

# REDUCTION OF PARTICULATE MATTER EMISSION AFTER ELECTROSTATIC PRECIPITATORS RECONSTRUCTION AT UNIT A5 OF THE TPP KOLUBARA

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# 1. INTRODUCTION

As one of the biggest polluters thermal power plants invest great amount of money into new facilities for reduction of particulate matter, sulfur and nitrogen oxides.

Electrostatic precipitators in Serbian power plants have been in operation for 20 to 35 years or more. The work analyses determined that performances are worse than projected values. PE Electric Power Industry of Serbia has adopted a long-term plan of modernization for pollution reduction.

Reconstruction of existing electrostatic precipitators in TPP Nikola Tesla (units A1, A2, A4 and A5) and TPP Kostolac (units A1 and A2) has been carried out to diminish emission of particulate matter below the referent value of  $50 \text{ mg/Nm}^3$ .

Tests for particulate matter emissions, before reconstruction of electrostatic precipitators, has shown that the emissions of particulate matter at unit A5 were:

- $259 \text{ mg/Nm}^3$  in 2006th and
- $425 \text{ mg/Nm}^3$  in 2008th.

## 2. BASIC DATA OF UNIT A5

Unit A5, nominal rate 110 MW became operational 1979th.

The steam boiler produced in the SES, Slovakia has pulverized coal combustion system, natural circulation, drum and reheated steam system.

The basic design characteristics of the boiler plant are given in Table 1.

Characteristics of the lignite from surface coal mining field Kolubara are given in Table 2

Table 1. *Basic design characteristics of the boiler plant at unit A5*

Parameter	Unit of measure	Value
Nominal steam production	t/h	380
Pressure of superheated steam	bar	136
Feeding water temperature	$^{\circ}\text{C}$	246
Temperature of superheated / reheated steam	$^{\circ}\text{C}$	540/540
Pressure of reheated steam	bar	35
Exit flue gas temperature	$^{\circ}\text{C}$	180

Table 2. *Characteristics of the lignite from surface coal mining field Kolubara*

Parameter	Unit of measure	Value
Net Calorific Value	kJ/kg	6280
Moisture content	%	49
Ash content	%	20
Combustible matter	%	30

### 3. BASIC DATA OF ELECTROSTATIC PRECIPITATORS

Manufacturer ZVVZ-Milevsko, Czech Republic has built two electrostatic precipitators at unit A5 TPP "Kolubara", Veliki Crljeni.

Precipitators have been reconstructed and modernized by the company from Poland ELWO and companies from Serbia Energoprojekt-Oprema i Energoprojekt-Entel.

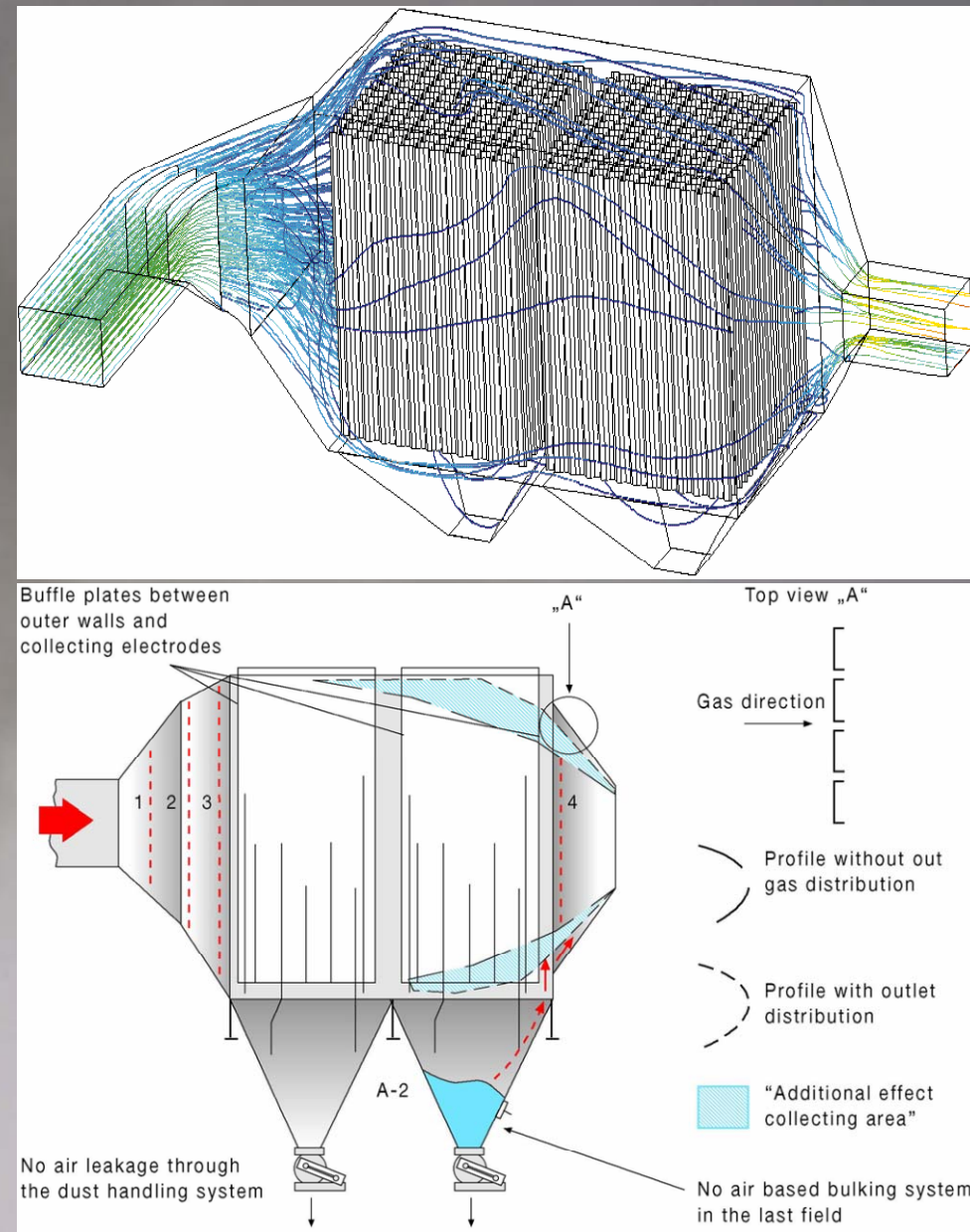
Reconstruction was performed in the period from 01.04. to 30.10. 2009th.. Electrostatic precipitators are shown in Figures 1-3.



**Figure 1. *Left electrostatic precipitator – side view***



**Figure 2. Right electrostatic precipitator – rear view**



**Figure 3. Flue gas flow through electrostatic precipitator**

The basic technical characteristics of the electrostatic precipitator are given in Table 3.

Table 3. *Technical characteristics of the electrostatic precipitator*

<b>Technical characteristics of one ESP</b>	<b>Before reconstruction</b>	<b>After reconstruction</b>
<b>Unit A5</b>		
Year of unit operational start /reconstruction ESP	1979	2009
Inlet mass concentration of particulate matter (g/m <sup>3</sup> )	46.6	46.6
Guaranteed electrostatic precipitator efficiency (%)	98,5	99,9
Number of fields - sections	4	4
Active ESP length (m)	10,2	13,5
Active high of electric field (m)	10,5	14,6
Number of gas passages	26	38
Width of a gas passage (mm)	300	400
Primary voltage (V)	380	400
Primary current (A)	-	zone 1: 2x210 zone 2: 3: 368
Secondary voltage-peak value without load (kV)	106	106
Secondary current-average value of field (mA)	1250	section 1 and 2 800 section 3 and 4 1400
Installed capacity (kVA)	-	section 1 and 2 84 section 3 and 4 147
Electrostatic precipitator's weight (t)	246	390

## 4. TEST RESULTS

Electrostatic precipitators manufacturer guarantees:

Particulate matter concentracion at electric precipitator outlet :  $\leq 50 \text{ mg/Nm}^3$  (dry gas,  $\text{O}_2=6\%$ ), only if gases are dedusting from electrostatic precipitator under these conditions:

### Fuel

Type: lignite

\* net calorific value: 6280 kJ/kg

\* ash content: 20%

\* moisture content: 59%

### Inlet flue gas at electrostatic precipitator

\* flue gas flow 846.200  $\text{Nm}^3/\text{h}$ , dry flue gas  
(1.057.750  $\text{m}^3/\text{h}$ , wet flue gas with 20%  $\text{H}_2\text{O}$ )

\* flue gas temperature 170 - 200°C (nominal 180 °C)

\* inlet particulate matter concentracion 40 – 46,6  $\text{g/Nm}^3$ ,  $\text{O}_2=6\%$ , dry flue gas

\* content  $\text{H}_2\text{O}$  17 – 21 %

\* content  $\text{O}_2$  6 %

Guarantee tests were performed in the July 2010 year by the Institute of Nuclear Sciences "VINČA", Laboratory for Thermal Engineering and Energy, in accordance with the program performance test, which is in accordance with ISO 9096.

Six tests have been performed at 100 % nominal unit power for both precipitators at the same time.

Totally, 12 tests have been performed. Test results of particulate matter emission for both electrostatic precipitators at unit A5 are shown in Figures 4-7.





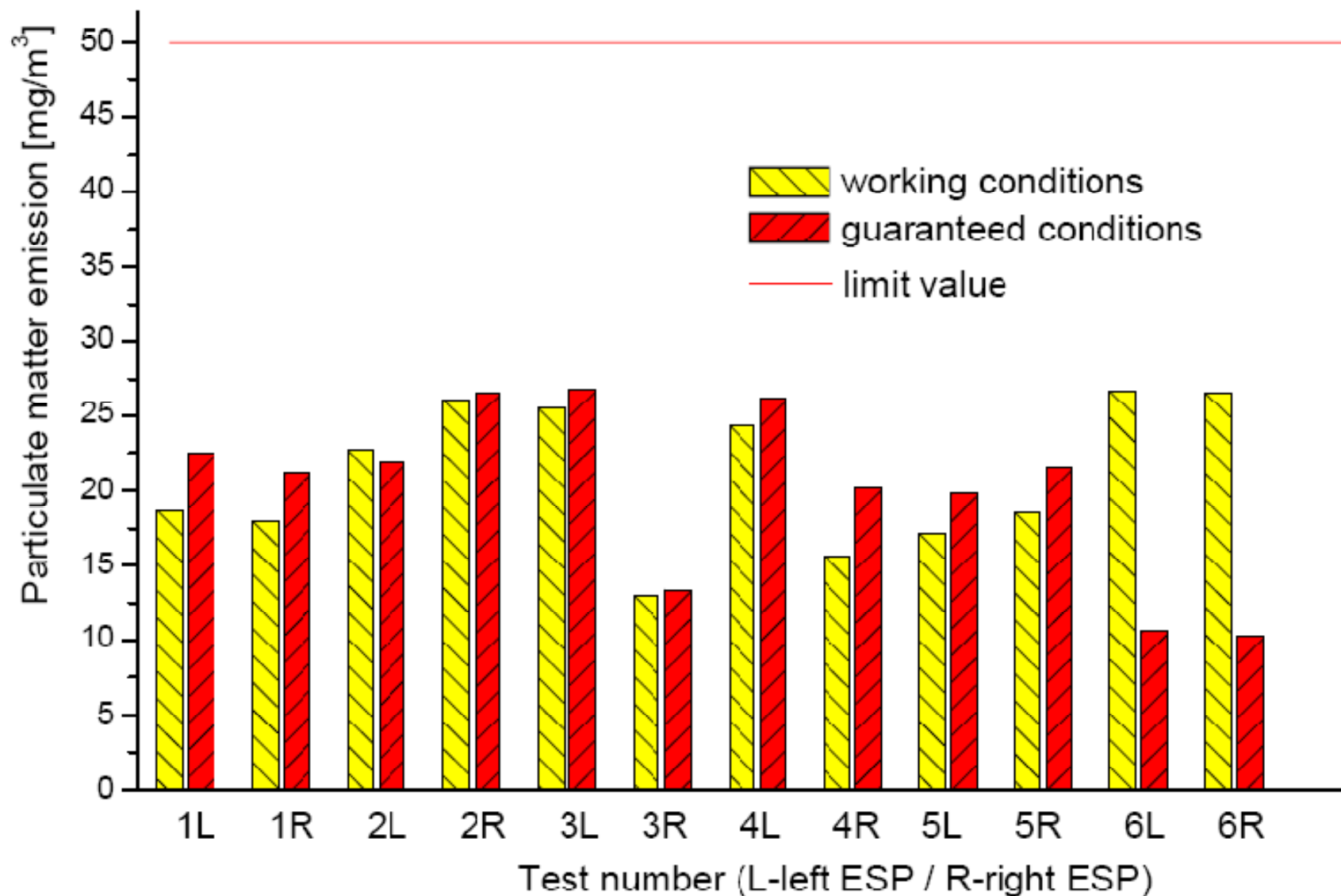
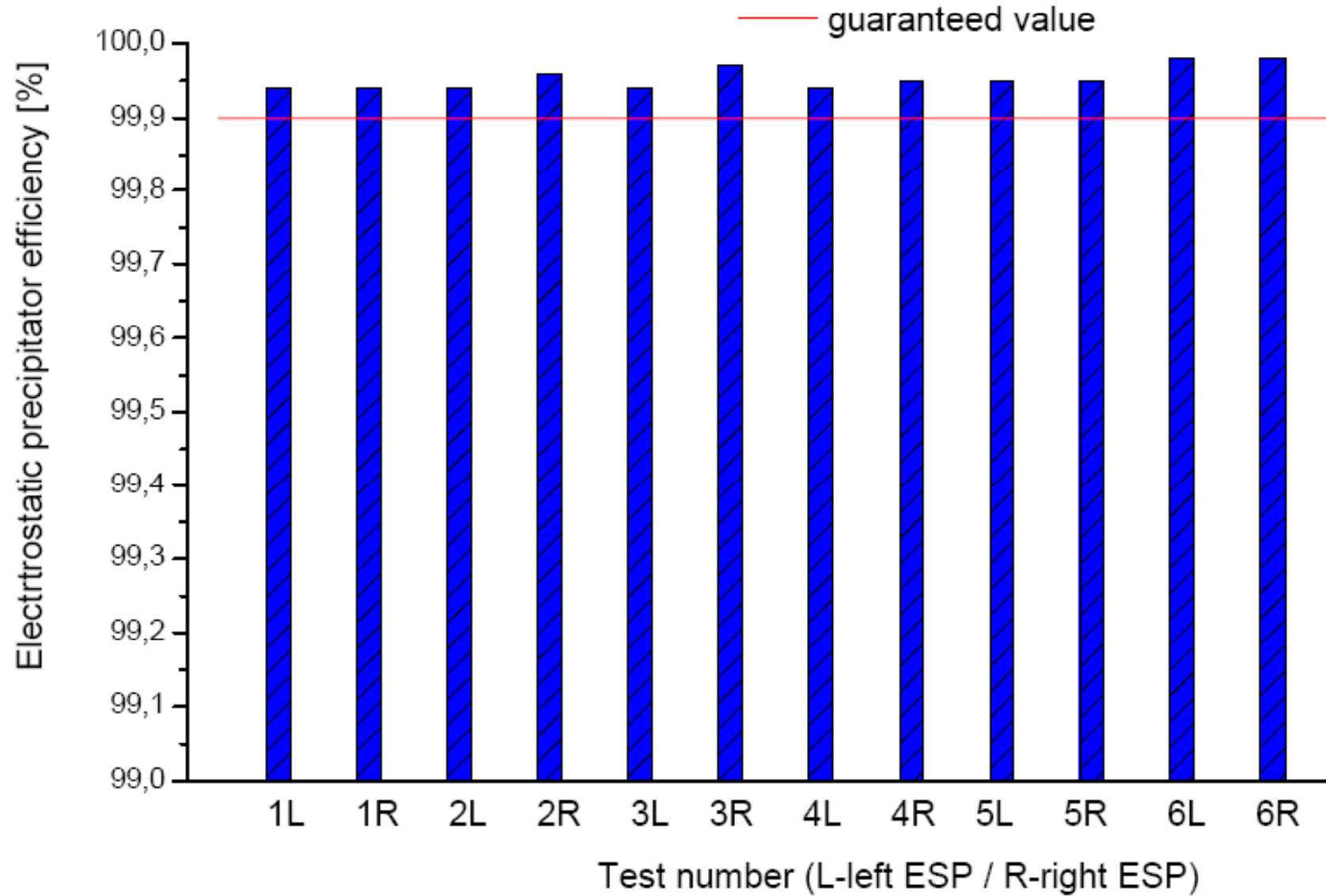
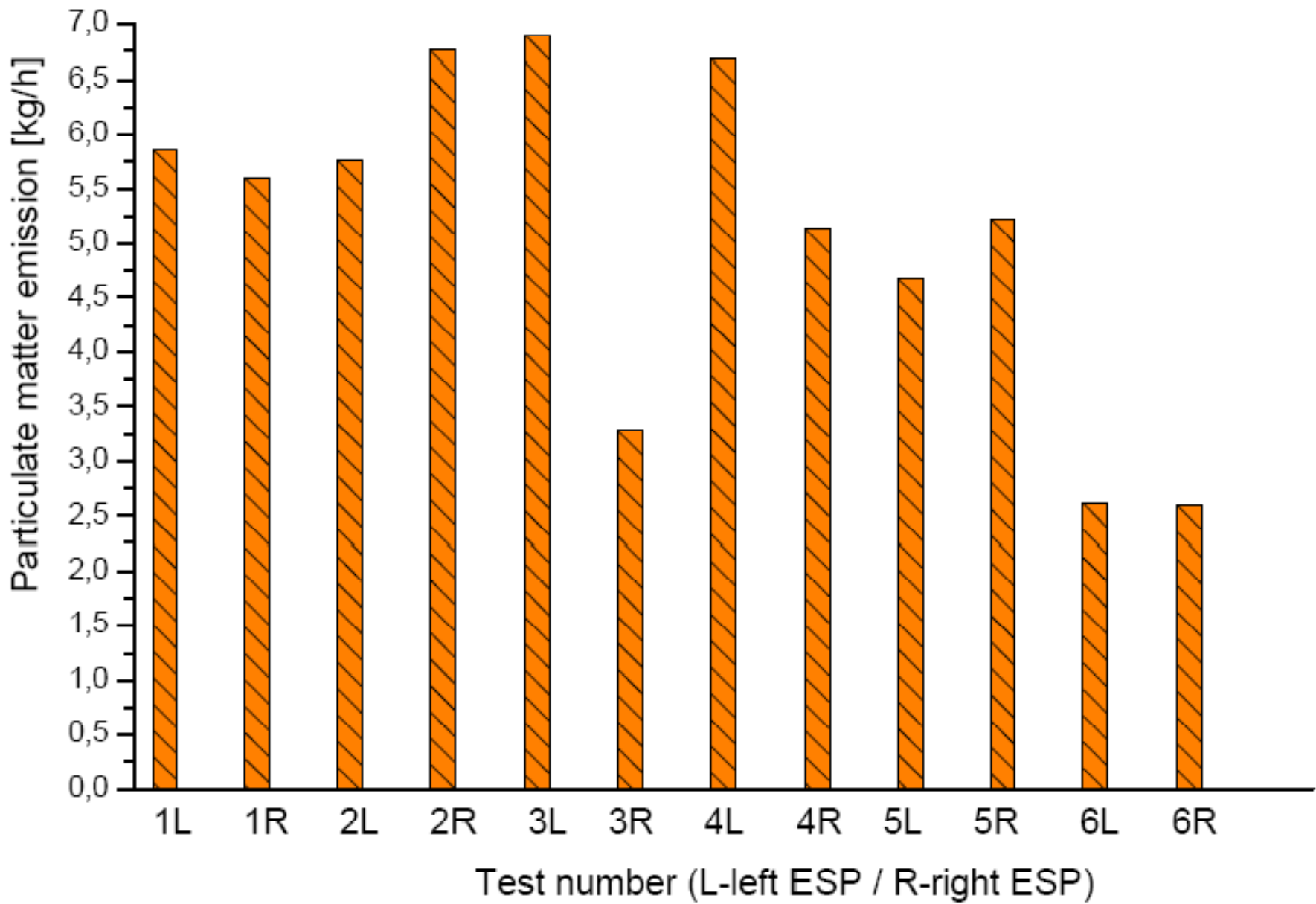


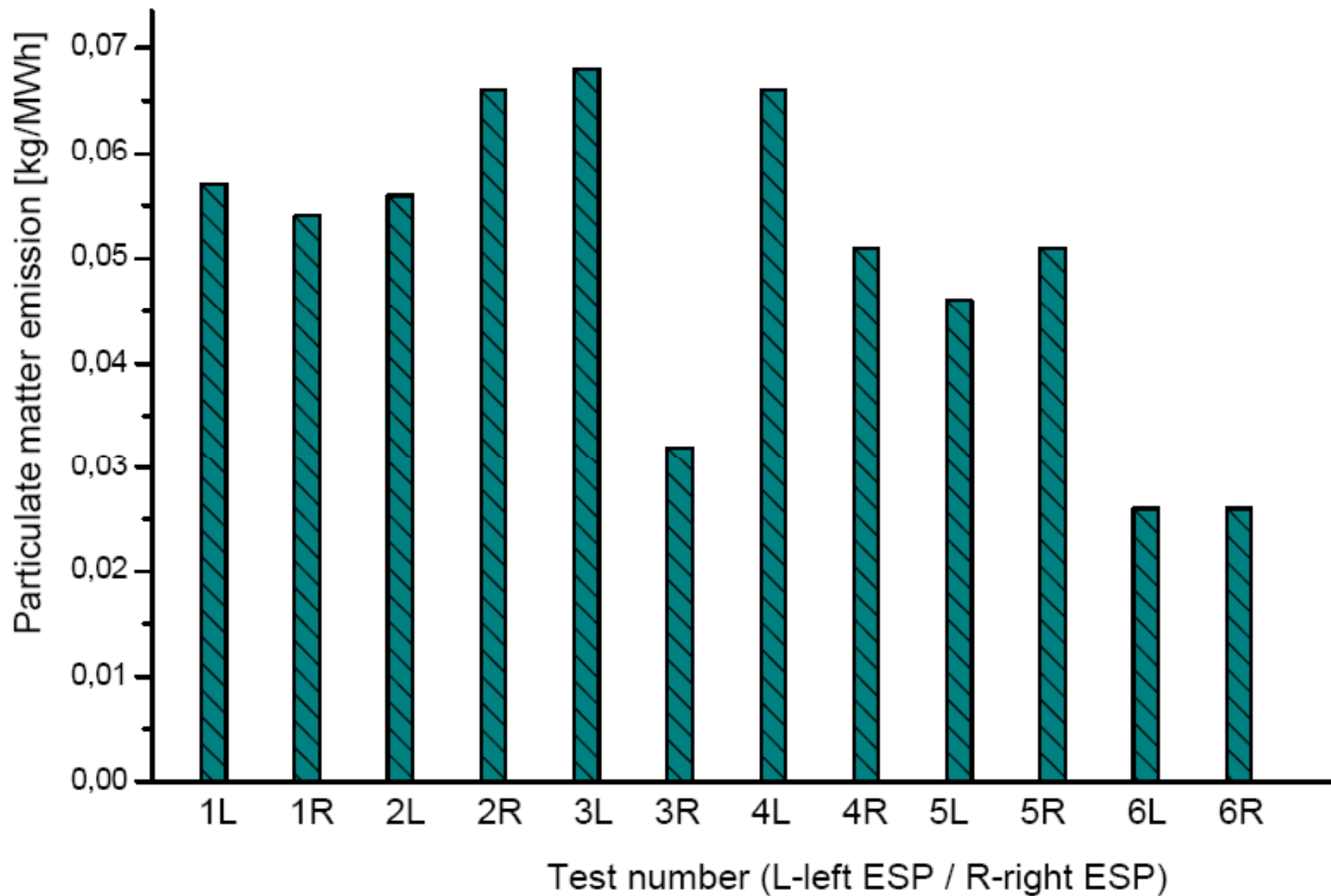
Figure 4. Particulate matter emission test results of ESP at unit A5



**Figure 5. *Electrostatic percipitator efficiency for guaranteed conditions***



**Figure 6. Particulate matter emission test results in kg/h for guaranteed conditions**



**Figure 7. Particulate matter emission test results in kg/MWh for guaranteed conditions**

## 5. CONCLUSION

Tests for particulate matter emissions, before reconstruction of electrostatic precipitators, has shown that the emissions of particulate matter at unit A5 were:

- 259 mg/Nm<sup>3</sup> in 2006th and
- 425 mg/Nm<sup>3</sup> in 2008th.

Electrostatic precipitators 12 tests have been performed According to the Programme performance at unit A5 of TPP Kolubara. Tests were performed at the same time on the left and the right precipitator.

Measured values of particulate matter concentration on electrostatic precipitator exit for guaranteed conditions of the boiler and precipitators are lower than guarantee value of 50 mg/Nm<sup>3</sup>. The highest single measured value is 26.7 mg/Nm<sup>3</sup>.

Conclusion, based on the measurements, analyzed results, and performed chemical analysis, is that the reconstructed and modernized electrostatic precipitators at unit A5 of TPP KOLUBARA fulfilled guaranteed value in term of particulate matter concentration at the exit of electrostatic precipitators.

***Thank you for your attention !***

