

Survey on Three-Dimensional Composite Rotor for Flywheel Energy Storage System

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Abstract- This review concentrates on finding the impacts of flywheel geometry on its energy storing/conveyance capability per unit mass, defined much specifically as specific energy. Different geometries of flywheels and their proposed respective energy storing capacity are discussed about in this article. Different profiles considered are solid, rimmed, webbed, spoke flywheel. The Specific Energy Performance is influenced by the geometry of flywheel and the working load impacts on the shafts are lessened because of decreased masses at high speeds. Designing flywheel productively increases the moment of inertia for less material and gives high dependability and long life. To ascertain Von-Misses stress and deformation of the flywheel, analysis is done on various loading conditions and set ups.

Key words: Flywheel, Design, Analysis, Optimization, FEA, ANSYS

I INTRODUCTION

The Definition of Problem:

The flywheel is an energy storing device, which stores the energy in the form of kinetic energy. This component is helpful in all sorts of auto motives ranging from small vehicles to large earth movers. But for the efficient and optimum use of the flywheel in a required application focuses on the design criteria of the flywheel and the selection of material of the same. The flywheels used in the earth movers are cumbersome and heavy and are required to withhold a large amount of kinetic energy for the working cycles. Hence the present review is focused on the selection of the most efficient design and selection of the material for the operation and maximum efficiency of the flywheel on the required application.

The review focuses mainly to determine effective design and material for the flywheel that can help in storing the kinetic energy in the most efficient way possible.

II LITERATURE SURVEY

A Reviews on Flywheel Design:

EMERSON et al. examined the capacity to remunerate potential sensor drifts during the operation of the

flywheel. The capacity of this system to separate the vibrations and remunerate the errors was tentatively approved, [2]. BAI et al. proposed a strategy to design a flywheel rotor of composite rim and metal hub by recognizing the connection between the rotor and the driving machine. Examination is carried on the impact of a few variables, for example, the material of rotor, setup, fracture techniques and association on energy density. Optimization of the hub can enhance the energy density productively. The test results and analysis results match, thus demonstrating that the design strategy is helpful, [5]. YOO et al. concentrated the flywheel stability in energy storing system upheld by magnetic bearings. Composed two flywheel systems that store usable energy at a greatest speed. They additionally improved it to store energy which brought about flywheel having a solid gyroscopic coupling. They inferred dynamic models utilizing FEM to examine framework steadiness precisely. Approved and thought about the models through examinations, [9]. PENG et al. done the investigations to concentrate the connection between the amplitude of vibration and high speed axis, levitation clearance, and frictional axis moment. They highlighted the ultrasonic bearing for its simple structure and strong levitation. This was accomplished for improving the flywheel storing capacity, [7]. PIETRASZEK et al. exhibited for the car business issue of streamlining the fuzzy regression approach. They summarized problem definition, measured data and examination of last with traditional and fuzzy regression approach. He additionally demonstrates the advantage of fuzzy regression approach, [12]. JIANG et al. built up a flywheel system for design adaptability. Additionally concentrated the substance of PMB through FEM and confirmed tentatively. Acquainted a crush damper with bolster base moving bearing, upgrade stability of the rotor framework and reduce lateral vibration. They demonstrated that the adaptable design and hybrid bearing for the setup take into account the utilization of a rolling bearing to diminish power loss, [19]. ARAKELIAN et al. examined the advancement of reactions planar parallel manipulators that applies no response moments or forces to the mounting base amid movement. Proposed design systems that permit

dynamic substitution of moving platform by three concentrated masses. A weightless connection with three concentrated masses is presented to by the dynamic model of moving platforms. They checked that controllers react through computer simulations, [27]. MOUSAVI G et al. displayed an audit of the cross breed vehicle control framework, and other system applications. They exhibited their favourable circumstances and weaknesses. They additionally talked about to sum things up power electronic converters in FESS, [28]. HAMZAOUI et al. presented two techniques of commands to apply in the system of converting wind energy into storage. The energy storage system based is associated with the wind generator. To receive a faster response, the direct control of the systems eliminates the block of pulse with loops of regulations and width modulation. The simulation results are developed in Matlab of the model of the complete system, [24]. CONTEH et al. investigated lamina mechanical properties suitable for flywheel. He implemented high strength composite material properties and low density for the constant stress portion of the flywheel. Results contributed to development as a promising application for energy storage because of significant improvements in technology and materials, [23].

B Reviews on Flywheel Analysis:

FABIEN et al. approached to the improvement of the flywheels of the stacked-ply type. This was obtained by allowing variety in the introduction of the strands in spiral plies. The outcomes demonstrate that the estimation of the energy density differs enormously relying upon the work of the failure criteria, [3]. TANG et al. the helper support was expelled until the flywheel passed the primary basic speed. The flywheel is at unbending state in basic condition and is tried at fast. Examined the lower damper impact on the proportions of modular damping and constrained vibrations. The sub critical rotor flow outline and pivot jewel bearing to be great answers for the turn test for the composite flywheel, [13]. YU et al. proposed novel flywheel energy storing for marine. The reason to enhance the power quality in a marine power system (MPS) and to fortify the energy reuse. The electrical machine configuration was further streamlined by the FEA in the temperature field, to locate the point of overheating under the ordinary operation condition and give direction to the cooling system. At last, it was finished up from the thorough field examination that the excess structure can enhance the effectiveness of the M/G and keep up the steadiness of the MPS, [14]. ESFAHANIAN et al. exhibited, outlined, demonstrating and reproduction of three crossover control trains. Presented based on power requirements

and design process for each stage in modelling process. Executing the part efficiency in each Powertrain is the most vital stage in the demonstrating procedure. The outcomes showed that the electric hybrid Powertrain has the most impact on the lessening of fuel utilization. The water driven half and half power prepare is suggested with respect to the creation costs and assembling intricacy, [16]. WEN et al. acquired the stress analysis of the flywheel rotor under rapid turn. They inferred greatest outspread anxiety area condition by Newton Iteration Method. They concentrated the impacts of the flywheel anisotropy degree and the symmetricity of the most extreme outspread stress area, [18]. RAMLI et al. dissected a half and half system with photovoltaic (PV) and diesel frameworks as the energy source. The investigation concentrated on the flywheel use and effect on power era, vitality and net present cost of specific sorts of half breed framework. Examination was gone up against fuel utilization and in addition carbon discharge diminishments for the framework arrangements in the paper, [21]. SPIRYAGIN et al. concentrated the instance of a run of the mill comprise of three coco diesel-electric trains, and considers replacing one unit with an option rendition, with a similar outline parameters, aside from that the diesel-electric plant is supplanted with flywheel energy storing gear, [17]. RUPP et al. examined the presentation of flywheel energy storing systems in a light rail travel prepare. Scientific models of driving cycle and flywheel energy storing system are created. Comes about recommend that greatest energy savings of 31% can be accomplished utilizing flywheel energy storing systems. The presentation of flywheel energy storing system in a light rail travel prepare can along these lines result in significant energy and cost savings, [26].

C. Reviews on Flywheel Optimization:

KRESS et al. managed the finding of dispersion of thickness along the radius of the midway bored flywheel. He made a worldwide shape advancement issue and a model in light of mechanical contemplations in Stodola's answer. The two are introduced in detail and the outcomes are analysed, [1]. YOON et al. adjusted and built up a control calculation for following issue when flywheel actuators are indeterminate. The calculation is connected to keep up the parameter estimations and maintain a strategic distance from parameter bursting. Calculative representations demonstrate that the controller manages the misalignments and obscure additions of flywheel actuators, [6]. HALLEY et al. considered that vitality recuperation frameworks had turned out to be material innovation for Formula 1.

The presence of mechanically-based rapid flywheel frameworks are giving race engineers expanded decision. Convolved in Motorsport Industry Association vitality proficient Motorsport activities and has assumed a key part in planning, developing and consolidating a mechanical Kinetic Energy Recovery System, [4]. KRACK et al. based on a diagnostic approach for finding stresses in multi-edge hybrid composite rotors; the nonlinear improvement issue was fathomed utilizing a multi-procedure enhancement design that consolidates a developmental calculation with a nonlinear inside point strategy. The issue was explained for an example rotor with a variable cost proportion of the edge materials. Rather than an ideal arrangement for every cost proportion, just four ideal outlines were acquired with a sharp transition between designs at particular cost proportions. This sharp transition is clarified by the perplexing interchange that exists between the objective function and the nonlinear imperatives forced by the connected failure criteria, [8]. KRACK et al. connected a scaling method; the multi-target design issue is diminished to the expansion of the energy per cost proportion as the single goal. Both an investigative and a limited component model were considered. Multifidelity methodologies were analysed to diminish the computational cost while holding the high precision and extensive displaying profundity of the finite element model. The computational cost was lessened to just a single third in contrast with utilizing just the finite element model. The advantages of the split-sort centre engineering were illustrated, [10]. RENSBURG et al. concentrated the past establishing's and recommended that there is opportunity to get better. Utilizing proposed issue detailing, flywheel rotors can be intended to get from the materials accessible higher energy density. Contributing minimal effort of the arrangement of flywheel and making it suitable for an extensive variety of uses, [15]. HA, et al. talked about three distinctive rim designs for a half and half composite flywheel utilizing advancement of quality proportion. Every occasion had diverse geometry, quality proportions and manufacture costs. One of the cases is effectively built by welding fibre and takes after press fit gathering, [11]. READ et al. introduced another logarithmic investigation that set up be utilized parameters of the flywheel system for regenerative braking application where the flywheel is utilized. This was connected to frameworks utilizing equipped transmissions with nonstop speed variety. The result was a harmony between high transmission and low framework mass and was shown for a passenger auto, [22]. HIROSHIMA et al. streamlined annular circles made up of carbon fibre strengthened composites

utilizing numerical computations and inspected two plate designs. They figured greatest burst tip speed for shifting thickness and most extreme vitality densities, including centre made of aluminium composite, [20]. JIANG et al. built up the shape advancement model of the flywheel by parametric geometry displaying technique with the target to boost the energy density of a flywheel rotor. Thus the declining simplex strategy is taken to take care of the nonlinear advancement problem in multidimensional space. In the long run, they got the advanced states of flywheel rotor which could essentially enhance the energy storing ability and working safety execution compared and the conventional plan flywheel of consistent thickness rotor, [25].

III. CONCLUDING REMARK

The literature reveals that performance and energy storage capacity for different geometry, material, techniques used by different researchers in their area of work. Flywheel like any other system used for energy storage can be further optimized. For this, the parameters like shape, design, geometry, cloth can be looked into and analysis is transmitted away to see the optimum flywheel design. The analysis done on the flywheel is important and necessary as it can help obtain the desired results in a short amount of time and at a reduced cost. It can also help compare different possibilities for a specific application of the flywheel. Recent flywheel designs are based on analytical structures derived from simulation results. Analysis and simulation of flywheel behaviour is a relatively new concept to the modelling done on flywheels. This can be of great assistance to specify the energy storage capacitance of the designed flywheel before actually developing one and thus can cut the cost expenditure if any faults are set up and can correct them. Thus we can conclude that the optimization of the flywheel is of extreme importance as it is an energy storage system with efficiency, higher compared to the other systems and possess a broad scope of application

IV. SCOPE OF THE WORK

- In automotive industries, the diligence of the flywheel is on a spacious plate.
- It can be evolved for better energy storage capacities for high end applications.
- Changing the parameter and different materials it can be optimized for better public presentation and a variety of applications.
- By studying more than one parameter we can further optimize the flywheel for more skilful application.
- One can also find a better combination of design geometry and material to obtain a

more optimized version of a specific application

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