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ANALYSIS OF INSTALLATION AND BASISING METHODS OF NODES OF TECHNOLOGICAL LINES OF METALLURGICAL SHOPPING PLANTS

Rolling production is the final stage of the metallurgical cycle, and the quality of finished products supplied to the consumer directly depends on the coordinated operation of all technological units. The high level of wear and tear of the main production assets of metallurgical enterprises necessitates not only their renewal, but also the constant modernization of outdated equipment. Since renewal is carried out in the conditions of existing production, this process involves complex installation work to integrate new or reconstructed equipment into already functioning production lines.

Operation of mechanical equipment is a set of three interdependent processes: performance of technological operations, wear during operation and performance of repair actions to restore operability. The rate of wear of machines and mechanisms depends on both the intensity of technological actions and the quality of installation work, lubrication modes of friction units, periodicity and completeness of technical maintenance.

The reliability of machines depends on the quality of design, technological and assembly work. Errors in dimensions, configuration, mutual arrangement of parts can lead to an unacceptable increase in forces and emergency failures. For metallurgical equipment, such errors often appear during assembly, which is understood as a set of operations to connect parts into a product. Thus, an important issue arises of establishing optimal methods for assembling metallurgical equipment in the conditions of a manufacturing enterprise in view of the possibility of minimizing all possible errors in assembly work.

Known methods of assembly and verification of basic parts of technological equipment are somewhat outdated and require constant and continuous improvement. The most accurate and fast method of controlling the accuracy of assembly and installation of basic parts is optical-geodetic, which allows you to free up to 20% of working personnel and at the same time save up to 30% of working time compared to the string method of controlling the assembly of metallurgical equipment units.

Keywords: foundation, installation accuracy, string method, optical-geodetic method, theodolite.

Problem statement. Modern technological lines of metallurgical production workshops have a lot of auxiliary and main equipment, which consists of various components such as gearboxes, electric motors, as well as the executive unit itself [1-3].

Operation of mechanical equipment is a set of three interdependent processes: performance of technological operations, wear during operation and performance of repair actions to restore operability. The rate of wear of machines and mechanisms depends on both the intensity of technological actions and the quality of installation work, lubrication modes of friction units, periodicity and completeness of maintenance. The quality of the restoration process (repairs and preventive maintenance) is determined by the level of knowledge about the patterns of failure of parts, the organization of repair production, and the qualifications of service personnel. High operational reliability of units and equipment is achieved through the use of the most modern methods of maintenance and repair [4-5].

The complexity of technological processes in metallurgy has significantly increased the requirements for the reliability of units and equipment. High operational reliability of equipment is achieved through the use of the most modern methods of maintenance and repair: centralization of repairs and repair forces, improvement of organization, planning, production and provision of spare parts; application of methods for increasing the durability of parts; industrial repair methods – large-unit and aggregate; improvement of the lubrication system [6].

The reliability of machines depends on the quality of design, technological and assembly work. Errors in the dimensions, configuration, and mutual arrangement of parts can lead to unacceptable growth of forces and emergency failures [7]. For metallurgical equipment, such errors often appear during assembly, which is understood as a set of operations to connect parts into a product.

Thus, an important issue arises of establishing optimal methods for installing metallurgical equipment in a production enterprise, taking into account the possibility of minimizing all possible errors in assembly work.

Analysis of recent research and publications. Assembly technology depends on the nature of production. In mass production, machines are assembled from interchangeable parts on conveyors, in serial production at several workplaces from parts that require minor adjustment, and in individual production on temporary foundations [8].

The basic parts of mechanical equipment include large supporting parts of machines [9], which are installed primarily on foundations or other bases [10].

The foundation is the supporting part of the equipment and is designed to transfer the load from the structures located on it to the base, that is, to the (soil) [11].

The operational qualities of the equipment, and of course the durability of its use, depend on the reliability and stability of the foundations. The cost of building foundations can be up to 40% of the cost of the equipment itself, but correcting mistakes is usually very expensive, so the construction of the foundation must be approached very responsibly. [12].

The soil located under the foundation and bearing the load from the weight of the equipment and the foundation itself is called the base. The bases under any buildings and structures can be of two types – natural and artificial [13].

Natural bases include those on which the foundation is laid without any additional reinforcement. An artificial base is one that is reinforced, for example, with sand bedding (sand cushion), crushed stone or other material, followed by tamping [14].

The initial indicators for designing foundations are the parameters and overall dimensions of the machine bases, the foundation loading scheme, data on geology, hydrogeology and physical and mechanical properties of the soil, schemes for attaching the foundation to the building, and the location of embedded parts, pits and channels [15]. In addition, an important point is not only the installation of equipment on the foundation, but also its interdependent attachment on the foundation to already installed structures and buildings, which is one of the main tasks of mechanical installers.

The basic parts are installed in the design position, checking along two mutually perpendicular axes in plan and in height. Thus, according to the known method [16], the position of the actuator drive reducer in plan is checked in kind along the reference axes, made in the form of strings stretched along the installation axes (Fig. 1).

With this method, it is necessary to perform a whole complex of interconnected and resource-intensive operations. According to the assembly diagram, first you need to install racks designed to hold the axes 4 (Fig. 1). Next, you need to stretch the strings 13, which duplicate the axes, and hang the pendulums 12 to them. It is important to connect the pendulums with the marks on the plates in such a way that they leave a gap of 1…2 mm to the mark.

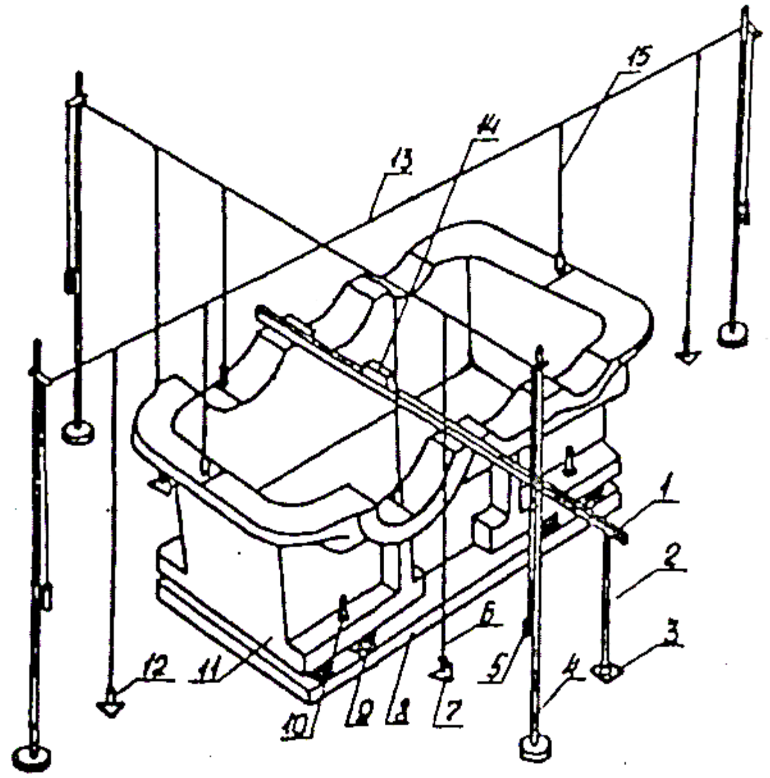

Figure 1 – Scheme of installation and calibration of the gearbox of the actuator of the metallurgical unit

On the gearbox housing 11, the longitudinal and transverse axes should be marked, focusing on the position of the driven wheel shaft inserts. Next, it is necessary to determine and form packages of installation and adjustment pads of the appropriate thickness. These packages 9 should be placed near the foundation bolts on the frame 8.

The next step is to precisely align the installation packages of the pads using a benchmark. After that, the body 11 is installed on the foundation bolts, and the towers 15 are brought closer to the strings 13. The longitudinal and transverse axes of the body should be carefully checked with the position of the towers.

Using the reference 3, ruler or measuring tape 2, alignment ruler 1 and level 14, it is necessary to check the height position of the housing. If there is a need to adjust the height, it should be adjusted using adjustment shims. After that, the foundation bolts 10 must be securely tightened. At the final stage, the final alignment of the structure is carried out.

The position of the base parts in the vertical plane is regulated using metal shims. Metallurgical equipment is mainly installed on packages of rectangular metallurgical shims. The height of the package is determined by calculation, based on the actual assessment of the top of the foundation concrete, provided in the executive diagram, and the design assessment of the bottom of the base of the base part. The height of the package is set with an overestimation of 1…3 mm, taking into account its subsidence when tightening the bolts. Gaskets with a thickness of 5 mm and above are called adjustment, and from 0.5 to 5 mm – adjustment. The base part is installed on the packages of shims. Using the adjustment shims and the level, its position in plan and in height relative to the benchmark and design axes is checked, and a form is drawn up for the installation of the base part. The number of shims or the required area of the package is determined by the formula [17]:

$$m = \frac{P + 0{,}75 n d^2 \left[\sigma\right]}{kF\left[\rho_\sigma\right]}, \quad (1)$$

where P is the technological load from the weight of the unit, N; n – number of anchor bolts; d – diameter of the anchor bolt, mm; [σ] – allowable stress from tightening the anchor bolt; k – coefficient of unevenness of the substrate to the foundation; F – area of the substrate package, mm^2; ρ_σ – permissible specific pressure on concrete from gaskets.

After final alignment, the substrates in the package are welded together by electric arc welding. The form indicates the actual and design dimensions and estimates, the alignment method, and the tool with which it was performed.

To perform this method of installation and adjustment, a team of at least four installation workers and an additional welder is required.

Research objective. Given the laboriousness of the known method of assembling basic parts and the acute shortage of working personnel in wartime conditions, the question arises of considering more promising and progressive methods of assembling and adjusting metallurgical equipment. The main goal of the study is to create prerequisites for assembly with a smaller number of working personnel, provided that the quality of the adjustment of basic parts does not deteriorate, but on the contrary, with the possibility of improving it.

Presentation of the main material.

The optical-geodetic method is a more accurate way to control the accuracy of assembly and installation of basic parts and machines compared to the string method given above. Its essence lies in fixing optical axes using high-precision theodolites, as well as in determining elevations using precise electronic levels and compact dotted lines. Theodolites are used to measure horizontal angles and angles of inclination, which allows you to determine the direction of the axes with high accuracy. They can be mechanical, optical or electronic, but optical models are most often used in installation work [16]. At the same time, given the constant development of equipment for performing installation work, it sometimes does not even require professional education to use, but basic engineering knowledge is enough. Thus, the teachers of the department purchased a laser theodolite from the Deko company, model Laser 4V1H, which belongs to professional installation devices, for conducting laboratory work. (Fig. 2).

This model belongs to the self -leveling laser x high-precision x devices that appointed and for construction and finishing works. He automatically leveled and capable to design not only horizontal and vertical lines, and also a point slope. For comfortable good job illuminated premises foreseen possibility using laser glasses that provide clear visibility beam on any surfaces.

Key characteristics models:

– projection: 5 lines and 6 points.
– operating range: up to 30 m without use receiver.
– laser type: combined, green.
– system Alignment: automatic.
– power supply: three AA batteries (1.5 V) or from a power supply unit operating from a 220 V household AC network.
– fastening: thread for 5/8" tripod.
– rotation: 360° [18].

For additional control of the equipment's tilt points, a compact digital protractor-level (inclinometer) is used. with a measurement accuracy of 0.2°. Although this device is quite simple to use, it allows you to control the deviation of the installed equipment from the horizontal or vertical axis by reproducing the tilt angles on the liquid crystal screen. In case of unexpected battery discharge, analog tilt angle control elements are installed – bubble capsules, which allows for comprehensive and continuous process control.

Another equally important factor is the attachment of the equipment to structures indoors or on an industrial site. The simplest and most effective in this aspect are laser rangefinders on the ProZone T-40 Red, which is also used for educational purposes when performing laboratory work in the educational process (Fig. 3).

The device is quite versatile and professional, allows you to perform height measurements at a distance, has the ability to perform unprecedented measurements. Its main characteristic is a measurement range of up to 40 m with an error of 1.5 mm, which allows you to perform high-precision alignment to shop communications.

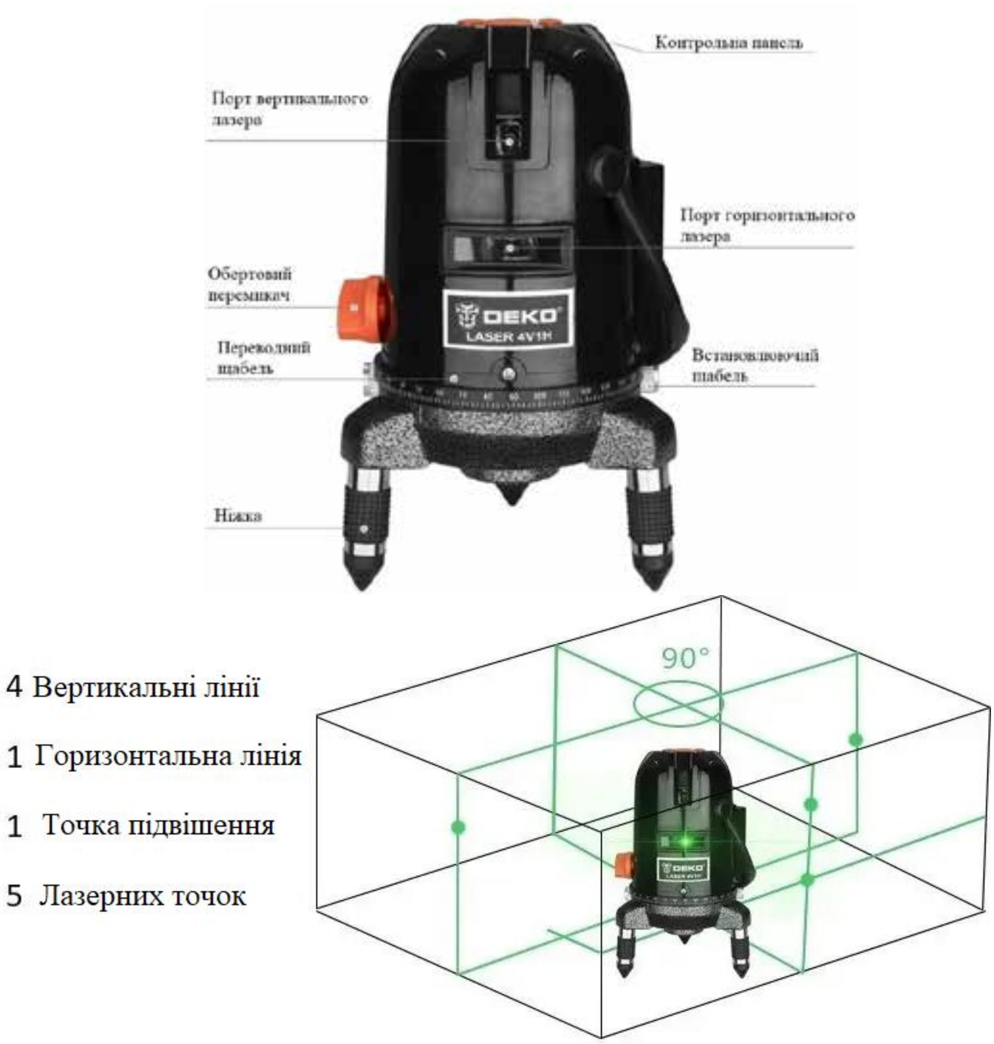

Figure 2 – Deko Laser theodolite model Laser 4V1H [18]

Figure 3 – Professional laser rangefinder ProZone T-40 [19]

The advantages of the device include the ability to instantly calculate not only the surface area of the foundation on which the equipment is planned to be installed, but also its volume, which at the installation stage will allow you to check the compliance of the calculations made for the manufacture of the foundation with its actual execution. The built-in memory allows you to store up to 20 of the last measurements.

Thus, the use of relatively inexpensive, but professional devices for performing the optical-geodetic method of basing parts when performing laboratory work allowed to reduce the time for conducting the practical component of measurements by 40%, and free up at least 2 personnel when imposing the equipment calibration scheme in relation to the string method. At the same time, the accuracy of setting up laboratory equipment has significantly improved.

Conclusions. An important stage in the modernization and repair of metallurgical equipment is its installation and alignment at the assembly stage. The most common and used string method of alignment of basic units is morally obsolete and is quite costly in terms of the use of human resources. The indisputable advantage over the string method is the use of the optical-geodetic method, which, thanks to the constant improvement and reduction in the cost of specialized devices, allows you to free up to 20% of human resources during the assembly of equipment. At the same time, the time for aligning basic parts on control marks can be reduced by a total of 30%, which is important in conditions of work with a shortage of service personnel.

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АНАЛІЗ МЕТОДІВ МОНТАЖУ ТА БАЗУВАННЯ ВУЗЛІВ ТЕХНОЛОГІЧНИХ ЛІНІЙ МЕТАЛУРГІЙНИХ ЦЕХІВ

Прокатне виробництво є завершальним етапом металургійного циклу, і якість готової продукції, що постачається споживачеві, безпосередньо залежить від злагодженої роботи всіх технологічних агрегатів. Високий рівень зношеності основних виробничих фондів металургійних підприємств зумовлює необхідність не лише їх оновлення, а й постійної модернізації застарілого обладнання. Оскільки оновлення здійснюється в умовах діючого виробництва, цей процес передбачає складні монтажні роботи з інтеграції нового або реконструйованого обладнання в уже функціонуючі виробничі лінії.

Експлуатація механічного устаткування – це сукупність трьох взаємозалежних процесів: виконання технологічних операцій, зношування в процесі експлуатації та виконання ремонтних впливів по відновленню роботоздатності. Швидкість зношування машин і механізмів залежить як від інтенсивності технологічних впливів, так і від якості монтажних робіт, режимів змазування вузлів тертя, періодичності й повноти технічного обслуговування.

Надійність машин залежить від якості конструкторських, технологічних і складальних робіт. Погрішності в розмірах, конфігурації, взаємному розташуванні деталей можуть привести до неприпустимого росту сил й аварійних відмов. Для металургійного встаткування такі погрішності часто проявляються при зборці, під якою розуміють сукупність операцій по з'єднанню деталей у виріб. Таким чином постає важливе питання встановлення оптимальних методів монтажу металургійного обладнання в умовах виробничого підприємства з огляду на можливість мінімізаціїї всіх можливих погрішностей складальних робіт.

Відомі методи монтажу та вивірки базових деталей технологічного обладнання дещо застаріли та потребують постійного і безперервного удосконалення. Найбільш точним та швидким методом контролю точності складання та встановлення базових деталей є оптико-геодезичний, який дозволяє вивільнити до 20% робочого персоналу та одночасно зекономити до 30 % робочого часу в порівнянні зі струнним методом контролю складання вузлів металургійного обладнання.

Ключові слова: фундамент, точність монтажу, струнний метод, оптико-геодезичний метод, теодоліт