

HYDROGEN CARS

Jelena Pisarov

Óbuda University, Budapest, Hungary
jelena.pisarov@gmail.com

Abstract: The paper presents hydrogen cars. More and more car manufacturers are seriously developing and producing hydrogen fuel cell vehicles. Electric cars powered by hydrogen will become more and more common in the future. Hydrogen cars are powered by fuel cells containing hydrogen.

Hydrogen and oxygen in the fuel cell of a hydrogen car produce electrical energy. This energy is fed into the electric motor and/or battery as needed. Hydrogen fuel cell cars run on an electric motor and are therefore considered electric cars. Short for FCEV, which stands for "Fuel Cell Electric Vehicle". The difference between hydrogen fuel cell cars and electric vehicles is that hydrogen cars generate their own electricity, so there is no need to charge the battery from an external source.

Key Words: hydrogen cars, hydrogen fuel cell vehicles, electrical energy, battery, fcev fuel cell electric vehicle.

1. INTRODUCTION

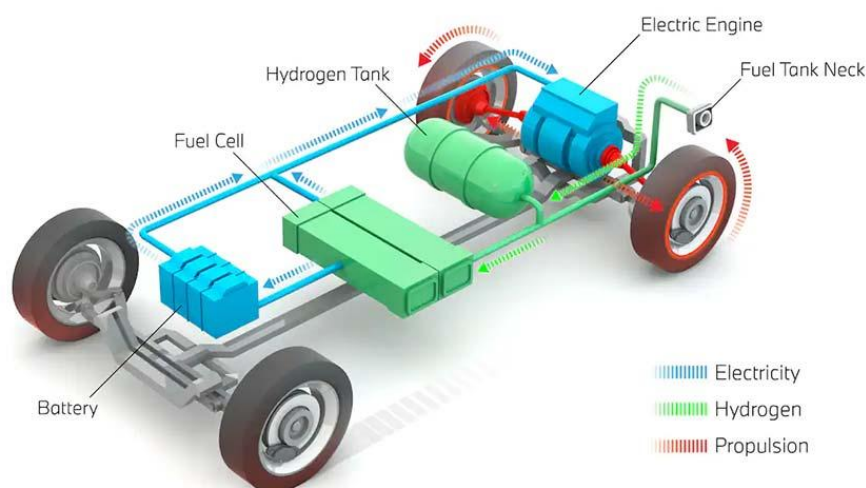
The paper presents the hydrogen cars. More and more car manufacturers are seriously developing and producing hydrogen fuel cell vehicles. Electric cars powered by hydrogen will become more and more common in the future. Hydrogen cars are powered by fuel cells containing hydrogen [1-10].

Hydrogen and oxygen in the fuel cell of a hydrogen car produce electrical energy. This energy is fed into the electric motor and/or battery as needed.

Hydrogen fuel cell cars run on an electric motor and are therefore considered electric cars. Short for FCEV, which stands for "Fuel Cell Electric Vehicle". The difference between hydrogen fuel cell cars and electric vehicles is that hydrogen cars generate their own electricity, so there is no need to charge the battery from an external source. The first chapter is the introduction, the second chapter presents the hydrogen fuel cell cars and the third chapter summarises the results of my research [11-25].

2. HYDROGEN FUEL CELL CARS

Hydrogen cars have their own efficient power source on board: the fuel cell. So it does not get its energy from a built-in battery that can be charged from an external power source, as in the case of electric or plug-in hybrid vehicles, Picture 1.



Picture 1. Hydrogen fuel cell car

The hydrogen in the fuel cell reacts with oxygen from the surrounding air, resulting in electrical energy, heat and water, which is released as water vapour through the exhaust [26-34].

The electricity produced in the fuel cell of a hydrogen engine can be used in two ways:

- either it flows into the electric motor and directly powers the hydrogen car,

- or it charges a battery, which stores the energy and is significantly smaller and lighter than the battery of an all-electric car because it is continuously charged by the fuel cell.

Like other electric cars, hydrogen cars can recover braking energy, converting the kinetic energy of the car back into electrical energy and feeding it into the battery.

3. ADVANTAGES AND DISADVANTAGES OF HYDROGEN CARS

The advantages and disadvantages of hydrogen cars are:

Advantages:

- enables environmentally friendly and sustainable mobility,
- hydrogen cars are safe, hydrogen is stored in liquid form in thick-walled tanks,
- hydrogen cars have a longer range than pure electric cars,
- the range of hydrogen does not depend on the outside temperature, so it does not decrease in cold weather,
- the hydrogen car's fuel cell can be recharged in a shorter time than the battery of an electric car,
- hydrogen cars could be the zero-emission technology for urban and road transport, thus contributing to climate change mitigation.
- crash tests have shown that hydrogen tanks are not damaged in collisions and therefore do not release hydrogen,
- driving a hydrogen car requires no special skills and is easy to refuel and maintain.

Disadvantages:

- the running costs per kilometre of hydrogen cars are currently higher than those of battery vehicles charged from external sources,
- the main shortcoming of hydrogen cars is currently the scarcity of refuelling options. There are still few refuelling stations for hydrogen cars in the world,
- the current high purchase price of hydrogen cars.

4. HYDROGEN CAR COMMERCIALLY AVAILABLE IN 2025

Toyota Mirai

Toyota, in terms of hydrogen cars, is the leading car manufacturer in the world. The Toyota Mirai has a total capacity of 5.6 kg of hydrogen in its tank, takes 5 minutes to fill up and has a range of 650 km, Picture 2.



Picture 2. Toyota Mirai

5. CONCLUSIONS

The paper presented hydrogen cars. More and more car manufacturers are seriously developing and producing hydrogen fuel cell vehicles. Electric cars powered by hydrogen will become more and more common in the future. Hydrogen cars are powered by fuel cells containing hydrogen. hydrogen cars could be the zero-emission technology for urban and road transport, thus contributing to climate change mitigation. The paper presented the advantages and disadvantages of hydrogen cars and the Toyota Mirai hydrogen car commercially available in 2025.

6. REFERENCES

- [1] Jelena L. Pisarov, Gyula Mester: *Self-Driving Robotic Cars: Cyber Security Developments*, Research Anthology on Cross-Disciplinary Designs and Applications of Automation, IGI Global, chapter 48, pp. 969-1001, 2022.
- [2] Jelena Pisarov, Autonomous Driving, IPSI Journal, IPSI BgD Transactions on Advanced Research (TAR), Vol. 17, Issue 2, pp. 19-27, ISSN 1820-4511, 2021.
- [3] Gyula Mester, Césár Bautista: *Automotive Digital Perception*, Review of the National Center for Digitization, publisher: University of Belgrade, Vol. 39, pp. 90-95, 2021.
- [4] Gyula Mester, Jelena Pisarov: *Digitalization in Modern Transport of Passengers and Freight*, Review of the National Center for Digitization, 2021, Vol. 39, pp. 83-89, 2021.
- [5] Jelena Pisarov, Gyula Mester: *The future of autonomous vehicles*, FME Transactions, ISSN: 451-2092, DOI: 10.5937/fme2101029P, 2021, Vol.49, Issue 1, pp. 29-35, 2021.
- [6] Jelena Pisarov, Gyula Mester: *Implementing New Mobility Concepts with Autonomous Self-Driving Robotic Cars*, IPSI Transactions on Advanced Research (TAR), Vol. 17, Issue 2, pp. 41-49, 2021.
- [7] Jelena L. Pisarov, Gyula Mester: *The use of autonomous vehicles in transportation*, Tehnika, Vol. 76, Issue 2, pp. 171-177, 2021.
- [8] Jelena Pisarov, Gyula Mester: *Rang lista fizičara Srbije*, Proceedings of the XXVI Skup Trendovi Razvoja: "Inovacije u modernom obrazovanju.", TREND 2020, Zlatibor, Serbia, pp. 559-562, 2020.02.16.
- [9] Jelena Pisarov and Gyula Mester, *The Impact of 5G Technology on Life in the 21st Century*, IPSI BgD Transactions on Advanced Research (TAR), Vol. 16, Issue 2, pp. 11-14, ISSN 1820-4511, July 2020.
- [10] Damir Sostaric, Gyula Mester: *Drone localization using ultrasonic TDOA and RSS signal: Integration of the Inverse Method of a Particle Filter*, FME Transactions, ISSN 1451-2092, Vol. 48, Issue 1, pp. 21-30, 2020.
- [11] Gyula Mester, Jelena Pisarov and Dalma Zilahy: *Magyarországi robotikai kutatók ranglistája*, XXXV. Jubileumi Kandó Konferencia 2019 (JKK2019), pp. 224-233, University Óbuda, Budapest, Hungary, 14-15.11.2019.
- [12] Gyula Mester, Jelena Pisarov and Endre Németh: *Óbudai Egyetem rangsorolása a Webometrics 2019-es ranglistákon*, XXXV. Jubileumi Kandó Konferencia 2019 (JKK2019), ISBN 978-963-449-163-7, pp. 234-240, Óbuda University, Budapest, Hungary, November 14-15, 2019.
- [13] Attila Albin, Gyula Mester, László B. Iantovics: *Unified Aspect Search Algorithm*, Interdisciplinary Description of Complex Systems, INDECS, Vol. 17, Issue 1-A, pp. 20-25, 2019.
- [14] Simon, J., Mester, G.: *Critical Overview of the Cloud-Based Internet of Things Pilot Platforms for Smart Cities*, Interdisciplinary Description of Complex Systems, Indecs, ISBN: 1334-4676, DOI: 10.7906/indecs.16.3.12, Vol. 16, Issue 3-A, pp. 397-407, 2018.09.30.
- [15] Attila Nemes, Gyula Mester, Tibor Mester: *A Soft Computing Method for Efficient Modelling of Smart Cities Noise Pollution*, Interdisciplinary Description of Complex Systems, Indecs, Vol. 16, Issue 3-A, pp. 302-312, 2018.
- [16] Gyula Mester: *Modeling of Autonomous Hexa-Rotor Microcopter*, Proceedings of the IIIrd International Conference and Workshop Mechatronics in Practice and Education (MechEdu 2015), pp. 88-91, 2015.
- [17] Gyula Mester: *Backstepping Control for Hexa-Rotor Microcopter*, Acta Technica Corviniensis - Bulletin of Engineering, Faculty of Engineering Hunedoara, Vol. 8, Issue 3, pp. 121-125, ISSN 2067-3809, 2015.
- [18] Gyula Mester: *New Trends in Scientometrics*, Proceedings of the 33rd International Scientific Conference Science in Practice, pp. 22-27, 2015.
- [19] Gyula Mester: *Design of the Fuzzy Control Systems Based on Genetic Algorithm for Intelligent Robots*, Interdisciplinary Description of Complex Systems, Indecs, Vol. 12, Issue 3, pp. 245-254, 2014.
- [20] Mester, Gyula: *Új tudományos eredmények mérése*, XXX Kandó Conference, Budapest, Hungary, pp. 1-10, ISBN 978-615-5460-24-1, 2014.11.20.
- [21] Gyula Mester, *Rankings Scientists, Journals and Countries Using h-index*, Interdisciplinary Description of Complex Systems, Indecs, Croatian Interdisciplinary Society, Vol. 14, No. 1, pp. 1-9, ISSN 1334-4684, DOI: 10.7906/indecs.14.1.1, 2016.
- [22] Gyula Mester: *Metode naučne metrike i rangiranja naučnih rezultata*, Proceedings of 57th ETRAN Conference, pp. RO3 5.1-3, 2013.
- [23] Aleksandar Rodic, Gyula Mester: *Control of a Quadrotor Flight*, Proceedings of the ICIST Conference, pp. 61-66, 2013.
- [24] Gyula Mester, Aleksandar Rodic: *Modeling and Navigation of an Autonomous Quad-Rotor Helicopter*, E-Society Journal Research and Applications, Vol. 3, Issue 1, pp. 45-53, July 2012.

- [25] Gyula Mester: *The Evaluation of the Impact Factor of the Journal Acta Polytechnica Hungarica*, Proceedings of the TREND Conference, pp. 70-73, 2011.
- [26] Gyula Mester: *Felsőoktatási világranglisták 2011*, Proceedings of the Conference Informatika a felsőoktatásban, pp. 269-277, Debrecen, Hungary, 2011.
- [27] Gyula Mester: *Sensor Based Control of Autonomous Wheeled Mobile Robots*, The Ipsi BgD Transactions on Internet Research, TIR, Vol. 6, Issue 2, pp. 29-34, 2010.
- [28] Gyula Mester: *Intelligent mobile robot motion control in unstructured environments*, Acta Polytechnica Hungarica, Vol. 7, Issue 4, pp. 153-165, 2010.
- [29] Gyula Mester: *Improving the Mobile Robot Control in Unknown Environments*, Proceedings of the YUINFO' 2007, pp. 1-5, Kopaonik, Serbia, 11-14.03.2007.
- [30] Gyula Mester: *Motion Control of Wheeled Mobile Robots*, 4th Serbian-Hungarian Joint Symposium on Intelligent Systems, SISY, Subotica, Serbia, pp. 119-130, 29-30.09.2006.
- [31] Gyula Mester: *Intelligent Mobile Robot Controller Design*, Proceedings of the 10th 2006 International Conference on Intelligent Engineering Systems, INES 2006, 282-286, DOI: 10.1109/INES.2006.1689384, IEEE Press, London, U K, June 26-28, 2006.
- [32] János Sánta, *Artificial Intelligence Applied in Enterprise Resource Planning*, Interdisciplinary Description of Complex Systems: Indecs, Vol. 22, Issue 3, pp. 360-363, DOI: 10.7906/indecs.22.3.11, ISSN 1334-4684, 2024.
- [33] Ugljesa Marjanovic, Gyula Mester and Bojana Milic Marjanovic, *Assessing the Success of Artificial Intelligence Tools: an Evaluation of ChatGPT Using the Information System Success Model*, Interdisciplinary Description of Complex Systems, INDECS, Vol. 22, Issue 3, pp. 266-275, DOI: 10.7906/indecs.22.3.3, 2024.
- [34] Dalma Zilahy, Gyula Mester: *Managing Negative Emotions Caused by Self-Driving*, Interdisciplinary Description of Complex Systems: INDECS, Vol. 21, Issue 4, pp. 351-355, 2023.