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COATED ELECTRODE WELDING AND ITS ADVANTAGES

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Abstract: The study presents a theme about the importance of quality control in welded joints and seeks to highlight the advantages found in the welding process with coated electrode. It was possible to understand that welding processes represent a large part of the manufacturing costs of a product and the quality control of welded joints exerts a relevant influence on product performance. A failure in a weld that is not detected in the control process can have serious consequences for the equipment manufacturer and losses for the company. The study concluded that, as it is considered a technique used on a large scale and encompasses several areas of engineering, it is essential that a welding professional seeks knowledge and qualification about the effects of the welding process, especially considering, in addition to the advantages, possible disadvantages and measure to what extent such disadvantages can compromise the process, costs and quality of welding.
Keywords: Coated electrode. Welding. Advantages.

INTRODUCTION

Welding is a manufacturing process widely used in the industrial environment and plays a key role in both the cost and performance of a given product. It is a process of joining materials, produced by heating to a suitable temperature, with or without the use of pressure and/or filler material" (*American Welding Society - AWS*).

The heat generated melts the base metal with the electrode core. The coating has the function of protecting the weld pool and adding alloys to certain specifications. The protection of the weld pool is given in the coating burning, where it generates a gaseous atmosphere, thus protecting the welded metal during solidification, with the coating burning it also generates a liquid slag that during solidification floats to the surface protecting the pool from melting and controlling the cooling temperature.

The continuous search for greater productivity generated the need for new technologies and new welding processes. Despite this, due to its high degree of employability, versatility, low operating cost, easy-to-handle equipment, use in places of difficult access, subject to moderate weathering, the coated electrode process is widespread in the industry; in the manufacture and assembly of equipment, in the area of maintenance and repairs, in construction in the field and in gravity welding in shipyards.

The numerous welding processes use a large concentration of energy and its origin defines the processes. Thus, according to the energy source, processes are classified into seven areas: solid phase, thermochemical, electrical resistance, unprotected arc, arc protected by fusible flux, arc protected by gas and radiant energy. The welding process, above all, must be correlated to the control of the atmosphere that surrounds the place of welding (MACHADO, 1996).

Stick arc welding (SWAW) is a process that produces coalescence between metals by heating and melting them with an electric arc established between the tip of a consumable stick electrode and the surface of the base metal in the joint being welded. soldier. This study is justified, therefore, when it comes to the majority of equipment and systems in various industrial segments, among which are: railways, automobiles, planes, ships, power plants, petrochemicals, steelworks and other industrial plants, it is configured in a very complex process, considering a multitude of components that depend on reliability, since a single equipment failure can cause an unscheduled stoppage in the production line.

This way, the guarantee for this not to occur is that each individual component performs well, which is expressed through the improvement or quality level of the components or products (SOUZA, 2019).

This study aims to present coated electrode welding and its advantages. The methodology used was a literature review, searched in databases such as Google Scholar and Scielo and to survey the theoretical framework, the FBTS handout - Fundação Brasileira de Tecnologia da Soldagem was used as the basis for the study. Welding inspector – CIS (2014).

FUNDAMENTALS OF THE COATED ELECTRODE WELDING PROCESS

According to FBTS (2014), in coated electrode electric arc welding (SMAW), the molten metal of the electrode is transferred through the electric arc and combines with the base metal, also melted by the action of the arc in the puddle. fusion (*). As the weld proceeds, solidification of the puddle occurs which gives rise to the weld metal.

A liquid slag with a density lower than that of liquid metal, formed from reactions between chemical elements from the decomposition and combustion of the electrode coating and impurities in the base metal, superimposed on the weld pool during welding, protecting it of atmospheric contamination. Figure 1 shows welding with coated electrode.

The coated electrode welding process presents several variables that must be correctly understood, with a view to obtaining welded joints compatible with the desired result in terms of mechanical properties, and also achieving good productivity. Thus, there is a need to understand that the process can be used in different configurations of joints found in industrial welding, and it is important to recognize the aspects and specifications of welding consumables for the correct selection.

It is essential to understand that the welding process as a coated electrode can be used to weld all positions and types of joints, that is, they are applicable for welding most

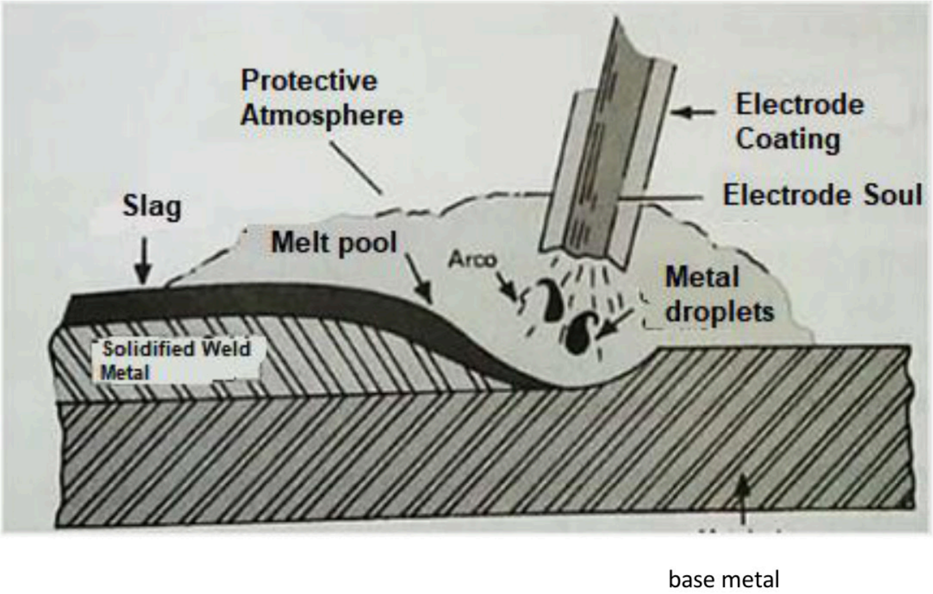

Figure 1 – Coated electrode welding.

Source: FBTS, 2014.

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non-ferrous materials, such as aluminum, copper, nickel and their alloys, both for welding of unions, as well as for coatings through layered depositions. It offers the possibility to soda base metals in a wide range.

The weld obtained from the coated electrode arc welding process can contain almost all types of discontinuities, below in Table 1 are the most common discontinuities that can be found.

Table 2 presents the advantages and limitations of the process.

Discontinuities	**Causes**
Porosity	Caused by the use of incorrect techniques, such as long arc length or excessive welding speed; the pooled porosity occurs at the opening and closing of the arch. The technique of welding with a small back pass, right after starting the welding operation, allows the welder to melt the area where the pass begins, releasing the gas from it, thus avoiding this type of discontinuity.
inclusions	They are caused by improper electrode handling and poor cleaning between passes. This is a foreseeable problem in the case of inadequate design with regard to access to the joint to be welded or with small bevel angles.
Lack of fusion	Resulting from poor soldering technique: too fast soldering, improper joint preparation, or too low current.
Lack of penetration	Fast welding, improper joint and material preparation, current too low, electrodes too small in diameter.
Concavity and overlap	Welder error tails
Trinca interlamenar	It is not characterized as a welder failure. It occurs when the base metal, not supporting high tensions generated by the contraction of the weld, in the thickness direction, cracks in the form of steps, located in planes parallel to the lamination direction.
Trinca na garganta e trinca naraiz.	When they appear, to be avoided, they demand changes in the welding technique or exchange of materials.
Crack on the bank and crack under the bead	These are cracks due to cold cracking, which manifest themselves some time after the execution of the weld, and may not be detected by an inspection carried out immediately after the welding operation.
bite	High current, very hot workpiece

Table 1– Process-induced discontinuities.

Source: FBTS, 2014.

Operation type: manual	Equipment: Rectifier, transformer and generator
Equipment cost: 1	
Features: Deposition rate: 1 to 5 kg/h Welded thicknesses (e): 2< and < 200m Position: all Usual types of joints: all Dilution: 25 to 35% Current range: 75 to 300 A	Process consumer: Electrode from 1.6 to 6.0 mm in diameter
Typical industrial applications: welding of most metals and alloys used in boilers, piping, structures and cladding	
Benefits: Low cost; Versatility; Operates in hard to reach places;	Limitations: Slow process due to low deposition rate; It requires a lot of manual skill;

Table 2 – Advantages and Limitations.

Source: FBTS, 2014.

COATED ELECTRODE WELDING EQUIPMENT

One of the reasons for choosing the coated electrode welding process is the simplicity of the equipment and the easy assembly of the welding circuit, allowing for more flexible work. The equipment that makes up the welding circuit are; power source, electrode holder and flexible cables, as shown in Figure 2.

WELDING MACHINE (POWER SOURCE)

It serves to provide energy to carry out the fusion between metals and can be of the transformer or inverter type. The two types have the same function and the inverter welding machine has the technology that allows a more compact size and, consequently, more practicality in the service. This practicality is related to weight, with the transformer having an average of 30 kg while the inverter does not exceed 14 kg, as shown in Figure 3.

One of the advantages of coated electrode welding (SMAW) equipment compared to another process, such as MIG/MAG (GMAW) for example, would be the equipment price and mobility. Equipment for welding with MIG/MAG needs other devices, such as a wire feed head and shielding gas, in addition to the machine being a little more robust, exceeding 15 kg. SMAW welding equipment can also be used in other welding processes such as the TIG (GTAW) process.

Figure 3 – Inverter welding machine.

Source: Shops esab.com, 2022.

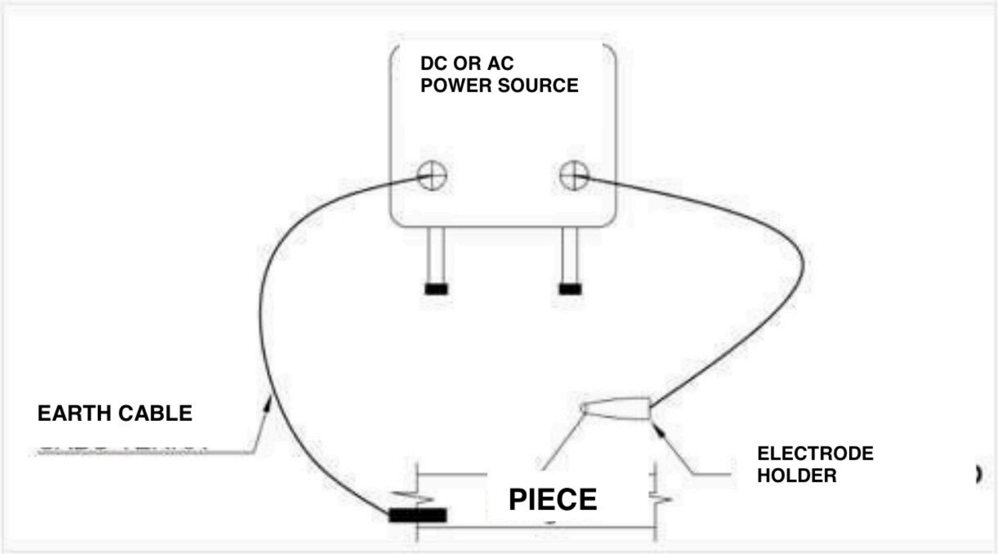

Figure 2 – Welding short circuit for coated electrode process.

Source: ESAB, 2005.

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WELDING CONSUMABLES

There is a wide variety of coated electrodes, easily found on the market, each electrode containing in its coating the ability to produce its own protection gases, dispensing with the additional supply of gases, necessary in other welding processes (WAINER, 1992).

Covered electrodes can be welded in all positions (flat, vertical, horizontal, overhead) as used on virtually all base metal thicknesses and in areas of limited access. The coated electrodes can be applied for hard coatings, cutting and gouging and the equipment has a relatively low investment cost (MACHADO, 1996).

The AWS standard usually used for classification of welding consumables in general, specified based on their mechanical properties of the deposited metal, type of coating, welding position, type of current and their operational characteristics.

The AWS specification is made up of a set of letters and digits. The meaning of the AWS designations is shown below in Figure 3 and Table 3.

The advantage of using the coated electrode, as shown in Figure 4 compared to other processes, is the price of the consumables, being among the cheapest welding consumables. However, it loses in terms of productivity and specific treatments for basic electrodes, which becomes a disadvantage compared to other consumables.

It is essential to understand that the welding process as a coated electrode can be used to weld all positions and types of joints, that is, they are applicable for welding most steels and non-ferrous materials, such as aluminum, copper, nickel and their alloys, both for welding joints and for coatings through layered depositions. It offers the possibility to soda base metals in a wide range. According to FBTS (2014), the success of the coated electrode welding process is associated with the welder's skill, as all welding is performed manually. In this sense, the welder must be able to control five items:

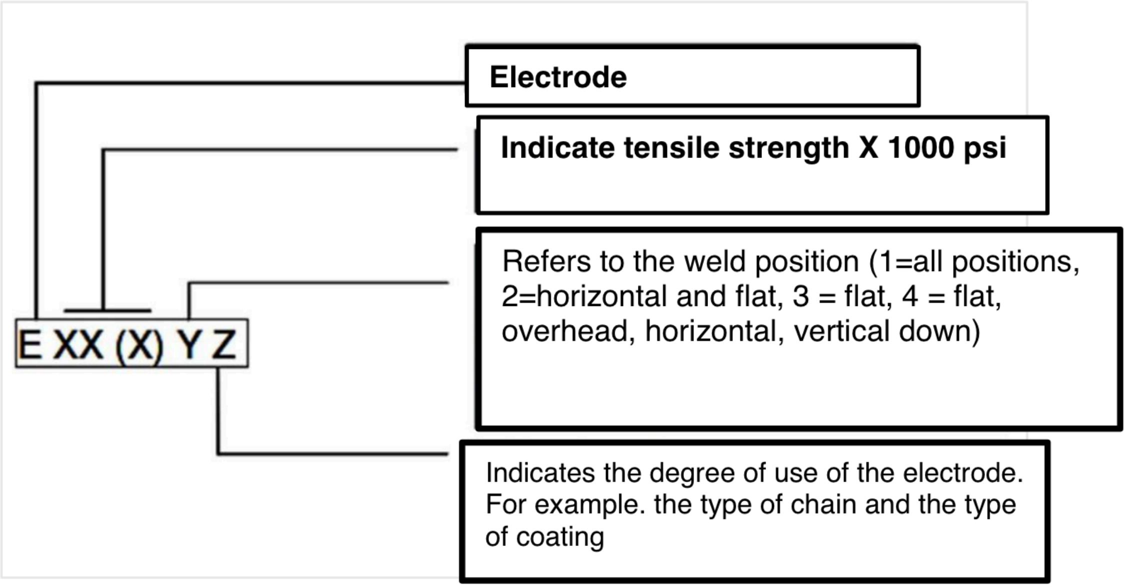

Figure 3 – Meaning of AWS designations.

Source: Fortes, 2004.

Class	Chain	Bow	Penetration	Coating/dross	Iron powder
EXX10	CC+	aggressive	profound	cellulose-sodium	0-10%
EXX11	CA/CC+	aggressive	profound	cellulosic-potassium	0
EXX12	CA/CC-	average	average	rutile-sodium	0-10%
EXX13	CA/CC-/CC+	soft	light	rutile-potassium	0-10%
EXX14	CA/CC-/CC+	soft	light	rutile iron powder	25-40%
EXX15	CC+	average	average	Low hydrogen-sodium	0
EXX16	CA/CC+	average	average	Low hydrogen-potassium	0
EXX18	CA/CC+	average	average	Low hydrogen -iron powder	25-40%
EXX20	CA/CC-	average	average	Sodium Iron Oxide	0
EXX22	CA/CC-/CC+	average	average	Sodium Iron Oxide	0
EXX24	CA/CC-/CC+	soft	light	rutile – iron powder	50%
EXX27	CA/CC-/CC+	average	average	iron oxide-iron powder	50%
EXX28	CA/CC+	average	average	Low hydrogen -iron powder	50%
EXX48	CA/CC+	average	average	Low hydrogen -iron powder	25-40%
The percentage of iron dust is based on the mass of the coating					

Table 3– AWS Designations.

Source: Fortes, 2004.

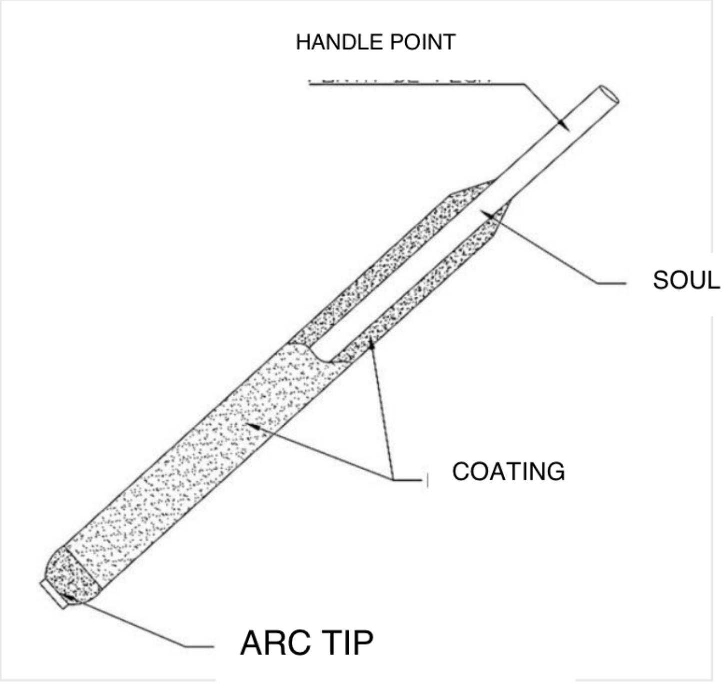

Figure 4 – Advantages of using coated electrode.

Source: ESAB, 2005.

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a) The length of the arc, which varies between 0.5 and 1.1 of the coated electrode diameter;

b) The working angle of electrode displacement;

c) The speed of displacement of the electrode;

d) Pass deposition techniques;

e) The current

In the same way, the welder must be qualified to prepare and clean the joints, since they must be free of oil, grease, rust, paints, residues from the examination by penetrating liquid, sand and soot from the gas preheating in a range of at least 20 mm on each side of the demagnetized edges.

ELECTRODE HOLDER

The electrode holder, shown in Figure 5, has the function of fixing the electrode and transmitting the electric current that comes from the power source (welding machine) by conduction. The electrode holder needs to be thermally and electrically insulating and have good ergonomics so that the welder can perform the service in a practical and safe way.

To perform SMAW welding, there are several parameters that need to be analyzed. They will define which electrode holder is suitable for each activity.

The specification of the electrode and its diameter will define the required amperage in the welding process. The application of time in welding and the intensity will define the work cycle.

Electrode holders with a higher duty cycle are recommended for welds where the process downtime is shorter, thus requiring greater performance from the electrode holder. The duty cycle is the time that the electric arc can remain open during a period of 10 minutes. That is, in a work cycle of 70%, the electric arc can remain open for 7 minutes and then need to be extinguished for 3 minutes for the welding components to cool down, such as: electrode holder, electrical conductor, power source, etc. .

Among all welding processes, the electrode holder device, known as welding pliers, is the one with the lowest cost and the easiest to use among all other welding processes. Figure 5 shows.

Figure 5 – Electrode holder.

Source: CARBIGRAFITE, 2021.

CONCLUSION

The study sought to briefly present the analysis of the advantages of the coated electrode welding process. It was possible to observe that there are many benefits, such as its ability to weld all positions and types of joints, that is, they are applicable in welding non-ferrous materials and their alloys, as well as for welding joints and for coatings by means of layered depositions.

However, it concluded that the process also has disadvantages such as presenting a slow process due to the low deposition rate and requires a lot of manual skill. It is considered essential to measure the extent to which such disadvantages may compromise the welding process, costs and quality.

REFERENCES

CARBOGRAFITE. **Porta Eletrodo**. 13 de agosto de 2021. Disponível em: https://carbografite.com.br/blog/detalhe/o-que-e-e-para-que-serve-um-porta- eletrodo-voce-sabe-qual-escolher-/. Acesso em: 27 de dezembro de 2022.

ESAB. **Eletrodo Revestido**, Assistência Técnica Consumíveis – ESAB BR. 2005.

ESAB. **Máquina de solda inversora** ESAB Handy Arc 132 i DV Bivolt. 2022. MACHADO, I.G. **Soldagem & técnicas conexas: processos**. Porto Alegre: Machado, 1996.

FBTS - Fundação Brasileira de Tecnologia da Soldagem. **Inspetor de Soldagem** - CIS - volumes 2. 2. Ed. Rio de Janeiro: Publit,. 2014.

SENAI-BA/SENAI-MG/SENAI-RJ. **Inspetor de Soldagem** / Rio de Janeiro: 2012. 440 p.

WAINER, E. **Soldagem**: Processos e Metalurgia. São Paulo: Blucher, 1992.