ISSN: 3049-7272

Review Article

Journal of Biomedical Sciences and Biotechnology Research

Design of Bio-Artificial Liver Organ

Emin Taner Elmas

Vocational School of Higher Education for Technical Sciences, Division of Motor Vehicles and Transportation Technologies, Department of Automotive Technology, Iğdır University, Turkey & Graduate School of Natural and Applied Sciences - Major Science Department of Bioengineering and Bio-Sciences, Iğdır University, Turkey Iğdır University, Turkey

Corresponding author

Emin Taner Elmas, Vocational School of Higher Education for Technical Sciences, Division of Motor Vehicles and Transportation Technologies, Department of Automotive Technology, Iğdır University, Turkey & Graduate School of Natural and Applied Sciences - Major Science Department of Bioengineering and Bio-Sciences, Iğdır University, Turkey Iğdır University, Turkey.

Received: July 17, 2024; **Accepted:** July 25, 2024; **Published:** July 29, 2024

ABSTRACT

This article introduces a project to be developed to manufacture an artificial liver and the name of the project is "Design of Bio-artificial Liver Organ". The main goal of the project is to make a liver by making use of bionic materials, electronic systems and mechanical systems, and incorporating mechatronics knowledge. To improve the quality of life of liver patients and restore their health will be the ultimate target. In addition, the scientific and technical studies to be carried out on this subject will contribute to the enrichment of the literature on the subject and will also be beneficial for scientific and technical progress. In our country, there are 14 million people with fatty liver problems and 2 million with hepatitis and liver cancer. Therefore, such a large population related to the liver experiences serious health problems such as liver failure. Undoubtedly, the liver is of vital importance like other organs, but the difference of the liver from other organs is that it performs many comprehensive functions such as storage, regulation, synthesis and destruction.

These features make the liver incredible and unattainable. We are a little far away from making an exact liver with the knowledge we currently have and the materials we can use. By the help of a bio-artificial liver organ, it is aimed to establish systems that can perform several functions of this distinguished organ that has more than one function [1-31].

The operation principle of the system of Bio-artificial Liver Organ shall be as follows: The albumin level in the blood connected to the dialysis machine is checked. The filtration process consists of a complex carbonaceous circuit. The dialysis machine vacuums the blood and draws it to the cleaning filter. Albumin separated from the patient's blood is passed through two special adsorbents and toxins bound to albumin are removed. Toxins formed by water-soluble molecules with low and medium molecular weights are removed from the patient's blood by hemodialysis performed in the dialysis circuit. The blood separated from the filtered albumin is adjusted by a pressure adjustment device and enters the patient's body in a clean state. Albumin contains toxic substances that are harmful to the body [1-31].

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

Introduction

This article introduces a project to be developed to manufacture an artificial liver and the name of the project is "Design of Bio-artificial Liver Organ". The main goal of the project is to make a liver by making use of bionic materials, electronic systems and mechanical systems, and incorporating mechatronics knowledge. To improve the quality of life of liver patients and restore their health will be the ultimate target. In addition, the scientific and technical studies to be carried out on this subject will contribute to the enrichment of the literature on the subject and will also be beneficial for scientific and technical progress. In our country, there are 14 million people with fatty liver problems and 2 million with hepatitis and liver cancer. Therefore, such a large population related to the liver experiences serious health problems such as liver failure. Undoubtedly, the liver is of vital importance like other organs, but the difference of the liver from other organs is that it performs many comprehensive functions such as storage, regulation, synthesis and destruction. These

Citation: Emin Taner Elmas. Design of Bio-Artificial Liver Organ. J Biomed Sci Biotech Res. 2024. 2(3): 1-4. DOI: doi.org/10.61440/JBSBR.2024.v2.12

features make the liver incredible and unattainable. We are a little far away from making an exact liver with the knowledge we currently have and the materials we can use. By the help of a bio-artificial liver organ, it is aimed to establish systems that can perform several functions of this distinguished organ that has more than one function [1-31].

In this targeted study, the subject of bionic artificial liver will be discussed. Efforts will be made to design a system that can perform some of the functions of the liver organ. Many patients die while waiting for a liver transplant, mainly due to the shortage of organ donors. Conventional hemodialysis techniques have little or no effect on liver detoxification, and do not cure patients. In patients with acute liver failure, most of the toxins that cause organ failure and accumulate in the blood to be excreted are bound to albumin. Therefore, it is very important to be able to perform albumin dialysis. Undoubtedly, presenting the liver organ with all its functions is our most important priority. To achieve this, it is necessary to blend electrical, electronics, mechanical, mechatronics, biology and medical sciences with an interdisciplinary understanding. The primary focus will be on the detoxification function of this organ, which has many functions. After the detoxification function is achieved, it would be appropriate to establish systems for other functions of the liver and eventually aim to create a truly artificial liver. The most widely developed detoxification system to date has been the Molecular Adsorbent Recirculation System (MARS). The MARS improves the patient's clinical condition by providing simultaneous liver and kidney detoxification. It is a system that, when functioning properly, can allow recovery from acute disorders and increase the chances of survival while waiting for a suitable organ donor [1-31].

The artificial liver organ targeted with this study will be a first in the world in this respect. If an artificial liver that can perform all functions can be produced, there will be little or no need for liver transplantation. The cost per patient of artificial liver organ support systems currently used in the world is extremely high. Finding organs is extremely difficult, besides liver patients wait long periods for organ transplantation and may completely lose their health during this time. The artificial liver organ to be developed by this study will improve the quality of life of many patients in our country and around the world, and the developed system will also be aimed to be economical. In addition, the artificial liver organ system to be developed thanks to the project will be local and national. In this respect, it will also provide economic benefit to our country. In summary, this project work is extremely important both in terms of human health, scientific and technical aspects, and the country's economy. In addition, it is of great importance for our university (Iğdır University, Turkey) to consider health, science and technology together and carry out such a project study [1-31].

Method, Findings and Discussion

The operation system of Molecular Adsorbent Recirculation System (MARS)is shown Figure 1 [1-31].

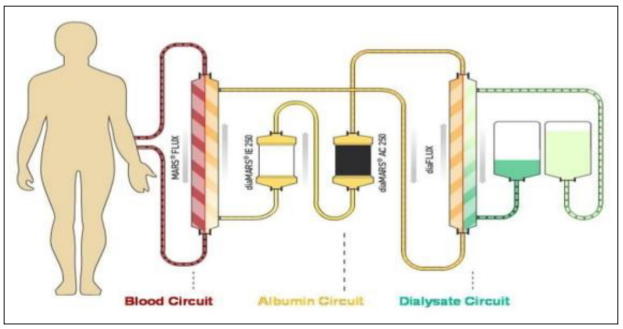

Figure 1: Molecular Adsorbent Recirculation System (MARS) [1-31].

The liver, which cannot perform blood purification, is contacted externally with the help of a sterile hose, and the dirty blood accumulated here is vacuumed into the MARS system. The blood connected to the system is cleaned through filtration processes. Here it is a liver support system that uses an albumin-enriched dialysate to facilitate the removal of albumin-bound toxins. The system has three different fluid compartments; A "blood circuit", an "albumin circuit" including a charcoal column containing 600 ml of 20% human albumin and an anion exchange resin column, and a "dialysate circuit". A regular dialysis machine circuit can be used to control the blood and dialysate circuits [1-31].

Molecular Adsorbent Recirculation System (MARS) is the best-known extracorporeal liver dialysis system and consists of two separate dialysis circuits [1-31].

The first circuit consists of the following; human serum albumin is in contact with the patient's blood through a semi-permeable membrane and there are two filters to clear the albumin after absorbing toxins from the patient's blood [1-31].

The second circuit consists of a hemodialysis machine and is used to clear the albumin in the first circuit before it is recirculated through the semipermeable membrane in contact with the patient's blood. The aim of these procedures is to ensure that the detoxification feature of the liver is maintained. In liver failure, bile acids, bilirubin, aromatic amino acids, metabolic wastes, fatty acids, mercaptans and various cytokines accumulate in the blood disrupt brain, kidney and macrophage functions. Historically, hemodialysis, plasmapheresis, and hemadsorption containing activated carbon were used to remove these substances from the blood [1-31].

Conclusion

The operation principle of the system of Bio-artificial Liver Organ shall be as follows: The albumin level in the blood connected to the dialysis machine is checked. The filtration process consists of a complex carbonaceous circuit. The dialysis machine vacuums the blood and draws it to the cleaning filter. Albumin separated from the patient's blood is passed through two special adsorbents and toxins bound to albumin are removed. Toxins formed by water-soluble molecules with low and medium molecular weights are removed from the patient's blood by hemodialysis performed in the dialysis circuit. The blood separated from the filtered albumin is adjusted by a pressure adjustment device and enters the patient's body in a clean state. Albumin contains toxic substances that are harmful to the body [1-31].

References

1. Emin T. Elmas, İhsan Ö. Bucak. Modeling and Simulation of Smart-Drug Algorithms Through Frequency Modulation for the Treatment of Covid-19 and Similar Viruses. Global Journal of Research in Medical Sciences. 2023. 3: 1-6.
2. Emin T. E, İhsan Ömür B. FM Modulated Smart Drug Algorithm for the treatment of Cancer Cells. In Global Journal of Research in Medical Sciences. 2024. 4: 1-6.
3. Emin Taner ELMAS. Prototype Desıgn, Productıon and Functıonıng of a Portable (Movable), Home-Type (Domestıcal) Hemodıalysıs Machıne (Unıt). In Global Journal of Research in Medical Sciences. 2023. 3: 11-12.
4. Emin Taner E. Thermodynamical And Experimental Analysis of Design Parameters of a Heat Pipe Air Recuperator. Global Journal of Research in Engineering & Computer Sciences. 2023. 3: 6-33.
5. Elmas, Emin Taner. Thermodynamical Balance Associated with Energy Transfer Analysis of the Universe Space as a Pressure Vessel Analogy. Journal of Applied Sciences, Redelve International Publications. 2019.
6. Elmas, Emin Taner. Productivity and Organizational Management (The Book) (Chapter 7): Prospective Characteristics of Contemporary Engineer (By the Approach of Mechanical Engineering) Contribution and Role of the Mechanical Engineer to the Organization Management and Productivity. Machado Carolina, Davim J Paulo (Eds.), DEGRUYTER, Walter de Gruyter GmbH, Berlin / Boston, Spain. 2017.
7. Elmas, Emin Taner. Prospective Characteristics of Contemporary Engineer (By the Approach of Mechanical Engineering) Contribution and Role of the Mechanical Engineer to the Organization Management and Productivity). DeGruyter, Germany. 2017.
8. Elmas, Emin Taner, Evaporation Plant for Recycling of Caustic Soda, International Journal of Engineering Technologies-IJET Emin Taner Elmas. 2017. 3.
9. Elmas, Emin Taner. Çağımızın Mühendisinden Beklenenler, Gece Kitaplığı. 2014.
10. Emin TE. Design, Production, Installation, Commissioning, Energy Management and Project Management of an Energy Park Plant Consisting of Renewable Energy Systems Established at Igdir University. In Global Journal of Research in Engineering & Computer Sciences.2023. 3: 67-82.
11. Çelik Üretiminde Elektrik Ark Ocaklarinda Enerji Maliyetlerinin Ve Enerji Verimlilik Faktörlerinin Araştirilmasi Investigation on Energy Costs and Energy Efficiency Factors of Electric Arc Furnace for Steeel Production, Fenerbahçe Üniversitesi Tasarım, Mimarlık ve Mühendislik Dergisi - Journal of Design, Architecture & Engineering Hasan TAMSÖZ *, Emin Taner ELMAS ** FBU-DAE. 2021. 1: 163-180.
12. Sinter Tesislerinde Enerji Kullanim Noktalari Ve Enerjiyi Verimli Kullanacak Yöntemlerin Belirlenmesi Determination of Energy Utilization Points and the Methods Using the Efficient Energy for Sintering Plants, Fenerbahçe Üniversitesi Tasarım, Mimarlık ve Mühendislik Dergisi - Journal of Design, Architecture & Engineering Adem KAYA*, Emin Taner ELMAS** FBU-DAE. 2022. 2: 170-181.
13. Emin Taner ELMAS. The Electrical Energy Production Possibility Research Study by using the Geothermal Hot Water Resources, which is a a kind of Renewable Energy Resource, located at the Region of Mollakara Village which is a part of Diyadin Town and City of Ağrı, Turkey. In Global Journal of Research in Engineering & Computer Sciences. 2024. 4: 90-101.
14. ELMAS, Emin Taner. Energy Analysis, Energy Survey, Energy Efficiency and Energy Management Research carried out at Iğdır University. In Global Journal of Research in Engineering & Computer Sciences. 2024. 4: 12-30.
15. ELMAS, Emin Taner. A Research Study of Salt Dome (Salt Cave) Usage Possibility for CAES - Compressed Air Energy Storage Systems. In Global Journal of Research in Engineering & Computer Sciences. 2024. 4: 128-131.
16. ELMAS, Emin Taner. Wankel Rotary Piston Engine Design Project. In Global Journal of Research in Engineering & Computer Sciences. 2024. 4: 1-4.
17. Emin Taner ELMAS. Project for Amphibious Mobile Snow Track Ambulance for Healthcare System. Am J Biomed Sci & Res. 2024. 22.
18. Emin Taner ELMAS*. The first "Olive Seedlings" and "Artichoke Seedlings" Planted in Iğdır Province, Turkey. Am J Biomed Sci & Res. 2024. 22.
19. ELMAS, Emin Taner. An innovative solar dish type collector - concentrator system having an original - unique geometrical mathematical model called as DODECAGON which has 12 equal segments. In Global Journal of Research in Engineering & Computer Sciences. 2024. 4: 31-38.
20. Emin Taner ELMAS. Waste Heat Recovery Boilers (WHRBs) and Heat Recovery Steam Generators (HRSGs) used for Co-generation and Combined Cycle Power Plants. Op Acc J Bio Sci & Res. 2024. 12.
21. ELMAS, Emin Taner. Presentation and Curriculum of Division of Motor Vehicles and Transportation Technologies & Department of Automotive Technology at Vocational School of Higher Education for Technical Sciences at Iğdır University, Turkey. In Global Journal of Research in Engineering & Computer Sciences. 2024. 4: 60-67.
22. Biyomedikal Mühendisliği ve Uygulamaları, Baş Editörler: Onur Koçak, Osman Eroğul, TMMOB Elektrik Mühendisleri Odası, EMO Yayın NO: GY/2019/726, 1. Baskı, Ankara, Nisan. 2019.
23. Elmas, Emin Taner. Medical Treatment Method of "Bio-robotic Resonance and Thermodynamical Interaction" with Analogy of "Frequency - Resonance Setting Formation" on the Application of "Algorithm for Smart Drugs Controlled by a Bio-robotic System" developed for the "Treatment of Covid-19, Coronavirus and Virus Infections". Open Access Journal of Biogeneric Science and Research (BGSR), Op Acc J Bio Sci & Res. 2020. 1: 1.
24. Emin Taner. Scope of Applications for Medical Technique at Science and Engineering, Open Access Journal of Biogeneric Science and Research (BGSR), Op Acc J Bio Sci & Res. 2020. 1: 1.
25. Elmas, Emin Taner. ELMAS's Theory of Thermodynamics": A Scientific Approach for 5th Law of Thermodynamics -A Theoretical Application Example for Medical Thermodynamics. Op Acc J Bio Sci & Res. 2020. 2.
26. Hartmut Zabel. Medical Physics, Physical Aspects of Organs and Imaging Walter de Gruyter GmbH, Berlin/Boston. 2017. 1.

27. Hartmut Zabel. Medical Physics, Radiology, Lasers, Nanoparticles and Prosthetics, Walter de Gruyter GmbH, Berlin/Boston. 2017. 2.
28. Harvey S Singer, Eric H Kossoff, Adam L Hartman, Thomas O Crawford. Pediatrik Nörolojik Hastalıkların Tedavisi. Çeviri Editörleri: Mehmet Saraçoğlu, Mehmet Güney Şenol, Taylor & Francis Group, Habitat Tıp Yayıncılık, ISBN: 978-605-4084-06-7.
29. ELMAS, Emin Taner. Three - Pass Fire Tube Boilers for production of Steam, Hot Water and Superheated Water. In Global Journal of Research in Engineering & Computer Sciences. 2024. 4: 29-38.
30. Emin Taner ELMAS. Medical Treatment Method of Alzheimer's Disease & Parkinson's Disease by the Help of the Natural Musical Sound of Nây-ı Şerîf, Instrument of Ney (Ney: Turkish Reed Flute, Nay). IJCMCR. 2024. 42.
31. ELMAS, Emin Taner. Design of Bionic Ear - Cochlear Implant and Artificial Hearing System; a Unique Project "Mobile Bio-Ear-Tronic System". In Global Journal of Research in Medical Sciences. 2024. 4: 6-11.