APPLICATIONS OF WELDING METHODS IN MANUFACTURING TECHNOLOGIES

KAYNAK YÖNTEMLERİNİN İMALAT TEKNOLOJİLERİNDEKİ UYGULAMALARI

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Özet

Kaynak, malzemelerin kaynak bölgesinde ısı ve/veya basınç yardımıyla ilave malzeme kullanarak veya kullanmadan birleştirilmesidir. Kaynaklı yapı elemanlarının imalat amacı, mümkün olan en düşük maliyette imal edilmesi, fonksiyonunu tam olarak yerine getirmesi ve işletmede uzun süreli kullanılmasıdır. Kaynakta, kaynak bölgesinin özelliklerinin ve birleştirilen parçaların tüm konstrüksiyona etkilerinin önceden belirlenmiş koşulları sağlamış olması gerekir. Kaynak, malzemeleri, genellikle metalleri veya termoplastikleri, parçaları bir arada eritmek için ısı kullanarak ve iki parçayı birbirine soğutan ve bağlayan bir erimiş metal birikintisi oluşturmak için bir dolgu malzemesi ekleyerek birleştiren bir imalat işlemidir. Kaynak, perçinleme ve cıvatalama gibi diğer birleştirme yöntemlerine göre çeşitli avantajlar sunan çok yönlü ve yaygın olarak kullanılan bir imalat işlemidir. Güçlü ve dayanıklı bağlantılardır. Kaynak, iki veya daha fazla malzeme parçası arasında güçlü, sürekli bir bağlantı oluşturabilir. Ortaya çıkan kaynak genellikle ana malzemenin kendisinden daha güçlüdür ve bu da onu strese ve yorulmaya karşı oldukça dayanıklı kılar. Bu, yapısal bileşenler, köprüler ve boru hatları gibi güç ve dayanıklılığın kritik olduğu uygulamalar için kaynağı ideal bir seçim haline getirir. Kaynak bağlantısı genelde metallerin birleştirmek için kullanılır. Kaynak, çeşitli imalat endüstrilerinde çok çeşitli ürünler için güçlü, dayanıklı ve sızdırmaz bağlantılar oluşturmada önemli bir rol oynayan çok önemli bir imalat yöntemidir. Otomobillerden havacılık bileşenlerine kadar karmaşık yapıları birleştirmek ve zorlu koşullar altında bütünlüklerini sağlamak için kaynak teknikleri kullanılmaktadır. Otomotiv sanayi, havacılık ve uzay sanayi, inşaat sanayi, gemi inşa sanayi, basınçlı kap imalatı, boru hatları inşaatı, demiryolu sanayi kaynak teknolojilerinin yoğun olarak kullanıldığı endüstri alanlarıdır. Genel olarak kaynak, diğer birleştirme yöntemlerine göre çok sayıda avantaj sunan çok yönlü ve avantajlı bir imalat işlemidir. Gücü, dayanıklılığı, çok yönlülüğü ve ekonomik olması onu geniş bir uygulama yelpazesi için ideal bir seçim haline getirir.

Anahtar kelimeler: Kaynak Yöntemleri, İmalat Teknolojileri, Makine Mühendisliği.

Abstract

The process of uniting materials in a welding area with the use of heat, pressure, and/or other materials with or without their use is called welding. The goal of welding structural parts during manufacture is to it is cheaply made, completely functional, and has a lengthy operational lifespan in the business. When welding, several requirements must be met regarding the characteristics of the welding region and how the linked pieces affect the overall construction. By using heat to melt the components together and adding a filler material to generate a puddle of molten metal that cools and ties the two pieces together, welding is a manufacturing method

that unites materials, most often metals or thermoplastics. Comparing welding to other connecting techniques like riveting and bolting reveals various benefits. Welding is a flexible and popular industrial procedure. These are robust and long-lasting bonds. A robust, continuous junction between two or more pieces of material can be produced by welding. Because the resultant weld is frequently stronger than the original material, it has a high fatigue and stress resistance. Because of this, welding is the best option for applications like structural parts, bridges, and pipelines where durability and strength are essential. Metals are often joined together via welding joints. Welding is a crucial industrial process that is used in many different manufacturing industries to create robust, long-lasting, and leak-proof connections for a wide range of products. Complex structures, such as parts of cars or aircraft, are put together using welding procedures, which also guarantee the structures' stability in challenging circumstances. The industrial sectors that employ welding technology substantially include the automotive, aerospace, construction, shipbuilding, pressure vessel manufacture, pipeline construction, and railway industries. Overall, welding is a very flexible and beneficial industrial process that has several benefits over other joining techniques. It is a great option for many different applications because of its strength, resilience, adaptability, and affordability.

Keywords: Welding Methods, Manufacturing Technologies, Mechanical Engineering.

1. INTRODUCTION

Early in the 20th century, welding technology advanced quickly to satisfy growing demand and establish itself as one of the most dependable and affordable production processes. Modern welding techniques, such gas metal arc welding, semi-automated and automatic techniques, and manual techniques like metal arc welding, were created after the two world wars. With the introduction of laser beam and electron beam welding in the second part of the century, the advancement of welding methods progressed. In this topic, scientific study is being conducted continuously nowadays. These days, robot welding is widely used in the sector. Research and development activities are still on to create novel welding techniques, weld high-quality components, and cut expenses. One of the main contributors to supplying humans' physical requirements is the metal industry. Technology for joining (welding) stands out as the most beneficial method ever employed in the metals business. Because welding technology is used in a variety of fields, it necessitates a variety of automation techniques as well as appropriate welding processes. Automatic systems are still developing in terms of design and automation, and they not only save resources but also improve quality. Like other production processes, flexible automated solutions are becoming more and more important in welding technology. Industrial robots are one way that adaptable automated solutions for the welding function are used nowadays. Research and development, however, are welcome on cost-effective, adaptable automated systems for application and transport operations.

2. METHOD

We consider the part's ability to be linked by welding when its welding attribute is specified. This trait is dependent on several factors. For instance, the part's material, the construction's form, the welding technique, the operation's difficulty, etc. The factors that impact these characteristics may be categorized into three groups: "welding possibility," "welding ability," and "welding safety." These conditions influence one another as well. It refers to a material's ability to weld; that is, its capacity to create an unbreakable metallic bond-whether solid, molten, or slurry-with other materials of the same or comparable composition using any kind of welding technique. Welding is a crucial process in various manufacturing industries, playing a pivotal role in creating strong, durable, and leak-proof joints for a wide range of products. From automobiles to aerospace components, welding techniques are employed to assemble complex structures and ensure their integrity under demanding conditions. Welding is a

fabrication process that joins materials, usually metals or thermoplastics, by using heat to melt the parts together and adding a filler material to form a puddle of molten metal that cools and bonds the two parts together. There are many different welding methods, each with its own advantages and disadvantages. Shielded Metal Arc Welding (SMAW), also known as stick welding, is a type of arc welding that uses a consumable electrode to create an arc between the electrode and the workpiece. The electrode is covered in a flux that produces a shielding gas to protect the weld pool from contamination. SMAW is a versatile welding method that can be used to weld a variety of materials, including steel, stainless steel, cast iron, and aluminum. Gas Metal Arc Welding (GMAW), also known as MIG welding, is a type of arc welding that uses a continuous wire electrode that is fed through a welding gun. The wire is fed through a contact tip that is connected to a power source. The power source creates an arc between the wire and the workpiece. The arc melts the wire and the workpiece, and the molten metal forms a weld pool. GMAW is a fast and efficient welding method that is commonly used to weld steel and aluminum. Gas Tungsten Arc Welding (GTAW), also known as TIG welding, is a type of arc welding that uses a non-consumable tungsten electrode to create an arc between the electrode and the workpiece. The tungsten electrode is inert, meaning that it does not react with the surrounding atmosphere. The arc melts the workpiece, and a filler metal is added to the weld pool to form the weld. GTAW is a precise welding method that is commonly used to weld thin materials, such as stainless steel and aluminum. (nexair.com, 2023).

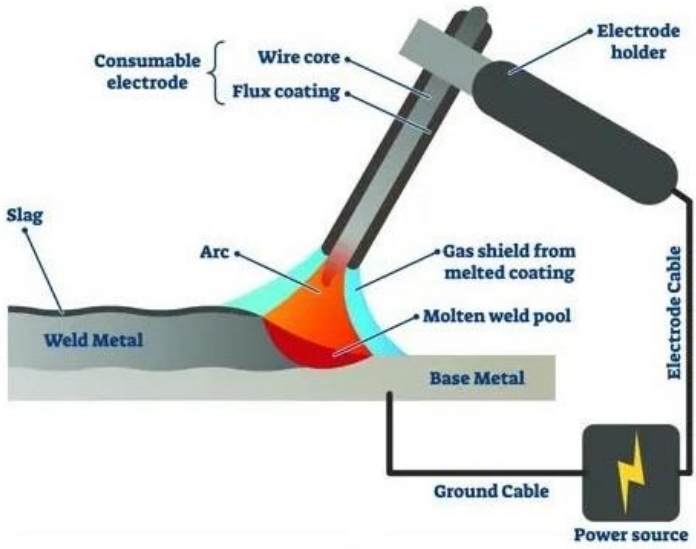


Figure 1. Structure of Stick Welding Method (fractory.com, 2023).

Submerged Arc Welding (SAW) is a type of arc welding that uses a consumable electrode that is fed through a flux blanket. The flux blanket protects the weld pool from contamination and also adds filler metal to the weld pool. SAW is a high-production welding method that is commonly used to weld thick materials, such as steel plates. Resistance Welding (RW) is a type of welding that uses heat generated by electrical resistance to melt the parts together. There are two main types of resistance welding: spot welding and projection welding. Spot welding uses two electrodes to apply pressure and current to the parts being welded. Projection welding uses raised projections on the parts being welded to concentrate the heat and current. RW is a fast and efficient welding method that is commonly used to weld thin materials, such as sheet metal.



Figure 2. FluxCored Arc Welding (FCAW) Method (fractory.com, 2023).

Electron Beam Welding (EBW) is a type of welding that uses a high-energy beam of electrons to melt the parts together. EBW is a high-vacuum welding method that produces high-quality welds with minimal distortion. EBW is commonly used to weld aerospace and medical components. Laser Beam Welding (LBW) is a type of welding that uses a laser beam to melt the parts together. LBW is a high-precision welding method that produces high-quality welds with minimal distortion. LBW is commonly used to weld electronics and medical components.

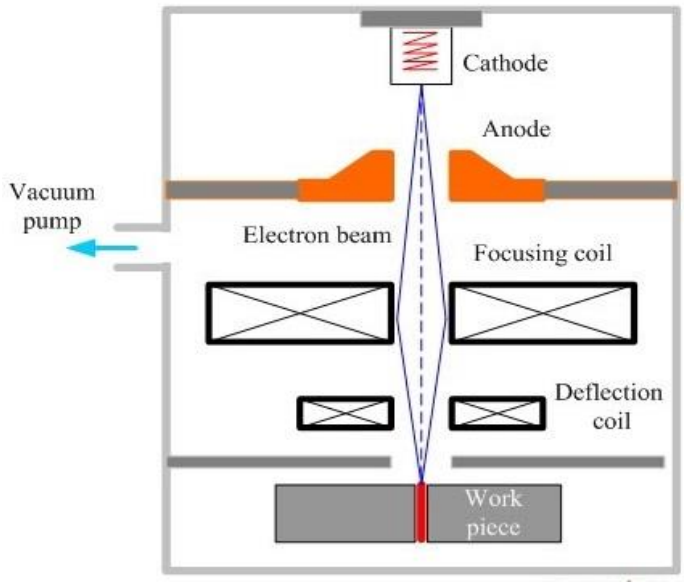


Figure 3. Structure of Electron Beam Welding (EBW) Method. (Substech.com, 2023).

Laser welding consists in a high energy, low contact, low heat input, and high performance bonding process, which can be used for deep penetration, high impact ratio, and low distortion welding. Because of recent advances in the laser sources technology, based on solid state components, the operating costs have been reduced and the global share of laser welding equipment. Laser welding, especially hybrid MAG-laser welding, shows great potential in the welding of structural steels in the shipbuilding industry. Advantageous properties include low distortion, high welding speed and easy automation. The shipbuilding industry has been one of the first to introduce high power laser and laser-hybrid welding for structural applications, with reducing distortion being the major motivation.

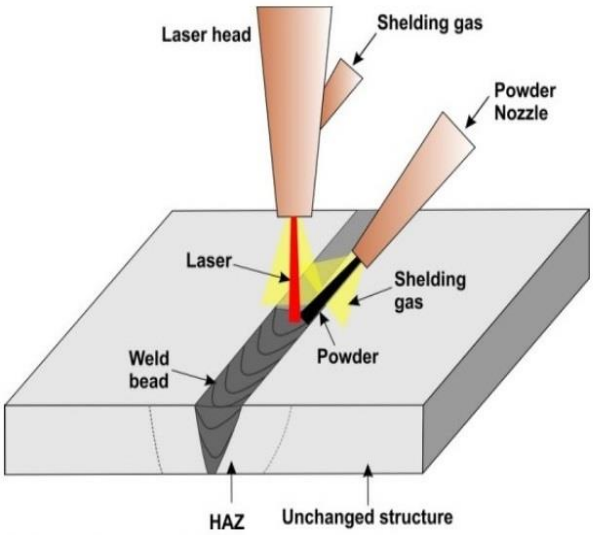


Figure 4. Structure of Electron Beam Welding (EBW) Method.

Laser welding is the process of joining materials together, whether this is one piece or multiple pieces of similar or dissimilar materials. The benefits are concentrated heat control, high welding speed, high-strength joints with high weld depth, small weld width, and low thermal distortion. The high welding speeds, ability to be perfectly automated and control of the process by monitoring online during the operation make laser welding a widely used joining process in modern industrial production (Kapustka, N., 2015) (Asadi, P., et al. 2012).

The laser is a high power density process that provides a unique welding capability to maximize penetration with minimal heat input. All materials can be welded conventionally are also generally weldable with the laser welding. In terms of quality, speed and economy, laser welding is even superior to the conventional process.

3. FINDINGS

The global welding market size was valued at $23.75 billion in 2022 & is projected to grow from $24.73 billion in 2023 to $34.18 billion by 2030. The welding industry plays a significant role in the global economy, contributing to various sectors and generating substantial revenue (linkedin.com/pulse, 2023).

Economic Contributions of the Welding Industry, Direct Economic Impact: The welding industry directly contributes to the economy through the production and sale of welding equipment, consumables, and services. This includes welding machines, electrodes, filler metals, welding gases, and training and certification programs. The demand for these products and services drives economic activity and creates employment opportunities. Indirect Economic Impact: The welding industry also has an indirect economic impact by enabling other industries to operate efficiently and produce goods. Welding is essential for manufacturing a wide range

of products, including automobiles, aerospace components, construction materials, ships, electronics, medical devices, and pressure vessels. Without welding, these industries would face significant challenges and productivity losses. Infrastructure Development: Welding plays a crucial role in infrastructure development, contributing to the construction of roads, bridges, buildings, pipelines, and other structures. The ability to create strong, durable, and leak-proof joints is essential for the safety and longevity of infrastructure projects. Job Creation: The welding industry is a significant employer, providing jobs for skilled welders, welding engineers, and other professionals involved in the design, manufacturing, and maintenance of welding equipment and services. The demand for skilled welders is expected to continue to grow as industries expand and adopt new welding technologies.Technological Advancements: The welding industry is constantly evolving, with continuous advancements in welding technologies, equipment, and materials. These advancements lead to increased productivity, improved weld quality, and the ability to weld new materials and create innovative products (A.Balaram N., et al., 2014).

The welding industry is an essential component of the global economy, contributing to manufacturing, infrastructure development, job creation, and technological advancements. Its direct and indirect economic impacts are significant, and its role in various industries is crucial for the production of goods and the development of infrastructure. As industries continue to grow and adopt new technologies, the welding industry is expected to play an even more prominent role in the global economy.

Here's an overview of the applications of welding methods in various manufacturing sectors: Automotive Industry: The automotive industry relies heavily on welding to assemble various components of vehicles, including the chassis, body panels, engine parts, and exhaust systems. Common welding methods used in automotive manufacturing include gas metal arc welding (GMAW), resistance spot welding (RSW), and laser beam welding (LBW). Aerospace Industry: In the aerospace industry, welding is critical for producing high-performance components that can withstand extreme temperatures, pressures, and stresses. Electron beam welding (EBW) and laser beam welding (LBW) are preferred methods due to their precision and ability to create strong, lightweight joints for aircraft and spacecraft components. Construction Industry: Welding is essential for constructing buildings, bridges, and other infrastructure projects.



Figure 5. Welding applications in Automotive Industry (americantorchtip.com,2023).

Shielded metal arc welding (SMAW), submerged arc welding (SAW), and flux-cored arc welding (FCAW) are commonly used methods for joining steel beams, pipes, and other structural components. Shipbuilding Industry: The shipbuilding industry utilizes welding to assemble various parts of ships, including the hull, decks, and superstructure. Gas metal arc welding (GMAW), submerged arc welding (SAW), and electroslag welding (ESW) are widely used methods for joining thick steel plates and creating strong, watertight joints. Electronics Industry: In the electronics industry, precision welding techniques are employed to assemble delicate components of circuit boards and other electronic devices. Laser beam welding (LBW) and resistance soldering are commonly used methods for creating fine, precise welds without damaging sensitive electronic components. Medical Device Industry: Medical device manufacturing requires high-precision welding techniques to produce implants, prosthetics, and other surgical instruments. Laser beam welding (LBW) and electron beam welding (EBW) are preferred methods due to their ability to create clean, sterile welds that meet stringent medical standards. Pressure Vessel Manufacturing: Pressure vessels are used to store and transport various fluids and gases under high pressure. Welding is essential for creating strong, leak-proof joints for these vessels. Submerged arc welding (SAW) and electroslag welding (ESW) are commonly used methods for joining thick plates and ensuring the integrity of pressure vessels. Pipeline Construction: Welding is crucial for constructing pipelines that transport oil, gas, and other fluids over long distances. Shielded metal arc welding (SMAW), submerged arc welding (SAW), and gas metal arc welding (GMAW) are commonly used methods for joining pipes and creating leak-proof joints. Railroad Industry: In the railroad industry, welding is essential for maintaining and constructing railway tracks. Gas metal arc welding (GMAW) and thermite welding are commonly used methods for joining rails and ensuring the safety and stability of railway infrastructure. Submerged arc welding (SAW), flux-cored arc welding (FCAW), and shielded metal arc welding (SMAW) are commonly used methods in this industry (A.Chennakesava R., et al., 1997).

4. RESULT, CONCLUSION AND SUGGESTIONS

Because it has benefits over other production processes, the welded manufacturing method is frequently employed. The method's affordability and practicality, as well as the creation of new welding techniques and technological advancements, have contributed to its widespread adoption.

As a result, the number of workers in this industry is beginning to rise daily. Nowadays, no industry exists that does not employ some form of welding technique. Even though automated machinery is becoming more and more common in the welding sector as a whole, hand welding still plays a significant role in both production and maintenance phases. In today's metalworking industry, the welding process is one of the most basic production methods due to the great convenience it provides. However, during welding processes, many harmful smoke, dust and particle emissions are released in the production area. This situation creates a dusty environment for employees and machines. Poor and unhealthy air quality causes serious illnesses and health problems for workers in the long run. Modern high-tech machine tools and equipment are harmed by submicron dust and emission particles created during the welding process, which can also lead to costly problems. Consequently, in order to overcome the difficulties brought on by welding fumes and to guarantee an effective, continuous production flow on welding production lines, it is imperative to invest in the appropriate air filtration solutions.

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