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Design and analysis of horizontal crystallizer for agro-chemical industries

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ABSTRACT

Crystallization is a process in which hot solution is allowed to cool in a shell to form crystals at the end of the process. Crystallization is predominantly used in chemical industries. In most of the industries vertical crystallizer are used for continuous crystallization. The proposed project is horizontal crystallizer used for batch crystallization. In this project we have tried to solve problem wherein blades were subjected to impact load and produced a greater number of vibrations in the crystallizer, due to which blades were failing at the location where blades were connected to the shaft end because of more stresses. Also, the blades will be subjected to elevated temperature for some period. To solve this problem some research about various types of agitators is available. Designing of two types of blades those are single helical blades and double helical blades has been done. These blades will be suitable for mixing viscous solution and these blades works on the principle of shearing the solution and pushing it. These blades will produce fewer vibrations as compared to pedal blades used in the industries. Static structural analysis and Steady State Thermal Analysis on blades as well as on Shell has been done. The Stresses and deformation pattern are produced within safety limits. After performing the Design and Analysis of Shell and Blades, a model which has a capacity of 440 Litres has been fabricated and the results are interpreted. The fabricated crystallizer is implemented in the chemical industry which is providing better crystals as compared with the already in use crystallizer.

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1. Introduction

When atoms or molecules are highly ordered into a structure known as a crystal, crystallization occurs, a solid is created. Precipitation from a solution, freezing, and, less frequently, direct depositions from a gas are a few processes that can result in the formation of crystals. The characteristics of the crystal that forms are greatly influenced by variables including temperature, air pressure, and, in the case of liquid crystals, the rate of fluid evaporation. Crystallization takes place in two main stages. The first is nucleation, which is the formation of crystals from a super-cooled liquid or a supersaturated solvent [1]. The second process, known as crystal growth, results in an increase in particle size and a crystallized state. It is crucial to note that during this stage, loose particles build layers on the crystal's surface and cling to exposed imperfections like pores and fissures. Most minerals and organic molecules crystallize easily, and the resulting crystals are generally of good quality, i.e., without visible defects. However, larger biochemical particles, like proteins, are often difficult to crystallize. The strength of either atomic forces (in the case of mineral substances), intermolecular forces (in the case of organic and biochemical substances), or intramolecular forces (in the case of molecules) substantially influences the ease with which molecules may crystallize (biochemical substances). Another method of chemical solid–liquid separation is crystallization, which involves the mass transfer of a solute from a liquid solution to a pure solid crystal. In chemical engineering, crystallization occurs in a crystallizer [2]. Crystallization is therefore related to precipitation, although the result is not amorphous or disordered, but a crystal [3]. The novelty of the project is that a new design of the horizontal crystallizer has been designed and the fabricated model is implemented in the chemical industry. The new design is efficient in producing good quality crystals (see Figs. 1-13).

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From Powders to Alloys: A Study of the Mechanical Alloying Process and Sintering

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Abstract

This study explores the intricacies of mechanical alloying, aiming to unlock its potential in modern engineering. It investigates the impact of milling duration, ball-to-powder ratio, and sintering temperature on the microstructure and mechanical properties of Al-7Zn-2.5Mg-2.5Cu alloy and Al7075 alloy. Mechanical alloying can produce alloys with exceptional hardness, strength, and ductility, while grain size can be controlled by adjusting milling parameters. Experimental techniques like X-Ray diffraction and transmission electron microscopy reveal microstructural changes during mechanical alloying, aiding in understanding metastable phases and element segregation, which influence the alloy's properties. Sintering, the subsequent consolidation step, determines final properties, with a trade-off between grain size and mechanical qualities observed at different sintering temperatures. This trade-off presents an intriguing avenue for developing materials with optimal properties. The study also explores potential applications of mechanical alloying across industries, including aerospace, biomedical, and energy. These unique mechanical alloys are attractive for various uses, from structural to catalytic and magnetic materials. They have the potential to revolutionize industries and drive technological advancements.

Keywords: *Ball to Powder Ratio, Mechanical Alloying, Mechanical Properties, Milling Duration, Sintering*

1.0 Introduction

1.1 Background

The demand for advanced alloys, exemplified by the Al-Zn-Mg-Cu alloy system, has surged due to their exceptional blend of strength, corrosion resistance, and low density, making them ideal for aerospace, automotive, and structural engineering applications. However, refining the microstructures and optimizing mechanical properties pose challenges, particularly in preventing coarse precipitates that can weaken ductility[1-5]. Innovative techniques like High-Pressure Torsion (HPT) and pre-stretching have been harnessed

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ORIGINAL CONTRIBUTION

Influence of Fiber Type on Electrical, Thermal and Mechanical Properties of Glass Fiber Reinforced Polymer Composites for Insulation Panel Applications

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Abstract The pursuit of crafting lightweight structures endowed with multifunctional properties has served as the impetus behind the initiation of this research endeavor. This manuscript elucidates an exploration into the intricate interplay between fiber orientation and multifaceted material properties encompassing electrical, thermal, and mechanical characteristics. The investigation entails the utilization of 2 distinct types of reinforcement—chopped strand mat (CSM) and woven roving (WR)—integrated within an epoxy matrix and synthesized through compression with a pressure of 200 kg/cm^2 molding facilitated by thermal induction at 160 °C, for a duration of 90 min. The findings from the electrical and thermal analyses revealed superior electrical resistance and heightened thermal resilience for CSM composites, exhibiting a degradation temperature of 300 °C and a notably low thermal conductivity of 0.045 W/mK. Contrastingly, under tensile conditions, the WR composite demonstrated a brittle nature, registering at 280 MPa, while the CSM counterpart exhibited ductile behavior, yielding 225 MPa. Moreover, the flexural properties of the CSM composite showcased a staggering 200% increase in comparison to the WR composite. Collectively, these results extrapolate that CSM composites possess superior potential as insulation panels for requisite applications owing to their commendable performance in thermal, mechanical, and electrical domains.

Keywords Woven roving · Chopped strand mat · Thermosetting composites · Thermosetting polymers · Fibrous polymers · Testing

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Introduction

Composite materials offer significant advantages over steel, including reduced weight, comparable or better stiffness and strength, and corrosion resistance [1]. In the electrical industry, composites have been increasingly utilized in applications such as bushings, circuit breakers, and coupling capacitors [2]. The design parameters for structural and electrical composites differ due to distinct property requirements. Low density, high strength-to-weight ratio, and desirable dielectric properties are sought after in electrical applications [3]. Incorporating fibrous reinforcements in polymer matrices enhances mechanical and electrical properties [4]. Superior mechanical and dielectric properties, such as high dielectric constant and low dielectric loss, are crucial for electrical devices. The dielectric property is important in designing effective insulation systems [5–7].

In pursuit of an innovative material solution for insulation panels, composite structures comprised of glass fiber, epoxy, polyacrylonitrile nanofibers, silica aerogel, and stone