WELDING CONSUMABLE: SO ILLUSTRIOUS, YET SO UNKNOWN

A practical discussion about the importance and relevant details regarding this important item in the manufacture of metal equipment.

Summary

1. Introduction

Welding is recognized as one of the most important and popular manufacturing processes used around the world.

It is widely used in the joining of metal parts so that equipment, structures, and complex systems, such as different geometries, can be reliably manufactured.

These items manufactured by welding are constantly incorporated into industries of the most varied sectors, such as petrochemical, food, pharmaceutical, oil and gas, chemical, pulp and paper, naval, etc.

In the union between parts by welding, most of the time welding consumables are used, in the form of coated electrodes, wires, rods, and also gases and protection fluxes, among others.

Consumables have characteristics and details that need to be understood and considered throughout the construction process of this equipment.

In this text, relevant aspects to be considered regarding consumables in the different phases of construction will be briefly addressed, that is: design, materials, inspection and manufacturing.

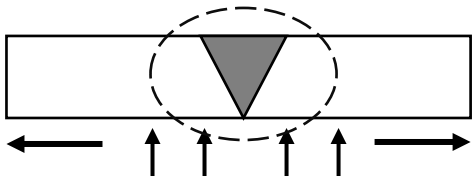
But first, let's evaluate the current scenario.

2. Development

2.1 Current scenario

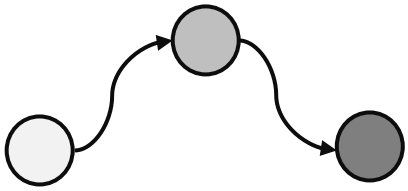
Two aspects are especially important when relating the current industrial scenario to the topic *of welding consumables.*

1) Welding consumables, as soon as they are used in the welding process, are incorporated into the welded region and therefore become an integral part of the equipment; and its chemical composition, mechanical properties, purity and other characteristics become part of the equipment or structure (fig. below), in which case any deviation in the consumable becomes a deviation in the equipment or system.



Therefore, if the consumables will be part of the equipment, the evaluation of their quality and characteristics will be as important as the evaluation of the plates, tubes and connections. Such analysis or evaluation is not made, except for exceptions that are increasingly rare.

2) With the globalization of the market over the last few years, Brazil has received welding consumables from the most varied origins, which has increased the difficulty of establishing the traceability of these consumables, that is, a consumable used without due care with its origin can condemn an entire equipment or even an entire system, such as entire stretches of pipes or pressure vessels, for example.



Given these challenges related to the scenario, it is necessary to focus on the following topics:

2.2 Design and materials

Any and all construction or alteration of an industrial plant, in its systems and equipment, begins with a project, which can be more or less elaborated.

Through the proper and well-executed design, the set of systems, equipment, piping and structures necessary is determined, and from this definition, the best materials to be used, their dimensions, geometries, manufacturing methods and other relevant details for the performance of its purpose are defined.

In the same way, the project defines the joints to be welded, the sizing of these joints, the consumables to be used and their compatibility with the use of the equipment.

Hence one of the challenges: to know more deeply the standards that regulate the properties of consumables such as their resistance, chemical composition, toughness (the latter an essential characteristic for equipment that operates at low temperatures and some other special conditions).

Therefore, in a few lines it is already clear that if welding is one of the main manufacturing processes and the manufacture of equipment requires projects, we need to talk about welding consumables in the design phases.

Let's pay attention in this case to:

- Materials used in the construction of the equipment;
- Basic mechanical strength required for the equipment;
- Range of equipment design and operating temperatures;
- Cyclic or static loads;
- Local operating atmosphere of the equipment and classification of the fluids that will come into contact with the equipment;
- Additional requirements with respect to other complementary characteristics of the base metal, such as coefficient of thermal expansion and considerations regarding the electrical conductivity of the base metal in some cases.

Factors such as the above have a lot of relevance in the selection of consumables to be used.

Example: in the design of hot-dip galvanizing vats, the vats are constructed of low-carbon and low-silicon material (SAE1005 steels/Armco Iron, etc.), in order to reduce the corrosive effects of the molten zinc bath on the surface of the vat. And such vats are constructed from plates joined by welding, whose welded joints are exposed to the zinc bath.

These low carbon/silicon steels have excellent weldability, but if the project fails to consider the use of a specific welding consumable for this purpose, the choice of conventional consumables for carbon steel may eventually be adopted (E7018 for example) and the result will be disastrous, due to preferential corrosive attack on the welded joints.

In this case, as in many other cases, detailed knowledge of the project requirements is essential to support the welding procedure and specific selection of the welding consumable.

2.3 Manufacturing and Inspection

Considering that the design has been adequate, the challenges related to proper manufacturing and inspection need to be addressed and the following aspects are essential:

Welding consumables should be inspected before use.

- Its receipt must follow a strict ritual, which includes the evaluation of its packaging (integrity, traceability and information required by standard
- Its physical inspection is also essential in order to identify deviations in its production and transportation. During this activity, evidence of oxidation, aging, lack of identification, among other deviations are evaluated.

The drying of consumables (when required), conservation, and traceability are also indispensable to maintain adequate quality assurance of the welding process.

The detailed orientation and procedure of your application also plays an important role in obtaining the best results required from welding consumables. Consumables not suitable for downward progression application or electrodes only suitable for use in flat welding are relevant in effective manufacturing with high productivity.

Throughout manufacturing, welding follow-up activities contribute greatly to the proper use of consumables and to the recording of the history of their use, which we call traceability.

It is one of the functions of welding inspectors to record which consumables including their batch

or run were used in each of the joints produced, which welder was responsible for the execution and which welding procedure (EPS) was actually used.

This activity is essential, for example, in the case of searching for root causes of the appearance of some deviation (defect or discontinuity) detected during or after the welding of a piece of equipment.

In view of the above, it is possible to perceive the wide range of possibilities of deviations due to lack of knowledge or disqualification of this subject.

2.4 Addictions and myths about consumables

All of the following 4 paragraphs are examples of addictions or myths to be combated that illustrate the need for constant training and dissemination of knowledge.

1. Replace drying in drying ovens by deliberately touching the coated electrode to the workpiece until the electrode warms up and is supposed to be dry.

Technik Comment: Full drying requires the controlled combination of time and temperature to be effective.

2. Understand that the coated electrodes stored in cans are already dry and do not require their initial drying.

Technik comment: the cans are not airtight and the coated electrodes absorb the moisture present in the environment and then package without being dried.

3. Understand that a weldability test of a consumable on a base metal is sufficient to adopt this consumable as being appropriate for that welded joint.

Technik Comment: The fact that it is possible to use several consumables of different classifications, the appropriate choice depends on several other factors, including metallurgical ones.

4. The existence of a qualified EPS for a combination of material and consumable is sufficient to ensure a quality weld.

Technik Comment: EPS is one of the tools for good welding quality. Other factors such as good quality of consumables, mains, proper joint cleaning and cleaning between passes, skilled welders and inspections via compatible non-destructive testing are also essential.

2.5 Consumables Certification

In addition to what has been discussed so far, there is a special chapter related to the certification system of consumables in Brazil.

This certification follows in a similar way to what is done with the other items that are considered important for the safety of Brazilian society. Other examples of items that go through certification are:

- Household appliances

- Toys
- Helmets
- Domestic stairs
- Fire extinguishers
- And so on.

It follows, therefore, in the form of questions and *answers*, made by the technical department of FBTS, a certified body for welding products – consumables:

1. In view of the large set of different consumables sold in the Brazilian market, can the certification of a brand be understood as a quality differential?

Resp. FBTS: Yes, because certification is the assurance given by a third party that the consumable meets the requirements set out in the standards and technical specifications.

By purchasing a certified consumable, you are assured that it has been impartially evaluated and approved.

Since 1997, FBTS has been a product certification body – OCP – 012 accredited by INMETRO, to carry out the certification of welding consumables.

2. What does the welding consumables certification system consist of?

Resp. FBTS: *The manufacturer of the consumable has two certification options: Type A - certification only valid for a certain batch manufactured or Type B, valid for three years, with annual maintenance. To apply for certification, the manufacturer must present ISO 9001:2015 certification.*

The manufacturer requests the certification of welding consumables from FBTS, which prepares a technical proposal, where all the technical details and costs related to the certification process are informed. After the proposal is approved, the welding and tests are carried out in laboratories accredited by INMETRO, and then the analysis of the results. After approval, the certificate of conformity is issued.

3. Does the use of a certified consumable involve costs for the user?

Resp. FBTS: *No, the costs of the certification processes are exclusively borne by the manufacturer of the consumable.*

4 During the certification process, are consumable manufacturing issues detected that would go unnoticed by the user?

Resp. FBTS: Yes, the activities carried out during the certification process involve tests to verify the mechanical properties and chemical composition of the welding consumables required by standard and/or technical specifications.

Failure to meet these requirements requires the manufacturer to make corrections to its formula or manufacturing process. These deficiencies would not normally be noticed by the user on a

visual inspection of receipt or when using a consumable. In a more critical situation it would only be perceived with a damage to the welded equipment.

5 How to identify if the consumable is certified?

Resp. FBTS: The user must consult the list of certified consumables made available by the Product Certification Body on the website www.fbts.org.br at the following link: http://fbts.org.br/CertificacaoQualidade/BuscaConsumiveisSoldagem.

Certification identification can be found on the product, however it is not mandatory.

In the list presented on the website, you are also informed about the validity of the welding consumable certification.

3. Conclusions and recommendations

As a rule, quality is usually understood as an item that increases construction costs. At the same time, the appeal for the purchase of lower-priced consumables has also proven to be a frequent practice in the Brazilian market.

Experience, however, shows that the lack of quality and choices for cheaper items have behind them a hidden cost that proves to be so high that it causes the need for reflection and evolution on the topic addressed.

Consumables without controlled origin, without certified mechanical properties, engineering teams without the support of welding professionals (welding inspectors/engineers) and the still significant existence of myths and folklores on the subject are sources of potential high risks that can be removed from the company to the extent that some attention is paid to the subject.

Therefore, it is strongly recommended the incorporation of new good practices regarding welding consumables, both by manufacturers and assemblers of industrial equipment and systems, as well as by users who sometimes perform their own maintenance, repairs and alterations to equipment.

Certainly, the most effective and efficient thing will always be to do it well the first time, with safety and quality.

The Technik Group is a Brazilian engineering company focused on design and analysis in the fields of mechanical engineering, process engineering, P&IDs, Safety Valves, HAZOP, NR-13, integrity of industrial assets, NR-12 and welding engineering

www.grupotechnik.com.br

Fernando Lescovar Neto is a naval engineer, N2 welding inspector, post-graduate in welding engineering and technical director of the Technik Group

fernando.lescovar@grupotechnik.com.br

We would like to thank the Technical Staff and Board of Directors of FBTS for their participation in important clarifications