**Universal Library of Medical and Health Sciences** **Original Article**

**ISSN: 3064-6545 | Volume 4, Issue 1**

**Open Access | PP: 54-62**

**DOI: https://doi.org/10.70315/uloap.ulmhs.2026.0401006**

# Bio-Artificial Liver Organ and ELMAS's Theory of Thermodynamics in relation to the 5th Law of Thermodynamics

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## Abstract

*Dr. Emin Taner Elmas's research describes a specific Bio-Artificial Liver Organ design [15] that targets liver detoxification by integrating biological filtration with mechanical systems.*

*The filtration system is designed as a multi-stage process specifically for removing toxins that standard renal dialysis often cannot reach:*

***Albumin Management:*** *The system continuously monitors albumin levels. It separates albumin from the patient's blood to clean it independently.*

***Dual Adsorption:*** *Separated albumin passes through two specialized adsorbents to strip away albumin-bound toxins.*

***Carbonaceous Circuit:*** *The primary filtration occurs through a complex carbon-based circuit designed for biological detoxification.*

***Pressure Adjustment:*** *A dedicated mechatronic device regulates the pressure of the cleaned blood and albumin before re-entry into the patient's body.*

*Dr. Elmas emphasizes that conventional hemodialysis has "little or no effect" on liver detoxification because it cannot effectively remove toxins that are bound to albumin in the blood. His design aims to bridge this gap, specifically modeled after the Molecular Adsorbent Recirculation System (MARS) but intended to be more economical and locally produced. [15]*

*Emin Taner Elmas's design offers a hybrid approach combining mechanical engineering with medical science. Here are the medical conditions the system targets and its prominent mechatronic components: [1], [15]*

***Treated Medical Conditions:*** *This bio-artificial liver is designed as a "bridge treatment" in cases where the liver has lost its ability to detoxify (remove toxic substances):*

• ***Acute Liver Failure:*** *Used to keep the patient alive in cases of poisoning, viral hepatitis, or sudden organ failure.*

• ***Acute Flare-ups in Chronic Liver Failure:*** *Stabilizes the system when existing liver disease suddenly worsens.*

• ***Liver Transplant Waiting Period:*** *Prevents the patient from entering a toxic coma (hepatic encephalopathy) until a suitable donor is found.*

• ***Albumin-Assisted Detoxification:*** *Enables the removal of protein-bound toxins such as bilirubin and bile acids that standard dialysis cannot remove. Mechatronic Design Components. [15]*

*Elmas emphasizes that the system is not just a biological filter, but also a precise mechatronic device:*

• ***Smart Sensor Network:*** *Includes sensors that instantly measure blood flow rate, temperature, and most importantly, albumin concentration.*

**Citation:** Emin Taner ELMAS, "Bio-Artificial Liver Organ and ELMAS's Theory of Thermodynamics in relation to the 5th Law of Thermodynamics", Universal Library of Medical and Health Sciences, 2026; 4(1): 54-62. DOI: https://doi.org/10.70315/uloap.ulmhs.2026.0401006.

• ***Pressure Regulator Unit:*** *Has a special control unit that adapts the blood pressure to the patient's physiological values before it is returned to the body.*

• ***Dual Adsorption Loop:*** *Electromechanical valves and pumps designed for albumin removal are used in carbon-based circuits.*

• ***User Interface and Controllers:*** *All stages of the system are managed by digital control panels that nurses and doctors can use.*

*The main goal of this system is to create a more economical and accessible domestic alternative to expensive imported devices (such as MARS).*

*Emin Taner Elmas, by applying the Elmas Theory of Thermodynamics to biological and medical systems, establishes a theoretical link between a bio-artificial liver organ project and the laws of thermodynamics. This relationship is based, in particular, on a systems approach where energy and matter are defined vectorially. [1], [15]*

*Elmas's Theory of Thermodynamics and the 5th Law of Thermodynamics: Elmas's theory is an addition to the existing laws of thermodynamics and is presented in the literature as a scientific approach to the 5th Law of Thermodynamics. [1]*

*Elmas uses this theoretical framework as a medical thermodynamics application that will form the basis of the "Bio-Artificial Liver Organ" project designed for patients suffering from liver failure.*

• *Open Thermodynamic System: Human body cells and artificial organ systems are considered "open thermodynamic systems". In these systems, a continuous transfer of energy and mass occurs through cell membranes or device filters.*

• *Detoxification Process: The project aims to cleanse the blood of accumulated toxins (bilrubin, bile acids, etc.) through albumin dialysis and filtration methods. In this process, the removal of toxins is modeled as "negative matter" (mass loss), and the transfer of clean blood is modeled as "positive matter" transfer on a vectorial basis.*

• *Medical Recovery Balance: The healing process is explained by maintaining control over the vectorial aspects (positive, negative, neutral) of drug-cell interaction. This balancing process ensures medical recovery by managing the system's entropy. [1], [15]*

*In summary, Elmas's 5th Law approach explains the complex functions of the liver organ (storage, synthesis, breakdown) through a mathematical and vectorial energy-mass balance, thus providing a theoretical basis for the development of more economical and indigenous bio-artificial systems that can mimic these functions. [1-54]*

**Keywords:** *Liver, Bio-artificial Liver Organ, Filtration, Nutrition System, Portal Vein, Hepatic Artery, Hepatocytes, Central Vein, Liver Support Systems, Artificial Liver Support Device, Molecular Adsorbent Recirculation System (MARS), The Liver's Blood Purification System, Detoxification, Medical Technique, AI - Artificial Intelligence, Hemodynamics, Medical Thermodynamics, ELMAS's Theory of Thermodynamics, 5th Law of Thermodynamics, Thermodynamics, Energy Transfer, Fluid Mechanics, Heat Transfer, Mathematics.*

## INTRODUCTION

Emin Taner Elmas, an Assistant Professor at Iğdır University, has authored research on the Design of Bio-Artificial Liver Organs. His work focuses on developing systems that can perform the critical functions of a human liver through a combination of biological and mechanical processes. [1], [15]

***Key Features of the Bio-Artificial Liver Design: [1-54]***

The system functions as a bridge or supportive device, operating similarly to a dialysis circuit but with specific enhancements for liver-related detoxification:

Albumin-Based Filtration: The system monitors albumin levels in the blood and uses a complex carbonaceous circuit for filtration.

Toxin Removal: It separates albumin from the patient's blood and passes it through two specialized adsorbents to remove albumin-bound toxins.

Hemodialysis Integration: Water-soluble toxins with low to medium molecular weights are removed via hemodialysis within the same circuit.

Pressure Regulation: A dedicated device adjusts the pressure of the cleaned blood before it is returned to the patient's body.

***Academic Context: [1-54]***

Author Profile: Dr. Elmas is associated with the Department of Automotive Technology and the Department of Bioengineering and Bio-Sciences at Iğdır University.

Publication: His primary paper on this topic, titled *"Design of Bio-Artificial Liver Organ,"* was published in the *Journal of Biomedical Sciences and Biotechnology Research* in 2024.

Broader Research: This project is part of his extensive work in medical engineering and biomechanics, which includes designs for artificial hearts, bionic eyes, and neuro-physical treatments for diseases like SMA. [1-54]

## MATERIAL, METHOD AND DISCUSSSION

Dr. Emin Taner Elmas's research describes a specific Bio-Artificial Liver Organ design that targets liver detoxification by integrating biological filtration with mechanical systems. [1], [15]

***Technical Specifications of the Filtration Circuit: [1-54]***

The filtration system is designed as a multi-stage process specifically for removing toxins that standard renal dialysis often cannot reach:

Albumin Management: The system continuously monitors albumin levels. It separates albumin from the patient's blood to clean it independently.

Dual Adsorption: Separated albumin passes through two specialized adsorbents to strip away albumin-bound toxins.

Carbonaceous Circuit: The primary filtration occurs through a complex carbon-based circuit designed for biological detoxification.

Pressure Adjustment: A dedicated mechatronic device regulates the pressure of the cleaned blood and albumin before re-entry into the patient's body.

Comparison of Dr. Elmas's Bio-Artificial System with Standard Dialysis is available in Table 1.

While standard dialysis primarily addresses kidney failure, Dr. Elmas's system is optimized for liver failure, which involves different toxic compounds:

**Table 1.** Dr. Elmas's System and Comparison with Standard Dialysis [1], [15]

| Feature | Standard Hemodialysis | Dr. Elmas's Bio-Artificial Liver |
|---|---|---|
| **Primary Target** | Water-soluble toxins (Urea, Creatinine) | Albumin-bound toxins and water-soluble toxins |
| **Toxic Scope** | Removes low-to-medium molecular weight waste | Targets bile acids, bilirubin, and aromatic amino acids |
| **Mechanism** | Simple diffusion and convection across a membrane | Complex carbonaceous circuit with dual adsorbents |
| **Albumin Treatment** | Generally avoids albumin loss | Separates and cleans albumin to return it to the body |
| **Clinical Goal** | Renal replacement therapy (kidney support) | Liver support and detoxification (bridge to transplant) |

Dr. Elmas emphasizes that conventional hemodialysis has "little or no effect" on liver detoxification because it cannot effectively remove toxins that are bound to albumin in the blood. His design aims to bridge this gap, specifically modeled after the Molecular Adsorbent Recirculation System (MARS) but intended to be more economical and locally produced.

Emin Taner Elmas's design offers a hybrid approach combining mechanical engineering with medical science. Here are the medical conditions the system targets and its prominent mechatronic components: [1], [15]

***Treated Medical Conditions: [1-54]***

This bio-artificial liver is designed as a "bridge treatment" in cases where the liver has lost its ability to detoxify (remove toxic substances):

• Acute Liver Failure: Used to keep the patient alive in cases of poisoning, viral hepatitis, or sudden organ failure.

• Acute Flare-ups in Chronic Liver Failure: Stabilizes the system when existing liver disease suddenly worsens.

• Liver Transplant Waiting Period: Prevents the patient from entering a toxic coma (hepatic encephalopathy) until a suitable donor is found.

• Albumin-Assisted Detoxification: Enables the removal of protein-bound toxins such as bilirubin and bile acids that standard dialysis cannot remove. [1], [15]

***Elmas emphasizes that the system is not just a biological filter, but also a precise mechatronic device: [1-54]***

• Smart Sensor Network: Includes sensors that instantly measure blood flow rate, temperature, and most importantly, albumin concentration.

• Pressure Regulator Unit: Has a special control unit that adapts the blood pressure to the patient's physiological values before it is returned to the body.

• Dual Adsorption Loop: Electromechanical valves and pumps designed for albumin removal are used in carbon-based circuits.

• User Interface and Controllers: All stages of the system are managed by digital control panels that nurses and doctors can use.

The main goal of this system is to create a more economical and accessible domestic alternative to expensive imported devices (such as MARS).

Emin Taner Elmas's Bioartificial Liver Organ project, along with his scientific paper published in 2024, is described as a "project to be developed." Key details regarding the prototype phase of the system are as follows: [1], [15]

***Prototype Development Process and Current Status: [1-54]***

• Conceptual Design Phase: Dr. Elmas has completed the theoretical framework and mechatronic architecture of the

system. The published work serves as a roadmap for the manufacturing of the device.

• Bionic and Mechatronic Integration: The prototype is created by combining bionic materials, electronic control systems, and mechanical components. This structure is based on a "bionic organ" model that mimics the biological functions of the liver.

• Goal: The ultimate goal of the system is to physically produce a tangible device that will improve the quality of life for liver patients and offer an economical alternative through domestic production.

***Technical Prototype Components: [1-54]***

The following subsystems are planned to be physically integrated in the developed prototype design:

• Filtration Circuit: A carbon-based cleaning unit that monitors albumin and separates toxins.

• Pressure Control Device: A mechatronic regulator that adjusts the blood return pressure to the body.

• Feeding and Nutrition System: A hydraulic structure that manages portal vein, hepatic artery, and central vein flows.

Dr. Elmas's work is in an initial phase aiming to develop a domestic engineering solution against artificial liver support systems such as MARS (Molecular Adsorbent Recirculation System), which are high-cost and imported in Türkiye.

Emin Taner Elmas's Bio-Artificial Liver Organ project is an advanced design model that blends biotechnology with mechatronics engineering. The technical depth of the project is built on three main pillars:

## Systematic Working Principle (Cyclical Detox) [1-54]

The system simulates albumin clearance, one of the most critical tasks of the liver. After blood is taken from the body, it goes through the following stages:

• Albumin Separation: Albumin (protein) in the blood is taken into a special module. While normal dialysis machines cannot filter the protein, this system recognizes and processes the protein.

• Double Layer Adsorption: The separated albumin passes through two different adsorbent substances. These substances "magnetize" and clean up heavy toxins (such as bilirubin) that are tightly attached to the albumin and cannot normally be excreted in the urine.

• Hemodialysis Integration: Other water-soluble wastes (urea, creatinine) are cleaned with a standard dialysis filter.

## Mechatronics and Control Units [1-54]

The engineering side of the project consists of intelligent systems that manage the biological process:

• Pressure Regulator: Includes a "Pressure Adjusting Device" that instantly adjusts the pressure to prevent the cleaned blood from damaging the vessels.

• Concentration Monitoring: Thanks to sensors that continuously monitor the albumin level in the blood, the cleaning process is optimized according to the patient's current needs.

• Carbon-based Circuits: The piping and filtration pathways of the system are designed from carbon-based materials to increase biocompatibility.

## Strategic Aim of the Design [1-54]

Dr. Elmas developed this project with the following two main goals:

• Domestic Production (Economy): Existing artificial liver systems (MARS, Prometheus, etc.) are multi-million dollar devices and are not found in every hospital. Elmas's design aims to reduce costs by localizing this technology.

• Bionic Integration: The design is not just a filtering machine, but the first step towards a bionic organ architecture that can be implanted inside the body or made portable in the future.

This project is an interdisciplinary study combining medical literature and engineering, aiming to extend the survival bridge for patients awaiting liver transplants. [1], [15]

## CONCLUSION

Emin Taner Elmas, by applying the Elmas Theory of Thermodynamics to biological and medical systems, establishes a theoretical link between a bio-artificial liver organ project and the laws of thermodynamics. This relationship is based, in particular, on a systems approach where energy and matter are defined vectorially. [1], [15]

***Elmas's Theory of Thermodynamics and the 5th Law of Thermodynamics: [1-54]***

Elmas's theory is an addition to the existing laws of thermodynamics and is presented in the literature as a scientific approach to the 5th Law of Thermodynamics.

• Vectorial Parameters: While energy and mass are treated as scalar quantities in classical thermodynamics, in Elmas's theory they are defined as vectorial parameters, just like force or velocity.

• Directional States: Energy and matter can have positive (entering the system), negative (leaving the system), and neutral (stable) directions. Total energy and total mass are expressed as the resultant of these vectorial components:

• System Equilibrium: According to the theory, a vectorial equilibrium exists between total energy and total mass on a universal scale or in any thermodynamic system.

***Relationship with the Bio-Artificial Liver Organ: [1-54]***

Elmas uses this theoretical framework as a medical

thermodynamics application that will form the basis of the "Bio-Artificial Liver Organ" project designed for patients suffering from liver failure.

• Open Thermodynamic System: Human body cells and artificial organ systems are considered "open thermodynamic systems". In these systems, a continuous transfer of energy and mass occurs through cell membranes or device filters.

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In summary, Elmas's 5th Law approach explains the complex functions of the liver organ (storage, synthesis, breakdown) through a mathematical and vectorial energy-mass balance, thus providing a theoretical basis for the development of more economical and indigenous bio-artificial systems that can mimic these functions. [1], [15]

## BIOGRAPHY OF AUTHOR

**Asst. Prof. Dr. Dipl.-Ing. Emin Taner ELMAS**

Asst.Prof. Dr. Emin Taner ELMAS is a Mechanical Engineer having degrees of B.Sc., M.Sc., Ph.D., and was born in Sivas in 1974. He completed his doctorate at Ege University, Graduate School of Natural and Applied Sciences, Mechanical Engineering Department, Thermodynamics Science Branch, and his master's degree at Dokuz Eylül University, Mechanical Engineering Department, Energy Science Branch. He also completed his undergraduate education at Hacettepe University, ZEF, Mechanical Engineering Department and graduated from the faculty with honors in 1995 and became a mechanical engineer. He was awarded a non-refundable scholarship by the Turkish Chamber of Mechanical Engineers in his 4th year because he was the most succesful student during his first 3 classes study at the faculty. He graduated from İzmir Atatürk High School in 1991.

Asst. Prof. Dr. ELMAS has completed his military service as a NATO Officer in Bosnia and Herzegovina. He was a "Reserved Officer" as a "2nd Lieutenant" as an "English-Turkish Interpreter". He was also a "Guard Commander" and served in Sarajevo, Camp Butmir within the SFOR task force of NATO. He has been awarded with 2 (two) NATO Medals and Turkish Armed Forces Service Certificate of Pride (Bosnia & Herzegovina).

In addition to his academic duties at universities, he has worked as an engineer and manager in various industrial institutions, organizations and companies; He has served as Construction Site Manager, Project Manager, Management Representative, Quality Manager, Production Manager, Energy Manager, CSO-CTO, CBDO, Factory Manager, Deputy General Manager and General Manager.

Asst. Prof. Dr. Elmas is Department Head and is an Assistant Professor of Automotive Technology at the Department of Motor Vehicles and Transportation Technologies at Vocational School of Higher Education for Technical Sciences at IGDIR UNIVERSITY, Turkey. He is also an Assistant Professor of Bioengineering & BioSciences at the same university. He has nearly 30 years of total experience in academia and in industry.

He has served as a scientific referee and panelist for ASME, TUBITAK and many scientific institutions, organizations and universities, including NASA.

He has published numerous international and national academic scientific articles, books, and book chapters, and serves as an editor for international academic journals. He also serves on the scientific committees of many international conferences, publishing conference and congress proceedings and giving presentations.

"Mechanical Engineering, Energy Transfer, Thermodynamics, Fluid Mechanics, Heat Transfer, Higher Mathematics, Evaporation, Heat Pipes, Space Sciences, Automotive, Bioengineering, Medical Engineering Applications, Neuroengineering, Medical Technique" are his academic and scientific fields of study; "Heating-Ventilation Air Conditioning Applications, Pressure Vessels, Heat Exchangers, Energy Efficiency, Steam Boilers, Power Plants, Cogeneration, Water Purification, Water Treatment, Industrial Equipment and Machinery, Welding Manufacturing, Sheet Metal Forming, Machining" are his industrial experience fields.

As of 2026, he has been awarded the Nobel Scientist Award by the international platform organization Scientific Laurels.

Asst. Prof. Dr. Emin Taner ELMAS is also a musician, saz (baglama) virtuoso player and ney (Nay, Turkish Reed Flute) performer. He plays also cümbüş instrument and performs darbuka rhythm instrument. He has a YouTube Music Channel (Emin Taner ELMAS) which includes some of his sound recordings of him playing the saz-baglama and blowing the ney. He composed the poem written by the great poet Âşık Veysel ŞATIROĞLU under the name of "Raşit Bey" in memory of his father Judge (Hâkim) Raşit ELMAS as "Raşit

Bey Türküsü", wrote it down, notated and published it as an academic article and broadcasted this song on his own music channel. He wrote the poems entitled "Canım Babam" and "Geldim Babam" which he wrote also in memory of his father and published in an academic literature journal, and composed instrumental musics for these poems. He also composed an instrumental song called "Annem Annem Türküsü" and gave it to his mother, Lawyer Tuna ELMAS, as a gift on Mother's Day, 11.05.2025. He also has a poem titled "Ney and Neyzen." He also wrote and presented a poem titled "Esra Kardeşim" to his sister, Esra ELMAS, an archaeologist and English teacher. He has published books including "Saz-Bağlama Tuning System Method" ("Saz-Bağlama Akort Sistemi Metodu") and "Ney and Neyzen; Ney's Pitches, Frets, Sound Stages, Octaves, Structure, Performance, Ney Maintenance and Basic Music Theory" (Ney ve Neyzen; Ney'de Perdeler, Ses Devreleri, Oktavlar, Yapısı, İcrası, Ney Bakımı ile Temel Musiki Nazariyatı) and My Collection of Literary and Musical Art Works – I Story / Anecdote / Essay / Poetry / Verse / Prose / Humorous; witty - satirical; poetic stories / Lyrics / Composition (Edebiyat ve Musiki Sanat Eserleri Külliyatım – I Hikâye / Anekdot / Deneme / Şiir / Manzume / Nesir / Mizahi; nükteli – hicivli; şiirsel hikâyeler / Güfte / Beste). He continues his artistic studies by writing various articles, books, poetry, lyrics and also realizing musical composition and repertoire works.

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