

FLUE GASES MEASUREMENT REPORT

MEASUREMENTS OF FLUE GASES FROM STEAM BOILER TYPE SBK/HYBRIT 6

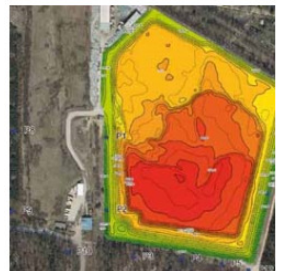
PREPARED FOR:

PAREP MILL KOCHANI, REPUBLIC OF NORTH MACEDONIA



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FLUE GASES MEASUREMENT REPORT MEASUREMENTS OF FLUE GASES FROM STEAM BOILER TYPE SBK/HYBRIT 6

Report № E702A

21/05/2021

Prepared by

SGS BULGARIA EOOD

Prepared for

**PAREP MILL KOCHANI, REPUBLIC
OF NORTH MACEDONIA**

Client Address:

36, Todosii Paunov Str., Kocani, Republic of
North Macedonia

Mr. Zhivko Zhelezov, Operational Director

Laboratory of SGS is accredited by
Bulgarian Accreditation Services

Accreditation certificate:

№ 86LI, dated 08.03.2021,
valid until 29.01.2025

Accreditation order: № A120/08.03.2021

This report is approved by

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Vasil Tomov
Field Manager

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Vesela Stancheva
On behalf of Laboratory Manager

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1. EXECUTIVE SUMMARY

Upon a request from Paper Mill DOO, Kochani, Republic of North Macedonia (hereinafter referred to as the 'Client') the Laboratory of SGS Bulgaria EOOD, performed on-site measurements, sampling, and laboratory analysis of four samples of flue gases from stationary emission source - Steam boiler Type SBK/HYBRIT 6 (stack ID AA2), part of Steam Production Plant for determination of mass concentration of SO₂, NO_x, CO, O₂ and dust in accordance to the requirements of Integrated Environmental Permit No.УП1-11/3-1326/2019 and SGS Proposal No.21/EHS/OF/018, dated 12th of January 2021.

On-site measurements were performed on 22nd of April 2021, laboratory analyses were performed in the period 26th of April – 7th of May 2021 and report preparation on 10-21st of May 2021.

Based on data provided by the Client, during the time of on-site measurements and sampling, the boiler was operational at approximately 70% of its production capacity (4.2. ÷ 4.4. t steam/hour), producing steam with pressure of 6.5 ÷ 7.5 bar and fuel consumption was 900-950 kg/hour. Fuel burned during the tests was pellets made from sunflowers shells.

The results of the measurements showed that the concentrations of SO₂, NO_x, O₂ and dust for all four tests are within permitted limit values, except of CO, which concentrations are above 6250 mg/Nm³. CO concentration was above the accredited detection limit of the laboratory and above the measuring range of the gas analyser.

2. INTRODUCTION AND BACKGROUND

The current report is prepared by SGS Bulgaria EOOD (SGS) for Paper Mill DOO, Kochani (the Client) and contains the results from measurements of flue gases from Steam boiler Type SBK/HYBRIT 6, located at the installation for recycling of waste paper, situated in Kochani, Republic of North Macedonia.

The objective of the measurements was determination of the concentration of following parameters:

- Dust;
- Sulphur dioxide (SO₂);
- Nitrogen oxides (NO_x);
- Carbon monoxide (CO);
- Oxygen (O₂).

Additional flue gas parameters were also determined, which include velocity (volume flowrate), moisture content, temperature and pressure of flue gases.

2.1 SUBJECT SITE

Client Name:	Paper Mill DOO, Kochani
Address:	36 Todosii Paunov str., 2300 Kochani, Republic of North Macedonia
Client Representative:	Mr. Zhivko Zhelezov, Operational Director
Operator:	Paper Mill Kochani DOO
Installation:	Installation for recycling of waste paper
Emission source:	Steam boiler Type SBK/HYBRIT 6
Location:	36 Todosii Paunov str., 2300 Kochani, Republic of North Macedonia

2.2 INFORMATION FOR THE LABORATORY, PERFORMING THE MEASUREMENTS

Laboratory Name:	Laboratory of SGS Bulgaria EOOD
Address:	1, William Froude Str., Institute of Hydro and Aerodynamics, 9003 Varna, Bulgaria
Accreditation certificate:	№ 86LI, dated 08.03.2021
Personnel performed on-site measurements:	Mr. Vasil Tomov – Field Manager Mr. Lyubomir Kolev – Field Technician
QA/QC:	Mr. Vasil Tomov – Field Manager
Laboratory Manager:	Mrs. Veselka Pashova
Laboratory Manager (EHS Lab):	Mrs. Vesela Stancheva

3. DESCRIPTION OF THE INSTALLATION

Paper Mill DOO, Kochani is installation for recycling of waste paper, located in the city of Kocani, Republic of North Macedonia. Company produces different type of paper (testliner, fluting, schrenz paper, kraft paper for paper bags, packaging paper, etc.) with permitted production capacity of 100 t/d.

The production process consists of the following stages/sub-processes:

- Sorting of old paper,
- Pulping (primary and secondary),
- Sorting, purifying, grinding, and mixing of pulp,
- Formation and drying of paper,
- Paper finishing,
- Production of auxiliary materials,
- Production of steam.

Steam used by the installation is generated in steam production plant, located on -site consisting of two boilers, as follows:

- Steam boiler Guro Gakovik STEAMBLOCK OPTIMAL TIP 800:
 Thermal capacity: 8.1 MW
 Fuel Type: Natural gas
 Stack identification: AA1
- Steam boiler Type SBK/HYBRIT 6:
 Thermal capacity: 4.2 MW
 Fuel Type: Solid fuel (pellets from sunflowers shells)
 Stack identification: AA2

Subject of flue gases measurements described in the current report is Steam boiler Type SBK/HYBRIT 6 (with stack AA2).



Picture 1: Steam boiler Type SBK/HYBRIT 6



Picture 2: Stack AA2 to Boiler

Steam production utilities consists of the following auxiliary equipment: Rechargeable water supply, feed pumps, vapor distributors, fuel supply system, fuel tank, fuel combustion system, boiler fly ash and bottom ash discharge system, recuperator for utilization of thermal energy of the flue gases, air intake fan, exhaust gases fan.

Steam boiler SBK/HYBRID 6, is operated as an additional power to the existing steam boiler Guro Gakovik STEAMBLOCK OPTIMAL TIP 800.

Steam boiler SBK/HYBRID 6 is combusting biofuel - solid fuel (pellets made from sunflower shells).

General scheme of steam production plant is shown on Figure 1 below:

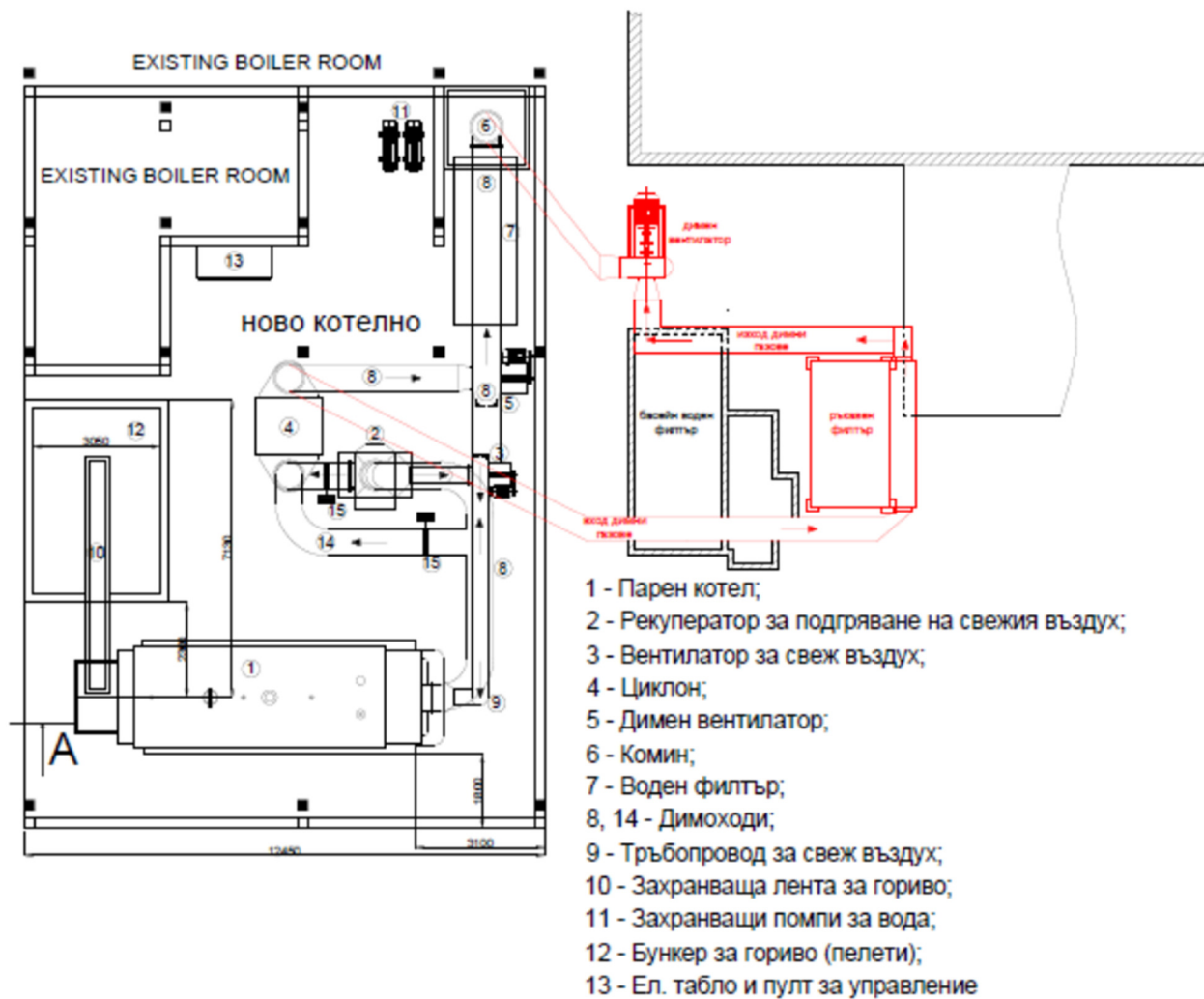


Figure 1: Steam production plant scheme

3.1 TECHNICAL SPECIFICATION OF STEAM BOILER SBK / HYBRID 6

Technical specifications of Steam boiler Type SBK/HYBRIT 6 are given in the table below, as provided by Client:

Table 1 Technical characteristics of the boiler

Manufacturer:	Birsan Enerji Mac San Tic As, Denizli, Turkey
Type:	SBK HYBRIT 6
Serial number:	92290001
Year of production:	2019
Capacity:	6 000 kg steam/h
Heating surface:	260 m ²
Max heat output:	4.2 MW
Max. allowable pressure	8.0 bar
Fuel Type:	Granular solid fuel (pellets from sunflower shells)

3.2 DESCRIPTION OF AUXILIARY FACILITIES AND EMISSION DISCHARGE POINT

The steam boiler SBK/HYBRID 6 consists of:

- Combustion chamber (lodge), where granular solid fuel (pellets, etc.) is being combusted.
- Boiler pipe screen, which is placed above the movable grate, next to the walls of combustion chamber, where steam is generated.

The flue gases, after leaving the combustion chamber, continue to move towards the cylindrical part of the boiler, and then to the boiler pipes, around which the hot water evaporates.

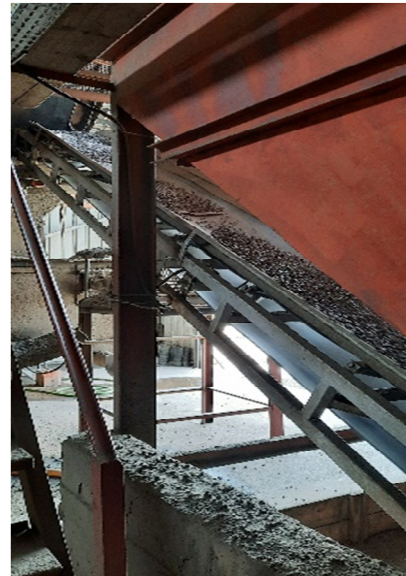
The boiler is combusting granular solid fuel (sunflower pellets), with net calorific value of 17000-18000 kJ/kg.

Combustion is performed on a movable grille made of high temperature resistant steel alloy, designed to provide fresh air supply from the bottom evenly along the entire length of the grille. This achieves complete combustion of the fuel.

The pellet supply system (Picture 3 and 4) consists of a primary tank and a conveyor belt for fuel transportation to the boiler. The primary tank is 16 m³ and allows app. 9 hours of continuous operation of the steam boiler.



Picture 3: Primary tank for storage of pellets



Picture 4: Belt conveyor for pellets

Flue gas abatement equipment is a bag filter (Picture 5). Treated flue gases are emitted to the atmosphere through stack with identification AA2 with the help of industrial fan (Picture 6).



Picture 5: Flue gases abatement equipment
(bag filter)



Picture 6: Electrical fan

4. SCOPE OF WORK

The purpose of the flue gas emission measurements, described in the current report is to provide data to the Client for the concentration of dust, SO₂, NO_x, CO and O₂ in flue gases from the emission source described above.

The measurements include direct measurements of O₂, CO, NO_x and SO₂ with portable gas analyser, collection of samples for further determination of dust concentration and measurements of flue gases thermodynamic parameters – all expressed as average values representative for the whole 30 min duration of each of four measurement runs.

All the measurements were carried out in accordance to CD CEN/TS 15675:2009.

Detailed description of the methods and standards used for determination of the abovementioned parameters is given in p.5 of the current report.

4.1 MEASUREMENT PLAN AND SAMPLING STRATEGY

The following measurement plan was developed prior the measurement by SGS technicians:

Table 2 Measurement plan and sampling strategy

Description of measurement site:	Paper Mill Kochani, Installation for recycling of waste paper
Operating conditions of the plant:	Steam boiler, max capacity 6 t steam/h, expected load: 70 %
Process characteristics:	Combustion of solid fuel in a steam boiler
Fuel (expected load):	Pellets from sunflowers shells (900-1000 kg/h)
Waste gas components:	Dust, NO _x , SO ₂ , CO
Reference quantities to be measured (mass flow):	Expected mass flow is about: Dust concentration: 0.800 kg/h; Nitrogen oxides (NO _x) ~ 2.000 kg/h; Sulphur dioxide (SO ₂) ~ 10.400 kg/h; Carbon monoxide (CO) ~ 2.000 kg/h.
Expected gas humidity:	6%
Expected gas temperature:	100-120 °C

Number of individual measurements:	It is expected that the boiler and flue gas treatment equipment operate in a stable condition, therefore three individual measurements are planned to be performed.
Timing and duration of individual measurements:	Duration of individual measurement to be minimum 30 minutes each, as the process is expected to be continuous and as per requirements of EN 13284-1 (for dust concentration) and Local Regulation on methodology for measurement of emissions from stationary sources (state gazette of RM, last updated 146/15).
Stack shape and diameter:	Circular, Ø 600 mm
Stack height:	21 m.
Measuring section (expected):	4.2 m.
Position of measuring plane:	In a section of a duct with at least 3 m. of straight duct upstream of the sampling plane and 2 m. downstream from the top of the stack, in a duct with constant shape and cross-sectional area.
Measurement points:	Grid measurements to be performed in minimum 2 sampling lines (diameters), in minimum 4 sampling points in accordance with EN 15259
Measurement ports:	At least two measurement ports, positioned in one horizontal axis (at a distance between them of 90°) with diameter min.90 mm.
Working platform:	Required load bearing capacity – minimum: 300 kg. Minimum area of working platform: 4 m ² Minimum length/wight: 2.20 m. Minimum height: 1.60 m. Fall protection equipment
Measurement site (Utilities):	Power supply (Electricity: 220 V)
Measurement site: Safety and environmental conditions:	Easy and free access to the site Equipment for safe lifting of sampling equipment Fall protection equipment (barrier and/or rails) Shelter (in case of bad weather); Helmet, working shoes, working glass, protective clothes Gas detector
Measurement methods:	The following measurement methods are agreed with the Client, based on the requirements of State Environmental Inspectorate of Republic of North Macedonia: O ₂ EN 14789 NO _x EN 14792; CO EN 15058 SO ₂ ISO 7935; Humidity EN 14790.
Measuring equipment:	Portable gas analyser Horiba PG-350E,

	Gas conditioning: M&C PSS-5 ST5 EVO – Dado Lab, Sampling line: ESC ESS, Tecora Flowtest ST, S-Type Pitot/Darcy Tube
Sampling strategy:	Grid measurements with isokinetic sampling to be performed in minimum 2 sampling lines (diameters), in minimum 4 sampling points, as described above

4.2 DESCRIPTION OF MEASURING SITE

Description of stack and sampling/measuring site is given in the table below:

Table 3 Description of measuring site

Emission source:	Steam boiler SBK HYBRIT 6
Stack ID	AA2
Coordinates	E:22.4318 N 41.9124
Duct Hight	21m
Duct shape at measurement plane	Circular
Duct internal diameter	Ø 600mm
Measuring section:	Meets the requirement of at least 4.2 m.
Position of measuring plane:	Meets the requirement of at least 3 m. of straight duct upstream of the sampling plane and 2 m. downstream from the top of the stack.
Measurement points:	Do not meet the requirements (2 sampling lines and 4 points needs to be measured). Due to lack of second measurement port the measurement is performed only in 1 sampling line, in 2 sampling points (at 8.76 mm and in 512.40 mm along the diameter) which are determined, based on the tangential method for circular ducts.
Measurement ports:	Do not meet the requirements: (at least two measurement ports, positioned in one horizontal axis (at a distance between them of 90°) with diameter min.90 mm.) Only one measurement port that meets the requirement is available on site, therefore measurement is performed in 2 sampling points, as described above.
Working platform:	Required load bearing capacity – minimum: 300 kg. - YES Minimum area of working platform: 4 m ² - YES Minimum length/wight: 2.20 m. - YES Minimum height: 1.60 m. - YES Fall protection equipment - YES
Sampling strategy:	4 measurements were performed, instead of planned 3, upon Client's request



Picture 7: Location of measurement port



Picture 8: Measurement port

4.3 DATE AND TIME OF MEASUREMENTS

On-site measurements for determination of SO₂, NO_x, CO and O₂, and thermodynamic parameters (gas temperature, velocity, volume flowrate, moisture content etc.), as well as the collection of samples for further determination of total dust content were performed on 22nd of April 2021 by:

Mr. Vasil Tomov – Field Manager

Mr. Lyubomir Kolev – Field Technician

Laboratory analysis of the samples for determination of dust concentration were performed in the Laboratory from 26th to 7th of May 2021 by:

Mrs. Dilyana Toteva – Senior Chemist and validated by Mrs. Vesela Stancheva – Laboratory Manager (EHS Lab).

The measurements were conducted on 22.04.2021, as follows:

- Measurement 1: 10:37 h ÷ 11:06 h;
- Measurement 2: 11:12 h ÷ 11:41 h;
- Measurement 3: 11:54 h ÷ 12:23 h;
- Measurement 4: 12:44 h ÷ 13:13 h;

During the on-site measurements and sampling no severe weather conditions occurred, which could influence the implementation of the activities and the measurement results, such as rain, snow, wind, high temperature, etc.

4.4 OPERATIONAL CHARACTERISTICS OF THE INSTALLATION DURING MEASUREMENTS

During the measurements, the installation operated under the following operational conditions, as provided by Client*:

Table 4 Installation operating conditions during measurements

Capacity (max steam production):	6 000 kg steam /h
Steam production during the measurements:	4200 ÷ 4400 kg steam /h
Max. allowable pressure	8.0 bar
Pressure during the measurements:	6.5÷7.0 bar
Fuel Type:	Sunflower pellets
Fuel consumption during measurements:	900÷950 kg/h

Note: Information above is based on a written information, received from the Client

5. METODOLOGY AND EQUIPMENT

Detailed information for the methodology, methods, equipment and consumables, used for the determination of the parameters subject to current report is given in current section 5 below.

Table 5 Parameters, methods, equipment, measuring ranges

Parameter	Equipment	Method	Measurement Range
O ₂	Portable gas analyser Horiba PG-350E	EN 14789	5,0÷25,0 % vol
SO ₂		ISO 7935 (NDIR)	2,86÷14 300 mg/Nm ³
NO _x		EN 14792	2,05÷5125 mg/Nm ³
CO		EN 15058	1.25÷6250 mg/Nm ³
Moisture content	Sampling: ST5 EVO – Dado Lab, ESC ESS Lab Analyses: Electronic balance MS204S Mettler Toledo	EN 14790	> 1 vol.%
Temperature	Ni-Cr thermocouple Tecora Flowtest ST	EN 13284-1	0÷1200 °C
Flow rate (velocity)	S-type Pitot Tube Tecora Flowtest ST	EN ISO 16911-1	0÷ 40 m/s
Dust concentration	Sampling: ST5 EVO-Dado Lab Lab Analyses: Electronic scale MS204S	EN 13284-1	>1 mg/Nm ³

5.1 ON-SITE MEASUREMENTS AND SAMPLING

5.1.1 Velocity, volume flow rate, temperature, absolute pressure and moisture content

Velocity, volume flow rate, temperature and absolute pressure of the flue gases were determined in accordance with EN ISO 16911-1 by using S-type Pitot tube, connected to portable automated processor TCR Tecora Flowtest ST, SN: 1341240ST.

The equipment is last calibrated in February 2021. Calibration certificate № 37B/15.02.2021; № 36B/15.02.2021.



Picture 9: TCR Tecora Flowtest ST

The flue gas temperature was measured with thermocouple type K, attached to the S-Pitot tube. The temperature transducer is part of the differential pressure measuring system. Measurements of moisture content of flue gases was performed in accordance with EN 14790. The measurements and sampling have been performed in 1 measuring plane 2 measuring points (located 87.6 mm, 512.40 mm from diameter) of the stack, positioned at only one axis, due to presence of one measuring point only.

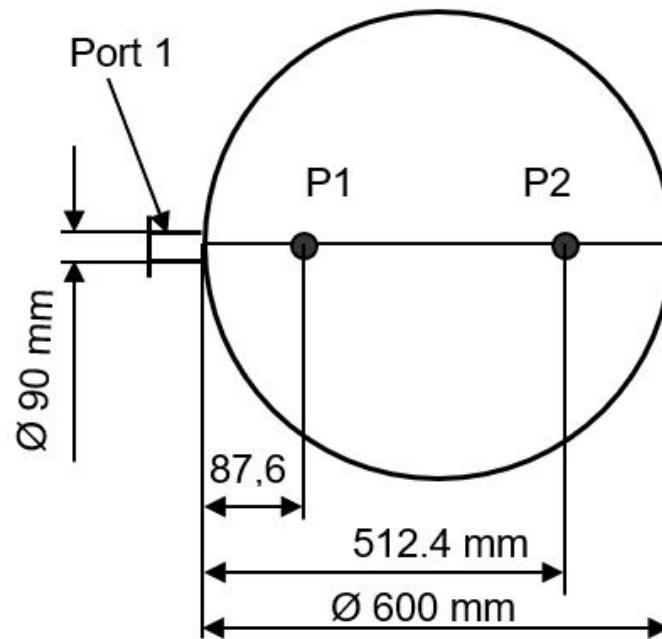


Figure 2: Measurement profile at sampling plane

5.1.2 Oxygen, Nitrogen oxides, Sulphur dioxide and Carbon monoxide

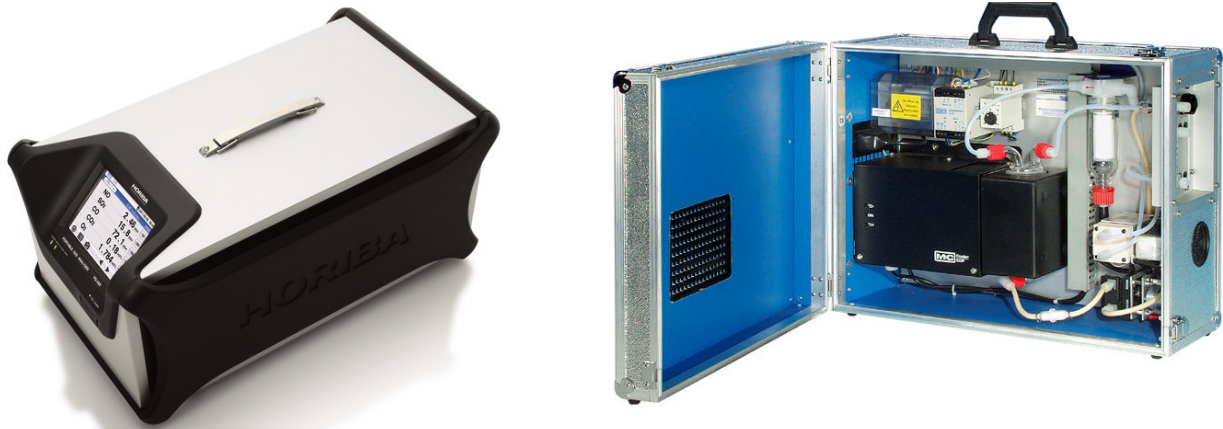
Oxygen (O₂), Nitrogen oxides (NO_x), Sulphur dioxide (SO₂) and Carbon monoxide (CO) were measured with extractive portable gas analyser Horiba PG-350E, operating on following principles:

- O₂ – paramagnetism, according EN 14789;
- NO_x – chemiluminescence, according EN 14792;
- SO₂ – NDIR, according ISO 7935;
- CO – NDIR, according EN 15058.

Before entering the gas analyser the flue gases have been conditioned by passing through ceramic filter installed at heated probe M&C PSP-4000, then trough heated PTFE line the flue gases enter M&C PSS-5 conditioning system, where the moisture have been removed by cooling down to app. 5°C. PSS-5 then feeds the dry gas into the analyser.

NO_x results represent NO₂ + NO, all expressed as NO₂.

Portable analyser Horiba PG 350-E (s/n UA03M650) is calibrated annually (last calibration certificate № 028/28.05.2020). The equipment was also checked for zero and span drift with certified reference materials, prior the measurements.



Picture 10: Portable analyzer Horiba PG 350-E and M&C PSS-5 conditioning system

5.1.3 Dust sampling

Dust concentration content has been determined in accordance with EN 13284-1.

A measured volume of flue gas has been extracted from the duct during 30 min measurement runs at controlled flowrate and isokinetic conditions, using combined isokinetic sampling probe, equipped with stainless steel 47 mm filter holder.

Pre-weighted 47 mm glass-fibre filter is installed in-stack in the stainless filter holder in order to collect particulates in the sample volume.

Isokinetic sampling of dust concentration is performed using automatic isokinetic sampler ST5 EVO Dado Lab.

According to EN 13284-1 after each sampling nozzle and filter holder were washed up in order to collect the particles which are attached to the surface of the nozzle and filter holder. Together with the filter, this liquid phase sample is part of the total dust sample together with filter itself.



Picture 11: ST5 EVO Dado Lab

After sampling filed blank, filters and liquid sample from the wash up of nozzle and filter holder were collected and transported to the laboratory for further analyses.

The total particle content is expressed as dust in mg/Nm³.

5.2 LABORATORY ANALYSES

Pre-weighting of the field blank and sample filters is done in controlled conditions in the laboratory. For the weighting of the filters is used calibrated Electronic balance MS204S Mettler Toledo, Calibration certificate № 80V-M-21 / 22.02.2021.



Picture 12: Electronic balance MS204S Mettler Toledo

Sampled field blank (filters and liquid sample from the wash up of nozzle and filter holder) were collected and transported to the laboratory for further analyses. The filter was weighted in controlled conditions together with dust remained after evaporated liquid from the wash up of nozzle and filter holder.

The results from field blank is given in section 5.3.2 of current report.

5.3 QUALITY ASSURANCE

5.3.1 Leak test procedure

In accordance to p.9.4 to EN 13284-1 a leak test is performed prior to the dust sampling, in order to check the integrity of the sampling system.

Measured leak is 0.163 l/minute (1.63 %), which is below 2.0 % of the expected sample gas flow rate (10 l/minute), which mean the test is valid.

5.3.2 Field blank

In accordance to p.9.7 to EN 13284-1 Filed blank sample is taken before measurement series.

Field blank results are given below:

Table 6 Field blank results

Filter ID	Method	Equipment	Weight, mg	Average sampled volume, Nm ³	Result, mg/Nm ³	ELV mg/Nm ³
56	EN 13284-1	Electronic balance MS204S Mettler Toledo	0.3	0.335	0.895	150

The result from filed blank is within the permitted value of 10 % of ELV (15 mg/Nm³).

5.3.3 Compliance with isokinetic criteria

Flow parameters were determined prior and during sampling. In order to assure compliance with isokinetic criteria a proper nozzle is calculated and installed.

Calculated nozzle for the isokinetic sampling was 6.35 mm. The same was used during the sampling.

Table 7 Compliance with isokinetic criteria

	Unit	Test 1	Test 2	Test 3	Test 4
Nozzle	mm	6.35	6.35	6.35	6.35
Velocity	m/sec	8.52	9.59	8.83	10.35
Velocity at nozzle	m/sec	8.447	9.485	8.757	10.306
Isokinetic Rate	%	-0.9	-1	-0.7	-0.4
Isokinetic criteria	÷	-5%÷15%	-5%÷15%	-5%÷15%	-5%÷15%
Compliance with isokinetic criteria	Yes/No	Yes	Yes	Yes	Yes

6. RESULTS

The results from the measurements are given in the tables below:

6.1 TEST 1 RESULTS

Table 8 – Measurement results test 1

Date	22.04.2021	Time period	10:37 ÷ 11:06			
Flow measurements						
Parameter	Method	Unit	Results	ELV	Equipment	
Velocity	EN ISO 16911-1	m/s	8.52	-	Tecora Flowtest ST	
Gas temperature		°C	104.6	-		
Ambient Pressure		hPa	984.2	-		
Volume flow rate		m ³ /h	8065	-		
Volume flow rate		Nm ³ /h	5663	-		
Volume flow rate, O ₂ ref. 11 % vol		Nm ³ /h	5199	7679.98		
Moisture content	EN 14790	% vol	7.0	-	ST5 EVO – Dado Lab, ESC ESS, Electronic balance Kern FKB 8K0.1A	
Gas measurements						
Parameter	Method	Unit	Results	ELV	Equipment	
Oxygen (O ₂)	EN 14789	%	11.82±0.59	-	Portable gas analyser Horiba PG-350E	
Carbon monoxide (CO)	EN 15058	mg/Nm ³	> 6250	-		
Carbon monoxide (CO), O ₂ ref. 11 % vol		mg/Nm ³	>6808	500		
Nitrogen oxides (NO _x)	EN 14792	mg/Nm ³	154.36±7.72	-		
Nitrogen oxides (NO _x), O ₂ ref. 11 % vol		mg/Nm ³	168.15±8.41	500		
Sulphur dioxide (SO ₂)	ISO 7935 (NDIR)	mg/Nm ³	81.52±4.08	-		
Sulphur dioxide (SO ₂), O ₂ ref. 11 % vol		mg/Nm ³	88.80±4.44	2000		
Carbon monoxide (CO), mass flow rate		kg/h	>35.40	-		Horiba PG-350E Flowtest ST, ST5 EVO – Dado Lab, ESC ESS, Kern FKB 8K0.1A
Nitrogen oxides (NO _x), mass flow rate		kg/h	0.874	-		
Sulphur dioxide (SO ₂), mass flow rate		kg/h	0.462	-		
Dust concentration sampling and analysis						
Sampling	Method	Unit	Results	ELV	Equipment	
Dust	EN 13284-1	mg/Nm ³	3.31±0.50	-	Flowtest ST,	

Dust, O ₂ ref. 11 % vol		mg/Nm ³	3.61±0.54	150	ST5 EVO – Dado Lab, ESC ESS, Kern FKB 8K0.1A Mettler Toledo MS204S
Total dust, mass flow rate		kg/h	0.0188	-	
Sampled Moist Volume at stack conditions		m ³	0.382	-	
Sampled Integrated Std Volume [T _{norm} P _{norm}]		Nm ³	0.332	-	

Notes: 1) The volume flowrate in m³/h and Nm³/h as well as concentrations of total dust, NO_x, SO₂, CO and O₂ refer to dry gas.

2) ELV values are according IP № УП1-11/3-1362/2019.

6.2 TEST 2 RESULTS

Table 9 – Measurement results test 2

Date	22.04.2021	Time period	11:12 ÷ 11:41		
Flow measurements					
Parameter	Method	Unit	Results	ELV	Equipment
Velocity	EN ISO 16911-1	m/s	9.59	-	Tecora Flowtest ST
Gas temperature		°C	103.9	-	
Ambient Pressure		hPa	984.2	-	
Volume flow rate		m ³ /h	9049	-	
Volume flow rate		Nm ³ /h	6369	-	
Volume flow rate, O ₂ ref. 11 % vol		Nm ³ /h	5949	7679.98	
Moisture content	EN 14790	%	7.3	-	ST5 EVO – Dado Lab, ESC ESS, Electronic balance Kern FKB 8K0.1A
Gas measurements					
Parameter	Method	Unit	Results	ELV	Equipment
Oxygen (O ₂)	EN 14789	%	11.66±0.58	-	Portable gas analyser Horiba PG-350E
Carbon monoxide (CO)	EN 15058	mg/Nm ³	> 6250	-	
Carbon monoxide (CO), O ₂ ref. 11 % vol		mg/Nm ³	>6692	500	
Nitrogen oxides (NO _x)	EN 14792	mg/Nm ³	160.32±8.02	-	
Nitrogen oxides (NO _x), O ₂ ref. 11 % vol		mg/Nm ³	171.65±8.58	500	
Sulphur dioxide (SO ₂)	ISO 7935 (NDIR)	mg/Nm ³	110.59±5.53	-	
Sulphur dioxide (SO ₂), O ₂ ref. 11 % vol		mg/Nm ³	118.41±5.92	2000	
Carbon monoxide (CO), mass flow rate		kg/h	>39.81	-	

Nitrogen oxides (NO _x), mass flow rate		kg/h	1.021	-	ST5 EVO – Dado Lab, ESC ESS, Kern FKB 8K0.1A
Sulphur dioxide (SO ₂), mass flow rate		kg/h	0.704	-	
Total dust sampling and analysis					
Sampling	Method	Unit	Results	ELV	Equipment
Total dust	EN 13284-1	mg/Nm ³	82.4±12.4	-	Flowtest ST, ST5 EVO – Dado Lab, ESC ESS, Kern FKB 8K0.1A Mettler Toledo MS204S
Total dust, O ₂ ref. 11 % vol		mg/Nm ³	88.2±13.3	150	
Total dust, mass flow rate		kg/h	0.525	-	
Sampled Moist Volume at stack conditions		m ³	0.428	-	
Sampled Integrated Std Volume [T _{norm} P _{norm}]		Nm ³	0.335	-	

- Notes: 1) The volume flowrate in m³/h and Nm³/h as well as concentrations of total dust, NO_x, SO₂, CO and O₂ refer to dry gas.
- 2) ELV values are according IP № УП1-11/3-1362/2019.

6.3 TEST 3 RESULTS

Table 10 – Measurement results test 3

Date	22.04.2021	Time period	11:54 ÷ 12:23		
Flow measurements					
Parameter	Method	Unit	Results	ELV	Equipment
Velocity	EN ISO 16911-1	m/s	8.83	-	Tecora Flowtest ST
Gas temperature		°C	110.8	-	
Ambient Pressure		hPa	985.3	-	
Volume flow rate		m ³ /h dry	8404	-	
Volume flow rate		Nm ³ /h	5813	-	
Volume flow rate, O ₂ ref. 11 % vol		Nm ³ /h	4668	7679.98	
Moisture content	EN 14790	%	6.5	-	ST5 EVO – Dado Lab, ESC ESS, Electronic balance Kern FKB 8K0.1A
Gas measurements					
Parameter	Method	Unit	Results	ELV	Equipment
Oxygen (O ₂)	EN 14789	%	12.97±0.65	-	Portable gas analyser Horiba PG-350E
Carbon monoxide (CO)	EN 15058	mg/Nm ³	> 6250	-	
Carbon monoxide (CO), O ₂ ref. 11 % vol		mg/Nm ³	>7783	500	
Nitrogen oxides (NO _x)	EN 14792	mg/Nm ³	144.36±7.22	-	

Nitrogen oxides (NO _x), O ₂ ref. 11 % vol		mg/Nm ³	179.78±8.99	500	
Sulphur dioxide (SO ₂)	ISO 7935 (NDIR)	mg/Nm ³	50.73±2.54	-	
Sulphur dioxide (SO ₂), O ₂ ref. 11 % vol		mg/Nm ³	63.18±3.16	2000	
Carbon monoxide (CO), mass flow rate		kg/h	>36.33	-	Horiba PG-350E Flowtest ST, ST5 EVO – Dado Lab, ESC ESS, Kern FKB 8K0.1A
Nitrogen oxides (NO _x), mass flow rate		kg/h	0.839	-	
Sulphur dioxide (SO ₂), mass flow rate		kg/h	0.295	-	
Total dust sampling and analysis					
Sampling	Method	Unit	Results	ELV	Equipment
Total dust	EN 13284-1	mg/Nm ³	15.8±2.4	-	Flowtest ST, ST5 EVO – Dado Lab, ESC ESS, Kern FKB 8K0.1A Mettler Toledo MS204S
Total dust, O ₂ ref. 11 % vol		mg/Nm ³	19.7±3.0	150	
Total dust, mass flow rate		kg/h	0.0919	-	
Sampled Moist Volume at stack conditions		m ³	0.386	-	
Sampled Integrated Std Volume [T _{norm} P _{norm}]		Nm ³	0.311	-	

Notes: 1) The volume flowrate in m³/h and Nm³/h as well as concentrations of total dust, NO_x, SO₂, CO and O₂ refer to dry gas.

2) ELV values are according IP № УП1-11/3-1362/2019.

6.4 TEST 4 RESULTS

Table 11 – Measurement results test 4

Date	22.04.2021	Time period	12:44 ÷ 13:13		
Flow measurements					
Parameter	Method	Unit	Results	ELV	Equipment
Velocity	EN ISO 16911-1	m/s	10.35	-	Tecora Flowtest ST
Gas temperature		°C	107.4	-	
Ambient Pressure		hPa	985.3	-	
Volume flow rate		m ³ /h	9840	-	
Volume flow rate		Nm ³ /h	6858	-	
Volume flow rate, O ₂ ref. 11 % vol		Nm ³ /h	5308	7679.98	
Moisture content	EN 14790	%	6.6	-	ST5 EVO – Dado Lab, ESC ESS, Electronic balance Kern FKB 8K0.1A
Gas measurements					

Parameter	Method	Unit	Results	ELV	Equipment
Oxygen (O ₂)	EN14789	%	13.26±0.66	-	Portable gas analyser Horiba PG-350E
Carbon monoxide (CO)	EN 15058	mg/Nm ³	> 6250	-	
Carbon monoxide (CO), O ₂ ref. 11 % vol		mg/Nm ³	>8075	500	
Nitrogen oxides (NO _x)	EN 14792	mg/Nm ³	129.40±6.47	-	
Nitrogen oxides (NO _x), O ₂ ref. 11 % vol		mg/Nm ³	167.18±8.36	500	
Sulphur dioxide (SO ₂)	ISO 7935 (NDIR)	mg/Nm ³	80.55±4.03	-	
Sulphur dioxide (SO ₂), O ₂ ref. 11 % vol		mg/Nm ³	104.07±5.20	2000	
Carbon monoxide (CO), mass flow rate		kg/h	>42.86	-	Horiba PG-350E Flowtest ST, ST5 EVO – Dado Lab, ESC ESS, Kern FKB 8K0.1A
Nitrogen oxides (NO _x), mass flow rate		kg/h	0.887	-	
Sulphur dioxide (SO ₂), mass flow rate		kg/h	0.552	-	
Total dust sampling and analysis					
Sampling	Method	Unit	Results	ELV	Equipment
Total dust	EN 13284-1	mg/Nm ³	4.97±0.75	-	Flowtest ST, ST5 EVO – Dado Lab, ESC ESS, Kern FKB 8K0.1A MS204S Mettler Toledo
Total dust, O ₂ ref. 11 % vol		mg/Nm ³	6.42±0.97	150	
Total dust, mass flow rate		kg/h	0.0341	-	
Sampled Moist Volume at stack conditions		m ³	0.461	-	
Sampled Integrated Std Volume [T _{norm} P _{norm}]		Nm ³	0.362	-	
Sample Filter ID		60	0.1455	0.1476	

- Notes: 1) The volume flowrate in m³/h and Nm³/h as well as concentrations of total dust, NO_x, SO₂, CO and O₂ refer to dry gas.
- 2) ELV values are according IP № УП1-11/3-1362/2019.

7. CONCLUSIONS

Upon a request from Paper Mill DOO, Kochani, Republic of North Macedonia (hereinafter referred to as the 'Client') the Laboratory of SGS Bulgaria EOOD, performed on-site measurements, sampling, and laboratory analysis of four samples of flue gases from stationary emission source - Steam boiler Type SBK/HYBRIT 6 (with stack AA2), part of Steam Production Plant for determination of mass concentration of SO₂, NO_x, CO, O₂ and dust in accordance to the requirements of Integrated Environmental Permit No.УП1-11/3-1326/2019 and SGS Proposal No.21/EHS/OF/018, dated 12th of January 2021.

On-site measurements were performed on 22nd of April 2021, laboratory analyses were performed in the period 26th of April – 7th of May 2021 and report preparation on 10-18th of May 2021.

Based on data provided by the Client, during the time of on-site measurements and sampling, the boiler was operational at approximately 70% of its production capacity (4.2. ÷ 4.4. t steam/hour), producing steam with pressure of 6.5 ÷ 7.5 bar and fuel consumption was 900-950 kg/hour. Fuel burned during the tests was pellets made from sunflower shells.

Summary of results from the measurements and analyses are given in the table below:

Table 12 Summary of the results

Operator:		Paper Mill DOO, Kochani					
Installation:		Installation for recycling of waste paper					
Location:		36 Todosii Paunov str., 2300 Kochani, Republic of North Macedonia					
Emission source		Steam boiler Type SBK/HYBRIT 6					
Duct shape		Circular					
Duct dimensions		Ø 600 mm					
Date		22.04.2021					
		Test 1	Test 2	Test 3	Test 4	ELV	Unit
		10:37÷11:06	11:12÷11:41	11:54÷12:23	12:44÷13:13		
1	Nitrogen oxides (NO _x), O ₂ ref. 11 % vol	168.15±8.41	171.65±8.58	179.78±8.99	167.18±8.36	500	mg/Nm ³
2	Carbon monoxide (CO), O ₂ ref. 11 % vol	>6808*	>6692*	>7783*	>8075*	500	mg/Nm ³
3	Sulphur dioxide (SO ₂), O ₂ ref. 11 % vol	88.52±4.43	118.41±5.92	63.18±3.16	101.07±5.20	2000	mg/Nm ³
4	Total dust, O ₂ ref. 11 % vol	3.61±0.54	88.2±13.3	19.7±3.0	6.42±0.97	150	mg/Nm ³

Note: *Actual concentrations are above the accredited detection limit of the laboratory and above the measuring range of the gas analyser.

8. LIST OF ABBREVIATIONS

°C	Degrees Celsius
%	Percentage
% vol	Percentage by volume
CO	Carbon monoxide
EN	European Norm
hPa	Hectopascals
l	litre
mg/Nm ³	Milligrams per normal cubic meter (at 101,3 kPa, 0 °C, dry)
NO _x	Nitrogen oxides
O ₂	Oxygen
SO ₂	Sulphur dioxide

9. APPENDICES

Appendix 1: ACCREDITATION CERTIFICATE

Appendix 2: ACCREDITATION SCHEDULE