DIRECTIONS OF IMPROVEMENT OF EQUIPMENT AND TECHNOLOGY FOR ELECTRODE MANUFACTURE

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The paper gives recommendations on improvement of coated electrode manufacture through the entire sequence of technological process, including direct grinding of coating components, preparation of liquid glasses and electrode rods, coating mixture preparation, electrode extrusion and heat treatment.

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At the current stage the volumes of consumption and manufacture of coated welding electrodes are reduced all over the world. This also leads to a significant lowering of attention and of investments into development of new engineering and technology solutions in this industry.

However, electrode productions that intend to stay in the electrode market, urgently need to work on the following: improvement of equipment and technology; development and introduction of new electrodes with highly effective welding-technological properties (specialists-electrode developers are working in this direction).

In the first area the objective in known: it is an essential improvement of stability and quality of electrode manufacturing at lowering of cost/productivity ratio. This can be achieved by applying a number of engineering and technology solutions.

1. Stage of preparation of welding electrode coating components — grinding:

a) at grinding it is necessary to stabilize the grain composition of each component by optimizing the respective mill operating modes (rotations, balls and their loading, time, size of ground component particles and its charging weight);

b) ensure production and utilization of powders of various materials with different required grain composition:

• fine (not less than 80 % of < 0.063 mm fraction), using special mills or batch-operation mills;

• coarse (within 80 % of > 0.160–< 0.355 mm fraction) with application of mills with continuous sieving.

Combining such grain compositions of different components at charge preparation allows, on the one hand, an essential improvement of technological (also plastic) properties of coating mixtures and, on the other, improvement of welding-technological properties of electrodes. This is achieved due to:

• minimizing the content of medium fraction of grain composition (> 0.063–< 0.160 mm) in the charge;

• presence of coarse fraction of grain composition in the charge in the amount of up to 30 vol.% (reinforcing component); the rest is fine fraction.

Reduction of production expenses will be not less than 10 %.

2. Liquid glass preparation:

a) soft-boiling of the lump and achieving stable parameters of liquid glass (with modulus of ≈ 3±0.05 and small viscosity of 100–500 cP, depending on electrode grade) due to application of no-autoclave method of lump soft-boiling without subsequent correction of viscosity (density);

b) stabilizing liquid glass properties after no-autoclave method of its manufacture proceeds very quickly — within about one day in settling tanks with simultaneous cooling and precipitation of a small residue.

This is followed by just liquid glass stabilizing by temperature (with mixing).

After silicate lump soft-boiling, when its impurities (contamination) and the rest have already had their effect on liquid glass properties (its characteristics) it is not rational to perform its filtering (i.e. expenses without effect).

Thus, liquid glass parameters will be stable, that, in its turn, stabilizes the technological properties of coating mixtures and process of electrode manufacture as a whole. Moreover, cost reduction in its manufacture will be equal to approximately 20 %.

3. Manufacture of sound rods with application of:

a) machine tools of simple design, easily readjusted and maintained with smooth cutting speed regulation;

b) efficient unwinding devices:

• for large bundles (1–1.5 t) — inertialess (without jerking and without stub-rods, respectively; smooth starting and stopping of bundle without braking);

• for small bundles (special wire) — rotating self-braking (with lubricator);

c) «octagon-shaped» knife to ensure the cut quality (without dents or burrs);

d) feed rollers with knurling and disc spring for their pressing up — stability of rod length and low wear of rollers;

e) funnel-shaped blocks from two sides.

It results in high quality of rods, minimum rejects, cost reduction and guarantee of their stable extrusion.

4. Preparation of coating mixtures and ensuring their high uniformity and plasticity by:

a) application of intensive counterflow mixers, that, in addition, eliminates the need for dry charge mixer:

• design of mixer, including actuators, should eliminate formation of dead areas and premature formation of mixture lumps with increased content of the liquid phase and hydrophylic components; in order to eliminate them, it is important that the velocity of impact of high-speed actuator was sufficient for breaking up such lumps along the entire height of coating mixture layer in the mixer;

b) rational method of plasticization, depending on charge composition, in particular grain composition, type and characteristics of liquid glass. This should result in good wettability of particles by liquid glass and medium rigidity of the structure of liquid glass gel in the film between charge particles. This is achieved by taking the charge–liquid glass–plasticizer system to medium activity, and to medium rigidity of liquid glass in the film.

Eventually, we get high plasticity and stability of coating extrusion process, particularly, in terms of non-uniform thickness; and higher efficiency.

5. Electrode extrusion.

Quality and stability are achieved at:

a) stable feeding of rods;

• high quality of manufactured and applied rods;

• stable axis of rod feed: vertical descent (including agitator), grip, first guide, feed rollers, second guide;

• smooth regulation of nip roller speed (depending on rod steel grade, amount and type of lubricant on the rods, rod surface condition, etc.);

• regulation of the distance between the gripping cage (nip roller axis) and feeding cage (feed roller axis) — $x = L_r - (10{\div}20)$ mm, where L_r is the rod length

• regulation of the distance between feed roller axis and outlet of extrusion head stalk tip — $y = L_r n$, where n is the rod number, i.e. extrusion ratio;

b) high plasticity of the mixture (considered above);

c) high angle of entrance zone (up to 160–180°) and minimum value of discard (10–15 mm thick);

d) efficient design of extrusion head:

• extrusion chamber of minimum volume between the tip and forming bushing (die);

• local expansions of mixture flow, also in the extrusion chamber in the course of flow formation from sleeve diameter up to die entrance, are not allowed;

• rod in extrusion chamber should constantly be slightly pressed-up by the mixture in one transverse direction;

• mixture flow in the extrusion head should be organized in the channel lined with wear-resistant replaceable elements;

• regulation of difference in thickness of electrode coatings during extrusion should be simple and reliable, due to minimizing the cross-sectional area of the composite cone in front of the die holder;

e) proper maintenance of the press (including briquetting press):

• elimination of formation of coating mixture blocks and their penetration into extrusion area (cleaning of briquetting press, hermetic storage of briquettes, cleaning of piston rod seal of extrusion cylinder to remove coating mixture remains, including discard, particularly at extrusion of electrodes of calcium fluoride type);

• timely replacement of worn working elements, including piston rod seals;

f) as regards dressing of electrode tips sound working elements and thorough adjustment of dressing machine.

All these measures will improve the quality of electrode extrusion at increase of efficiency by 10–15 %.

6. Electrode heat treatment.

This is the most labour-consuming and delicate stage of electrode manufacturing process. A rather tangible effect in heat treatment of electrode coating can be achieved:

a) due to improvement of technological, in particular, drying properties of coating mixtures associated with optimization of charge granulometric composition; application of low-viscosity liquid glasses; application of certain plasticizers (special additives);

b) due to application of the most effective heat treatment method (heating method), namely, induction, when the rod is heated by an induced field of high-frequency currents (8000 Hz). Here the heat and moisture flows in the coating are oriented in the same direction, that markedly accelerates the process of moisture removal. Moreover, heat losses during heat treatment are markedly lowered. Unfortunately, however, it is very costly to realize this method in the currently available productions: it is too expensive and takes a long time;

c) at convective heating method due to improvement of the carrying frame design, eliminating electrode coating damage, with minimizing of frame weight, and by organizing the optimum flows of heat carrier in the furnace working space so that the electrodes were blown along their axis. This provides uniform heat application over the entire coating surface and effective moisture removal at low blowing speeds, respectively. Under such conditions it is possible to heat treat, for instance, UONI-13/55 electrodes of 4 mm diameter, without preliminary curing, to moisture content of 0.2 % in 110–120 min.

At this stage 20 % reduction of power consumption for the process at simultaneous improvement of coating heat treatment quality can be achieved.

It is believed to be rational to strongly recommend application of operative simple instrument for non-destructive testing of difference in coating thickness of electrodes of any typesize.

Quite important also is sound piece-by-piece marking of electrodes with application of readily adjustable and maintainable device.

In conclusion it should be noted that in all the considered areas we have concrete design and technological solutions, verified and implemented in equipment and in productions.

Optimizing the other components of electrode production should be performed by production managers on the modern level (staff, training and certification, raw materials, all kinds of control and accounting, certification testing, packing, sale, etc.).

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