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AUTOMOBILE WITH PNEUMATIC ENGINE

Urgency of the research. In the modern times, more often, there are alternatives to the drive, which help the environment. First of all, there are many engine alternatives, but also hybrids with low emissions.

Target setting. The main goal was to design a vehicle that powered by compressed air. Then take the vehicle to competition. For one pressure cylinder, this vehicle get over a longer track and the other category reached a higher speed.

Actual scientific researches and issues analysis. In the past few years were realized ten Aventics pneumobil competitions. That year was the eleventh grade of this pneumatic competition. This vehicle ran for the first ride in all categories. There are many publishers in the field of pneumatics systems. The issue of pneumatic motors is new in Slovakia, since it is one of the first pneumatic driven vehicles.

Uninvestigated parts of general matters defining. This article focuses on analysis of the proposed of pneumatic driven vehicle and few parts of this vehicle.

The research objective. The aim of the research was to design and assembly a compressed air-powered car that was supposed to attend in competition of pneumobil.

The statement of basic materials. The analysis consists of basic information about competition, by Aventics. The definition of the vehicle is described below. Based on this knowledge, the 3D model and frame of the vehicle are further developed. MKP-FEA simulations were performed on this frame. Basic information and parts of the pneumatic engine have been provided.

Conclusions. This article describes the design, simulations, parameters and basic parts of a pneumatically-powered vehicle. The design of a pneumatic driven vehicle is based on the rules by Aventics. Based on these rules, the development of this vehicle was realized. The next step was to analyse the frame that protect pilot in the event. One of the simulation was described and explained. Some of the basics were also described. The result of this student project is a vehicle that took place in the Hungarian town of Eger. The vehicle ran in each of category. There were a total of 51 teams from all over the world. Only 34 teams completed the technical inspection. In the "long distance" category finished in 15th place.

Keywords: pneumatic engine; competition aventics; pneumobil.

Fig.: 7. References: 4.

Problem definition. The concept of the car is based on the rules of the International Aventics Pneumobil Competition 2018. It is the first car of this type made in Slovakia. The car has a three wheel chassis with twenty six inch wheels and is powered by a pneumatic three cylinder engine with a volume of 1885 cm³ powered by compressed air. As an energy source, the air pressure of 20 MPa in a pressure vessel. The pneumobil does not produce any harmful emissions like gasoline and diesel combustion engines.

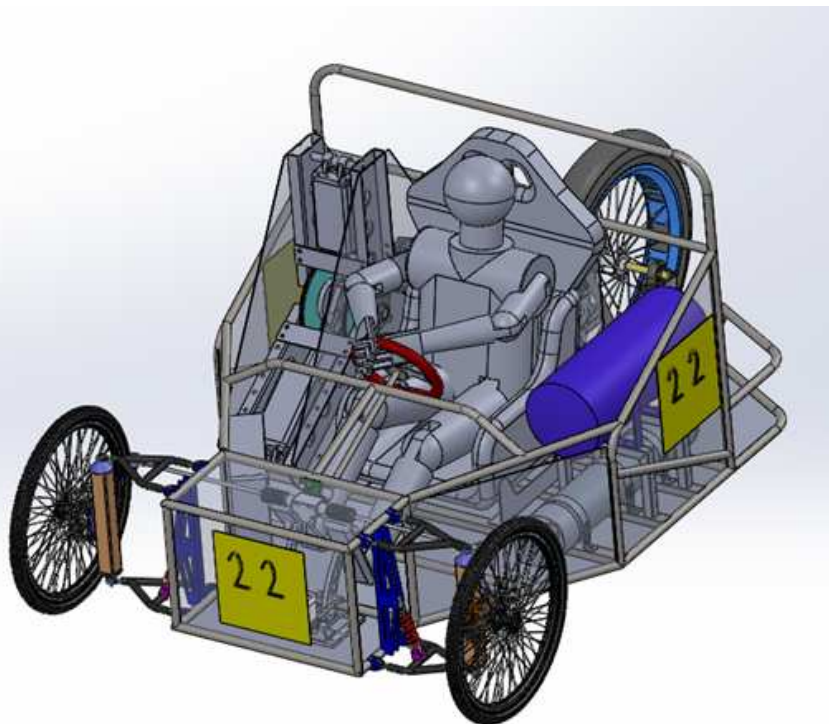


Fig. 1. Proposed vehicle model of pneumobil

The pneumatic engine consists of three star-shaped pneumatic cylinders which are gradually actuated and by means of a crank gear, the linear motion of these pistons is transformed into a rotary movement of the output shaft of the motor [1]. The torque of the motor is then transmitted by the chain gear to the rear drive wheel of the vehicle. The front wheels are mounted on suspension axles. Monitoring the vehicles operation and ensuring maximum drive efficiency is addressed by the Bosch Rexroth IndraControl L10 PLC system.

The length of the car is 2390 mm and the width is 1480 mm. The maximum height is 1113 mm. The weight of the entire vehicle is approximately 150 kg. The clearance height of the chassis is 88 mm. The clearance height can be adjusted by as required. The frame of the vehicle is made up of a welded steel structure designed to meet the relevant safety regulations to provide the driver with maximum protection in the event of an accident.

When designing the structure, the front impact of the car and its overturning was also simulated. The car is equipped with four-point safety belts and safety pneumatic elements. The pressure vessel is located on the side of the vehicle so that it is protected by a safety frame in the event of an accident. The car is equipped with all-wheel disc brakes and the braking system consists of two separate circuits, front and rear. Two brake cylinders are used, each for one brake circuit. The rear brake circuit includes a handbrake. Pneumatic elements and control unit for this car have been provided by sponsors Aventics and TBH Technik, s.r.o.

3D model and frame of the vehicle. The concept of the car is based on the rules of the competition. The 3D model has been designed to meet the limits of lengths, width and height. Fig. 1 shows model of the frame.

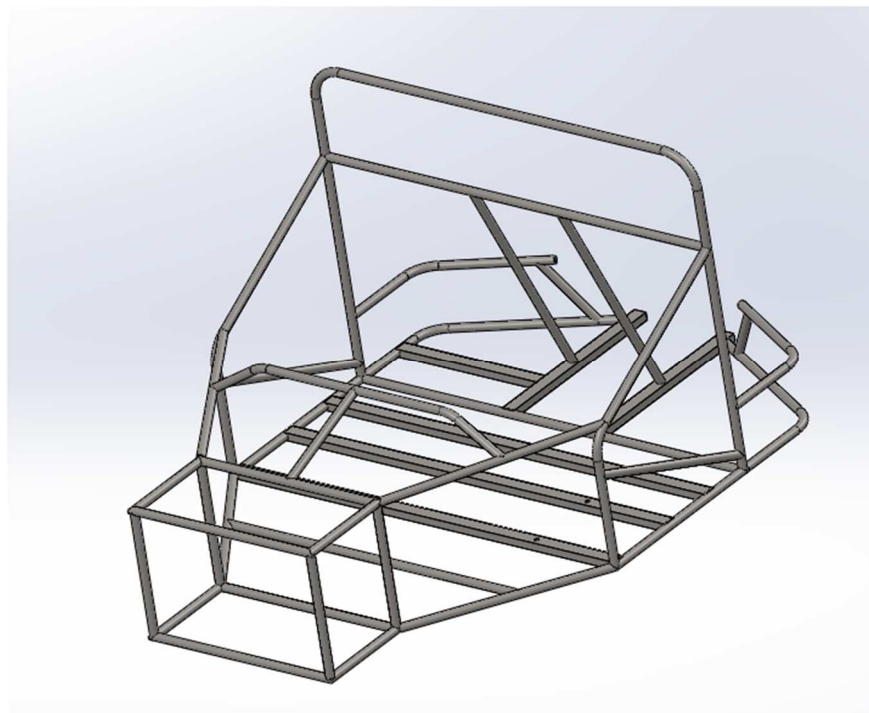


Fig. 2. 3D model of the frame

3D model and frame of the vehicle. The concept of the car is based on the rules of the competition. The 3D model has been designed to meet the limits of lengths, width and height. Fig. 2 shows model of the frame.

The pneumatic frame is made of welded steel tubes of 25x2 size and the auxiliary elements are made up of rectangular sections measuring 40x25x2. The seat of the pilot is located at the center of the frame over which is a protective armor to protect the rider in case of overturning. The whole structure of the frame is designed to provide the rider with maximum protection in the event of any accident. On Fig. 3 is real frame of the vehicle.



Fig. 3. Frame of pneumobil

The simulation simulated the perpendicular impact of the vehicle into an obstacle where the front part of the frame was loaded with a force of 1000N. Fig. 4 shows a frame shift which is minimal and the rider is safe. Protection of the rider is ensured in particular by the protective frame, the safety sports seat and the 4 point seat belts. The bottom of the vehicle is covered with 2 mm aluminium plate all over the area.

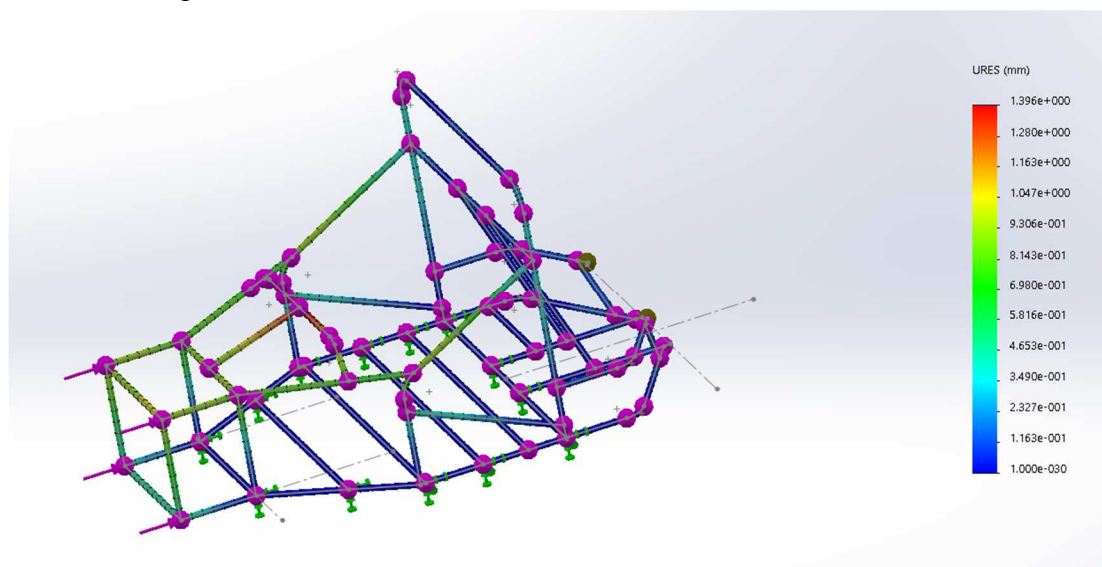


Fig. 4. Simulation of the frame

The pressure cylinder is located on the side of the vehicle, next to the rider's seat. Because of the center of gravity it is positioned as low as possible and is fastened with two steel strips and clamps. These strips and clamps are removable, allowing the pressure vessel to be replaced. Puffer container has a CE-Certificate: 2009/105 EC and 97/23 EC (P.E.D.).

Pneumatic engine. The engine consists of three linear pistons that are arranged in the star, the pistons being turned 120° to one another [2]. The pistons are mounted in steel frames and the piston tips are mounted on one crankshaft. The ends of the pistons are attached to the frame by means of pins containing the bearings and at the same time the pins connect the frames [3].

With their linear motion, they rotate together with the crankshaft, which with the help of sprockets and chains, transmits the torque through the gearbox to the driven wheel. The motor is attached to the frame by means of four bearings that are mounted to the frame by M16 screws. The engine is located on the right side of the frame. Fig. 5 shows star shaped engine.

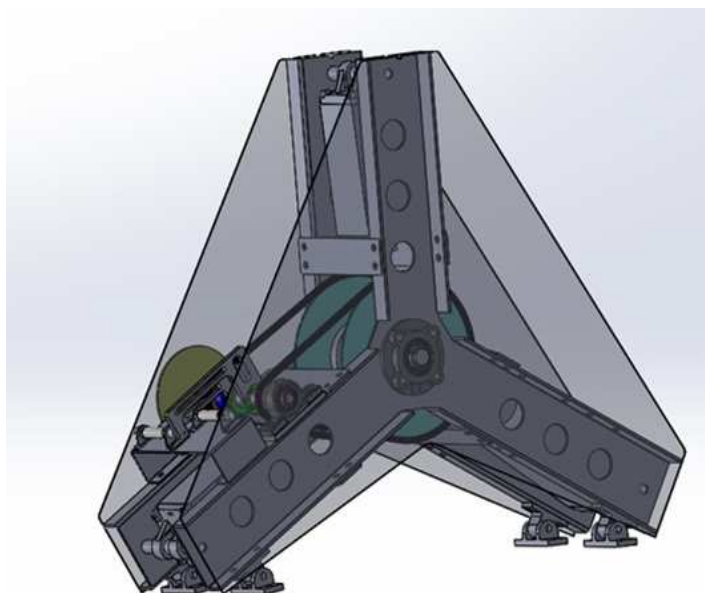


Fig. 5. Star shaped engine

This pneumatic star shaped motor consists of few parts. Primary components are two steel frames and three linear pistons, by Aventics. Another parts of the sprocket wheels, the crankshaft and the gearbox. At the beginning of each piston is coupling pin. Frames connected together with stiffener platforms [4].

The drive system is presented with a two-speed gearbox that is inspired by automotive competitive vehicles. It uses a gearing system. Sprockets are used to facilitate the passage of higher axial distances. Gears are controlled by pushrods to provide torque transmission either through the first gear or the second permanent gear that drives the rear wheel.



Fig. 6. Pneumobil

The front wheels are fitted as well as on ordinary bicycles, so the wheel is mounted on the axis and attached to the nut. The rear wheel is mounted on the produced shaft, which is stored in the bearing houses. The rear axle is driven from the gearbox and is connected to a rear wheel that includes a freewheel. The rear wheel is attached to the shaft with lock rings and adjusting screw in the bearing house. Fig. 7 shows team on competition.



Fig. 7. Pneumobil in Eger, HU

Conclusions. This article describes the design, simulations of frame, parameters and basic parts of a pneumatically-powered vehicle. The design of a pneumatic driven vehicle is based on the rules by Aventics. Based on these rules, the development of this vehicle was realized.

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АВТОМОБІЛЬ ІЗ ПНЕВМАТИЧНИМ ДВИГУНОМ

Актуальність теми дослідження. У наш час набувають поширення альтернативні двигуни на джерелах палива, які не забруднюють довкілля. Існує велика кількість різновидів двигунів на альтернативних джерелах палива, а також із гібридними установками.

Постановка проблеми. Основною метою є проектування автомобіля, що працює на стисненому повітрі. Взято участь у змаганнях пневматичних автомобілів. При тому ж самому тиску в циліндрі цей автомобіль подолав більшу відстань, а в іншій досяг більш високої швидкості.

Аналіз останніх досліджень і публікацій. За останні кілька років взято участь у десяти змаганнях Aventics з пневмомобілем. В цьому році був одинадцятий раз участі в змаганнях. Цей автомобіль фінішував першим у всіх категоріях. У галузі пневматичних систем опубліковано багато праць. Питання пневматичних двигунів є новим у Словаччині, представлений пневматичний транспортний засіб є одним із перших автомобілів із пневматичним приводом.

Виділення недосліджених частин загальної проблеми. У цій статті основна увага приділяється аналізу запропонованого автомобіля з пневматичним приводом й деяких його елементів.

Постановка завдання. Мета дослідження полягала в тому, щоб спроектувати і зібрати автомобіль із пневматичним приводом для участі у змаганнях пневмомобілів.

Виклад основного матеріалу. Аналіз складається з основної інформації про турнір Aventics. Наведено опис автомобіля. Продовжено дослідження 3D-моделі рами автомобіля. Для цієї рами було виконано моделювання МКР-FEA. Представлено основну інформацію про пневматичний двигун і його деталі.

Висновки відповідно до статті. У цій статті описано конструкцію, моделювання, параметри й основні частини пневматичного автомобіля. Конструкція пневматичного автомобіля спроектована за правилами Aventics. На основі цих правил була здійснена розробка автомобіля. Наступним кроком був аналіз рами, яка захищає пілота від дорожньо-транспортних пригод. Описано й пояснено один із варіантів моделювання. Деякі основні моменти були також пояснені. Результатом цього студентського проекту є автомобіль, який представлено в угорському місті Егер. Автомобіль брав участь у всіх категоріях, де загалом змагалися 51 команда з усього світу. Тільки 34 команди завершили технічний огляд. У категорії «довга дистанція» пневматичний автомобіль посів 15-е місце.

Ключові слова: пневматичний двигун; змагання Aventics; пневмомобіль.

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