ERDAL ÇETKİN, PhD

Prof. Dr.

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# Education

**PhD** Duke University, Mechanical Engineering and Materials Science May 2013

Dissertation: “Constructal Vascularized Structures for Cooling and Mechanical Strength”

 Advisors: Adrian BEJAN, Sylvie LORENTE

**BS** Kocaeli University, Mechanical Engineering July 2007

# Honors and Awards

**Ministry of Education Abroad Education Scholarship**  2008-2013

Abroad Graduate Studies in the US

**The Scientific and Technological Research Council of Turkey** 2007

Graduate Scholarship for Undergrad students

**Izocam Inter-Universities National Insulation Competition** 2007

Second Place

# Research Projects

1. “Optimization of plate design for a specific plate heat exchanger”, **VBS Enerji, Mühendislik ve Danışmanlık (Supported by Bosch Thermotechnology, Manisa)**, **Consultant**, 2022-2022.
2. “Electric scooter with fast charging capability”, **VBS Enerji, Mühendislik ve Danışmanlık**, **PI**, 2022-2022.
3. “High-pErformance moduLar battery packs for sustaInable urban electrOmobility Services – HELIOS”, **European Union Horizon 2020**, **Institution PI and WP Leader**, 2021-Ongoing.
4. “Design optimization for a specific plate heat exchanger”, **VBS Enerji, Mühendislik ve Danışmanlık (Supported by Bosch Thermotechnology, Manisa)**, **Consultant**, 2021-2021.
5. “Light weight window structure design for periodically pressurized structures”, **TUSAŞ Lift-up**, **Academic Consultant**, 2020-2021.
6. “Infrared drying and paint curing oven”, **Carob Mühendislik (Sistem Teknik Makine TUBITAK TEYDEB 1507 project)**, **Consultant**, 2020-2021.
7. “Electric vehicle battery pack and thermal management system”, **TUBITAK TEYDEB 1512**, **PI**, 2020-2021.
8. “Thermal management of electric vehicle battery cells with microchannel heat exchangers”, **İzmir Institute of Technology BAP**, **PI**, 2020-2021.
9. “Hydraulic performance optimization for dishwashers”, **İztek A.Ş. (Vestel TUBITAK TEYDEB 1507 project)**, **Consultant**, 2020-2020.
10. “Eliminating overheating of hot stamping molds and mold lifetime increment”, **TUSAŞ Lift-up**, **Academic Consultant**, 2019-2020.
11. “Investigation of cooling designs to increase the lifetime of batteries in electric vehicles during fast charging”, **TUBITAK 1001**, **PI**, 2019-2021.
12. “Constructal tree structures for mechanical strength and cooling of aircraft, CTair”, **US Air Force Research Laboratory**, **Researcher**, 2011-2013.

# Teaching Experience

**İzmir Insitute of Technology** 2014 - 2023

Asst/Assoc/Full Professor, Department of Mechanical Engineering

* Heat Transfer, Undergraduate
* Thermodynamics – I, Undergraduate
* Thermodynamics – II, Undergraduate
* Introduction to Computational Fluid Dynamics, Undergraduate
* Hydraulics and Pneumatics in Automation, Undergraduate
* Constructal Theory and Design, Graduate
* Convective Heat Transfer, Graduate
* Computational Fluid Dynamics, Graduate
* Advanced Thermodynamics, Graduate
* Heat Conduction, Graduate
* Thermal Radiation, Graduate
* Numerical Methods in Mechanical Engineering, Graduate

**Duke University** 2008 - 2013

Teaching Assistant, Department of Mechanical Engineering and Materials Science

* Constructal Theory and Design, Undergraduate
* Convective Heat Transfer, Graduate

**Doctoral Students Advised**

Turgay COŞKUN, “Experimental investigation of a hybrid thermal management system for an electric vehicle battery module”, 2022

Şahin GÜNGÖR, “Investigation of cooling designs to increase the lifetime of batteries in electric vehicles during fast charging”, 2021

**Masters Students Advised**

Gülşah YARIMCA, “Investigation of semi-empirical battery ageing models of electric vehicles”, 2023.

Fatih EDİZ, “Investigation of windshield defogging and defrosting designs to decrease energy consumption in vehicles”, 2023

Resul Çağtay ŞAHİN, “Numerical investigation of various heat transfer mechanisms on thermal management of a lithium-ion battery pack”, 2022

Çağlar GEDİKSİZ, “Numerical and experimental investigation of an electric vehicle battery module thermal management system”, 2022

Sinan GÖÇMEN, “Numerical and experimental investigations of an air-cooled battery thermal management system”, 2021

Furkan Tuğberk SEVENCAN, “Investigation of microchannel heat exchangers for condensers”, 2021

Ceren KARADOĞAN, “Four-way refrigerant piping system design for variable speed compressor”, 2021

Sylevaster KYALIGONZA, “Numerical investigation of thermal management in photovoltaic cells with phase changing materials (PCM) and high conductivity inserts”, 2021

Güven NERGİZ, “Design optimization of an industrial oven heat exchanger”, 2021

İsmail Gürkan DEMİRKIRAN, “Computational fluid dynamics (cfd) analysis of latent heat storage in heat exchangers by using phase change materials (pcm)”, 2020

Soykan YAŞAR, “Investigation of compressor cycle operating point for various air conditions”, 2019

Ömer Berhan ERİK, “Hydraulic design optimization and performance evaluation for a dishwasher”, 2019

Çağatay KÖK, “Numerical investigation of thermal management for an airfoil profile to prevent ice formation”, 2019

Hasel Çiçek KONAN, “Snowflake shaped high conductivity inserts for heat transfer enhancement”, 2018

Mehmet KARA, “Experimental investigation of a combi boiler heat exchanger”, 2018

Eylem ÇETİN, “The effect of T-shaped fin geometries on heat transfer rate enhancement”, 2017

Onur YENİGÜN, “Numerical and experimental investigation of radial and tree-shaped vascular channels for self-cooling structures”, 2016

# Publications

## Journal Publications

U. Ege Samacioglu, Ali Koşar, **Erdal Çetkin**, Optimization of Y-Shaped Micro-Mixers with a Mixing Chamber for Increased Mixing Efficiency and Decreased Pressure Drop, ASME Journal of Heat and Mass Transfer, 1-40, doi.org/10.1115/1.4064443, 2024.

Turgay Coşkun, **Erdal Çetkin**, Cold plate enabling air and liquid cooling simultaneously: Experimental study for battery pack thermal management and electronic cooling, *International Journal of Heat and Mass Transfer*, 217, 124702, 2023.

F. Naseri, S. Gil, C. Barbu, **E. Cetkin**, G. Yarimca, A.C. Jensen, P.G. Larsen, C. Gomes, Digital twin of electric vehicle battery systems: Comprehensive review of the use cases, requirements, and platforms, *Renewable and Sustainable Energy Reviews*, 179, 113280, 2023.

Sinan Gocmen, **Erdal Cetkin**, Experimental investigation of air cooling with/out tab cooling in cell and module levels for thermal uniformity in battery packs, ASME *Journal of Heat and Mass Transfer*, 145 (2) 022903, 2023.

Turgay Coşkun, **Erdal Çetkin**, Vascularized mini cooling channels to achieve temperature uniformity: Battery thermal management and electronic cooling*, Res. Eng. Struct. Mater.*, 9(3), 675-685, 2023.

Umit Gunes, **Erdal Çetkin**, Bahri Şahin**,** Gemi Sevk Gücü ve Isı Transferinin Yapısal Gelişim Teorisi ile İlişkisi, Gemi ve Deniz Teknolojisi, 222, 138-152, 2023.

Resul C. Sahin, Sinan Gocmen, **Erdal Cetkin**, Thermal management system for air-cooled battery packs with flow-disturbing structures, *Journal of Power Sources*, 551, 232214, 2022.

İsmail G. Demirkıran, **Erdal Cetkin**, Computation time reduction of pcm melting process by changing modeling parameters, *Numerical Heat Transfer, Part:A Applications*, DOI: 10.1080/10407782.2022.2149229 (published online), 2022.

Sahin Gungor, **Erdal Cetkin**, Sylvie Lorente, Thermal and electrical characterization of an electric vehicle battery cell, an experimental investigation, *Applied Thermal Engineering*, 212, 118530, 2022.

İsmail G. Demirkıran, Luiz A.O. Rocha, **Erdal Cetkin**, Emergence of asymmetric straight and branched fins in horizontally oriented latent heat thermal energy storage units: Enhanced heat transfer with constant fin material, *International Journal of Heat and Mass Transfer*, 189, 122726, 2022.

Sahin Gungor, **Erdal Cetkin**, Sylvie Lorente, Canopy-to-canopy liquid cooling for the thermal management of lithium-ion batteries, a constructal approach, *International Journal of Heat and Mass Transfer*, 182, 121918, 2022.

Sahin Gungor, **Erdal Cetkin**, Enhanced temperature uniformity with minimized pressure drop in electric vehicle battery packs at high C-rates, *Heat Transfer*, 51(8) 7540-7561, 2022.

Sinan Gocmen, **Erdal Cetkin**, Emergence of elevated battery positioning in air cooled battery packs for temperature uniformity in ultra-fast dis/charging applications, *Journal of Energy Storage*, 45, 103516, 2022.

İsmail G. Demirkıran, **Erdal Cetkin**, Emergence of rectangular shell shape in thermal energy storage applications: Fitting melted phase changing material in a fixed space, *Journal of Energy Storage*, 37 102455, 2021.

**Erdal Cetkin**, Antonio F. Miguel, Asymmetric Y-shaped micromixers with spherical mixing chamber for enhanced mixing efficiency and reduced flow impedance, Journal of Applied Fluid Mechanics, 14(5) 1389-1397, 2021.

S. Kyaligonza, **Erdal Cetkin**, Photovoltaic system efficiency enhancement with thermal management: phase changing materials (pcm) with high conductivity inserts, *International Journal of Smart Grid*, 5(4) 138-148, 2021.

Sinan Göçmen, Sahin Gungor, **Erdal Cetkin**, Thermal management of electric vehicle battery cells with homogeneous coolant and temperature distribution, *Journal of Applied Physics*, 127(23) 234902, 2020.

Turgay Coskun, **Erdal Cetkin**, Heat transfer enhancement in a microchannel heat sink: nanofluids and/or micro pin fins, *Heat Transfer Engineering*, 41(21) 1818-1828, 2020.

Turgay Coskun, **Erdal Cetkin**, A review of heat and fluid flow characteristics in microchannel heat sinks, *Heat Transfer*, 49(8) 4109-4133, 2020.

**Erdal Cetkin**, Antonio F. Miguel, Constructal branched micromixers with enhanced mixing efficiency: Slender design, sphere mixing chamber and obstacles, *International Journal of Heat and Mass Transfer*, 131, 633-644, 2019.

**Erdal Cetkin**, The effect of cooling on mechanical and thermal stresses in vascular structures*, Journal of Thermal Engineering*, 4(2), 1855-1866, 2018.

Hasel C. Konan, **Erdal Cetkin**, Snowflake shaped high-conductivity inserts for heat transfer enhancement, *International Journal of Heat and Mass Transfer*, 127, 473-482, 2018.

**Erdal Cetkin,** Constructal microdevice manifold design with uniform flow rate distribution by consideration of the tree-branching rule of Leonardo da Vinci and Hess-Murray rule, *Journal of Heat Transfer,*139(8), 2017.

**Erdal Cetkin**, Vascular structures for smart features: Self-cooling and self-healing, *Journal of Thermal Engineering*, 3(4), 1338-1345, 2017.

Eylem Cetin, **Erdal Cetkin**, The effect of cavities and T-shaped assembly of fins on overall thermal resistances, *International Journal of Heat and Technology*, 35(4), 944-952, 2017.

Onur Yenigün, **Erdal Cetkin**, Experimental and numerical investigation of constructal vascular channels for self-cooling: Parallel channels, tree-shaped and hybrid designs, *International Journal of Heat and Mass Transfer,***103**, 1155-1165, 2016.

**Erdal Cetkin**, Alessandro Oliani, The natural emergence of asymmetric tree-shaped pathways for cooling of a non-uniformly heated domain, Journal of Applied Physics, 118(2), 2015.

**Erdal Cetkin**, Sylvie Lorente, Adrian Bejan, Vascularization for cooling and reduced thermal stresses, *International Journal of Heat and Mass Transfer*, 80, 858-864, 2015.

**Erdal Cetkin**, Inverted fins for cooling of a non-uniformly heated domain, *Journal of Thermal Engineering*, 1(1), 1-9, 2015.

**Erdal Cetkin**, Constructal vascularized structures, *Open Engineering*, 5(1), 220-228, 2015.

**Erdal Cetkin**, Constructal structures for self-cooling: Microvascular wavy and straight channels, *Journal of Thermal Engineering*, 1(5) 166-174, 2015.

**Erdal Cetkin**, Constructal vascular structures with high-conductivity inserts for self-cooling, *Journal of Heat Transfer*, 137(11), 2015.

**Erdal Cetkin**, Three-dimensional high-conductivity trees for volumetric cooling, *International Journal of Energy Research*, 38(12), 1571-1577, 2014.

**Erdal Cetkin**, Emergence of tapered ducts in vascular designs with laminar and turbulent flows, *Journal of Porous Media*, 17(8), 715-722, 2014.

**Erdal Cetkin**, Sylvie Lorente, Adrian Bejan, Constructal paddle design with "fingers", Journal of Applied Physics, 113(19), 2013.

Sylvie Lorente, **Erdal Cetkin**, Tunde Bello-Ochende, Joshua P. Meyer, Adrian Bejan., The constructal-law physics of why swimmers must spread their fingers and toes, *Journal of Theoretical Biology*, 308, 141-146, 2012.

**Erdal Cetkin**, Sylvie Lorente, Adrian Bejan, Vascularization for cooling a plate heated by a randomly moving source, *Journal of Applied Physics*, 112(8), 2012.

**Erdal Cetkin**, Sylvie Lorente, Adrian Bejan, The steepest S curve of spreading and collecting flows: Discovering the invading tree, not assuming it, *Journal of Applied Physics*, 111(11), 2012.

**Erdal Cetkin**, Sylvie Lorente, Adrian Bejan, Hybrid grid and tree structures for cooling and mechanical strength, *Journal of Applied Physics*, 110(6), 2011.

**Erdal Cetkin**, Sylvie Lorente, Adrian Bejan, Vascularization for cooling and mechanical strength, *International Journal of Heat and Mass Transfer*, 54(13-14), 2774-2781, 2011.

**Erdal Cetkin**, Sylvie Lorente, Adrian Bejan, Natural constructal emergence of vascular design with turbulent flow. Journal of Applied Physics, 107(11), 2010.

## Book Chapter under Review

S. Gungor, **E. Cetkin**, S. Lorente, Thermal Management for Batteries: From Basic Design to Advanced Simulation and Management Methods, Chapter 15: Battery cells and their thermal management with a constructal approach, Elsevier.

## Conference Papers

Sinan Gocmen, **Erdal Cetkin**, Evolution of a cross flow heat exchanger for electric vehicle

thermal management, 12th Constructal Law Conference Freedom, Design and Evolution

CLC 2023 Turin (Italy), 21 – 22 September 2023, Oral Presentation.

**Erdal Cetkin**, Sinan Gocmen, Battery thermal management with phase change materials: passive and active cooling, 24th Congress on Thermal Science and Technology with International Participation (Ulibtk'23) Ankara (Turkey) 06-08 September 2023, Oral Presentation.

Gulsah Yarimca, **Erdal Cetkin**, Predictive models for li-ion battery calendric aging: NMC and LFP cells, 24th Congress on Thermal Science and Technology with International Participation (Ulibtk'23) Ankara (Turkey) 06-08 September 2023, Oral Presentation.

**Erdal Cetkin**, Emergence of hybrid battery thermal management systems to prolong battery lifetime in electric vehicles, The 6th International Conference on New Energy and Future Energy Systems (NEFES 2021), Xi`an (China), 01-04 November 2021, Oral Presentation (Online).

Sinan Gocmen, **Erdal Cetkin**, Experimental investigation of a hybrid (liqud+air) thermal management system for battery packs, 6th International Conference on Advances in Mechanical Engineering (ICAME 2021), Istanbul, 20-22 October, 2021, Oral Presentation (Online).

**Erdal Cetkin**, Evaluation of distinct thermal management strategies in electric vehicle battery packs, 23. Isı Bilimi ve Tekniği Kongresi, Gaziantep, 8-10 September, 2021, Oral Presentation (Online).

İsmail G. Demirkıran, **Erdal Cetkin**, Numerical Investigation of Eccentric Arrangement of Multitubes in Circular and Rectangular-Shaped Shell-and-Tube Heat Exchanger, 23. Isı Bilimi ve Tekniği Kongresi, Gaziantep, 8-10 September, 2021, Oral Presentation (Online).

İsmail G. Demirkıran, **Erdal Cetkin**, Computation Time Reduction in Numerical Modeling of Latent Heat Thermal Energy Storage (LHTES) Units, 23. Isı Bilimi ve Tekniği Kongresi, Gaziantep, 8-10 September, 2021, Oral Presentation (Online).

Turgay Coskun, **Erdal Cetkin**, Elektrikli Araç Batarya Hücresinin Mikrokanallı Isı Değiştiricisi ile Isıl Yönetimi, 23. Isı Bilimi ve Tekniği Kongresi, Gaziantep, 8-10 September, 2021, Oral Presentation (Online).

**Erdal Cetkin**, Constructal channel designs for cooling of fuel cells, Constructal Law & Second Law Conference 2019 (CLC 2019), Porto Alegre, Brazil, 11 – 13 March 2019, Invited Speaker.

**Erdal Cetkin**, Circular and semi-circular constructal vascular channels for cooling and reduced stresses, Constructal Law & Second Law Conference 2017 (CLC 2017), Bucharest, Romania, 14 - 16 May 2017, Oral Presentation.

**Erdal Cetkin**, Vascular structures for smart features: self-cooling and self-healing, International Conference on Advances in Mechanical Engineering, İstanbul, 10-13 May 2016, Oral Presentation.

**Erdal Cetkin**, Constructal structures with and without high-conductivity inserts for self-cooling, Constructal Law & Second Law Conference, Parma, Italy, 18-19 May 2015, Oral Presentation.

Onur Yenigün, **Erdal Cetkin**, Constructal tree-shaped designs for self-cooling, Constructal Law & Second Law Conference, Parma, Italy, 18-19 May 2015, Oral Presentation.

Alessandro Oliani, **Erdal Cetkin**, Tree-shaped high-conductivity pathways for cooling of a non-uniformly heated domain, Constructal Law & Second Law Conference, Parma, Italy, 18-19 May 2015, Oral Presentation.

**Erdal Cetkin**, Constructal structures for self-cooling, Energy Technologies Conference (ENTECH), İstanbul, 22-24 December 2014, Oral Presentation.

**Erdal Cetkin**, Constructal vascularized structures, Diffusion in Solids and Liquids (DSL) Conference, Paris, France, 23-27 June 2014, Invited Speaker.

**Erdal Cetkin**, Sylvie Lorente, Adrian Bejan, Emergence of high conductivity vascular trees for cooling, Diffusion in Solids and Liquids (DSL) Conference, İstanbul, 25-29 June 2012, Oral Presentation.

**Erdal Cetkin**, Hasan Karabay, Evlerin mimari projeleri nedeniyle enerji kayıplarının araştırılması, IV. Ege Enerji Sempozyumu, İzmir, 21-23 May 2008, Oral Presentation.

# Patents

**Erdal Cetkin**, “Bulaşık makineleri için pasif bir kurutma sistemi,” Turkish Patent, Application No. 2022/051287

**Erdal Cetkin**, “Mikromobilite araçlari için hızlı şarja olanak sağlayan bir batarya paketi,” Turkish Patent, Application No. 2022/009442

**Erdal Cetkin,** “Elektrikli araç yüksek hızlı şarj istasyonu ile bu istasyonlara entegre bir batarya paketi ısıl yönetim sistemi”, Turkish Patent, Application No. 2021/010753

**Erdal Cetkin**, Sinan Gocmen, Sahin Gungor, “Batarya tecrit sistemi,” Turkish Patent, Aplication No. 2021/004735 (Patent Issued, in publication).

**Erdal Cetkin**, “Hibrit ısıl yönetim sistemine sahip bir batarya paketi,” Turkish Patent, Application No. 2020/19571 (Patent Issued, in publication) / PCT: WO2022119524A1, “A battery pack with thermal management system”.

**Erdal Cetkin**, Sinan Gocmen, Sahin Gungor, “Soğutucu akışkanın batarya hücrelerine homojen olarak dağıtılmasını sağlayan bir manifold,” Turkish Patent, Aplication No. 2020/14494 (Patent Issued, in publication) / PCT: WO2022055466A1, “A manifold providing homogeneous coolant distribution between battery cells”.

**Erdal Cetkin**, Sahin Gungor, Sinan Gocmen, “Conduction-based tab cooling methods for batteries,” Turkish Patent, Aplication No. 2020/06753 / PCT: WO2021221596A3.

**Erdal Cetkin**, Sahin Gungor, Sinan Gocmen, “Convection-based tab cooling methods for batteries,” Turkish Patent, Aplication No. 2020/06755 (Patent Issued, in publication) / PCT: WO2021221597A1.

**Erdal Cetkin**, Sinan Gocmen, Sahin Gungor, “Dendritik yapıya sahip bağlantı (tab) noktası içeren bir batarya,” Turkish Patent, Aplication No. 2019/17239/ PCT: WO2021091507A1.

# Professional Affiliations

Professor, 2021-Present

İzmir Institute of Technology, Department of Mechanical Engineering

Associate Professor, 2016-2021

İzmir Institute of Technology, Department of Mechanical Engineering

Assistant Professor, 2013-2016

İzmir Institute of Technology, Department of Mechanical Engineering

Member, 2021-Present

Türk Isı Bilimi ve Tekniği Derneği

Associate Editor, 2019-Present

Journal of Thermal Engineering

Editorial Board Member, 2018-Present

International Journal of Hydromechatronics, Inderscience Publishers

Editorial Advisory Board Member, 2016-Present (appointed until 2026)

Mathematical Modelling of Engineering Problems

Department MUDEK Coordinator, 2016-2020

İzmir Institute of Technology, Department of Mechanical Engineering

PhD Qualification Committee Member, 2015-2020

İzmir Institute of Technology, Department of Mechanical Engineering

Department Vice Chair, 2019-2019, 2023-ongoing

İzmir Institute of Technology, Department of Mechanical Engineering

Executive Committee Member, 2016-2019

İzmir Institute of Technology, Faculty of Engineering

# Professional Service

**Peer-Reviewed Articles for**:

* Scientific Reports, Nature Publishing
* Physics Letters A, Elsevier
* Proceedings A, Royal Society
* International Journal of Heat and Mass Transfer, Elsevier
* Journal of Energy Storage, Elsevier
* International Journal of Hydrogen Energy, Elsevier
* International Communication on Heat and Mass Transfer, Elsevier
* International Journal of Thermal Sciences, Elsevier
* Energy and Buildings, Elsevier
* Thin Walled Structures, Elsevier
* Heat Transfer Engineering
* Heat and Mass Transfer, Springer
* Heat Transfer, Wiley
* International Journal of Exergy
* Current Nanoscience
* Engineering Optimization
* Advances in Mechanical Engineering, Sage Publishing
* International Journal of Heat and Technology
* Journal of Thermal Engineering, Yildiz Technical University Press
* Open Engineering
* Journal of Thermal Science and Engineering Applications, ASME
* Open Journal of Engineering, ASME