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Bio-Waste as an Enhancement Additive for Nano-Flux Powder in Welding- An Overview

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Abstract. Oxyacetylene welding is quite a novel technique of connecting metals with each other that was developed to address the drawbacks of other welding techniques. The use of chemical compounds known as fluxes in the welding process does this, resulting in improved weld characteristics and increased weld depth. Recently, the use of agro-wastes as alternate fluxes has received keen interest from researchers. This is partly because agro-wastes recycling facilitates cleaner environments and could be cheaper. In this study, a critical review was carried out on some particular types and properties of welding. The review also considers the assessments carried out on welded joints and the use of agro-waste.

1. Introduction

Welding is a fabrication process of coupling materials especially metals through melting the metal piece with the aid of a filler substance to produce a molten weld pool. The welded portion is covered with a welding flux [1]. It's a chemical that removes oxide impurities from welds and absorbs pollutants from slag.

The flux activator is used to reduce the material's corrosive influence at room temperature and elevate the job's temperature to a specific level [2].

Sometimes, pressure can be used alone or in like manner with heat. Oxidation bound to occur during welding, to prevent this a filler material as a shield is required to the molten metal from contamination. Welding can be carried out with oxygen-acetylene flame, arc, laser, electron beam, friction, and ultrasound [3]. This can be carried out outdoors, below the surface of the water, and space Welding is a process that involves joining two or more materials by heating and applying pressure. This procedure is associated with various hazards such as destruction by the action of heat, electrocution, sight impairment, breathing in

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poisonous gaseous substances and smoke, as well as being open to ultraviolet emission [2]. Historically, the only welding technique available was forge welding, which was utilized by workers in metals to connect iron and steel by making them hot and striking [4]. With advancements in technology, the late 1800s saw the introduction of arc and oxy-fuel welding, followed by electric resistance welding [2]. In the early 1900s, welding technology rapidly evolved as the demand for cost-efficient and reliable joining methods increased [4]. Subsequently, various current welding procedures were produced post-wars, comprising processes done by hand like shielded metal arc welding and automated techniques like gas metal arc welding, submerged arc welding, flux-cored arc welding, and electroslag welding [5]. Over the ultimate mid-20th century, laser beam welding, electron beam welding, magnetic pulse welding, and friction stir welding were developed. Today, robotic welding is increasingly common in industrial environment, and ongoing research continues to improve welding techniques in addition to enhancing weld quality [5].

Currently, various welding methods are utilized to unite metals, including: Gas Tungsten Arc Welding (GTAW), Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW), Submerged Arc Welding (SAW), Flux Cored Arc Welding (FCAW), Electron Beam Welding (EBW), Electro Slag Welding (ESW), and Laser Beam Welding (LBW) [1]. Arc welding has become a widely acknowledged welding standard, and the parameters that regulate it have been changed to create a number of varieties employed in industry [6]. The primary principle of GMAW, SMAW, GTAW, FCAW, and Autogenous TIG welding is to create an electrical arc by the the joint action of the electrode and the workpiece, and then use the heat produced to melt a welding wire or fuse the workpiece together without utilizing a welding wire [1]. Welding fluxes, which vary from oxides to fluorides, can significantly improve the welding operations' characteristics. Welding fluxes are chemicals that better the weld characteristics of a weld joint in the course of being utilized. They are deployed to join different ferrous and non-ferrous metals in a number of welding methods, including GMAW, GTAW, and plasma arc welding (PAW), laser beam welding (LBW), and EBW [2]. Among several forms of welding used in this project, TIG welding is the most crucial, also called Gas Tungsten Arc (GTA) welding, is a procedure of combining metal parts applying heat generated through an arc formed betwixt the work to be combined and a non-replaceable Tungsten electrode [4]. This was designed in the earliest part of 1940s in Southern California by Russell Meredith. The Northrop aviation industry required a means to mix magnesium and aluminium that prevalent welding procedures couldn't handle at the time. The purpose was to allow airplane makers to cost-effectively combine light metal alloys used in airframe production while achieving first-rate welds, setting it as a model for welding fuselage. It is widely utilized industrially to connect ferrous and non-ferrous metals. It yields an even pure weld that may be completed from any welding location [7]. When high-quality welds are required, it is a reliable procedure due to the effect of the shielding gas on the weld pool. It was approved for the welding heat exchanger components in various industrial sectors, including nuclear, aeronautics, and shipbuilding. It may be used with or without filler metal to generate dense segment welds, as well as autogenous welds [3]. TIG welding, is associated with a number of disadvantages that limit its application in the industry, including low weld penetration in a sole pass and high priced as a result of the requirement for special preparation and the need for extra welding wire to fill up the welds [7]. Some of the challenges that can develop when using TIG welding are as follows: Because it cannot bring about profound penetration joints, the workpiece must be smaller than 3mm in diameter in order to be joined reliably. For workpieces thicker this, joint edge preparation and several passes to fill in the joint were required [3]. Welding tools having denser cross-sections together involves combining decreased welding velocities and numerous-pass soldering procedures, which results in the welding pool growing too wide and having a modest rise in weld penetration as weld current or travel velocity falls, resulting in low productivity. The cost of edge preparation and the extra time needed to execute the many passes required to fill the joint are additional expenditures connected with this procedure.

2. Types of Welding

2.1 . Shielded Metal Arc Welding (SMAW)

In welding processes, shielding gases are utilized to guard the welding area from oxygen and water vapor. The most common welding methods utilizing shielding gases are Gas Metal Arc Welding (GMAW) and Gas Tungsten Arc Welding (GTAW), also called Metal Inert Gas (MIG) and Tungsten Inert Gas (TIG) [4]. The selection of shielding gases is crucial as the presence of ambient gases during welding may negatively affect weld quality or make welding difficult, depending on the materials being joined [2]. For Shielded Metal Arc Welding (SMAW), the electrode is concealed in a flux that generates carbon dioxide, which acts as a partially inactive shielding gas suitable for welding steel [2]. Unsuitable selection of shielding gases results in poor weld quality, including porosity and weakness, and excessive spatter, which decreases productivity by requiring additional cleanup. Moreover, the incorrect use of shielding gases can lead to oxygen deprivation and result in hypoxia and death [4].

2.1.1 Properties of Shielded Metal Arc Welding

In welding, the attributes of shielding gases play a crucial role in ensuring a quality weld. Key attributes include thermal conductivity and heat transmission, density compared to air, and smooth ionization [8]. Heavy gases such as argon provide effective shielding and need reduced flow rates compared to lighter gases like helium [8]. The heat transfer capability of shielding gases is essential for heating the surrounding area of the arc. The ionizability of an arc determines the ease of starting an arc and the voltage required [8]. Shielding gases can be used individually or in combination with two or three different gases for protection. In laser welding, it prevents the formation of plasma above the weld, which could absorb a significant portion of the laser energy, especially useful for CO2 lasers [8]. The ionization capacity of Helium makes it a suitable gas for this purpose as it can absorb a significant quantity of energy prior to ionizing [8]. Argon has the highest frequency of usage as a shielding gas and also employed as a foundation for more technical gas mixtures [2]. Carbon dioxide is cheapest shielding gas, but its use may negatively impact arc stability and increase spatter [2]. A mixture of carbon dioxide (1-2%) and argon is commonly used to minimize the surface tension of the molten metal, while a mixture of 25% carbon dioxide together with75% argon is popular for GTAW [2]. Helium requires higher flow rates as it is lighter than air [8]. It is a non-reactive gas with excellent heat conductivity, but ionization is difficult, thus requiring a higher voltage to start the arc. For aluminum, magnesium, and copper alloys, a greater ionization ability leading to a hotter arc, larger voltage, and a wider, deeper bead, which is desirable [8]. Other gases may also be used in specific welding applications. Helium mixtures having 5–10% argon and 2–5% carbon dioxide can be deployed in the welding of stainless steel (known as "tri-mix"). Other non-ferrous metals, like aluminum and other non-ferrous metals, are also utilized, particularly for thicker welds. Helium produces a more energetic and reduced stable arc than argon. Helium as well as carbon dioxide have been utilized as shielding gases right from World War Two. In carbon dioxide laser welding, helium serves as a shield gas. Because helium is costlier than argon and demands larger flow rates, it might not be the most profitable alternative for large quantity manufacturing, despite its advantages. Steel isn't heated with pure helium because it creates an unexpected arc and makes spatter more likely. Small amounts of oxygen are mixed with other gases; for example, 2–5% argon is mixed with oxygen [8]. By reducing molten metal surface tension and increasing solid metal wetting, it increases arc stability [9].It can be used to spray transfer weld mild carbon steels, low alloy steels, and stainless steels. Because it exists, the degree of slag created grows. Blends of argon-oxygen (Ar-O2) and argon-carbon dioxide (Ar-CO2) are widely used in place of Argon-oxygen (Ar-O2). Also used are mixtures of argon, carbon dioxide, and oxygen. Welding aluminum, magnesium, copper, and some unusual metals is not recommended because oxygen causes the weld to oxidize. Insuffcient deoxidizers in the electrode gives rise to higher amount of Oxygen which leads to the electrode being oxidized by the shielding gas, causing porosity in the sediment [9]. Brittleness in the heat-affected zone can be caused by too much oxygen, principally when used in non-prescribed applications. Because of the requirement of low carbon content in the weld for austenitic stainless steel, argon-CO2 cannot be utilized, argon-oxygen mixtures with 1–2% oxygen are employed; the weld possesses a rough oxide layer and may actually involve cleaning. Hydrogen welding is put to use in joining nickel together with stainless steels, mainly denser segments. It enhances molten metal fluidity as well as surface cleanliness [9]. It is commonly added to argon in concentrations of less than 10%. In argon-carbon dioxide mixes, it can be utilized to reduce carbon dioxide's oxidizing effects. Its presence reduces arc width while increasing arc temperature, resulting in improved weld penetration. It can be used at greater concentrations to fuse conductive materials like copper (up to 25 percent hydrogen). It must not be used on either steel, aluminum, or magnesium since it has the ability to create porosity and hydrogen fragility; instead, it should be used on stainless steels. Ozone production is reduced by adding nitric oxide. It can also aid to maintain the arc stable while welding aluminium along with high-alloyed stainless steel [9].

2.1.2 Applications of SMAW

In welding applications, the price of the shielding gas, facilities and site are major constraints to consider. Factors such as the type of gas, cost, and availability can impact the choice of welding technique, with less expensive options like shielded metal arc welding being preferred in some cases. The use of shielding gases may also be limited to indoor settings with controlled surroundings and atmospheric gases inhibited from penetrating the welding zone. The required shielding gas flow rate is influenced by several variables, including weld shape, speed, current, gas type, and metal transfer mode. For instance, flat surfaces require a higher flow rate than grooved surfaces, and faster welding speeds require more gas. The flow rate also varies among the four main types of gas metal arc welding (GMAW), with short-circuiting and pulsed spray modes typically requiring 10 L/min and globular transfer requiring about 15 L/min for optimal coverage. Additionally, helium requires a higher flow rate compared to argon.

2.2 Process of Coating

The process of coating can be achieved by various techniques. The use of sacrificial coating according to a research work involves placing the substrate in a solution which was carried out in an industrial firm. The substrate was deposited in acid and was made free from grease substances before it was deposited into the plating solution. Ion Vapor Deposition is also another process of coating which is usually performed in a vacuum deposition chamber [10]. There are many techniques to achieve the molecular/atomistic deposition on a substrate: chemical vapor deposition (CVD), physical vapor deposition (PVD), electro-less plating, electroplating, plasma-enhanced CVD, laser vaporization and others [6]. Physical vapor deposition (PVD) are generally used in coatings and thin film fabrication. Industrially, physical vapor deposition has been combined with other various methods of producing coating which possess higher properties [3]. According to the operating environment,

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physical vapor deposition processes are further divided into ion plating, ion-beam assisted deposition, sputter deposition and vacuum operation. 1-10nm/s is the typical physical vapor deposition rate [6]. In chemical vapor deposition (CVD) solid materials which possess high quality and performance are produced in a vacuum. Chemical reactions take place between halide compounds and organometallic are later deposited to other gases to produce solid thin films on substrates. The thin films are nonvolatile [10].

2.2.1 Durability and Performance of Coating

Coating durability is influenced by a couple of factors. Structure condition as one of these factors determines some properties of the final result. For instance, a metal that is about to be coated should be free from existing coating otherwise the coating that will be applied to the metal will bond to the old coating which can prevent it from adhering properly to the underlying metal. The metal should also be free from rust before being coated. Another factor is the environmental condition during application and during service. Temperature and humidity are the main concerns. Adhesion is affected by high humidity while very high temperatures can make the coating dry too quickly. Very low temperatures can be an issue as well because it can lead to the coating not drying at all or drying too slowly. The quality of the coating is another factor which cannot be neglected. High quality coatings have higher contents of solids that form a coating of greater thickness and add a binder element which helps in achieving good adhesion [11]. The performance of coating is affected by factors such as wear resistance, hardness, thickness, impact resistance, porosity, ductility and corrosion resistance.

2.3 Tungsten Inert Gas (TIG) Welding

The Gas Tungsten Arc Welding (GTAW) method, also known as Tungsten Inert Gas (TIG) welding, utilizes a non-consumable tungsten electrode to create the weld [10]. Inactive shielding gas, such as argon or helium, is employed to protect the weld region and electrode against oxidation including other impurities. While a number of welds, like endogenous or fusion welds, don't demand filler metal, it is often used. The use of helium in welding is referred to as heliarc welding. A steady-current welding power source supplies current that is transferred towards the arc via a plasma frame, a column of extremely ionized gas in addition to metal vapors [10]. GTAW is mainly employed in welding small portions of stainless steel along with non-ferrous metals like aluminium, magnesium also copper alloys.

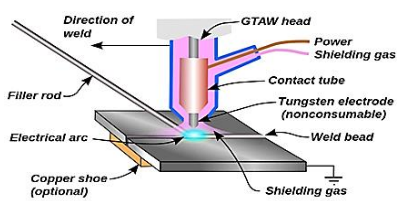

Figure 1: TIG Welding Setup Source: [10]

It offers the worker more command over the weld compared to alternative methods like shielded metal arc welding and gas metal arc welding, resulting in tougher and better-quality welds. Though, GTAW is also more intricate and challenging to control and slower than other welding methods. Plasma Arc Welding, a similarly automated technique which employs a somewhat different welding flame to form a further concentrated welding arc, is another alternative [10].

2.3.1 Safety in Gas Tungsten Arc Welding

In (GTAW), welders are required to wear appropriate protective clothing such as light gauntlet and high collared long sleeve shirts to minimize predisposition to intense (UV) radiation [4]. The brightness of the arc in GTAW can pose a risk to the operator, including arc eye and injury to the skin , due to the lack of smoke in the process which results in a brighter arc compared to stick welding or shielded metal arc welding. To protect their eyes and skin, welders put on opaque helmets having black eye lenses and complete head and neck covers. The helmet may also feature a self-darkening liquid crystal-type face plate. To protect others from UV radiation, see-through welding curtains constituting polyvinyl chloride plastic film are frequently deployed [10].

In addition to UV radiation, welders are open to hazardous gases and particles generated by the welding action, such as ozone and nitric oxides. Although the levels of these gases may be low, the duration with rate of openness, combined with the grade and amount of smoke obtained and change in circulating air, must be observed to prevent health hazards such as emphysema, pulmonary oedema, and ozone burn [4]. Furthermore, toxic fumes may be generated during cleaning and degreasing of objects due to the heat from the arc. These cleaning processes should be conducted away from the welding site and with proper ventilation to ensure the safety of the welder.

2.3.2 Applications of Gas Tungsten Arc Welding

In the engineering field, gas tungsten arc welding (GTAW) is utilized for welding diverse substances, particularly nonferrous metals, in multiple industries. It is widely applied for welding thin workpiece, especially in the aerospace industry, as well as in the bicycle industry for small-diameter, thin-wall tubes. Additionally, the method is commonly used in space vehicle manufacturing and in making root or first-pass welds on assorted pipe proportions. GTAW is also frequently employed in servicing and rehabilitation tasks for repairing implements and dies made of aluminium and magnesium [10].

The GTAW process offers a wide range of options for welding filler metals since the electric arc does not carry the weld metal. This feature allows for welding a broad array of alloys in diverse product designs, which is not possible with most open arc welding processes. The GTAW method also eliminates the loss of filler metal alloys, for example elemental aluminium together with chromium, by means of volatilization, unlike other welding methods [10].

2.3.3 Welding Torch

In GTAW, the torches arrive with either air or water cooling devices and are designed for manual or automatic function. The hand operated torch features a handle, whereas the automatic torch has a mounting rack. The head angle, which is the angle between the center line of the handle and the center line of the tungsten electrode, is adjustable on a number of hand operated torches according to operator's choice. Air cooling is typically utilized for low-current operations to the tune of (200 A), on the other hand, water cooling is necessary for high-current welding to the tune of (600 A). The torches are linked to the power source through cables along with the shielding gas source and, if adopted, the water source through hoses.

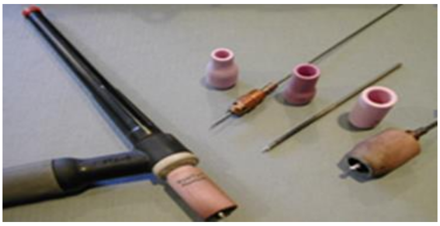

Figure 2: Welding Tourch Source: [10]

2.4 Activated Flux TIG Welding (A-TIG)

In order to enhance the conventional TIG welding process, the (A-TIG) welding method was developed. In 1960, the Paton Institute of Welding developed a specialized welding technology referred to as Flux Zone Tungsten Inert Gas (FZTIG) welding. The A-TIG process involves applying a thin film of active influx onto the surfaces to be connected prior to the TIG welding operation. The heat generated during this process melts the flux, resulting in increased TIG welding penetration depth.

2.4.1 Properties of Activated Flux TIG weld

The performance of A-TIG welding was explored by Bhawandeep and Avtar [11], who employed it to weld mild steel plates. Cr203, MgCOa, MgO, Ca0, and AlO were among the fluxes studied. The CrOs flux had the greatest impact on weld penetration, however, the MgCO3 flux had the least. A Vickers hardness test revealed that employing fluxes improved weld quality. [10] created a flux powder for welding DMR-249A Shipbuilding Steel and investigated the mechanical properties of the welded joint. They discovered that penetration is determined by the flux's combined content of oxygen and silicon. They also discovered that adding fluxes improved the quality of the weld, which was validated through the Vickers hardness test [10]. proposed a flux depth, which requires optimizing silicon and oxygen concentrations to obtain maximum penetration depth. A 3mm air gap, 60 mm/min torch speed, also 270 A weld current were used to discover an utmost penetration of 7.8 mm.

2.5 Oxy/Acetylene Welding

This welding method involves the combustion of oxygen and acetylene gases to create a high-temperature flame. The flame temperature can be controlled by adjusting the oxygen to acetylene ratio through the torch or blowpipe valves. The resulting flame temperature is around 3,200°C and is used for welding and cutting operations. [4].

2.5.1 Parameters Affecting the Weld

Controlling the weld process requires a thorough understanding of these factors and the weld quality that results. Understanding these factors and the weld quality produced as a result is critical to controlling the weld process. Welding parameters determine penetration depth, process productivity, and the effect of activating flux. Weld parameters are a set of rules that govern the appearance and characteristics of a weld. Torch speed, electrode gap, welding current, welding voltage, electrode diameter, work piece material, and shielding gas are just a few of these variables to consider [12]

3. Bio-Waste as Enhancement

3.1 Coconut Shell

Coconut shell is a type of agricultural waste that can be found in tropical areas all round the world. In certain places, coconut shells are burned openly, contributing considerably to CO2 and methane radiation. They are universally used to produce charcoal which makes for 25–30% composition dry weight of shells used in the traditional pit method of production. This technique yields a range of quality charcoal, which is frequently contaminated with foreign materials and soil. The pit method produces smoke that is both nuisance and dangerous to health [13]. The calorific value of the coconut shell is 20.8 MJ/kg, which is high thus making it suitable for producing steam, bio-oil, energy-rich gases, charcoal, and other products. The shell is a solid fuel with advantages such as low ash content, high volatile matter content, and cost-effectiveness. Additionally, the high fixed carbon content in coconut shells results in the production of premium solid waste that can be useful in the treatment of wastewater as activated carbon. Furthermore, coconut husk equally has an appreciable calorific value of 18.62 MJ/kg, due to its remarkable composition of lignin alongside cellulose. This fuel source is abundant in areas where coconuts are widely used for food processing and is often utilized as a direct fuel source or converted into charcoal. With low cost and widespread availability, coconut husks have the potential to be used in power plants as a substitute for traditional fuels like wood [13].

Coconut (Cocos Nucifera) is a widely cultivated agricultural commodity with various uses, including food and cosmetics. It is grown in approximately 90 countries with a whole tilled land of 14.231 million hectares and an annual production of 11.04 million tonnes (MT). The nations leading in global coconut production are: India, Philippines, and Indonesia, accounting for 19.20%, 23.91%, and 25.63% respectively [13]. Cocos nucifera belongs to the family of Arecaceae and is commonly referred to as coconut or coco [14]. Though the coconut originated in Malaysia, Indonesia, and the Philippines which are in Southeast Asia including the islands located between the Indian and Pacific Oceans, it has dispersed around the world and is a significant produce in many nations namely: Sri Lanka, Indonesia,Vietnam Philippines, Thailand, Tanzania, Mexico, Brazil and India. The coconut tree is a monocotyledonous tree that grows to be about 25 meters tall with a dense canopy, an unbranched stem, and a fasciculate root. It also has pinnate leaves with a rachis, petiole, and leaflets that look like feathers. When the conditions are ideal, an adult coconut tree can produce 12-14 bloom spikes per year [15]. India produces the most coconuts per country (21.665 billion nuts), with Indonesia (16.354 billion nuts) and the Philippines (3.35 billion nuts) following closely behind (14696 million nuts). The volume of coconut produced internationally has expanded substantially, as has the volume of coconut debris (coconut shell) produced globally. The two major byproducts of the coconut shelling process are coconut shell and husk. A core waste matter obtained from the consumption of coconut is coconut shell which makes up 60% of domestic waste and causing severe dilemma in the local environs as regards its riddance [15].

3.1.1 Properties of Coconut Shell Powder

Madakson et al [16] explored the potential for coconut shell ash to be used in MCs for automotive applications. Metal matrix Composites (MMCs) are composites that are made by mixing metal alloys with an organic component to improve the metal matrix's properties over an unreinforced alloy. Damping capacity, wear resistance, specific strength, and specific modulus are among the qualities that have been improved. The coconut shell ash was made by pulverizing dried coconut shells and then burning it in an electric resistance furnace at 1300 degrees Celsius. Particle size analysis, density measurement, refractoriness test, mineralogical characterization using X-ray diffractometer and spectrometer (XRD and XRF, respectively), microstructural analysis, also Fourier transform infrared spectroscopy were among the experiments performed on the ash. It was found that, the particle sizes fall within 63um, 125um, 180um and 355um size fractions, with the coconut shell ash having a density of 2.05g/cm3 with a maximum refractory temperature of 1500°C, the XRD analysis revealed that SiO2 is a major constituent of the ash and all these elements Zn, C, Mg, Al, Fe, K, NA, O, Si" Fe are present in the ash, the XRF analysis confirmed this and exposed the existence of elements like MgO, Fe2O3, SiO2 and Al2O, as major elements and FTIR graphs disclosed that Mullite, Quartz and Vitreous, carbon states were found in coconut shell ash powder and the usage of coconut shell ash in MMCs as particulate reinforcement was proposed [16].

The elemental and proximate composition of coconut (Cocos nucifera) shell was discussed by Ewansiha et al [17]. They discovered that the coconut shell was made up of 0.46 percent crude protein, 2.14 percent crude fat, 2.28 percent ash, 10.10 percent moisture, 32.39 percent crude fiber, and 56.63 percent carbohydrate, while its elemental composition or components were calculated using the proper analytical tools and found to be 1.22 mg/100g Mg, 0.76 mg/100g Na, 1.20 mg/100g Zn, 3.30 mg/100g K, 6.0 mg/100g Mn, 11.64 mg [17].

conducted a preliminary investigation of SP involving its physical and chemical properties for use as a concrete filler. Shredded coconut shells were collected and processed to a fine powder, which was then subjected to a range of tests, including density, X-Ray Fluorescence (XRF), Particle Size Distribution, and Scanning Electron Microscopic analysis. The chemical and physical properties of the coconut shell were determined with the aid of scanning electron microscopy (SEM) and specific gravity. The elements with the highest detectable percentages were C and K203, which were 10.0 percent and 1.21 percent, respectively, according to the XRF. About 1% of the total was made up of the new components found in CSP. The percentage of silicon oxide in concrete is 0.98 percent, which is a critical ingredient in the mixing process. The coconut shell powder was found to include particles with diameters of 600um and below, with the majority of the particles being smaller than 150um, which is required for its usage as a filler in concrete, using the sieve analysis method [18].

Mohamed et al. [19] investigated whether coconut shell powder together with coconut shell activated carbon composites might be used as electromagnetic interference absorption materials. In this work, basic materials such as coconut shell powder (SP) with coconut shell activated carbon (SAC) were combined with an amine hardener and an epoxy resin composite to capture microwave signals with frequencies ranging from 1 to 8 GHz. The carbon content of the primal matter was analyzed using CHNS Elemental Analysis to investigate their use as EMI absorption materials. The TM3000 Scanning Electron Microscope (SEM) investigated the surface structure of the raw materials, also, the complex permittivity of the composites was evaluated with the aid of high temperature dielectric probe jointly with the Network Analyzer.

3.2. Egg Shell

The disposal of large quantities of eggshell waste generated worldwide annually presents a challenge as most of it ends up in landfills, leading to odors and promoting microbial growth. However, the transformation of this biowaste into new, value-added products can offer significant environmental and economic benefits [11]. A simple and sustainable method was developed to synthesize hydroxyapatite from eggshell biowaste, which was then utilized for the elimination/removal of Co2+ from aqueous solutions. Batch studies were conducted to evaluate the influence of contact time and initial metal concentration on the removal efficiency, while X-ray diffraction and scanning electron microscopy analyzed the results. Equilibrium was achieved within 80 minutes since the process was fast with removal effectiveness of 70-80%, surpassing other waste-derived adsorbents. The removal mechanism involved adsorption of CO2+ on the surface of the hydroxyapatite particles and ion interchange with Ca2+, leading to the formation of a Co-phosphate. The conversion of eggshell waste into a low-cost adsorbent for the remediation of metal-polluted waters may help in managing this biowaste in a more sustainable manner. In the food processing sector, managing the massive amounts of waste generated is a daunting task. The circular economy concept is based on the 3R principles (reduce, reuse, and recycle), which can transform waste into valuable resources, leading to improved sustainable development and waste management practices [16].

In the food processing sector, eggshell is a distinctive example of product-specific waste with usable portions still present. By 20305–7, global egg output will have increased to almost 90 million tons. Because eggshells are considered useless, the vast majority of this trash is discarded in landfills without being converted into valuable products. However, the management of this waste necessitates appropriate techniques that take into account rising disposal prices, environmental considerations such as pathogen propagation risk, disagreeable odour, and disposal site availability [15]. The proper disposal of large volumes of eggshell waste generated globally presents a challenge as it is typically discarded in landfills, leading to potential odor and microbial issues. To address this issue, transforming eggshell waste into value-added materials has been recognized as having significant benefits environmentally and economically. The utilization of eggshell waste as a starting material for the synthesis of hydroxyapatite was proposed as a sustainable and efficient method for removing heavy metal ions, such as Co2+, from aqueous solutions. The process was characterized using X-ray diffraction together with scanning electron microscopy, displaying high removal effectiveness of 70-80% in a short time frame of 80 minutes. The transformation of eggshell waste into a low-cost sorbent material could provide a more viable and efficient approach to managing this bio-waste [20].

Additionally, eggshell waste is classified as hazardous by the European Union, making it imperative to seek alternative methods for utilizing it. The composition of eggshell includes 94% calcium carbonate ($CaCO_3$), 1% magnesium carbonate ($MgCO_3$), 1% calcium phosphate ($Ca_3(PO_4)_2$) and organic matter, also, it represents approximately 11% of the whole weight of an egg [11, 21]. To this end, repurposing eggshell waste into various applications can benefit both the environment and the economy, encompassing the utilization of eggshell as a biological model for catalysis and antimicrobial applications, food additives, in addition to soil conditioners, cosmetics, pure calcium carbonate, as well as biomaterials. The utilization of eggshell as a starting material for hydroxyapatite production can also reduce the dependency on natural phosphate rock for water remediation [22-23].

4.0 CONCLUSION

The use of bio-oil as an enhancement additive for Nanoflux powder in welding has been reviewed in this study. The following conclusion has been reached based on the findings of this review

i. The use of Nanoflux as an additive during welding could be helpful in strengthening the welded joints.

ii. Agrowastes like coconut and egg shells are viable materials for development of Nanoflux powder.

iii. The use of these Agrowastes as alternatives to conventional flux powder could possibly produce joints with superior weldments.

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