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RECONSTRUCTION OF THE ASH AND SLAG REMOVAL SYSTEM IN CHP-2 OF JSC «ARSELORMITTAL TEMIRTAU»

This article discusses the modernization of the ash and slag removal system at CHPP-2 of JSC «ArcelorMittal Temirtau», the transition from the wet method of cleaning ash and slag to a more technologically advanced dry one. The long-term use of the hydraulic ash and slag removal system (GZSHU) has led to the accumulation of a huge amount of ash, which is subsequently not used. A comprehensive replacement of wet cleaning equipment for dry cleaning is considered. The wet method offers quenching with water (in this case, up to 1 % of the thermal efficiency of the TP-81 boiler unit is lost), followed by the use of drag pumps and the removal of ash and slag through the hydraulic ash removal channels to the ash dump.

In the future, this ash cannot be used. During dry ash and slag removal, extinguishing with water is not used, but a pneumatic system for removing combustion products is used. Ash from gas cleaning plants through a system of pneumatic chamber pumps and intermediate hoppers is fed through ash pipelines to a silo warehouse. The use of this technology allows minimizing the harmful impact on the environment by reducing groundwater pollution with pulp, reducing the area of ash dumps, reducing water consumption by the station, using ordinary types of steel in pipeline systems, and reducing the cost of equipment maintenance.

Keywords: boiler, slag, ash and slag removal, dust preparation, hydraulic ash removal, fuel, coal, ash.

Introduction

Today, ash disposal is an urgent problem. Up to 30 million tons of ash and slag waste is generated annually in Kazakhstan, most of which is sent to giant dumps and is not used in any way.

In order to use ash and slag, it must be turned into a commodity, it is necessary to modernize the ash and slag removal system operating at the coal-fired CHPP-2, replacing the wet method with a more technologically advanced dry one.

The long-term use of the hydraulic ash and slag removal system (GZSHU) has led to the accumulation of a huge amount of ash, which is subsequently not used.

The toxicity of ash and slag hydromass consists in the release of alkali, which enters directly into the ground, contaminating groundwater. Obvious environmental consequences are complemented by economic ones [1].

Materials and methods

The hydraulic ash removal system is designed to remove ash and slag from the bunkers of the boiler unit and transport them outside the station territory (ash dump).

In the boiler shop of CHPP-2 in JSC «ArcelorMittal Temirtau» two pump rooms are installed, to which process water is supplied from the circulation conduit №7 through valves with a diameter of 400 to the pump room №1,2 and from the circulation conduit №8 through a valve with a diameter of 600 additionally to the pump room branch №2. Clarified water is supplied from the GTS workshop to the CHPP-2 boiler shop through the JET filter located inside building of the bager pump house №2. The filter is cut off by two valves with a diameter of 400 [2].

The filter is equipped with a bypass line through a valve with a diameter of 300. Further, after the filter, the clarified water collector before entering the boiler shop is divided into two flows into pump rooms №1 and №2. One pipeline enters to pump room №2 through a valve with a diameter of 300, the other pipeline, passing through the workshop №1 along row D at elevation 4m in the area of DV-4B through a sectional valve with a diameter of 400, enters the suction in pump room №1 through a valve with a diameter of 400. Pump room №1 is mounted at the permanent end of the boiler shop.

In the distribution manifold of pump room No. 1, the suctions of flushing pumps NSV No. 1,2 and irrigation pumps NOV No. 1,2,3 and washing of boilers NOK No. 3 crash into the distribution manifold. Pump room No. 2 is mounted between queues No. 1 and 2. Suctions of flushing pumps NSV No. 3,4 and irrigation pumps NOV No. 4,5,6 and washing of boilers NOK No. 2 crash into the distribution manifold of the pump room. Heads NSV No. 1-4 through valves supply water to a common collection manifold of flush water with a diameter of 325x8, mounted along row D. From it, through a pipeline with a diameter of 159x4mm, water is supplied to the incentive nozzles of the GZU channels, the ShZU channel, slag baths, through a pipeline with a diameter of 133x4mm on flushing nozzles of trays (collecting collectors for water seals) of electrostatic precipitators, on irrigation units of ring emulsifiers of boilers TP-81 No. 1-4. In the DV-4B area of the flush manifold, a sectional valve with a diameter of 300 was mounted. In the area of

DV-2A, 2B, the flushing intakes of the boilers NOK No. 1 and 4 cut into the flush manifold from the flush manifold.

Heads NOV No. 1-6 through valves supply water to a common collecting collector of irrigation water with a diameter of 325x8 mm, mounted along row E. From the irrigation collector, water is supplied to the irrigation units of the ring emulsifiers of boilers TP-81 No. 1-4 and to irrigation of hydraulic seals of electrostatic precipitators of boilers TP- 81 No. 5 and 6 through 4 collectors 89x3.5. In the area of the ring emulsifiers TP-81 No. 3, a circulation line is provided through a valve with a diameter of 300 mm between the irrigation and clarified water collectors [3].

To clean flue gases at the boiler unit TP-81 No. 5.6, electrostatic precipitators of the ESG2X4 type with high-voltage converter units of the ADOR POWERTRON type are installed. Electrostatic precipitators provide deep purification of gases (purification degree 98%) and almost completely trap particles with a size of 0.01 mm or more. To clean flue gases, ring emulsifiers are installed at boiler units TP-81 No. 1-4 [4].

The system of hydraulic ash removal includes: channel GZU, flushing nozzles through the channels GZU, slag baths – 4 pcs. per boiler, screw conveyor – 4 pcs. per boiler, single-roll crushers – 4 pcs. per boiler, irrigation water pumps - 6 pcs. per workshop, flush water pumps – 4 pcs. per workshop, smoke exhausters – 2 pcs. for the boiler, ash-flushing devices (hydraulic locks) with nozzles – 4 pcs. for boilers TP 81 No. 1–4, 12 pieces for TP-81 No. 5.6 for the ash collection unit [5].

Dry ash removal systems use: manual, mechanical and pneumatic methods.

Results and discussion

Pneumatic dry ash removal finds its application in cases where separate removal of slag and ash is required, which can be used as raw materials in the cement industry, production of building materials and agriculture.

The pneumatic ash removal system uses air as the driving force. The slag entering this system requires crushing and grinding to certain sizes. For this, crushing plants are installed under the bunkers. The temperature of the slag for crushing should not exceed 600 °C.

Pneumatic systems can be vacuum, pressure and combined.

The vacuum system is used in case of a short distance to the receiving hopper or consumer. At the end of the pneumatic system, a vacuum pump or ejector is installed, which creates a vacuum in the pipeline. Ash and slag enter the pneumatic pipeline, are picked up by air and sent to the cyclone for purification and further transportation. The vacuum system is characterized by tightness and compactness of the equipment and ease of operation.

The pressure system is used to transport the removed slag and ash over a distance of up to 1000 meters. Dry ash removal is carried out using compressed

air. To create the necessary pressure, compressors, fans or pumps are installed at the beginning of the system.

The combined system makes it possible to transport slag and ash waste over a considerable distance (more than 1 km). Dry ash removal of this type consists of two or more pressure and vacuum systems connected in parallel.

The pneumatic ash removal system can be suction, discharge and combined. When using a suction system, slag and ash are transported under vacuum, which is created by a vacuum pump or steam ejector, in a stream of sucked air. For the pressurized system for transporting slag and ash, a compressed air flow supplied from a compressor is used. Combined systems combine the principles of transporting a suction and discharge system. At the same time, slag and ash are taken according to the suction system scheme, and transported to the consumer (for example, to a building materials plant) - according to the discharge system scheme.

For pneumatic transport of slag and ash from steam or hot water boilers, it is recommended to use a suction system. In this case, the distance to the unloading station should not exceed 200m. The operating mode of the pneumatic ash removal system should be periodic, lasting no more than 4 hours per shift.

Schematic diagram of pneumatic ash and slag removal, performed on a suction system. With such a system, the entire route of the ash pipelines is under vacuum. This ensures the absence of dusting along the entire slag and ash transportation path. The slag is preliminarily prepared and crushed to a size of about 20 mm in two-roll or three-roll crushers. Transportation of crushed slag and ash is carried out in dry form, while selection into the system is made only from one point. For the complete removal of slag and ash, all intake devices connected to the pneumatic system are switched on in turn.

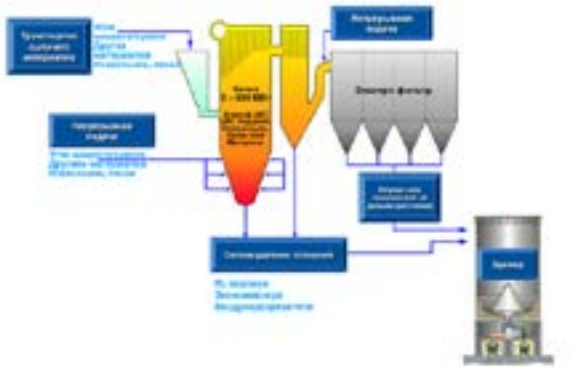
The main elements of the pneumatic slag ash removal system are slag crushers, ash receiving devices, ash pipelines, a vacuum plant and an ash settling station. At the same time, the ash settling station consists of a settling chamber, two series-connected centrifugal cyclones and a bunker for collecting slag and ash.

The slag after opening the shutter enters through the crusher into the horizontal suction nozzle. At the same time, due to rarefaction in the system, atmospheric air is sucked into the nozzle 4, which picks up slag from the nozzle and transports it through the pipeline to the settling chamber. Purified from suspended particles in the settling chamber and two cyclops connected in series, the air is ejected by the ejector into the chimney or through a special pipe into the atmosphere. Instead of an ejector, a vacuum pump can be used.

After removing the slag from the hopper, the nozzle is disconnected from the pipeline by turning the handle of the cork valve. The fly ash caught in the ash catcher or the ash accumulating in the flue is sucked into the ash pipeline through a telescopic nozzle.

The release of slag and ash from the settling chamber is carried out after opening the butterfly valve (not shown in the figure) through the flasher valve. Before the release of slag and ash in the system, the vacuum is removed. The release of fine ash from the cyclones is carried out after the vacuum is removed by opening the valve [6,7].

The dry ash removal system (SZSHU) assumes that the ash from the bunkers of gas cleaning plants is poured into pneumatic chamber pumps. Then compressed air drives it to the silo through special ash pipelines.



Picture 1 – The dry ash removal system

In ash storage silos, aeration (entrainment) is carried out periodically to prevent the occurrence (overcompacting) of ash, as well as during its unloading. Only 20–25 % of the silo bottom area is laid with aerating tiles; supply air pressure should be 2–3 atm at a flow rate of 0.25 m^3/min per 1 m^2 of aerating surface.

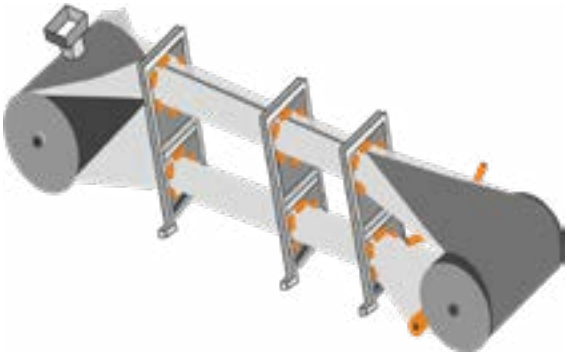
Picture 2 – Silo bottom aeration system

Each silo has three unloading lines: dry unloading to road transport, wet unloading to road transport, ash supply to the circulation station. Equipment for dry

loading (unloading) of ash is an aspiration sleeve. The suction sleeve is a telescopic two-channel coaxial design. When loading, bulk material enters the container to be filled through the inner cavity of the sleeve, and the dust that occurs at the outlet of the sleeve is sucked into the outer cavity and transported by an individual fan back to the silo, ensuring the complete absence of dust when unloading the material. It is also possible to use suction arms with their own filter bag [8,9].

The silo warehouse consists of two cylindrical tanks with a height of 70 m and a volume of 20,000 m³. The design is a bit like an elevator, only instead of grain, a by-product of burning coal is collected inside. Despite the impressive size of the silos, it is enough for the station to work a little more than two days in a row to fill them.

Part of the ash from the silos is shipped for sale, because it is not just a waste, but also a valuable raw material used in industry and agriculture. Today, ash can be simultaneously loaded into four tank trucks and six rail cars. The unclaimed volume is sent to the pipe belt conveyor, along which it moves to the place of permanent storage (ash dumps).



Picture 3 – Pipe belt conveyor

Pipe belt conveyor is a unique engineering structure. Its length is 4.5 km. First, the ash is poured onto a rubber band, in the course of movement, the rollers twist this tape into a pipe. This ensures the transport of ash in a closed form.

The pipe belt conveyor ends with a spreader, which lays the ash in even layers. The layers are compacted by bulldozers and rollers. To prevent dusting, the dump is irrigated. After filling the dump, loamy soil is applied to its surface and grass is sown, and sowing and watering are automated.

Pneumatic chamber pump (PKN) is designed for transportation of bulk powder materials through pipelines using compressed air.

Due to the use of original design solutions and optimization of the operating modes of the pump, the reduction in compressed air consumption during the transportation of bulk materials in conventional pneumatic transport systems reaches up to 35 %. The temperature of the transported material of the PNK-20 pump is 150 ^{0}C, which is less than the temperature of the ash, and therefore the temperature of the ash will decrease in the air slides.

It is proposed to install a dry method for cleaning slag behind boilers 5 and 6 using existing electrostatic precipitators.

The flow rate of the resulting ash in one boiler is 6 t/h.

Based on the selection of pneumatic transport, 2 pneumatic chamber pumps PKN – 20 series of the POSEIDON [10] will be installed behind one boiler with a capacity of 20 m3 / h.

Picture 3.2 –Pneumatic chamber pumps
PKN – 20 series of the POSEIDON

Pneumatic transport will be located in the Pump Room No. 1, which is mounted at the permanent end of the boiler shop. Compressed air will be supplied from the compressors of the steam power plant located on the territory of JSC «ArcelorMittal Temirtau». The cost of upgrading the ash removal system is more than 25 million tenge.

Conclusions

The article considered a comprehensive solution for the removal of ash and slag at the station. The change of the hydraulic ash and slag removal system to dry ash and slag removal is considered. This will achieve the following effects:

1) The implementation of the project for the construction of a system for dry ash removal and storage of ash and slag waste at a dry landfill according to

a high-load scheme will provide the station with storage for storage for a period of up to 40 years.

2) The harmful impact on the environment will be minimized by reducing the pollution of groundwater with pulp.

3) Reducing the area of ash dumps.

4) Reduction of water consumption by the station.

5) Reducing the level of electricity consumption at the station.

6) Possibility of using common types of steel in piping systems.

7) Reducing the cost of equipment maintenance.

Since the proportion of combustibles in the slag is very high, it is therefore possible to consider the option of returning the slag to the combustion chamber of the boiler. In this case, the following results can be achieved:

1) Optimization of costs associated with the removal of slag by road, its storage and reclamation on the territory of the ash dump.

2) Improvement of the existing slag removal scheme with an increase in the level of mechanization and automation of this process.

3) Increasing the level of the sanitary and hygienic condition of the premises of the working area of the slag removal site.

The project is self-sustaining, the payback period is 6 years and 6 months.

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РЕКОНСТРУКЦИЯ СИСТЕМЫ ЗОЛОШЛАКОУДАЛЕНИЯ В УСЛОВИЯХ ТЭЦ-2 АО «АРСЕЛОРМИТТАЛ ТЕМИРТАУ»

В данной статье рассмотрена модернизация системы золошлакоудаления на ТЭЦ-2 АО «АрселорМиттал Темиртау», переход с мокрого способа очистки золы и шлака на более технологичный сухой. Многолетнее применение системы гидрозолошлакоудаления (ГЗШУ) привело к тому, что скопилось огромное количество золы, которая в последствии не используется. Рассмотрена комплексная замена оборудования мокрого способа очистки на сухое. Мокрый способ предлагает гашение водой (при это теряется до 1% теплового КПД котельного агрегата ТП-81) с последующим применением багерных насосов и уноса золошлаков по каналам гидрозолоудаления на золоотвал. В дальнейшем использовать эту золу нельзя. При сухом золошлакоудалении гашение водой не используется, а применяется пневматическая система удаления продуктов горения. Зола из газоочистных установок через систему пневмокамерных насосов и промежуточных бункеров подаётся по золопроводам на силосный склад. Применение данной технологии позволяет минимизировано вредное воздействие на окружающею среду, путем снижения загрязнения подземных вод пульпой, уменьшить площади золоотвалов, уменьшить потребление воды станцией, использовать обычные виды стали в трубопроводных системах, уменьшить стоимость технического обслуживания оборудования.

Ключевые слова: котел, шлак, золошлакоудаление, пылеприготовление, гидрозолоудаление, топливо, уголь, зола.

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КҮЛ-ҚОЖ ШЫҒАРУ ЖҮЙЕСІН ҚАЙТА ЖАҢАРТУ «АРСЕЛОРМИТТАЛ ТЕМІРТАУ»АҚ 2-ЖЭО ЖАҒДАЙЫНДА

Бұл мақалада «АрселорМиттал Теміртау» АҚ 2-ЖЭО-да күл-қожды жою жүйесін жаңғырту, күл мен қожды тазартудың дымқыл тәсілінен негұрлым технологиялық құрғақ тәсілге көшу қарастырылды. Көп жылдар бойы гидрокүл-қожды шығару жүйесінде (ГККШ) қолдану нәтижесінде көп мөлшерде күлдің жиналуына әкелді, ол кейіннен пайдаланылмайды. Дымқыл тазарту әдісін құрғақ тәсілмен кешенді ауыстыру қарастырылған. Сулы әдіс сумен сөндіруді ұсынады (бұл жағдайда ТП-81 қазандық агрегатының жылу тиімділігінің 1 %-ке дейін жоғалады), содан кейін бағерлік сорғыларды қолдану және күл үйіндісіне гидрокүл жою арналары бойынша күл-қождын шығару. Болашақта бұл күлді пайдалану мүмкін емес. Құрғақ күл-қожды жою кезінде сумен сөндіру пайдаланылмайды, ал жану өнімдерін жоюдың пневматикалық жүйесі қолданылады. Gorenje. Газ тазарту қондырғыларынан күл пневмокамералық сорғылар мен аралық бункерлер жүйесі арқылы күл құбырлары арқылы сүрлем қоймасына беріледі. Бұл технологияны қолдану жер асты суларының пульпамен ластануын азайту, күл үйінділерінің ауданын азайту, станцияның су тұтынуын азайту, құбыр жүйелерінде Болаттың әдеттегі түрлерін пайдалану, жабдыққа техникалық қызмет көрсету құнын азайту арқылы қоршаған ортаға зиянды әсерді азайтуға мүмкіндік береді.

Кілтті сөздер: қазандық, қож, күл-қожды шығару, шаң дайындау, гидросол шығару, отын, көмір, күл

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