al., 2020; Siddique et al., 2022)
Coolth delivery	Air distribution	Type 11: Controlled Flow Mixer	Std.	(Siddique et al., 2022)
		Type 145: Duct	Std.	N/A
		Type 148: Tee-Piece Flow Mixer	Std.	N/A
	Water distribution	Type 31: Pipe	Std.	N/A
	Electricity distribution	Type 188: Busbar	Std.	N/A
Storage	Heat	Type 4: Hot water tank	Std.	(Boero & Agyenim, 2020; Buonomano, Calise and Ferruzzi, 2013; Calise, Libertini, et al., 2017; Plytaria et al., 2019; Rossetti, 2018; Siddique et al., 2022; Tashtoush et al., 2015)
		Type 158: Constant Volume Liquid Storage	Std.	(Cerezo et al., 2018; Mehmood et al., 2020; Siddique et al., 2022)
		Type 534 Vertically cylindrical storage tank	TESS	(Herrando et al., 2021; Thomas & Andre, 2012)
		Type 340: Stratified fluid storage tank	Non-Std.	(Drück, 2006)
	Electricity	Type 47: Batteries	Std.	N/A
		Type 185: Quasi-static model of lead-acid battery	Std.	N/A
Financial	LCC	Type 582: Life Cycle Cost Analysis	TESS	N/A

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