ASPECTS REGARDING PRODUCT QUALITY ASSURANCE IN INDUSTRY

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ABSTRACT: Ensuring the quality of products in industry is a particularly important issue regardless of the type of technologies used or the products obtained. In recent years, due to the exponential evolution of "green" energy, which includes obtaining electricity with the help of wind systems or solar panels, a critical problem has arisen, namely its transport over long distances. To solve this situation, the need for electrical cables of various sizes that interconnect production sites usually located at significant distances from urban areas, where electrical consumers are located, has almost suddenly arisen. In this regard, the quality of wires obtained by drawing is of great importance and these aspects will be presented in this article.

KEY WORDS: wire-drawing, process, quality, manufacturing

1. INTRODUCTION

Wire drawing and drawing are technological processes for obtaining semi-finished products by plastic deformation, in which the metal material under the action of a pulling force is forced to pass through a calibrated hole of a tool, which is smaller than the initial section of the material. The tools for wire drawing are called dies, and for drawing — dies. Wire drawing is the technological process of obtaining a wire of smaller dimensions (of diameter f), by cold deformation of a ductile product (of diameter F), by successive passes through a series of dies. If the tensile force is provided by a drum, drum or roller, on which the deformed material is wound, the process is called wire drawing; if the tensile force is exerted by a machine element with rectilinear movement, and the deformed products (bars or pipes) are obtained straight, the technological process is called drawing [1,2,3]. As processing processes, they have been known since antiquity (the first evidence was discovered in Egypt), being used only to obtain wires with various profiles in the cross-section. A more extensive development was achieved in the Middle Ages, after the transition from manufacturing to the first mechanized installations, the principle of which is preserved to this day in modern wire drawing and drawing benches. Nowadays, wire drawing and drawing are applied to obtain semi-finished products and profiles from various metals and alloys, with very precise dimensions and physical and mechanical properties, which practically cannot be obtained by other technological processes (e.g. wire for springs, when we want to obtain hardened product surfaces without heat treatment), or the economic efficiency of

production by another method is reduced. The raw material is brought from the raw material warehouse, located in the immediate vicinity of the wire drawing area, with the help of the overhead bridge. The wire is placed on the unwinder of each trellis. From the unwinder, the wire is passed through a range of dies, depending on the desired final diameter. After this operation, the dies are mounted in the die holder. From the final die, the wire is passed onto the wire accumulator and from there to the double winder.

The drawing of aluminum wire is done starting from the diameters indicated above. The wires obtained from the heavy drawing process constitute a finished product for electrotechnical purposes or by-products used in the construction of other types of insulated or non-insulated electrical conductors. During drawing, the main technological property manifested is ductility. This is the property that allows the cold deformation of materials. In the case of cold plastic deformation, a change in the crystalline structure of the material occurs. This change is called work hardening. Work hardening modifies the mechanical, electrical and physical properties of materials. Wire drawing is the technological process of passing aluminum wire through several "modules" of die-drawing drum, in order to obtain the various wire diameters needed for the manufacture of conductors. The wire slips or slides on the surface of the drawing drum, if there is a difference between the speed of the wire and that of the drawing drum in direct contact with the wire. The speed of the wire can be between zero and the speed of the drawing drum. In practice, the term "module" has been replaced by that of "pass", and thus wires with 13 passes, 9 passes, 5 passes are considered, which means that the respective wire has 13 dies and drums, 9 dies and drums, 5 dies and drums. In wire drawing, the state of tension is complex and consists of a compressive stress to which is added a tensile stress, which deforms the crystalline structure, through sliding and elongation, which allow the preservation of the cohesion of the structure of the material to be processed.

2. WIRE DRAWING TECHNOLOGY

From a practical point of view, the technology for obtaining firechlor by wire drawing includes the following steps:

- upon entering the shift, the operator visually checks the wire drawing machine for the existence of connections to the grounding belt of all parts powered with an electrical voltage greater than 24 V (electrical panel, control panel, electric motors), as well as the status of the safety and protection limiters present on the machine
- the electrical voltage from the general power supply panel is introduced (if the machine was not already in operation or powered)
- the Al/Cu coil is placed and fixed in the unwinder, using the straps
- the series of dies is chosen depending on the diameter of the wire to be drawn
- the wire end inside the coil is grasped and moved to the pointing (sharpening) machine
- the pointing machine is started, pressing the "ON" button (green) and the wire end is inserted into the channels made in the two rotating drums, channels that have dimensions starting with the diameter of the socket wire up to 1.0mm. When the end of the wire is sufficiently pointed, it is inserted through the die fixed in the die holder, and the pointed (sharp) part is clamped in the threading pliers with which a number of 3-4 turns are drawn onto the drum. The procedure is repeated for each die separately
- the dies are fixed in the recess made in the trefilor frame and the trefilor is threaded
- the lubrication pump is turned on
- the trefilor is turned on to "play" and the wire is fixed on the accumulator (ballerina), respectively the bobbin
- the bobbin is inserted and fixed in the trefilor winder
- the wire distributor is adjusted, by fixing the left-right limiters
- the end of the drawn wire is caught on the bobbin on which it is wound
- the trefilor is turned on and the potentiometer is rotated to the right, to increase the speed, respectively to the left, to reduce the drawing speed

- when the bobbin is full, the trefilor is stopped, the full bobbin is exchanged for an empty one by operating the levers from the hydraulic distributor mounted on the bobbin frame
- the drawing is performed according to the order and the protocol
- in case of wire breakage during the drawing process all the machine threading operations listed above are resumed
- at the end of a coil, a new coil with socket wire is placed in the support, and the end of the coil will be electrically welded to the beginning of the coil inserted into the machine, and drawing will continue
- notify the process manager (foreman, technological engineer) if a mechanical or electrical defect occurs during the operation of the machine.

2.1 Raw materials and materials used in wire drawing

For drawing aluminum, in order to manufacture uninsulated aluminum conductors, cast and continuously rolled semi-finished aluminum wire is used. The technical quality conditions, physical/mechanical/electrical characteristics, quality control rules, verification methods, packaging, marking, storage, transportation and necessary documents for aluminum wire are those provided in the technical specification. The most commonly used diameters of the semi-finished wire are: 9.5-12-15-19-25 mm.

For drawing aluminum alloy (AlMgSiE-I), in order to manufacture uninsulated aluminum alloy conductors, cast and continuously rolled semi-finished aluminum alloy wire is used. The technical quality conditions, physical/mechanical/electrical characteristics, quality control rules, verification methods, packaging, marking, storage, transport and necessary documents for aluminum alloy wire are those provided in the technical specification. The diameter of the wire in this case is 9.5 mm.

Copper wire is used for drawing copper, in order to manufacture uninsulated copper conductors, as well as metal screens. The technical quality conditions, physical/mechanical/electrical characteristics, quality control rules, verification methods, packaging, marking, storage, transport and necessary documents for copper wire are those provided in the technical specification. The diameter of the semi-finished copper wire is 9 mm.

2.2 Drawing lubricants

Lubricants are intended for drawing aluminum and its alloys on drawing machines with very high passing speeds, giving the drawn wire an excellent finished surface. Their lubricating characteristics avoid blocking the drawing dies with very fine aluminum particles, while reducing the frictional forces between the dies and the aluminum.

The relatively low viscosity of the lubricants allows them to be pumped into the lubrication systems of the drawing machines, and allows the very fine aluminum particles to settle very quickly. Thus, the drawing oil will remain clean, ensuring perfect lubrication of the drawing dies.

Whatever the type of lubricant used, it is necessary to comply with some rules regarding:

- storage - the barrels are stored in areas protected from sunlight, protected from moisture. The ideal storage temperature is 5... 35 ℃. Lubricant barrels must have a lid to prevent rainwater from entering.
- handling - proceed according to the manufacturer's instructions
- preparation - it is very important that machines, pipes, lubricant tanks are cleaned before filling with lubricant. Even new equipment must be cleaned. For this, cleaning agents are used - simultaneous sterilization. If necessary, special cleaners can be used during operation to remove grease deposits from the dies. Kerosene can be used for this purpose, but it can have an adverse effect on the stability of the emulsion.
- temperature - from this point of view, a balance must be achieved regarding the lubricating, cooling and stability properties of the lubricant. In general, the optimal operating temperature is between 35...45 ℃. Lubricant at 40 ℃ is cleaner than a colder or

hotter one, while prolonged use of lubricants at temperatures above 50 °C reduces their stability. Cooling is obviously less, and changes in the color of the aluminum wires may occur
- filtration - effective filtration is an essential part of a good cooling system.
hydrocyclones and paper filters can be used, most often
- weekly control tests - concentration (Babcok test), pH value (alkalinity or acidity),
conductivity (amount of salts in solution), bacteria level (max 1 million/ml), visual appearance.
It is very important to protect lubrication systems from water contamination (in the case of using lubricants undiluted with water). In these cases, water adversely affects the quality of drawing and can cause destruction of the dies and damage to the surfaces of the drawn wires.

2.3 Abrasive materials

For grinding/polishing of wire drawing dies, profiled steel tools and grinding powder (boron carbide - 28...40 μm, and diamond powder - 7...28 μm) are used. The grinding/polishing operation can be performed on special die grinding machines.

2.4 Degreasing materials

Aqueous solutions are used to degrease aluminum wires that go directly to the insulation operation.

3. QUALITY ASSURANCE IN WIREDRAWING PRODUCTION

The quality assurance procedures specify that:
- the operator is responsible for drawing the products in quality and quantity
- the team leader ensures the technical conditions and materials for the execution of the products in quality conditions, eliminating the causes that led to the obtaining of non-conforming products
- during his shift, each operator produces semi-finished products as described in the Launch Sheet and Protocol, and performs checks and measurements according to the Quality Control Plan and Measurement Sheet [4,5,6,7].

2.8.3 Ensuring product traceability

In order to ensure product traceability, the following conditions must be met:
- each Al / Cu core coil is accompanied by a label from the supplier, with the batch number, coil number, wire quality
- a white label with the internal quality control stamp ("OK")
- a raw material not accompanied by both labels is not accepted for use, as above top
The information regarding
- batch number
- coil number
- date
- operator brand
- operator name
- drawn wire name
- drawn wire spool identification number
- measurement sheet identification number are entered in the machine register, to restore the history (traceability) of the product
After filling it, a white, numbered label is attached to each drawn core spool, on which the operator writes the following information:
- the machine (drawing machine) from which the wire comes
- wire diameter
- hardening status
- operator name
- operator decision regarding the quality of the drawn wire ("OK" or "NOTOK")
In case the operator's decision regarding the quality of the drawn wire is "NOTOK", a red non-conformity label is also attached to the drawn wire spool, also numbered, which contains:
- the name operator
- date
- machine (drawing machine) from which the wire comes
- blank (wire diameter)
- reel number
- operator shift
- brief description of the non-conformity
In this case, the blank is sent to the quarantine area for drawn wires, to prevent its accidental use.[8]

3.1 Handling of non-conformities

The main non-conformities that can occur during the drawing process are:
- drawn wire with diameter outside the given tolerances
- drawn wire with elongation and breaking force outside the given tolerances
- drawn wire with electrical resistance outside the given tolerances (when required)
- scratched drawn wire - due to lack of lubricating oil
- drawn wire with oil stains - due to wrong choice of die series[9]
- drawn wire with dimensional deviations - due to wrong choice of die series
- peeling - due to material defects from the supplier

3.2 Establishing responsibilities regarding quality assurance in drawing aluminum or copper wires

Within the companies in this field, methods and responsibilities regarding the execution of the drawing process are established. The scope of application is made by the management staff of the power cable manufacturing section, as well as by the staff assigned and qualified to work on the drawing lines.

3.3 Responsibilities

In order to meet quality objectives, there are several levels regarding the establishment of responsibilities placed on hierarchical levels. The specific responsibilities are presented below, starting from the highest level to the lowest.
1. Responsibilities of the PCE Manager
The manager of a drawing section has the following responsibilities:
- is responsible for the full implementation of all processes related to power cables;
- is concerned with the implementation and maintenance of the Quality Management System, applied in the areas of manufacturing of power cables;
- participates in the appropriate evaluation of human and material resources (Management Plan, Annual Training Program) and is responsible for their appropriate use.
2. Responsibilities of a technological engineer
Within a wire drawing section, the technological engineer has a very high importance. Among his responsibilities, the following stand out:
- is responsible for the quantitative, qualitative and timely implementation of the established manufacturing plan;
- ensures the proper storage of raw materials, to avoid their deterioration, and clearly identifies the storage areas for compliant and non-compliant raw materials, to avoid the unintentional use of non-compliant raw materials;
- ensures, upon entering the PCE section, the exclusive reception of raw materials fully identified and accepted by the QC Department;
- ensures the organization of the operators' table according to the requirements defined in OP-SL-QMS-8.5.2;
- provides the machine with the valid documents necessary for the proper conduct of the wire drawing process, for the complete identification of the drawn wires:
- OI-SLE-PCE- Operational Instruction
- IL-SLE-PCE- Work Instructions
- OP-SL-QMS-8.3.5 A3 Launch Sheet
- DP-TREF Process Data, Protocol
- instructs subordinate personnel regarding:
- organization of the operator's table and the content of the documents present at the machine;
- strict compliance with the process parameters prescribed in the DP or Protocol;
- filling in the machine register with the necessary data;
- identification and traceability of wires, as well as performing quality control operations and making quality records with the frequencies indicated in ST-SL-QC-001 and FO-SL-RQMS-001;
- detection, recording and reporting of non-conformities;
- effective application of the 6S Methodology (Order, Cleanliness, Standardization);
- establishes and visually identifies (red stripes, red barriers, delimitation labels) quarantine areas for the visible separation of non-conforming drawn wires.

3. Responsibilities of the foreman or team leader with foreman responsibilities
He verifies the development of activities related to the wire drawing process, as defined by the technological engineer.[10]
4. Responsibilities of the wire drawing operators
- performs all operations that define the wire drawing process;
- performs quality checks, in accordance with ST-SL-QC-001 and FO-SL-RQMS-001 and records the results;
- makes the decision on the status of semi-finished products, OK or NOTOK, based on the acceptance criteria established in ST-SL-QC-001 and FO-SL-RQMS-001;
- detects, records and identifies non-conforming products accordingly;
- informs the foreman when detecting non-conformities;
- notifies the process manager (foreman, technological engineer) if a mechanical or electrical defect occurs during the operation of the machine.[11]
5. Responsibilities of the PCE AQ Representative
The PCE AQ Representative monitors the implementation and maintenance of the Quality Assurance System defined for the wire drawing area, and compliance with the provisions of this operational instruction.
6. Responsibilities of the Quality Management Representative
The Quality Management Representative has the following responsibilities:
- monitors the implementation and maintenance of the Quality Assurance System defined for the wire drawing area;[12]
- verifies, through internal audits, the compliance with the requirements of the documents established for this area.

3. CONCLUSION

The article presents the most important elements regarding the wire drawing production technology and the quality assurance elements, from a practical point of view, that take place in a factory in this field. Compared to the specialized literature that presents these aspects theoretically, the presented work brings new elements that need to be known by specialists in the field.

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