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Low-cost Evaporator Protection Method against Corrosion in a Pulverized Coal Fired Boiler

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Corrosion processes appearing on the watertubes in a combustion chamber of pulverized coal-fired boilers require permanent control and service. Subject to the power plant strategy, different anti-corrosion protection methods can be applied. Technical-economical analysis has been performed to evaluate and support the decisions on maintenance and operation services. The paper presents and discusses results of the application of an air protection system in boiler *OP-230* in view of anti-corrosion measures. It is indicated that a low-cost protection method of watertubes (evaporator) against corrosion can be efficient and lead to financial savings in comparison to the standard procedure of replacement of watertube panels.

Keywords: *technical-economical analysis, corrosion protection, boiler.*

1. Introduction

In coal-fired boilers low-alloyed watertubes of a combustion chamber are always exposed to corrosion risk, whereas its rate also depends on the combustion conditions, the type of the fuel burnt, the type of burners, the boiler design, etc. Since low-NO_x burning conditions are widely applied to power engineering to fulfill the environmental requirements and to minimize the NO_x emission during the coal combustion, a significant increase in the corrosion rate in boilers has been observed. It is principally caused by the appearance of reducing atmosphere (air stoichiometric ratio $\lambda<1$) near the watertubes (mainly in lower and middle parts of the combustion chamber), which disables or inhibits the formation of a protective oxide layer on the metal surface. Under these conditions the course of other reactions (sulphidation, chlorination) and processes (erosive action of a soot blower, flame impingement) is facilitated. It leads to fast destruction of the watertube material and uncontrolled decrease in the tube thickness. As a result, more frequent replacement of watertube panels is required, resulting in an increase in maintenance and operation costs. Moreover, in extreme situations the unexpected failures and shutdowns of boilers are registered, and then additional overhauls and repairs cause to power plants financial losses.

Different counteractions can be undertaken to diminish the corrosion rate and extend the lifetime of watertubes, the most important (and the most popular) of them are:

- replacement of corroded watertubes fragments,
- overlay of protective coatings (metallic, ceramic, hybrid),
- installation of the Air Protection System (*APS*),
- installation of a monitoring system (gas measurement points in waterwalls to measure the flue gas composition).

Unfortunately, the preventive methods mentioned above are characterized by different investment costs, maintenance costs, time durability and operation manner. Hence, the decision about the choice of an anticorrosion method may be complicated. It depends also on the predicted lifetime of the boiler and its role in the electric grid. It is of great importance to power plants to compare all costs, but the anticorrosion methods specified above are very difficult to be compared. In addition, power engineering companies are often orientated towards short-time profits and they do not invest assets into a long-term perspective. The financial means assigned for maintenance and operation of boilers are also limited.

To support the decision on a preferred anticorrosion method, technical-economical analysis should be made to provide the information about the short and long-term financial consequences of taken actions.

In the paper, the air protection system (*APS*) as a low-cost method of the evaporator protection against corrosion is presented.

2. Idea of the air protection system

The aim of the *APS* is to introduce the air along/close to the watertube walls of the boiler to keep the oxidizing atmosphere. It can be realized using specially deviated air nozzles from the burner box or additional air nozzles built in the evaporator wall (in its corners, in the middle, etc.). The *APS* arrangement also depends on the furnace type, the burner type and their disposition. As a result, the protective oxides layer is created on the surface of the watertube, thus minimizing the corrosion process of the watertube material caused by the aggressive flue gas compounds and reducing atmosphere. The size of the evaporator area protected by the additional air stream depends on the location of the area threatened by corrosion. In general, the protected area is from the level of the burner box band up to that of the *OFA* (*Over Fire Air*) nozzles. The possibilities of air introduction into the watertube surrounding are schematically shown in Fig. 1.

The most common methods are *LNCFS* (Low NO_x Concentric Firing System) and horizontal air staging (Wróblewska and Golec 1996). However, to protect the walls by using O_2 to reach the atmosphere, the air should have sufficient kinetic energy to penetrate the flue gases of high viscosity (5-10 times higher than air) and to achieve the expected range of operation. It is suggested to maintain the air outlet velocity at ca. 50 m/s (Florkiewicz et al. 2002, Pronobis et al. 2005). Such velocity should guarantee appropriate evaporator protection from the flue gases and protect it against local appearance of the reducing atmosphere. Unfortunately, if the air pressure in the secondary air duct is too low, it may require an additional air fan application to obtain the designed protective air velocities. Otherwise, the range of the *APS* will not exceed 6-7 meters. It is especially important in the case of larger boilers whose walls may be over 15 m wide.

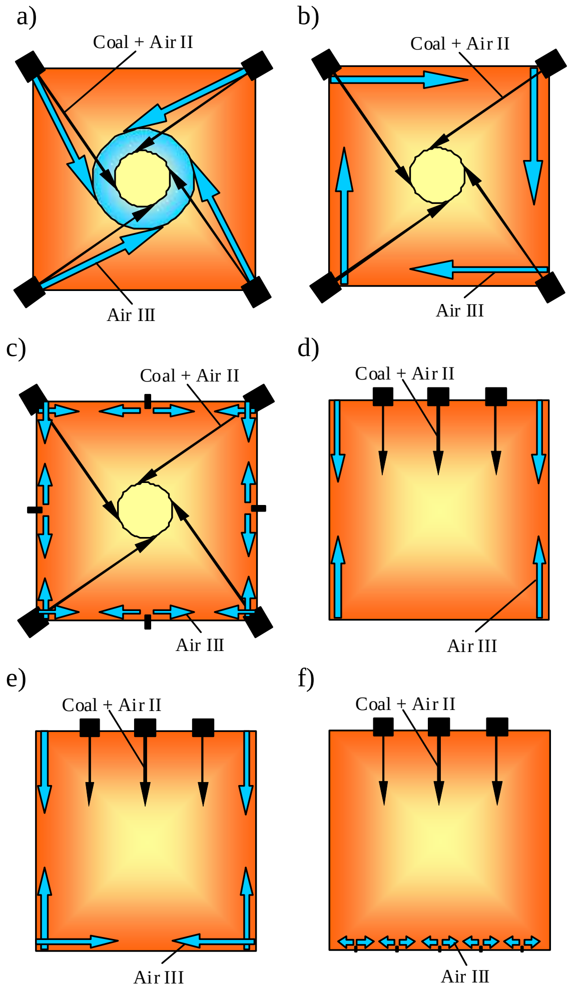


Fig. 1. Introduction of the protective air against evaporator corrosion

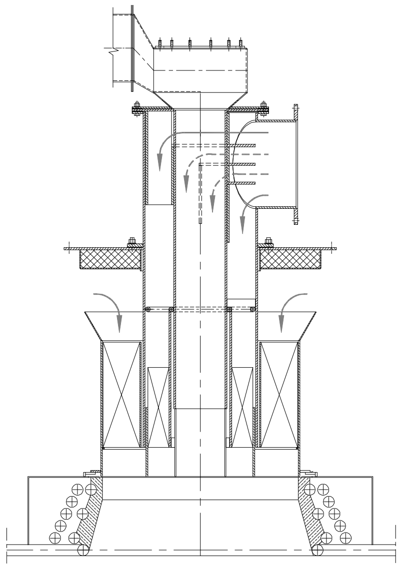
3. *APS* installation in the analyzed boiler

Technical-economical analysis and estimation of the effectiveness of evaporator protection by the boundary *APS* was performed using the data of boiler *OP-230* (*K-6*) at thermal power plant *EC Gdynia* (*EC Wybrzeże SA, EDF Group*).

Boiler *OP-230* (*K-6*) is a pulverized fuel boiler fuelled with bituminous coal and equipped with four swirl burners installed on the front wall (Fig. 2). The combustion chamber walls are tight and made of steel *16M*. The swirl burners generate short and wide flame resulting in corrosion problems on the side walls of the furnace. For this reason the *APS* built in the year 2006 covers the sidewalls only in the area of burners (

Fig. 3). The *APS* nozzles are installed on some levels. The air to the *APS* is delivered from a hot-air collector after the rotary air heater under pressure in the range of 1.5-2.0 kPa. The *APS* does not require an additional air fan causing relatively low investment and maintenance costs.

a) swirl burner



b) swirl burners arrangement

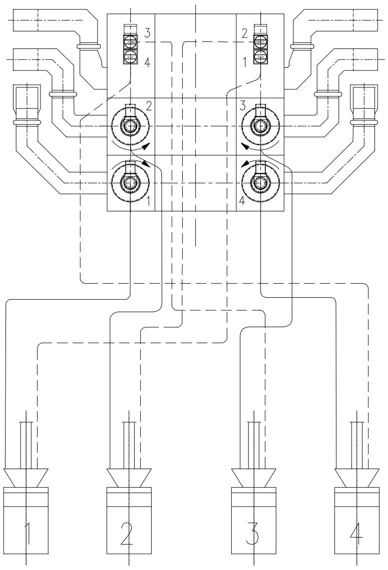


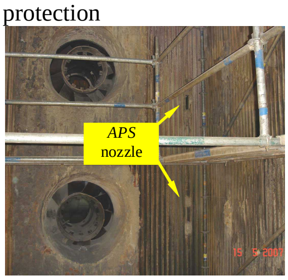
Fig. 2. Scheme of the swirl burners arrangement on the front wall in boiler OP-230 (K-6) at EC Gdynia (Consortium of Polish Universities 2008)

4. Corrosion hazard determination of the evaporator in boiler *OP-230*

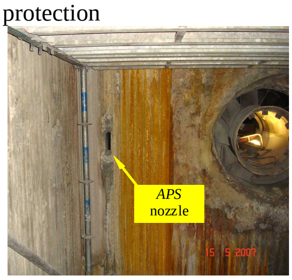
To determine the corrosion rate of watertubes the historical data of the watertube thickness measured in 2000-2006 have been used. The differences in watertube thickness measurements have allowed to estimate the local corrosion rate and that corresponding to it with and without the *APS*. Percentage of the evaporator area affected by various corrosion rates is presented in table 1.

These data provide the information about the frequency of watertube replacement which is necessary to avoid failures and unexpected shutdowns of the boiler and are a reference point in the technical-economical analysis.

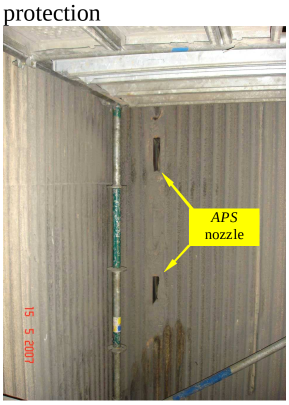
a) *APS* nozzle in the front wall for the right wall protection



b) *APS* nozzle in the front wall for the left wall protection



c) *APS* nozzle in the rear wall for the right wall protection



d) air duct for the APS nozzles

Fig. 3. APS nozzles in boiler OP-230 (K-6)

Table 1. Average proportional areas indicating the constant evaporator pipes corrosion rate in boiler OP-230 (K-6) at EC Gdynia in 2000-2006

Corrosion rate	% of the considered area (230 m^2) of an evaporator screen			
	Right wall	Left wall	Rear wall	Average for the boiler
0.1 mm/year	24.37%	19.64%	25.01%	23.01%
0.2 mm/year	15.85%	18.10%	24.64%	19.53%
0.3 mm/year	15.61%	12.90%	19.81%	16.11%
0.4 mm/year	13.91%	10.88%	11.47%	12.09%
0.5 mm/year	6.03%	7.25%	8.68%	7.32%
0.6 mm/year	4.17%	6.60%	3.38%	4.71%
0.7 mm/year	3.29%	4.91%	2.23%	3.48%
0.8 mm/year	4.17%	4.16%	1.17%	3.17%
0.9 mm/year	1.96%	3.95%	1.14%	2.35%
1 mm/year	2.47%	2.21%	0.81%	1.83%
> 1 mm/year	8.18%	9.40%	1.66%	6.41%

Based on the assumption that minimal (critical) pipe thickness is 3 mm (tube size: ϕ 57 x 5 mm), the consequences for evaporator walls replacement are as follows: annual pipes exchange concerns the areas with corrosion rate > 1 mm/year, for the other wall areas with lower corrosion rate ($\leq$ 1 mm/year) the replacement should be performed less often (Table 2).

Table 2. Yearly loss of thickness of the membrane tubes and the forecast area and the period of tubes renewal in boiler OP-230 (K-6) (Consortium of Polish Universities 2008)

Corrosion rate, mm/year	Average % of considered area (230 m^2) of screens	Forecasted area of membrane walls replacement, m^2	Period between walls exchanges in years
0.1	23.01%	52.92	20
0.2	19.53%	44.92	10
0.3	16.11%	37.05	7
0.4	12.09%	27.80	5
0.5	7.32%	16.83	4
0.6	4.71%	10.84	3
0.7	3.48%	8.00	3
0.8	3.17%	7.28	3
0.9	2.35%	5.41	2
1	1.83%	4.20	2
> 1	6.41%	14.75	1

5. Effectiveness of the *APS* in boiler *OP-230*

The historical data of watertube thickness measured in 2006-2007 were used to calculate the corrosion rate after the *APS* installation in 2006. Using the data concerning the losses of thickness of watertubes before (2005-2006) and after the installation of *APS* (2006-2007) it was calculated that the average rate corrosion on the sidewalls (right and left wall) without the *APS* was 0.49 mm/year and 0.13 mm/year with the *APS* (table 3). It should be added that in both cases the boiler operated under the same limit/regime of NO_x emission.

The collected data (Table 2) were used also for the calculation of anticorrosive effectiveness *S* of the *APS* from the following formula:

$$S = \frac{\frac{1}{n_1}\sum_{i=1}^{n_1}(x_i^{p1} - x_i^{k1})}{\frac{1}{n_2}\sum_{i=1}^{n_1}(x_i^{p2} - x_i^{k2})} \tag{1}$$

where:

S – effectiveness of *APS*,

xi^{p1} – no. *i* measurement of tube thickness before *APS* installation at the beginning of period 1,

xi^{k1} – no. *i* measurement of tube thickness before *APS* installation at the end of period 1,

xi^{p2} – no. *i* measurement of tube thickness after *APS* installation at the beginning of period 2,

xi^{k2} – no. *i* measurement of tube thickness after *APS* installation at the end of period 2,

n_1 – number of places of measurements of watertubes thickness before the *APS* was installed,

n_2 – number of places of measurements of watertubes thickness after the *APS* was installed.

Table 3. Average corrosion rate of the evaporator in boiler OP-230 (K-6)

Period	Right wall	Left wall	Rear wall	Whole boiler
	Average corrosion rate without *APS*, mm/year			
2005-2006	0.36	0.62	0.34	0.44
	Average corrosion rate with *APS* on sidewalls, mm/year			
2006-2007	0.10	0.17	0.25	0.18
	APS effectiveness *S* with *APS* on sidewalls			
	3.60	3.64	1.36	2.63
	APS effectiveness *S* with *APS* over the whole protected area*			
				3.6*
	APS effectiveness *S* with *APS* and monitoring system over the whole protected area*			
				5.0*

* *estimated values*

Table 3 indicates that the corrosion rate of the protected side walls of the boiler furnace has decreased ca. 3.5 times after installation of the *APS*, and the corrosion rate of the rear side (without the *APS* protection) included in the calculations is ca. 2.5 times.

Determined effectiveness *S* of anticorrosion protection can be assumed to be satisfactory, despite the fact that it is less than the effectiveness of the boundary air system installed in boiler *OP-650* at power plant *EL Rybnik S.A.* that was estimated 4.5 (Dyjakon et al. 2006). However, it should be noted that *APS* at *EL Rybnik S.A.* is a more complex installation and is equipped with an additional air fan. On the one hand, it allowed to get higher boundary air velocities near the walls of the furnace and to adjust to the actual conditions of combustion in the boiler furnace, which can be the reason of better efficiency of anticorrosion protection. On the other hand, it has caused higher investment and maintenance costs of the *APS*.

6. Technical-economical analysis of the *APS* as an anticorrosive protection method of the evaporator

6.1. Evaluation of replacement costs of evaporator walls

The problem of estimating the boiler walls replacement costs is complex, because the total cost includes various fragmentary expenditures. The overall costs of boiler walls replacement should contain cost of panel workmanship (in the case of tight walls), material cost (steel), and cost of replacement.

Workmanship cost of the membrane wall panel depends first of all on the pipes diameter, difficulties in panel assembly (for example, bending a pipe), and the company.

The replacement costs are mainly determined by the kind of repair, combustion chamber insulation, the work of panel replacement and scaffolding assembly and disassembly cost. The replacement costs including assembly and welding works, insulation exchange (brass from recovery), material and welded joints x-ray examinations were evaluated by *EC Wybrzeże S.A.* as 7 500 PLN/m^2 (Consortium of Polish Universities 2008). The scaffolding is not included.

6.2. Evaluation of the *APS* costs in boiler *OP-230* (*K-6*) at *EC GDYNIA*

The investment costs of the *APS* can be differentiated depending on: boiler capacity, kind of burner arrangement (frontal, corner), constructional solution adopted (jet burner type, the protected area) and compressed air source (additional ventilator, etc.).

APS exploitation costs are influenced by the use of ventilators, or steam injection to supply the air. The other exploitation cost component can be cost of a corrosion hazard monitoring system. An example is the continuous measurement system of flue gas composition in a wall adjacent layer, which allows to evaluate the evaporator walls corrosion hazard and to change aerodynamics in the combustion chamber. The investment and maintenance costs for such monitoring system are 200 000 PLN and 4 000 PLN/year, respectively (Hardy and Kordylewski 2007).

Boiler *OP-230* is equipped with the *APS* (without additional ventilator) protecting the area of burners on the side walls.

On the basis of data obtained from *EC Wybrzeże S.A.* the *APS* investment cost is 270 000 PLN, and exploitation cost - 1 000 PLN/year (Consortium of Polish Universities 2008).

6.3. Data and assumptions about economical analysis of anticorrosive protection methods

In order to perform technical-economical analysis on the method of anticorrosive protection of boiler walls for boiler *OP-230 (K-6)* at *EC Wybrzeże S.A.* the following assumptions have been made:

- boiler type: *OP-230*,
- depreciation rate: 10%,
- discount rate: 12%,
- effective tax rate: 15%,
- average boiler operation time: 7 100 h/year,
- analyzed period of exploitation: 11 years,
- protected area: 230 m^2 (left wall 70 m^2, right wall 70 m^2, back wall 90 m^2),
- initial state of watertubes: corroded pipes (in the initial period 100 m^2 of the evaporator area should be replaced),
- calculated area of screens fragments assigned for replacement because of the minimal watertube thickness reached in accordance with Table 4,

Table 4. Calculated area of screens fragments assigned for replacement because of reaching the minimal watertube thickness

Year of operation	Boiler without *APS*	Boiler with *APS* (right and left wall protected)	Boiler with *APS* (right, left and rear wall protected)	Boiler with *APS* + monitoring
1	6.4%	2%	2%	1%
2	10.6%	4%	3%	2%
3	17.8%	7%	5%	4%
4	17.9%	7%	5%	4%
5	18.5%	7%	5%	4%
6	21.9%	8%	6%	4%
7	22.5%	9%	6%	5%
8	17.9%	7%	5%	4%
9	17.8%	7%	5%	4%
10	42.2%	16%	12%	8%
11	6.4%	2%	2%	1%
12	29.3%	11%	8%	6%
13	6.4%	2%	2%	1%
14	26.7%	10%	7%	5%
15	29.9%	11%	8%	6%
16	17.9%	7%	5%	4%
17	6.4%	2%	2%	1%
18	21.9%	8%	6%	4%
19	6.4%	2%	2%	1%
20	72.5%	28%	20%	15%

- scaffolding assembly and disassembly cost: 25 000 PLN,
- watertube replacement costs evaluated by *EC Wybrzeże S.A.* (Consortium of Polish Universities 2008): 7 500 PLN/m^2,

- annual expenditure for the evaporator diagnostic (surface preparation and evaporator pipes thickness measurements, without scaffolding assembling and disassembling costs): 17 500 PLN,
- in a case of the *APS*, the watertube diagnostics will take place every 2 years,
- evaporator pipes material: *16M*,
- evaporator pipes dimensions: ϕ 57 x 5 mm,
- thickness limit of a watertube: 3.0 mm.

Furthermore, it has been considered that:

- due to the application of anti-corrosion protection methods, high-temperature corrosion unexpected failures will not occur,
- damages resulted from fitting faults have not been taken into account.

6.4. Results of the comparison of anticorrosion protection costs of boiler *OP-230* (*K-6*)

Based on the data and assumptions the financial expenditures on boiler *OP-230* (*K-6*), evaporator (230 m^2) pipes protection in the period of 11 years in the form of the *Cash Flows* (*CF*) for the base method (evaporator walls replacement) and the proposed method (*APS*) have been estimated.

For example, evaporator walls replacement comprises the necessity of purchase and assemblage of 100 m^2 tight panels in the period *0* (in accordance with the assumptions, diagnostics and scaffolding cost: (100 m^2 * 7 500 PLN/m^2) + 25 000 PLN + 17 500 PLN = 792 500 PLN), and in the next periods, successive fragments replacement (according to the forecast presented in Table 4). The walls exchange costs should be enlarged by adding the scaffolding and diagnostics costs. For example: in the first period 6.4 % = 14.75 m^2, which refers to the cost: 110 634 PLN. In addition, the scaffolding and diagnostic costs are added, thus giving: 110 634 PLN + 25 000 PLN + 17 500 PLN = 153 134 PLN. In the next years the procedure is similar.

In a case of the *APS* with this system on sidewalls, in the first period only 2% of the protected area should be replaced (Table 4) which gives 4.6 m^2 and refers to the final costs (including watertube replacement, scaffolding and diagnostic): (4.6 m^2 * 7 500 PLN/m^2) + 25 000 PLN + 17 500 PLN = 77 000 PLN.

Then the discounted and cumulated *Cash Flows* were calculated, taking into account a discount rate and the Net Present Value (*NPV)* in accordance with the definition:

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} - I_0 \tag{2}$$

where:

CF_t – the net cash flow (the amount of cash) at time *t*.

R – discount rate (the rate of return that could be earned on an investment in the financial markets with similar risk),

I_0 – initial expenditures,

T – time of the cash flow.

NPV is a standard method for the financial appraisal of long-term projects. When used for capital budgeting, and widely throughout economics, it measures the excess or shortfall of cash flows, in present value (*PV*) terms, once financing charges are met.

From an economical point of view, the most profitable anticorrosive undertaking generates the lowest cumulated cash flow in the exploitation period of analyzed boilers.

Calculated cash flows and cumulated costs (undiscounted and discounted) are presented in tables 5-8 and Fig. 4-5, respectively.

Table 5. Undiscounted Cash Flows (in PLN) of maintenance of 230 m^2 evaporator part of boiler OP-230 (K-6) at EC Wybrzeże S.A. during 11 years

Type of corrosion protection	Year											
	0	1	2	3	4	5	6	7	8	9	10	11
Exchange of watertubes fragments without anticorrosion (as received)	775,000	153,134	225,202	349,058	351,435	361,636	421,126	431,019	351,435	349,058	770,597	0
Air Protection System (right and left wall)	1,045,000	85,566	112,969	160,062	160,966	164,844	187,464	191,226	160,966	160,062	320,343	1,000
Air Protection System (right, left and rear wall)	1,207,000	73,646	93,283	127,031	127,678	130,458	146,668	149,363	127,678	127,031	241,891	1,000
Air Protection System + monitoring	1,375,000	70,627	85,040	109,812	110,287	112,327	124,225	126,204	110,287	109,812	194,119	6,000

Table 6. Discounted Cash Flows (in PLN) of maintenance of 230 m² evaporator part of boiler OP-230 (K-6) at EC Wybrzeże S.A. during 11 years

Type of corrosion protection	**Year**											
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Exchange of watertubes fragments without anticorrosion (as received)	775,000	136,727	179,530	248,452	223,343	205,202	213,355	194,971	141,939	125,874	248,112	0
Air Protection System (right and left wall)	1,045,000	76,398	90,058	113,929	102,297	93,537	94,975	86,501	65,011	57,720	103,142	287
Air Protection System (right, left and rear wall)	1,207,000	65,755	74,364	90,418	81,142	74,025	74,306	67,564	51,567	45,809	77,883	287
Air Protection System + monitoring	1,375,000	63,060	67,794	78,162	70,089	63,737	62,936	57,088	44,543	39,599	62,501	1,725

Table 7. Undiscounted cumulated costs (in PLN) of maintenance of 230 m² evaporator part of boiler OP-230 (K-6) at EC Wybrzeże S.A. during 11 years

Type of corrosion protection	**Year**											
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Exchange of watertubes fragments without anticorrosion (as received)	775,000	928,134	1,153,337	1,502,394	1,853,829	2,215,464	2,636,590	3,067,609	3,419,043	3,768,101	4,538,697	4,538,697
Air Protection System (right and left wall)	1,045,000	1,130,566	1,243,535	1,403,597	1,564,562	1,729,407	1,916,871	2,108,096	2,269,062	2,429,124	2,749,467	2,750,467
Air Protection System (right, left and rear wall)	1,207,000	1,280,646	1,373,928	1,500,959	1,628,637	1,759,095	1,905,763	2,055,126	2,182,805	2,309,835	2,551,727	2,552,727
Air Protection System + monitoring	1,375,000	1,445,627	1,530,667	1,640,479	1,750,766	1,863,093	1,987,318	2,113,522	2,223,809	2,333,620	2,527,739	2,533,739

Table 8. Discounted cumulated costs (in PLN) of maintenance of 230 m² evaporator part of boiler OP-230 (K-6) at EC Wybrzeże S.A. during 11 years

Type of corrosion protection	**Year**											
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Exchange of watertubes fragments without anticorrosion (as received)	775,000	911,727	1,091,257	1,339,709	1,563,052	1,768,254	1,981,609	2,176,580	2,318,519	2,444,392	2,692,504	2,692,504
Air Protection System (right and left wall)	1,045,000	1,121,398	1,211,456	1,325,385	1,427,682	1,521,219	1,616,194	1,702,695	1,767,706	1,825,426	1,928,568	1,928,855
Air Protection System (right, left and rear wall)	1,207,000	1,272,755	1,347,119	1,437,537	1,518,679	1,592,705	1,667,011	1,734,575	1,786,143	1,831,951	1,909,834	1,910,121
Air Protection System + monitoring	1,375,000	1,438,060	1,505,853	1,584,015	1,654,104	1,717,842	1,780,778	1,837,866	1,882,409	1,922,008	1,984,510	1,986,235

It is important to point out that the costs of the evaporator protection against low-NO_x corrosion change during the exploitation period of boiler *OP-230* (*K-6*). As a result, exploitation time of the boiler is crucial for economical analysis and final conclusions or recommendations. Figure 5 shows that in a short-term (3-5 years) the final costs for standard watertube exchange method and the *APS* are the same. The *APS* does not bring any profits to a power plant, moreover, requires much higher initial investment costs. However, in a long-term perspective (10 years and longer) the *APS* can be very attractive and highly recommended for realization, because the savings for the power plant seems to be significant. Application of the *APS* has given the cumulative cost of the evaporator protection approximately 30% lower in comparison to the standard watertubes replacement method.

An interesting option for anticorrosion protection is the *APS* combined with a monitoring system of the flue gases composition in the watertube boundary layer. Such solution of *on-line* diagnostic of the boiler increases not only protection effectiveness of the boiler against corrosion, but it can also influence boiler efficiency giving the essential information to the operation room (operators) about the combustion process in the furnace. In the case of longer exploitation time, the additional investments costs of the monitoring system installation will be paid back.

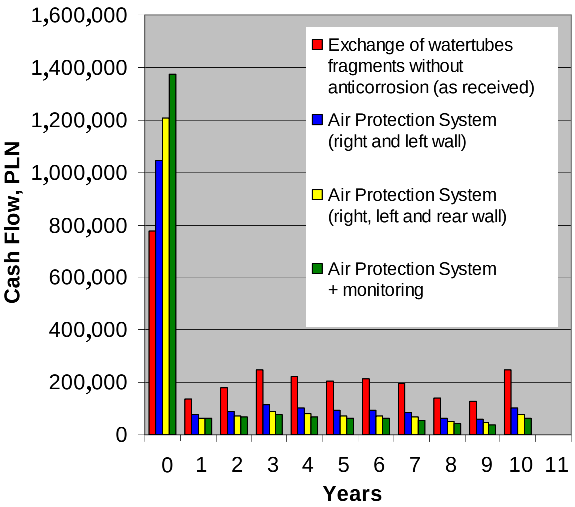


Fig. 4. Discounted Cash Flows of maintenance of 230 m^2 corroded evaporator watertubes of boiler OP-230 (K-6) at EC Wybrzeże S.A. (period simulation of 11 years)

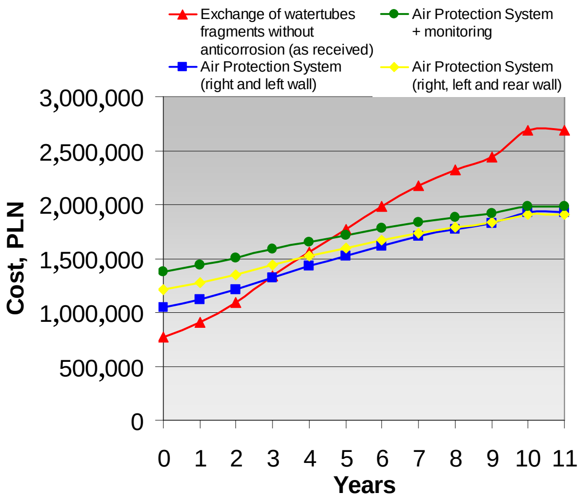


Fig. 5. Accumulated costs of maintenance of 230 m^2 corroded evaporator watertubes of boiler OP-230 (K-6) at EC Wybrzeże S.A. (period simulation of 11 years)

7. Conclusions

In the furnace of the boiler the watertubes protection against corrosion is an essential requisite to limiting financial expenditures, unexpected shutdowns and expensive repairs. There are many possibilities and measures decreasing corrosion hazards of watertubes. The most known methods are: replacement of corroded watertubes, overlaying of the protective coatings, and installation of the air protection system (*APS*). However, proper selection of the method to be applied is a complex matter and not always clear to operators or service company. Moreover, the anticorrosion protection methods are characterized by various investments and maintenance costs as well as to protection effectiveness and protection duration.

To help decision makers the economical analysis can be applied which shows in short-term and long-term perspectives the financial consequences for the power plant.

Technical-economical analysis of replacing the membrane walls parts (standard method) in comparison with the *APS* (alternative method) in the evaporator exploitation of boiler *OP-230* (*K-6*) at *EC Wybrzeże S.A.*) in the eleven years period leads to the following conclusions:

- standard method of replacing the parts of corroded membrane walls of the evaporator is cheap in a short-term only, whereas in a long-term perspective it is a very expensive protection method.
- *APS* can decrease the corrosion rate of watertubes in the range of 2.5-5.0 depending on the solution and complexity of the system (additional fan, flue gas monitoring system, etc.),
- in the long-term period the *APS* is a low-cost anticorrosion protection method (especially without an additional fan),
- technical-economical analysis is a very good and helpful tool, which from a long-term investment point of view can bring a lot of savings and clarify the investment strategy for the power plant.

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Smulkinta anglimi kūrenamų šildymo katilų garintuvų apsaugos nuo korozijos metodas

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Smulkinta anglimi kūrenamų šildymo katilų degimo kameros vamzdžiuose vykstantį korozijos procesą būtina nuolatos kontroliuoti ir priežiūrėti. Pagal energijos jėgainių strategiją galimi skirtingi apsaugos nuo korozijos metodai. Atlikus techninį-ekonominį vertinimą, galima priimti sprendimą dėl tam tikros metodikos pasirinkimo. Straipsnyje aprašoma šildymo katilų oro apsaugos nuo korozijos sistema ir analizuojami jos taikymo šildymo katile *OP-230* rezultatai. Nustatyta, kad pigus garintuvo vandens vamzdžių apsaugos nuo korozijos metodas gali būti efektyvus. Jį taikant, galima sutaupyti sąnaudas, palyginti su standartine vandens vamzdžių keitimo procedūra.

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