

PRACTICAL EXPERIENCE AND RESULTS OF ESP OPERATION COLLECTING HIGH RESISTIVITY FLY ASH WITH HIGH DUST LOAD.

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ABSTRACT.

The article describes results gained during an ESP replacement programme at Aksu power plant in Kazakhstan, carried by the power plant and under the pressure from the State, in order to improve environmental situation in the region.

The task was to both meet reduced emission requirements when collecting a high resistivity fly ash from Ekibastus coal in combination with the use of the same foundation and support structures. The coal has low sulphur (<0.6%) and high ash content (> 40%) resulting in an ESP inlet load of 60 g/Nm³ and higher. Intensive back-corona was expected to develop inside the ESP. The fly ash is highly abrasive. The combination of these factors required special precautions during project implementation.

Combination of modern ESP technology with the use of spiral discharge electrodes and state-of-the-art microprocessor controllers resulted in successful project implementation with much lower than required emission level.

INTRODUCTION.

The problem of collecting of high resistivity fly ash in Electrostatic Precipitators (ESP) while burning low sulphur coal is well known in the power industry. The aim of meeting modern emission requirements with affordable cost during old ESP's replacement is even more challenging, taking into account that boiler units designed 30 years ago do not provide sufficient space for enlargement of air pollution control equipment.

The privatisation process in CIS (the Commonwealth of Independent States - former USSR except the Baltic states) countries, that also involved the energy sector, reflected environment problems in the industry and forced generating companies firing fossil fuels to allocate resources for upgrading of particulate collectors. Emission payments and penalties for exceeding of approved emission values are introduced by local authorities and comprise substantial portion of their income. This situation creates a contradiction between their intention to improve ecology in the region and to increase the amount of the payments through introduction of new and stricter emission legislation. Limited investment resources may result in discontinuity in plant operation due to inability to meet the emission requirements and the emission penalties.

On this background, Aksu Power Plant belonging to Euroasian Energy Corporation (Kazakhstan) launched a longterm modernisation programme, thus pro-actively responding to market environment challenges.

AKSU POWER PLANT.

Aksu Power Plant is located in the northern part of Kazakhstan, close to the Ekibastus coal deposit. The power plant belongs to Euroasian Energy Corporation that possesses the coal mine pit as well.

The power plant was originally built in 1960's and comprises now seven 300 MWe units. Each unit is designed as a double shell boiler implying that each half of the unit can be operated independently on the same turbine. One ESP is installed for each gas ductwork – totally two ESP's for one boiler unit.

The main user of the electricity is Aksu Ferro-Alloy plant located nearby, which consumes up to 50% of the Power Plant output. Part of the output is sold to the grid and to some other big electricity consumers in the northern part of the country.

EXISTING ESP OPERATION.

Existing ESP's were built in 1960's. An open type local mine pit was just developed at that time.

Temperaure, °C	110	120	130	140	150
Resistivity, Ohmcm, *10 ¹²	7	9,2	9,5	9	8

Figure 1. Resistivity of Ekibastus fly ash vs. flue gas temperature

Easy-to-burn fuel was very attractive from economical point of view, but it immediately created problems with emissions. Similar situations are still common in other CIS and East European countries where existing technology used for particulate control was built more than 30 years ago.

The combination of a high dust concentration (over 60 g/Nm³), high abrasive dust (rapping shaft bearings were replaced yearly) and a high resistivity (close to 10¹³ Ohmcm at operating conditions) resulted in emission levels higher than designed from the very beginning of operation. The boiler load was therefore often limited to 60 – 70 % of rated load.

Severe back-corona occurred in all fields of the ESP's and that was clearly reflected in voltage-current curves. The ESP's used 300 mm spacing and rod/byonet type emitting electrodes, which were later replaced with punched needle type. The transformer-rectifiers were initially based on transductor (magnetic type) controllers. They were also later on replaced with analogue thyristor type controllers. All changes nevertheless did not allow significant improvement of the collecting efficiency that hardly exceeded the 95% level at a output less than nominal. The abrasive fly ash also resulted in excessive wearing of exhaust fans impellers. Repair and replacement of them had to be undertaken every 9-12 months to prevent output decrease due to inability to maintain necessary negative pressure in the furnace.

Heating value	15,6 MJ/kg
Ash	41%
Sulfur	0,6-0,8%
Coal ash analysis	
P ₂ O ₅	-
SiO ₂	63 - 64%
Fe ₂ O ₃	4 - 5%
Al ₂ O ₃	23 - 28 (25)%
TiO ₂	-
CaO	1 - 1,5%
MgO	0,4 - 0,8(0,6) %
SO ₃	0,6 - 0,9 %
K ₂ O	0,5 - 0,65 %
Na ₂ O	0,3 - 0,4 %
Unburnt:	1.8 - 5.0%
CaO Free	1%

Figure 2. Characteristics of coal and fly ash

In 1998 Euroasian Energy Corporation decided to develop a different solution which would allow a drastic change of the situation. The limit for the new solution was defined by utilisation of existing support structures with no possibility to extend the ESP in length.

PROPOSED SOLUTION.

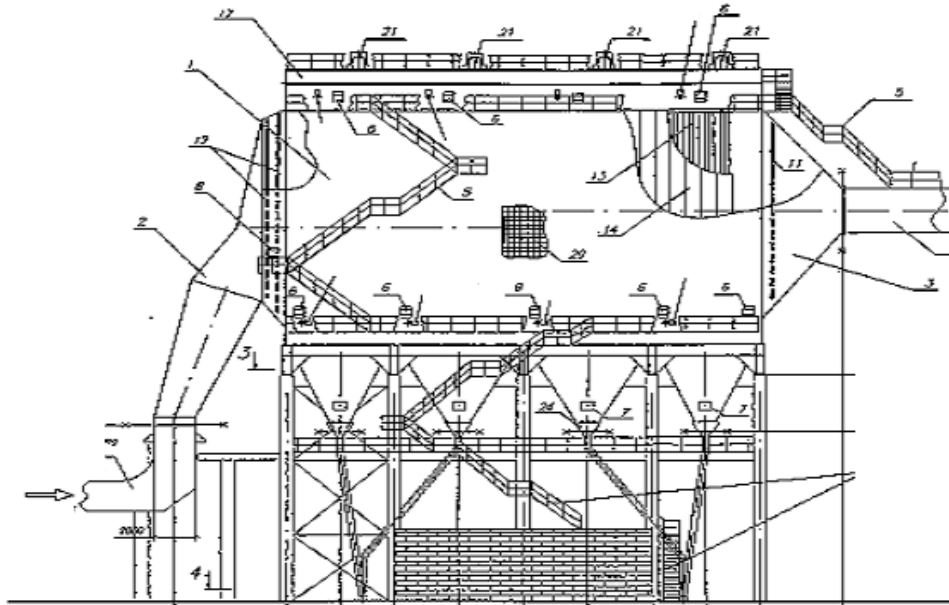


Figure 3. ESP plant after installation.

The solution proposed by ALSTOM was aimed to minimise civil engineering work and, at the same time drastically increase the ESP collecting efficiency with the target of achieving more than 99.5% at full boiler load. This challenging task of meeting the requirements required the utilisation of all available means of modern ESP technology.

Mechanical design.

The following factors had to be taken into account:

- The ESP fields had to be designed with different lengths to fit different sizes of the hoppers. Two bus sections were designed on three rows of the hoppers to keep the valley angle and the height of the support structures.
- The spacing was increased to compensate for the additional weight with the use of 15 m high collecting plates instead of 12 m. The increased collecting efficiency in combination with an increased ESP volume implies an increase of effective migration velocity (wk) by 3 times. This comparison is recalculated to the same spacing.
- Spiral type emitting electrodes were used to make the current distribution more even and thus reduce back-corona [Ref. 1].



Figure 4. Emitting and collecting electrodes of the new ESP

- Special type rapping shaft bearing design was used to extend the lifetime of the bearings 5 to 10 times.
- Efficient rapping with tumbling hammers was a necessity in order to ensure cleaning of the collecting plates from the high resistivity ash [Ref. 2].
- Strict quality control procedures were applied at all phases of manufacturing process for both internals and steel structures.

Power supply.

The focus of elimination of back-corona required modernisation of the distribution transformer on the substation. The other features of proposed solution though being standard solution by the supplier were mainly aimed to quench back-corona inside ESP fields.

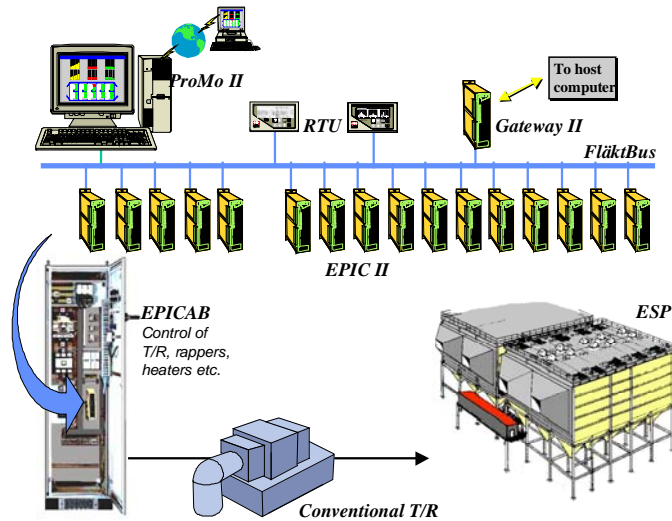


Figure 4. ESP control and monitoring system

- Workstation with data logging system allowed visualisation of ESP operation and information of the ESP's performance.

- The transformer/rectifier units with 95 kV peak voltage instead of existing ones with only 70 kV peak were used and designed for outdoor installation on the ESP roof. Bus bar connection allowed avoiding the use of high voltage cabling.

- State-of-the art control system (EPIC) allowed the use of advanced Semipulse[®] energisation with automatic selection of charging ratios for each bus section [Ref. 3].

- Power control rapping were used to increase the efficiency of collecting plates rapping and to limit dust peaks to the stack [Ref. 4].

ACHIEVEMENTS AND RESULTS.

The approach to solve the problem by combining modern ESP technology by utilisation of existing support structures proved to be successful for the described case. The results of emission measurements carried out under supervision of local authorities showed an efficiency of 99.6-99.7% at full load of the boiler - much better than required by the emission regulation. An inspection of internal condition of the ESP carried out after one and half year of operation showed no signs of abnormal wearing that used to be a permanent problem before. The monitoring of emission with the use of a calibrated opacity meter shows no deterioration of efficiency since the start up of the installation, i.e. after 1.5 year. The replacement of ESP's on another unit of this plant confirmed the data obtained during the first project implementation.

Of course, 1.5 year of operation is not a long observation time and the Aksu Power Plant continues monitoring the ESP operation, replacing meanwhile ESP's on other units. At present two ESP's are in operation and the third one is being erected.

The main learning from this project proved that for achievement of high efficiency in ESP's all processes influencing fly ash collection – characteristics of the dust, process parameters, ESP design, gas distribution, power control, etc. are to be considered. Improvements of only one of

them will not be sufficient for the success. By applying modern technology for ESP's substantial improvements can be achieved by replacing old ESP's utilising the same ground area.

CONCLUSION.

The results of the implementation of the ESP replacement programme at Aksu Power Plant of Euroasian Energy Corporation demonstrate the possibility of meeting environment requirements by replacing old ESP's utilising the same foundation. Modern ESP technologies allow the achievement of substantial emission reduction when upgrading old plants. Migration velocity was increased by a factor of three at the Aksu Power Plant. The ESP technology is a cost-effective solution in modernisation projects in CIS countries.

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