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Experience in Repairing Converter Gas Boiler-Coolers

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Abstract. In this project technical solutions were made based on many year working experience with boiler equipment in the converter shop. This project will reduce converter downtime and increase the volume of the produced liquid metal up to 400 thousand tenge and, taking into account all the extraneous factors, It will increase the economic effect of the ArcelorMittal Temirtau JSC by about $180 million per year without investing additional funds. This will also lead to increasing jobs in the Karaganda region and the opportunity to compete with foreign suppliers. In addition, when working at this project, the share of Kazakhstan content in the manufactured products of the ArcelorMittal Temirtau JSC increases. The use of the repair method described in the article will lead to improving the environmental situation in the city of Temirtau, since the normal functioning of the converter gas boiler-cooler directly affects the pollution of emitted impurities into the city atmosphere. Germany and Russia are interested in this technology.

Keywords: welding seam, lining, converter, lack of penetration.

Introduction

At the first glance, metallurgy seems to be an extremely conservative industry, where changes and modernization are not the trend of today but something that comes after a long run-in and experimentation [1]. But this is not so. The growing demand for high-quality steel grades will require special attention to equipment, both at new and modernized enterprises, and digitalization will be an integral part of all the stages of production activity [2, 3].

For example, such complex equipment as converter gas boiler-coolers is an extremely important thing in production [4]. They are designed to cool and to recover heat from waste gases of steelmaking converters, and serve to generate steam for technological needs [5]. The design of boiler-coolers takes into account high thermal loads, their cyclicity, and high dust content of gases leaving the neck of the converters [6]. Therefore, it is extremely important to carry out their timely and high-quality repairs.

There are several types of boiler-coolers for converter gases mounted behind converters with upper oxygen purge [7]. Such boilers are used for afterburning converter gases and cooling combustion products to the temperature of 250-300 °C, at which it becomes possible to clean them from dust [8].

Cooling converter gases by admission of cold air is associated with high energy costs to remove the gas-air mixture and the loss of a significant amount of heat. To reduce the temperature of gases from the 100-130 ton converter without burning CO, the required amount of air for dilution is 25 m^3/s [9]. When gas is uniformly mixed with air, the CO concentration in the mixture is 7.15%, which is much lower than the lower limit mixture for CO (12.5%). However, it is almost impossible to avoid explosive local concentrations, so CO has to be burned off. In this case, the air flow rate is about 140 m^3/s, the power of the electric motors of the smoke exhausters behind the gas cleaning to remove the gas-air mixture reaches 5000 kW [10].

The temperature and pressure at which the elements and devices of the boiler-cooler operate, provide increased requirements for quality and reliability during their production and repair. In addition, the production of boiler equipment is not serial. In some ways it is unique, and this is where the additional complexity of manufacturing and repairing industrial boilers lies.

1. Research methods

The technology of repairing boiler-coolers leads to increasing the overhaul period by paralleling repair work, as well as better and more efficient repairs in the presence of a reserve recoiling part of the boiler-cooler and repairing the heating surfaces of the boiler stationary part in a large-block way on special repair stands, which in turn reduces repair time and increases the service life of equipment.

With proper operation of boiler-coolers, repairs to the recoiling part can be carried out once every 12-14 months. This is extremely important to take it into account, since when the converters are heavily loaded, the enterprise does not have the opportunity to frequently stop production to carry out routine repairs.

The proposed technology makes it possible to combine the work of overhauling the recoil part and the lining of the converter. This period of downtime can be used to repair and to replace the recoiling and stationary parts of the boiler-coolers. If there is a reserve recoiling part, the replacement can be carried out within 7-9 days.

2. Results and discussion

From 2014 to 2020, the team of authors participated in mounting and repair work in the converter shop of the metallurgical plant of the ArcelorMittal Temirtau JSC. The company performed such work as repair of recoiling parts of converter gas boiler-coolers, replacement of skirts and heating surfaces of the stationary part of boiler-coolers.

Within this period, in the territory of the production workshop of the Praktika-T company, there were manufactured hinges, skirts, heating surfaces of the stationary part, filling caissons and the recoiling part of the boiler-coolers (Figure 1).

a)

b)

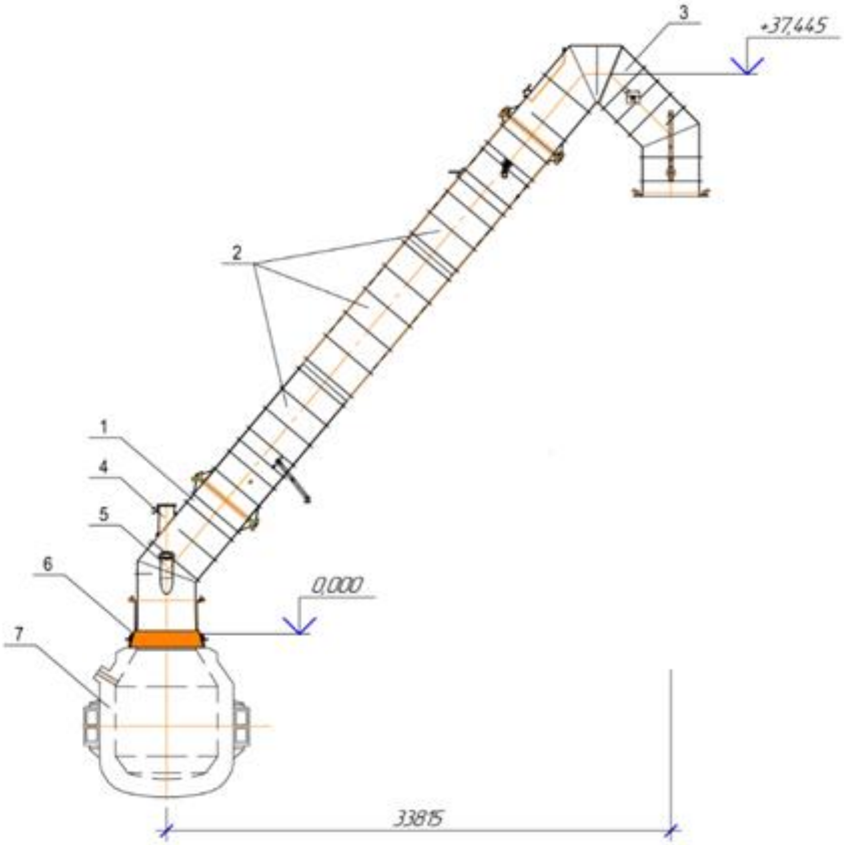
c)

a) skirt; b) filling caissons; c) recoiling part

Fig. 1. – Manufacturing the parts of boiler-coolers at the the Praktika-T company

To manufacture the recoiling part of the boiler-cooler, a special assembly stand and platforms for transportation were used. In 2018, the work was completed to mount and to put into operation the ecoiling part of the boiler-cooler of converter No. 1.

Boiler-coolers for converter gases are designed to cool and to recover heat from the waste gases of steelmaking converters (Figure 2). They also serve to generate steam for the technological needs of the plant. The design of boiler-coolers takes into account high thermal loads, their cyclicity, and a high dust content of gases leaving the neck of the converters.

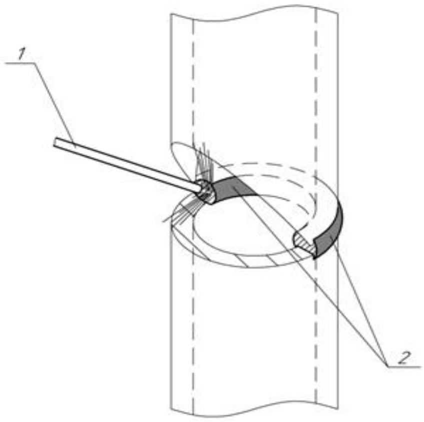


1 – recoiling part; 2 – stationary inclined part; 3 – stationary bypass elbow; 4 – tuyere caisson;
5 – caisson of bulk materials; 6 – skirt; 7 – converter

Fig. 2. – Converter gas boiler-cooler

This design of boiler-coolers is particularly complicated for carrying out repair work at the boiler work site. One of the difficulties is the forced use of operational welds to weld the heating surfaces of the boiler-cooler. During the repair work at the working sites of boiler-coolers, there were encountered such difficulties as inaccessibility of welding work, which entailed the need to perform operational welds.

The operational welding seam is used in a hard-to-reach place, through a technical window. It is mainly used in pipe welding. This type of welding seam has two significant disadvantages: frequent lack of penetration and the ingress of foreign particles in the form of slag and scale from welding into the pipe. This is extremely unacceptable for the normal functioning of the boiler-cooler. This significantly reduces the quality of the repair work performed, since the performance and service life of the boiler directly depends on the purity of the water.



1 – welding seam; 2 – welding the pipe from the inside

Fig. 3. – Operational welding seam

Based on the experience gained, there was proposed changing the technology of repairing boiler-coolers.

The repair technology developed includes the presence of a reserve recoiling part of the boiler-cooler and the repair of heating surfaces of the stationary part of the boiler using a large-block method on special repair stands.

With proper operation of boiler-coolers, repairs to the recoiling part can be carried out once every 12-14 months. Due to a high load on converters, it is not possible to frequently stop production for routine repairs.

Once a year, the work on converter lining is carried out. The developed technology makes it possible to combine the work on the overhaul of the recoiling part and the lining of the converter. This period of downtime can be used to repair and to replace the recoiling and stationary parts of the boiler-coolers. If there is a reserve recoiling part, the replacement can be carried out within 7-9 days. The failed recoiling part is placed on a special repair stand, which will allow performing a complete troubleshooting and high-quality repair, preparing it for further re-use until the next repair of the recoiling part in operation. Repairing the recoiling part on a special repair stand gives full access to welding work, the ability to test and to perform repair technology at a high level that is difficult to do when repairing the working platforms of a boiler-cooler.

The blocks for repairing heating surfaces of the stationary part of the boiler-cooler are assembled at the repair site using special repair stands. Replacing the damaged part with one large block makes it possible to carry out repair work quickly and efficiently. The blocks for repair can also be assembled at the manufacturer's factory.

Conclusions

The main advantages of the proposed technology of repairing boiler-coolers is significant increasing the quality of repair work, which in turn halves the costs and the time of its implementation. It is worth noting that this repair technology will be effective if the metal smelting technology is strictly followed, since adherence to the technology directly affects the service life of the power equipment of the converter shop.

This will also lead to increasing jobs in the territory of the converter shop and the opportunity to compete with a foreign supplier.

In addition, when working at this project, the share of Kazakhstan content in the manufactured products of the ArcelorMittal Temirtau JSC increases.

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