

A REVIEW ON STUDIES ON TRIBOLOGICAL CHARACTERIZATION WITH OPTIMIZATION OF ALUMINIUM BASED WS₂ NANO COMPOSITE MATERIAL & ITS FABRICATION

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Abstract: — *The review work is dedicated to contribute the mechanical and physical properties, aluminium alloys possess wide potential in the automotive industry, particularly in hot reciprocating applications such as pistons for diesel and petrol engines. WS₂ particle-reinforced composites could bring further improvements by reducing friction and wear between moving parts. Reducing friction improves efficiency by lowering energy/ fuel use, ultimately leading to lower greenhouse gas emissions, while antiwear properties can prolong component life. This study compares for the first time the tribological performance of powder metallurgy-consolidated Al composites reinforced with either IF- or 2H-WS₂ particles, so as to elucidate their mechanism of action in test conditions similar to those encountered in engine applications.*

Keywords :— *Aluminium Alloy , Pistons, WS₂, Composites..,*

1. INTRODUCTION

Improving the efficiency of mechanical systems can be attributed to the consequence of overcoming friction. This has led to the Development of materials and techniques that reduce friction in various mechanical components in the industries such as aerospace, automobile, electrical and structural industries. Some potential solutions to reduce friction in such areas include development of (i) novel aluminum alloys and composites, (ii) advanced surface engineering techniques and anti-friction coatings and (iii) solid lubricant additives. The introduction of solid lubricant as additives to coatings, bulk aluminum alloys and composite materials is an emerging technology for reducing friction and thereby improving the mechanical efficiency. The desire in the engineering community to develop a new material with greater wear resistance and better mechanical properties, without much compromise on strength to weight ratio led to the development of metal matrix composites. Metal Matrix Composites (MMCs) have found noteworthy applications in almost all engineering sectors. Among various types of MMCs, aluminum is one of the most commonly used metal for the production of MMCs that has gained special interest in the field of automobile and aerospace industries. Al MMCs possess an Al alloy matrix and different material particle additions to modify the properties of the composite. Improvements in hardness, tensile strength, wettability, friction properties, wear resistance or load carrying capacity can be achieved, depending on the type of particle constituents [1–3]. The extent of the Improvements correspond to an application-specific optimal particle size [1,4] a uniform particle distribution in the Al matrix [1,2,5,6] and an adequate concentration [4,7-12]. The inferior tribological properties of pure aluminium, has led to ceramic particle additions such as SiC and Al₂O₃ to Al MMCs to increase the mechanical properties of the Al matrix [1,5,6,10]. But their addition leads to a high COF and their abrasiveness in the contact above a certain carried load [11]. To mitigate this aspect, particles such as graphite or tungsten and molybdenum dichalcogenides are added to reduce friction in tribological contacts due to the very low shearing forces between their weakly bonded layers of atoms. Thereby the development of Aluminium MMCs dispersed with solid lubricants is primarily directed towards overcoming the principle drawbacks of Aluminium as a tribological material. Tungsten disulfide, one of the novel materials, has shown excellent performance by reducing friction and wear in composites with different matrices and its

individual effect on aluminium metal, following press and sinter powder metallurgy route has not been evaluated yet. Further in applications involving vacuum or dry environments WS2 is known to perform better than graphite.

A. Aluminium Properties

It is a silvery-white, soft, nonmagnetic and ductile metal in the boron group. Aluminium is remarkable for its low density and its ability to resist corrosion through the phenomenon of passivation. Aluminium and its alloys are vital to the aerospace industry and important in transportation and building industries, such as building facades and window frames. The oxides and sulfates are the most useful compounds of aluminium. Aluminium composites containing a mixture of 3–5 wt.% 2H-WS2 and 5–20 wt.% SiC were shown to significantly reduce the COF and improve wear resistance in dry tests against hard materials such as steel. 2H-WS2 were also found to be flexible, due to their morphology, and cover the surface of the contact well. Although WS2 shows significant friction reduction and wear resistance when used as particle additions in MMCs, the major difficulty lies in the preparation of the composites. WS2 is reactive towards molten Al, and these types of MMCs were available only after the development of powder metallurgy processes, which require lower manufacturing temperatures. Controlling the temperature of the fabrication process is important in order to avoid the reaction of WS2 with the matrix before its operational use.

Table 1: Properties of Aluminium

PROPERTIES	Melting point	Young's modulus	Vickers hardness	Thermal conductivity	Boiling point	Density
Aluminium	933.47 K (660.32 °C, 1220.58 °F)	70 GPa	160–350 MPa	237 W/(m·K)	2743 K (2470 °C, 4478 °F)	2.70 g/cm ³

B. WS2 Properties

Tungsten disulfide (WS2) is a transition metal made up of WS2 sheets. These sheets are characterized by an S-W-S sandwich-like structure, in which the elements form a hexagonal crystal structure. WS2 presents a lower coefficient of friction and improvement in oxidation resistance and thermal stability, even for about 100°C above the well-known MoS2[13].

Table2: Properties of WS2

Properties	Melting point	Young's modulus	Vickers hardness	Thermal conductivity	Boiling point	Density
WS2	1250°C	70 GPa	160–350 MPa	237 W/(m·K)	2743 K (2470 °C, 4478 °F)	7.5g/cm ³

C. AISI 304 Stainless Steel Properties

Non-magnetic Alloy 304 is the most versatile and most widely used of all stainless steels. It has a lower carbon content to minimize carbide precipitation. Its characteristics are exceptional durability, toughness and corrosion resistance.

Table 3: Properties of AISI 304 Stainless Steel

Properties	Melting point	Young's modulus	Vickers hardness	Thermal conductivity	Poissons ratio	Density
AISI 304	673°C	193GPa	129MPa	16.2W/(mK)	.265	7.85g/cm ³

RELATED WORK

These deals with the study done by the various scholars on p solar MPPT, various algorithms few are enlisted as:

Rajyaguru Designed and simulated grid connected photovoltaic (PV) system using Matlab/ Simulink. This work aim to discuss the need to turn to solar photovoltaic source as it holds tremendous potentials to meet the increasing daily demand of energy. In order to solve the problem of climate change or global warming, renewable energy, especially solar PV system has to be given serious consideration. Study also showed that solar PV source is widely useful as it is pollution-free, maintenance-free and abundant in nature. **Mustafa** designed and simulated grid connected solar PV system using Maximum Power Point Transfer (MPPT) integrated grid-tie inverter. The concept of the work is to harness maximum power from solar module using maximum power point tracking scheme. Study also suggested implementation of solar photovoltaic system as intentional measure against greenhouse emission and other environmental effects of electricity production. The researcher also found out that only 20% of total solar radiation emitted is intercepted by the earth. **Menon and Madhumitha** designed and modelled solar micro inverter with multiple loads. The main idea is to emphasize the need to use smaller inverter ratings to ensure reliability and efficiency. The researcher also defined electricity generated from sunlight as solar electricity and the process of conversion from solar light into electricity as solar PV process. This energy so generated, the researcher found out, could solve power crisis in developing countries. In spite of dynamic nature of sunlight, energy produced by PV system is considered the most essential resources for renewable energy due to its sustainability and abundance of sun's energy. It was also found out in the study that panel temperature and energy from the sun determines electricity to be converted by solar module. **Deepansh and Thakur** did an in depth assessment of grid tie solar PV system of 1MW with respect to varied tilt angles. PVSyst software was used in simulation and analysis [7]. The researcher found out that normalized energy output from optimized angle which is approximately the same as the latitude of the location or close to the latitude of the location is more with corresponding increase in array losses. 4000 solar panels of 250Wp each and 30 units of 30kW and 5 units of 20kW grid tie inverters were used to develop the plant. It was also found that approximately 16% of generated energy was lost in the various subsystems. Study also showed that high ambient temperature significantly hinders PV system performance, in spite of abundance of solar resources. **Hung-I Hsieh et al** proposed system is to create Photo

Voltaic (PV) power pump constant with optimum Maximum Power Point Tracking (MPPT), which increase the PV operation and to transmit the outstanding PV energy for additional storage space in the beat break period. MPPT may be alternating to lose the track optimization. However, the proposed PV- Burp Charge System (BCS) not simply can formulate MPPT constant for mounting the PV utilization, but as well can transmit and store the residual PV energy for power saving throughout the pulse break time, achieve energy treasure and improvement conception. The idea of parallel charge three batteries by utilize direct renewable source create a new subject, which make it come accurate to realize the energy treasure and mending thought. **Kenji Iba, Ryuichi Yokoyama and Kaoru Koyanagi** described that constructing small power sources and consumed renewable energy from solar and wind sources would affect the power grid through fluctuation of power output and the deterioration of power quality. Therefore, a new social infrastructure to supply electric power would be required. Introduced and cluster-oriented expandable networks are discussed focusing on the resiliency of the grid against natural disaster.

2. PROBLEM FORMULATIONS

Recently, the availability of power in India has not just increased but also improved, although the demand consistently rose more than the supply. That's why non- conventional sources have become the center of attraction. Among these fast growing non-conventional sources the Wind energy system and solar photovoltaic system are very common. Now India has become fifth in installed capacity of both Wind and solar power plant. As of 30th September 2013 the installed capacity of Wind power in India was 19881MW. But, as the Wind is season and region based, it was not so reliable so we go for hybrid system of power generation. The above literature review shows the existing research resulting for photovoltaic system. Thus, the following problem topics still need further investigation: maximum power point tracker of the PV, the topology of the photovoltaic system, the power electronics interface, the voltage control and current control in island mode and grid connected mode. The single stage photovoltaic system is a cheap topology because it uses fewer components; costs less and weighs less. The DC/AC inverter handles the maximum power point and inverts the DC current into AC current. The goal is to operate the PV system at the maximum power point and at the same time to produce current with less harmonic distortion.

3. METHODOLOGY

The proposed work is based on the renewable source of energy and has been utilized for the stand alone purpose during failure of the main power grid. the Simulation idea of 100kW grid-connected solar PV system by utilizing MATLAB/SIMULINK. Solar array characteristics depend on the sunlight radiation and temperature these are in nonlinear nature its power is shifts consistently with climate evolving conditions. In this condition, MPPT is utilized to track the most extreme power from the solar array.

- ✚ The MPPT is used for maximum power from renewable sources.
- ✚ To calculate the current and voltage
- ✚ To check the efficiency
- ✚ PV arrays are implemented
- ✚ The proposed work in done mat lab Simulink

5. CONCLUSION

In this paper I have discussed about various reviews a 100 kW three-phase grid-connected PV power system model is presented, and the power control issues are studied in this paper. In this model, main components such as PV panels, a boost converter, inverter and utility grid are physically modeling for high-fidelity

simulation. Also, a PQ controller is presented and studied for grid-connection control. Simulation results demonstrate the effectiveness of this model and the controllers.

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