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INVESTIGATION OF DESIGN AND ANALYSIS OF HYBRID DRIVE SYSTEM WITH WIND POWER

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ABSTRACT

One of the main problems of irreversible resource (oil derivates) resource relate to their irreplaceability. This caused the engineers direct their attention toward building Hybrid cars to use other forms of reversible energy in industrial designs. The research aim is to build Hybrid cars by means of wind power¸ of course¸ the design has been applied successfully by Japanese¸ American¸ French and German car companies. But¸ what depicts the difference this research from others relate to the fact the design of rotor and rotor placement. To evaluate the project success¸ through Fluent¸ Gambit and Solidework softwares¸ the exerted pressure on rotor would be calculated. Through having pressure and applying the governed relations on system¸ the amount of rotor circulation would be calculated to help main shaft. Then the rate of increase in fuel consumption due to exert Drag force toward moving the system based on rotor existence would be calculated. The results show, designing such system increase %27 of fuel consumption.

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KEY WORDS

Hybrid Cars¸ Solid Work¸ Gambit¸ Fluent, Rotor

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INTRODUCTION

The researchers from BMV¸ a Germanic company¸ regarding to design wind hybrid vehicles in 2012 [1] ¸ triggered the first sparks of motivation for the engineers of this Germanic company to build such vehicle. But¸ because of rotor placement on the car shaft¸ and due to adding an opposed force toward fuel consumption increased. Thus they couldn´t find an economic justification to the project. As a result¸ the project of this Germanic company failed. The researches of Toyota Company regarding to design a wind hybrid vehicle in 2012 [2] encouraged the engineers of TOYOTA Company to decide on building such vehicles. Because of unsuitable designing of rotor on the shaft and adding a positive force in movement caused the increase in fuel consumption and they couldn´t find an economic justification to the project. As a result¸ the project of this company failed¸ too. The researches were done by Phlox¸ a Germanic car company¸ in 2001 [3]. Phlox was the first company with suggestion in designing such cars Emanuel, in American¸ investigated the impact of Air turbulence in vehicles ahead influenced on steep in front part of the cars [4 - 5]. In this regard¸ he found the more increase in vehicle´s ahead step¸ the less air turbulence in car´s ahead part. Thus¸ in designing the canal¸ ducts and rotor ¸ one should take the rotor performance into consideration such that the length of vehicle´s ahead experiences no increase. Eljur (2010) ¸ in Spania¸ investigated the air turbulence analysis in the car´s ahead [6]. In this regard¸ the impact of vehicle´s dimension on air turbulence was discussed. To investigate these two moods by means of software¸ having to build a spindle / duke form is the best one¸ which help to experience the least drag force in front of the vehicle. Migind (2010) ¸ in U.S.A¸ analyzed aerodynamic turbine´s air blades with Combit software [7-10]. Metyl bench¸ solved Navier Stokes unlinear equation to calculate the turbine´s rotor speed through numerical and analytical methods. Their method in solving such equation is in Navier-stokes linear un-homogenous equation with considering the assumption according to equation (1, 2) and getting derivation from it and placing it in Navier-stokes equation¸ we have:

$$\psi(X;Y) = u_{XX} + V_{YY} + \text{Y}(X;Y) \qquad (1)$$

$$\text{Y}(X;Y) = \int F(X;Y)\sin\frac{n\pi}{L}\,dx \qquad n = 1; 2; 3 \ldots \qquad (2)$$

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Navier-stokes equation is converted into homogenous linear equation and then solves it through inseparable way. The manner of air turbulence and airflow pass by mean of software is depicted in fig (1) [14]. It shows air turbulence in the front part of vehicle is far more than the back part. For this¸ it is better to design the rotor and air inlet channel is designed in the front part¸ to maintain air turbulence such that falling pressure by the rotor cause decrease drag force from the front part of vehicles.

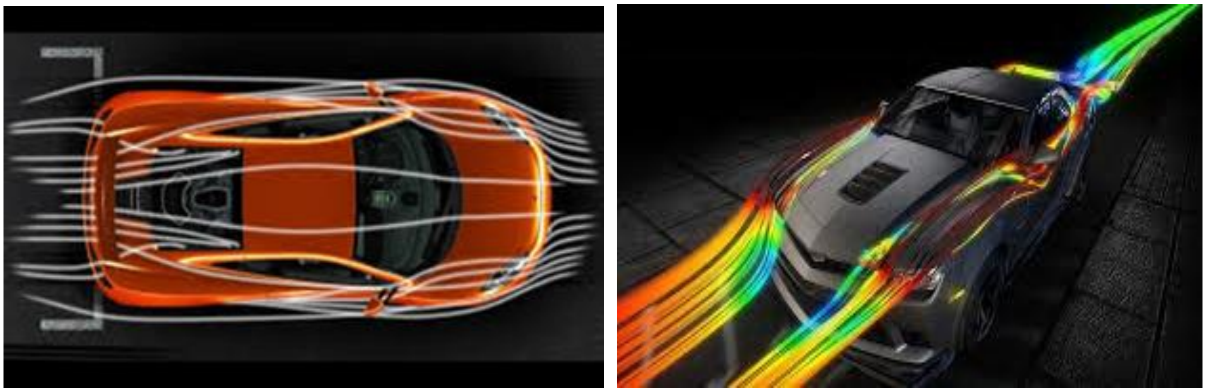

Fig: 1. Airodynamic Analysis of the vehicle along with the car [14]

In a book titled ″Turbomachine Principle″¸ how to calculate the rotor speed based on the exerted force on rotor used by project¸ which the amount of this speed is [15]:

$$V_n = \frac{n_{st}\sqrt{P}}{\sqrt{\rho}\,(gh)^{\frac{5}{4}}} \qquad (3)$$

Where: V_n is the speed of air collision with rotor¸ n_{st} undimensional speed; P, is pressure¸ ρ is density¸ g = 9/81; V is inlet air speed¸ A is channel cross-section. To calculate the received power from rotor based on air collision speed to rotor the equation (4) is used [16]:

$$P = 0.3925\ C_p\ .\rho.d^2.v^2.\sqrt{c_d{}^2 + c_L{}^2} \qquad (4)$$

Where: C_p is power coefficient¸ ρ is density¸ V is speed¸ C_d is drag coefficient and C_L is lift coefficient. Relayed each other as rotor blades.
In the Allen´s book titled ″ Mechanical motors ″ it is expressed¸ the fuel consumption percentage due to exerting an opposite force in the direction of the movement [17] ¸ vehicle route¸ vehicle fuel consumption increased considerably. The percent of increase in fuel consumption depends on some factors including: gear coefficient¸ the exerted force on the system¸ difference coefficient…, reffered it in (5). The percent of increase in fuel resulted in exerting an opposed force in the order of move equals:
The % of increase in fuel consumption

$$= \frac{\text{rotor power} \times \textit{gear coefficient}}{\text{difference coefficient} \times \textit{power coefficient} \times \textit{the created turning by rotor}} \qquad (5)$$

The research evaluated the effective factors on Drag force in New York¸ Genoa¸ Department of Mechanics [18_20] ¸ including: the material employed in the vehicle body¸ the lines on vehicles body¸ and vehicle appearance. One of the factors considered in designing the vehicle is to operate in some parts of vehicle¸ the nodes¸ and / or the other word to happen turbulences [21-24]. The purpose of aerodynamic currents is air movement on the body surface. Generally¸ the air passed on the surface of vehicle body divide into 2 parts: Laminar current¸ the current which move with a specified order on the vehicle body. These currents have no turbulences and irregularities in the vehicle movement¸ and occur¸ mainly¸ in the front¸ lower side and two sides of vehicles. The lines on the body help to direct these currents [25]. Turbulence current: these currents have some irregularities. These cause a huge turbulence and appear¸ mainly¸ in the back part of vehicle. The amount of these currents in Sedan vehicles has far more drag force than other vehicles. The engineers and designers to remove these currents through improving the aerodynamic characteristics. The less turbulence current occurs in the vehicle¸ the less drag force would be experienced in the vehicles [27-31].

To design channel and rotor

$$Q=VXA \qquad (6)$$

If the changes in the cross-section of channel be stable because the primary and secondary. Cross-section is equal¸ the average speed of inlet air would be equal with air collision speed to rotor. With increase of cross-section¸ the area of outlet air become more than inlet air. The air collision average speed with rotor is less than inlet air. As a result¸ less turn would create. With gradual decrease of channel cross-section the speed of air collision is more than the inlet air. As a result¸ with increase of air collision speed with rotor¸ the rotor turning increase is more than two other modes. On the other hand¸ with decrease of channel cross-section¸ the rotor length placed on the channel bottom decrease based on two previous moode which cause decrease in rotor weight. As a result¸ the applied channel in the project decrease the cross-section gradually. In solid works¸ a rectangular channel with gradual decrease of cross-section with inlet dimensions of 150 $\times$ 50 cm^2 and outlet aspects of 100 $\times$ 40 cm^2 and a rotor with the length of 100 cm and radius of 20 cm was designed and¸ at least¸ the designed rotor and channel are assembled together. The assembled channel is saved in solid work environment and mustered in Gambit and networked in Gambit environment. The networked channel is saved in Gambit environment and mustered in fluent environment. With considering the turbulent¸ compressible and air inlet speed of 30 $\frac{m}{s}$ ¸ the air pressure into kpas channel is 100 and 25 $^{\circ}C$ temperature the problem was solved and pressure / fluid pressure the rotor is changes obtained.

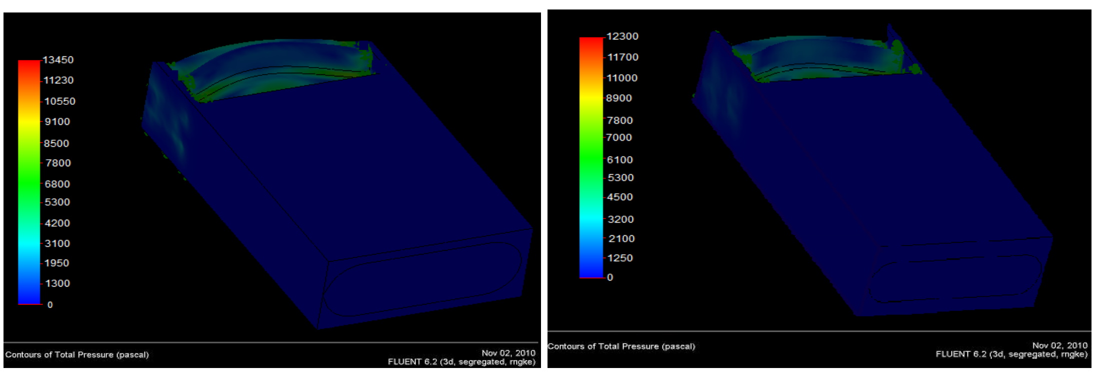

Fig 2: The analysis of systems force changes in fluent environment

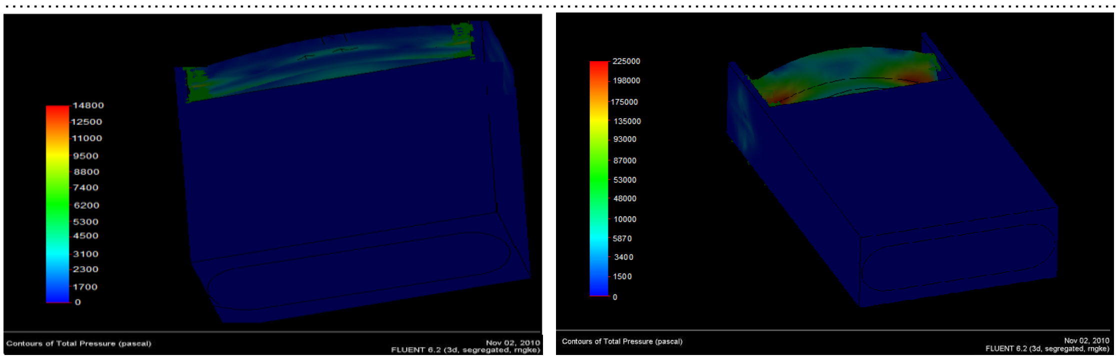

Fig: 3. The analysis of systems force changes in fluent environment

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To compare the pressure changes in rotor surface one should calculate the pressure in several point of surface. From the left part¸ in the equal distance¸ 12/5 cm¸ the points 1-9 would be clarified.

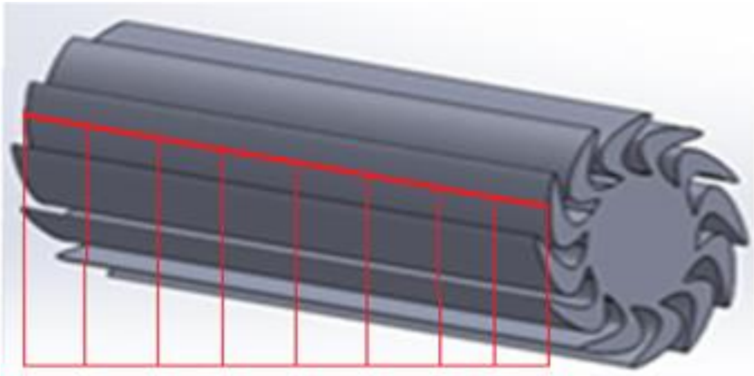

Fig: 4. To divide the rotor into 8 parts to analysis the pressure changes

At first¸ the bladder-formed rotor¸ the changes of pressure in bladdered rotor surface is shown in the purposed points in **Table-1**.

Table: 1. To examine the pressure changes in points 1-9 in bladdered shape rotor surface

point of surface	1	2	3	4	5	6	7	8	9
Pressure Bladded rotor	83.11	78.2	68.01	61.2	55.73	61.2	68.01	78.2	83.11

The changes of pressure in Elliptic rotor surface are shown in the purposed points **in table-2**.

Table: 2. To examine the pressure changes in Elliptic rotor surface

point of surface	1	2	3	4	5	6	7	8	9
Pressure Elliptic rotor	87.02	79.23	70.68	65.09	89.72	65.09	70.68	79.23	87.02

The force changes in triangular rotor surface in the purposed points are depicted in **table-3**.

Table: 3. To examine the pressure changes in the points (1-9) in triangular rotor surface

point of surface	1	2	3	4	5	6	7	8	9
Pressure triangular rotor	93.05	84.01	76.54	71.08	63.08	71.08	76.56	84.01	93.05

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Table: 4. The changes pressure in airfoil rotor surface is depicted in table

point of surface	1	2	3	4	5	6	7	8	9
Pressure airfoil rotor	85.78	78.36	69.4	62.98	57.24	62.98	69.4	78.36	85.78

The pressure change in rectangular rotor surface in the purposed points of **table -5** is shown.

Table: 5. the pressure change in the points 1-9 in the rectangular from rotor surface.

point of surface	1	2	3	4	5	6	7	8	9
Pressure rectangular rotor	91.18	85.42	73.38	67.06	64.28	67.07	73.38	85.42	91.18

Based on the tables of pressure changes in the surface of bladded¸ rectangular¸ triangular¸ elliptical and airfoil in the points (1-9) are drawn in diagram (1) with Excel software.

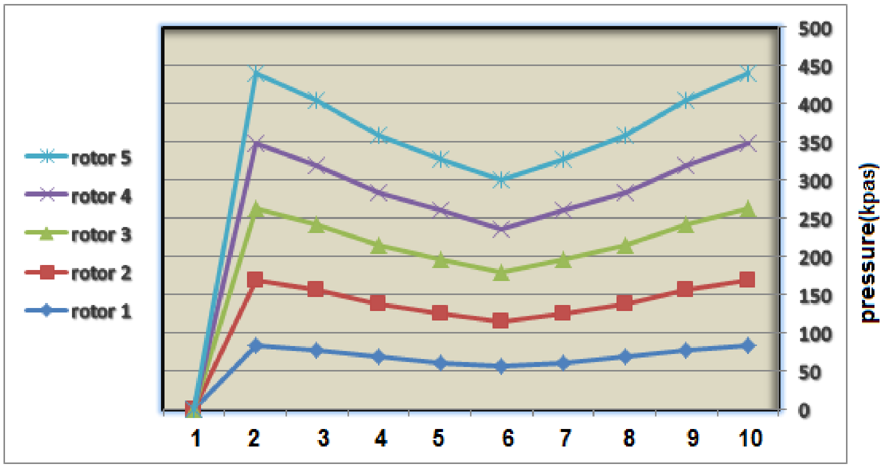

Fig: 5. Chart of force change in 5 rotors

According to diagram (1) ¸ the least force relates to bladded rotor¸ so bladder-formed rotor are the basis of the work. Inlet air speed is 30$\frac{m}{s}$¸ rotor length is 100 cm¸ and rotor radius is 20 cm and channel rectangular cross-section has 20 × 100 cm^2 dimensions. The force which exists on this rotor surface¸ according to table (1-5) is 55.73kpas. The temperature is 25°C and air pressure is 100kpas. Thus the sound speed in the environment is: thus the air Mach number equals:

$$V_c = \sqrt{\gamma RT} = \sqrt{1.4 \times .287 \times 298.15} = 10.18 \qquad (7)$$

$$M = \frac{V}{V_C} = \frac{30}{10.18} = 2.94 \qquad (8)$$

Since Mach number is more than so¸ inlet air current into channel are compressible¸ and the density of inlet air equals:

$$\rho = \frac{P}{RT} = \frac{100}{0.287 \times 298.15} = 1.169 \frac{Kgr}{m^3} \qquad (9)$$

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From fluid mechanics¸ we remember the pressure loss of compressible current equals:

$$p_1 - p_2 = G\,(V_2 - V_1) - \frac{R}{A} \qquad (10)$$

$$G = \rho_1 V_1 = \rho_2 V_2 = 1.169 \times 30 = 35.07 \qquad (11)$$

Thus¸ the air speed in the channel¸ when collisioning with rotor equals:

$$100 - 55.73 = 35.07(V_2 - 30) - \frac{0.287}{0.2}$$

$$V_2 = 31.28$$

$$\rho_1 V_1 = \rho_2 V_2 \qquad (12)$$

$$1.169 \times 30 = \rho_2 \times 31.28$$

$$\rho_2 = 1.138\,\frac{kgr}{m^3}$$

Air collision speed to rotor of V_n gives:

$$V_n = \frac{n_{st}\sqrt{p}}{\sqrt{\rho}\,(gh)^{\frac{5}{4}}} = \frac{31.28\sqrt{73.18}}{\sqrt{1.138}\,(9.81\times 0.1)^{\frac{5}{4}}} = 39.66\,\frac{m}{s} \qquad (13)$$

To clarify the outlet air current condition¸ Mach number of outlet air is calculated from channel. If Mach of outlet currents be 0/4 < M < 1¸ air current is subsonic. If M > 3¸ outlet air current is ultra sound.

$$M = \frac{V}{\sqrt{\gamma RT}} = \frac{V}{\sqrt{\rho g RT}} = \frac{V}{\sqrt{Pg}} = \frac{39.66}{\sqrt{73.18\times 9.81}} = 4.581 \qquad (14)$$

Thus¸ outlet air current of channel is ultra-sound.

C_d coefficient is equal 0/38¸ C_L= 0.42, C_p=2. Thus the power rotor is equal:

$$P = 0.3925\, c_p\,.\rho.d^2.v^2.\sqrt{c_d{}^2 + c_l{}^2} \qquad (15)$$

$$P = 0.3925 \times 2 \times 1.138 \times (0.4)^2 \times (39.66)^2 \times \sqrt{(0/38)^2 + (0/42)^2} = 125.87W$$

The created torque by rotor¸ according to dynamic relations equals:

$$\text{The created torque} = \frac{P.r}{V} \qquad (16\,)$$

Thus the created turn by rotor equal:

$$T = \frac{125.87 \times 0.2}{39.66} = 0.635\; n.m \qquad (17)$$

With adding the rotor¸ an opposite power added in the direction of system should be calculated. What amounts of vehicle power would spend to overcome this force. In calculating the increase in fuel consumption by opposite force¸ this equation is answered:

The %of increase in fuel consumption=

$$\frac{\text{rotor power} \times gear\ coefficient}{\text{difference coefficient} \times power\ coefficient \times the\ created\ turning\ by\ rotor}$$

To calculate the gear coefficient and difference coefficient table (6) is used:

Table: 6. Difference and Gear Coefficient

Gear Coefficient 1	3/455
Gear Coefficient 2	1/850
Gear Coefficient 3	1/200
Gear Coefficient 4	0/9687
Gear Coefficient 5	0/756
Vehicle Difference Coefficient	4/529

Because the speed is more than 30 $\frac{M}{S}$ ¸ then the gear coefficient and difference coefficient equal: 4/529. Thus the vehicle fuel consumption is equal:

$$\text{The \%of increase in fuel consumption} = \frac{125.87 \times 0.756}{4.529 \times 38 \times 2} = 0/27 \quad (19)$$

Adding the rotor to vehicle about % 27 of fuel consumption would increase¸ means if in the vehicle in 100km 8l fuel is assumpted¸ with adding rotor in 100km 10/16 l fuel would be asumpted.

DISCUSSION

The research aim was to bring change in designing rotor¸ in the system (to create a rectangular channel under the vehicle and placing the rotor under the vehicle and placing the rotor at the bottom of channel) to modify other related works with designing this system in solid work environment¸ networking the system in the Gambit environment in a mode with the least pressure on the rotor in the inlet speed 30 M/S for the inlet air entered the channel and with obtaining the pressure and doing the calculation by the aim of the governed relation on system this project encountered with fault¸ because :

1. Adding rotor under the vehicle increase the fuel assumption about %27¸ while the aim saving in the gasoline consumption as a resource is irreversible.

2. According to the increase in the system designing cost against the common vehicles¸ about 38 N/m torque was applied in flywheel rotation¸ in which this few rotation can´t meet the required propulsion for movement of vehicle.

3. Another important aim is to reduce the pollution¸ produced due the increase in fuel consumption the rotor produce more greenhouse gases.

4. High cost of designing and producing such system under the vehicle¸ according to increase in fuel consumption there is no economic justification.

5. Opposite power toward movements is far more than drag power existed in the front part of vehicle. As a result¸ the vehicle need more acceleration for move.

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CONFLICT OF INTEREST
There is no any form of conflict of interested.

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