

ENVIRONMENTAL AND ENGINEERING EVALUATION OF THE KOSOVO COAL GASIFICATION PLANT, YUGOSLAVIA

by

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Abstract

Lignite gasification is presently a worldwide process. Around the world, researchers are involved in obtaining an improved form of power from all kinds of coal as well as a more efficient and economical recovery of the coal substance itself. In the United States there is also a great interest in producing a low- and medium-Btu gas from coal. In this context, an assessment of environmental problems arising from such technological processes coupled with the development of techniques for their reduction or elimination are of great importance. The Environmental Protection Agency has initiated and is carrying out a broad research program on the above problems together with various corporations in the United States.

Within the range of operations of the program on Scientific-Technological Cooperation between the United States and Yugoslav governments, EPA has also initiated such investigations in Yugoslavia. Yugoslavia harbors substantial lignite reserves that are primarily used for electric power generation. In addition, great efforts are devoted to the development of an extremely adequate and economical technology for lignite processing. In Obilic, near Pristina, a commercial plant has been erected and put on stream for gas production from Kosovo lignite according to the Lurgi Process.

This paper outlines the research program carried out in the plant for the production of gas under pressure with a net heating value of 3600 kcal/m^3 on the basis of lignite dried by the Fleissner Process. The plant consists of six Lurgi gasifiers, each 3.6 m in diameter. The an-

nual output is 480 mil m^3 of clean gas. The research program includes: process description (ratio of masses and composition of major charges and output streams); description of measurement points; sampling; analysis and identification of major and minor pollutants; evaluation of resulting data and methods used in the investigations; determination of the amounts of individual pollutants; preparation of gasification process thermal balance and preparation of sulphur material balance. Analysis and identification of pollutants is performed on emissions discharged into the atmosphere, waste waters, and solid residues of the gasification process (dust, slurry, and slag). Three ambient samples are also analysed.

In addition, the paper indicates the problems encountered during the conversion of low-heating value Kosovo lignite into gaseous fuel by the Lurgi Process.

INTRODUCTION

An accelerated effort is currently underway in the United States to develop advanced coal gasification technology to provide an alternate source of energy. Inherent in the application of this developing technological area is the need to assess the environmental problems of these processes and to develop techniques to reduce or eliminate these problems.

The first phase of this assessment is the identification and quantification of pollutants in existing similar processes. Presently, there are no commercial coal gasification plants operating within the United States; therefore, any investigation must be conducted outside the borders of the U.S.A.

Preliminary data acquisition from pilot operations has indicated that a multiplicity of pollutants are emitted by the gasification reactor. Materials found in effluent and process streams include major pollutants, such as sulfur, nitrogen, NH_3^+ , particulate tars and oils, and minor pollutants, such as trace elements and hydrocarbons. A comprehensive analysis providing the composition and levels of major and minor pollutants found in the process and various effluent streams will provide a basis for the determination of the potential environmental degradation accompanying the gasification

process and for the evaluation of currently utilized clean-up and purification systems.

By initiating test programs in foreign countries EPA is currently utilizing the various coal gasification processes and steps are being taken to develop the methodology and necessary pollutant control equipment before the construction of commercial full scale gasification plants in the U.S.A.

Data acquired in these foreign studies will supplement information currently being acquired in pilot plant test programs in U.S.A.

In Yugoslavia similar efforts are underway.

Yugoslavia has in situ considerable deposits-resources of lignite. Although lignite is used primarily as a fuel to generate heat and power, at the present time, the research is underway to develop the most adequate and economical process technology for conversion of lignite (fuel of low caloric value) to synthetic gas and liquid fuels.

In Socialist Autonomous Province Kosovo a commercial gasification plant has been erected and is in operation using Lurgi procedure for gas production from Kosovo-lignite.

All above mentioned facts prove the significance of the problem. On the basis of the agreement about scientific and technological cooperation between American and Yugoslav Governments, the following organizations:

- Environmental Protection Agency from the United States of America,
- Rudarski Institut - Beograd, and
- REMHK Kosovo - Obilic, Socialist Autonomous Province Kosovo,

made out a programme and agreed upon the project statement for the research project entitled: "Environmental and Engineering Evaluation of the Kosovo Coal Gasification Plant."

The research work under this project will be carried out by:

- Research and Development Department REMHK Kosovo - Obilic, and
- Rudarski Institut - Mineral Dressing Department, Beograd.

The project is to be completed within 3 years from the date of signing. The project officer is Mr. Kelly Janes, chemical engineer from EPA, USA.

The principal researcher is Mr. Becir Salja,

dipl. chem. from REMHK Kosovo-Obilic.

Mrs. Mira Mitrovic, chemical engineer is responsible for the part of work carried out at Rudarski Institut.

The objective of the research is therefore to identify and quantify pollutants in existing gasification processes in order that improved techniques can be developed to reduce or eliminate environmental injury resulting from implementation of one such technology. Specific objectives will be the identification of composition and levels of major and minor pollutants of all process streams and the identification and levels of all pollutants in the various effluent streams or materials (air, water, solids). Determination of the fate of pollutants, allowing for the evaluation of potential environmental degradation, and a study of the effectiveness of present day clean-up and purification systems will also be made. Priority will be given to quantification of major pollutants, i.e., sulfur, nitrogen, NH_3^+ , particulate tars, and oils in the initial phase (I). Subsequent investigations will study the minor or trace pollutants in phase II.

The investigations should result in the selection of sample analysis methods to be applied.

The following text is comprised of:

- date of Kosovo Lignite Gasification Plant by Lurgi Procedure,
- investigation Programme (Phase I and Phase II) and Methodology for determination of gaseous, liquid, and solid pollutants contained in air, water, and solid wastes, and
- observed problems relevant for above theme.

GAS PRODUCTION FROM LIGNITE KOSOVO

In Obilic, near Pristina, Socialist Autonomous Province Kosovo, a plant was erected and started up for the production of gas under pressure (clean gas net heating value 3600 Kcal/m_N^3) from dried Kosovo lignite (Lurgi generators, Dia 3.6 m). The plant capacity is 480 million m_N^3 of clean gas per annum, representing only the first phase of Kosovo gasification plant. According to the long-term development program for this coal basin, total

gas production should reach approximately 1500 million m_N^3 per year.

The specific purpose of the gas as a power fuel for the requirements of Steel Works Skopje and surrounding industry, i.e., as a raw material for nitrogen fertilizer production in Obilic, was significant in deciding on the erection of the gasification plant in Kosovo Basin.

The Kosovo Basin Gasification Plant includes the following sections:

- gas generators: 6 generators with a capacity of 18,000 m_N^3 of crude gas each, with coal feeding and slag disposal arrangements,
- condensation,
- "rectisol" installation for gas cleaning with gas delivery station,
- air decomposition plant,
- tar and medium oil separation,
- "phenosolvent" installation for phenol separation, and
- installation for biological wastewaters cleaning.

Gasification plant feed consists of dried lignite according to the "Fleissner" method with a size range - 60 + 6 mm.

Of the mentioned amount ($480 \cdot 10^6 m_N^3/\text{year}$), 77 percent is further processed in order to remove the hydrogen required for ammonia synthesis. The residue is a methane enriched fraction mixed with the remaining clean gas. This mixture ($256 \cdot 10^6 m_N^3/\text{year}$) represents the pipeline gas with a net heating value of 4000 Kcal/ m_N^3/year , supplied into the gasline system.*

Material and Power Balances of Kosovo Lignite Gasification*

Feed		
Dried coal (-60+6 mm)	86t/h	688,000 t/year
95 percent oxygen	11,560 Nm^3/h	$92.5 \times 10^6 Nm^3/\text{year}$
Steam, 30 atm	74 t/h	592,000 t/year
Electric power	9,730 kWh	77,840 MWh/year
Phenosolvent (diisopropylether)	—	—
Methanol	56 kg/h	448 t/year

Hydrochloric acid	4 kg/h	32 t/year
Sodium-hydroxide	2.5 kg/h	20 t/year
Aluminum sulphate	2.5 kg/h	20 t/year

Output

Cleaned gas	60,000 Nm^3/h	$480 \times 10^6 Nm^3/\text{year}$
Tar	2.2 t/h	17,600 t/year
Oil	1.0 t/h	8,000 t/year
Crude gasoline	7.5 t/h	60,000 t/year
Gas water	90 Nm^3/h	720,000 m^3/year
Carbon dioxide	25,000 Nm^3/h	$200 \times 10^6 Nm^3/\text{year}$

*Data taken from the project.

PROGRAM OF INVESTIGATION

The research program includes the following tasks:

Phase I:

1. Process description (ratio of masses and composition of major feeds and outlet streams),
2. Sampling and analysis of major pollutants occurring in large quantities, determination of mass ratios and compositions of major feeds and outlet streams.

Note:

- a. Sampling is carried out simultaneously on all measurement points while the plant is operating under constant condition over an 8-hour period. The samples are divided and processed in two laboratories,
- b. Sampling campaign completed according to the following schedule:
 - test run,
 - first campaign,
 - second campaign,
 - third campaign, and
 - repeated testing if required.
3. Evaluation of test data acquired by processing the pollutants occurring in large quantities and the methods used during the tests.
4. Identification of trace pollutants (Phase II).
5. Evaluation of data acquired by process-

ing the pollutants occurring in small quantities and evaluation of the effectiveness of methods used for analyses (Phase II).

6. Heat Balance for Gasification Process on the basis of determined statistical data on the amounts and heating value of the coal consumed for:
 - a. gasification (dried lignite)--generators
 - b. heat generation (raw mine coal)--steam production for the generators, etc. as well as for:
 - c. the heat consumed in the gasification process, and on the basis of determined calories in:
 - d. the produced gas, and
 - e. liquid products.

Lignite heat recovery will be calculated for the Lurgi process of gasification.

7. Sulphur material balance in the process of Kosovo lignite gasification:

- a. *Feed:*
 - Coal
- b. *Outputs:*
 - synthesis gas and medium BTU gas,
 - tar (storage),
 - medium oil (storage),
 - gasoline (storage),
 - phenol (storage),
 - discharges into the atmosphere,
 - waste waters,
 - gasification slag (disposal area), and
 - heavy tar and coal dust (disposal area).

8. Final report with the evaluation of the technological process and environmental pollution, from Kosovo lignite gasification by "Lurgi" procedure and possible improvement proposals.

Pollutants determination includes:

- a. Control of Air Emissions

Analyses:

H₂S
Phenols
Ammonia
Particulate

CO₂

SO_x

COS

NO_x

Hydrocarbons

- b. Control of Generator Wastewaters Analyses:

COD

BOD₅ (dilution method)

Permanganate Value

Phenols, volatile and nonvolatile

Ammonia, free and fixed

Cyanide

Hydrogen sulfide

Tar oil (ether extracts)

Suspended solids

Dry solids (105° C and 850° C)

pH value

Chloride

Sulfates

Rhodanate, Thiosulfates

Fluorides, Nitrites, Nitrates,

Sulfites

- c. Control of Solid Wastes from the Coal Gasification Process (Sludges and Dusts from Gas Purification Slag and Ash)

Analyses:

Moisture

Dry solids (105° C and 850° C)

Ash composition

Phenol, total and volatile, in water filtrate

Elementary analysis of dry material (105° C)

COD (water filtrate)

BOD (water filtrate)

Notice: All pollutants will be determined as to ASTM procedure.

In studying the foregoing research program, due consideration should be paid to the following:

- Location of sampling points, fitting the required sampling connections, and installation of platforms and accesses for sampling.
- Repair and calibration of all equipment, purchased and borrowed, in order to secure adequate operation.
- Preparation of test schedule, together with a list of sampling methods,

methods for sample preparation and selection of analysis methods (ASTM).

- Compilation of plant operative data over the test period.
- Provision of the equipment required for the analysis of samples, representative samples will be taken and appropriately preserved. Repeated double analyses will be performed.
- Regular preparation of reports on the results of works during a reasonable period upon analyses completion.

Specific key streams will be sampled in the Kosovo Coal Gasification Plant, and appropriate analyses will be carried out in accordance with the information supplied below:

Figure 1--Sampling points (plant streams and ambient)

The samples presented in Figure 1, found enclosed, are considered the most useful ones for initial research in this plant. A total of 19 sampling points has been located for gaseous, liquid, and solid samples. Table 1 (enclosed) includes the sample to be taken, required stream measurements, analyses of trace elements and trace organic materials, GCMS, HPLC, and AA analyses and size comprise determinations.

General locations of area sampling points are also indicated on Figure 1. Three area samples are to be taken at locations to be selected.

In area samples (three), the following components will be determined by use of appropriate methods:

ANALYSIS	METHOD
CO	NDIR
NO _x	Chemiluminescent
SO ₂	
H ₂ S	FPD/GC
COS	
CS ₂	
Mercaptans	
HC	FID/GC
Particulates	Hi Vol
Organics	XAD-2/GCMS

DESCRIPTION OF THE TECHNOLOGICAL PROCESS AND SAMPLING POINTS IN COAL GASIFICATION PLANT KOSOVO

Figure 1 presents the flow sheet of Coal Gasification Plant Kosovo and the sampling points in the process streams and area.

Sampling will be carried out in the following plant sections:

- Generators (Figure 2),
- Condensation and tar separation (Figures 3 and 4),
- Rectisol (Figure 5),
- Phenols separation (Figure 6),
- Cooling water air cooling system, and
- Storage (Figure 7).

In addition, three area samples will be taken on plant site.

Sections not included in sampling:

- Coal drier,
- Air decomposition,
- Biological water cleaning,
- Heating plant, and
- Water preparation.

Generator Section

The Generator Section (Figure 2) performs the gasification of coal according to the Lurgi process. The dried coal of class - 60 + 6 mm is fed by conveyor belts to the coal bin (1). In the bin, the coal is protected by nitrogen atmosphere. By the coal lock bucket (2) the coal is fed into coal lock (3) and further into generator (4). In the generator, the coal is gasified in the presence of steam and oxygen. The crude gas formed is lead first through the cooler with direct water injection (5), and then through two indirect coolers (6) and (7) and supplied to the Condensation Section. From the raw gas, condensates and high boiling points (tar) are separated in the coolers, as well as one part of the carried dust and contained water vapour. This tar gas liquor is fed into the gas liquor tank (15) and gas liquor gate (16) at start, i.e., directly to the tar separation section. The ash and a part of unreacted coal are discharged from the generator through the ash lock (9) and ash chamber (10) into the quenching bath, and then to the disposal area. Since the locks (3) and (9) are under pressure, their charging i.e., discharging requires partial

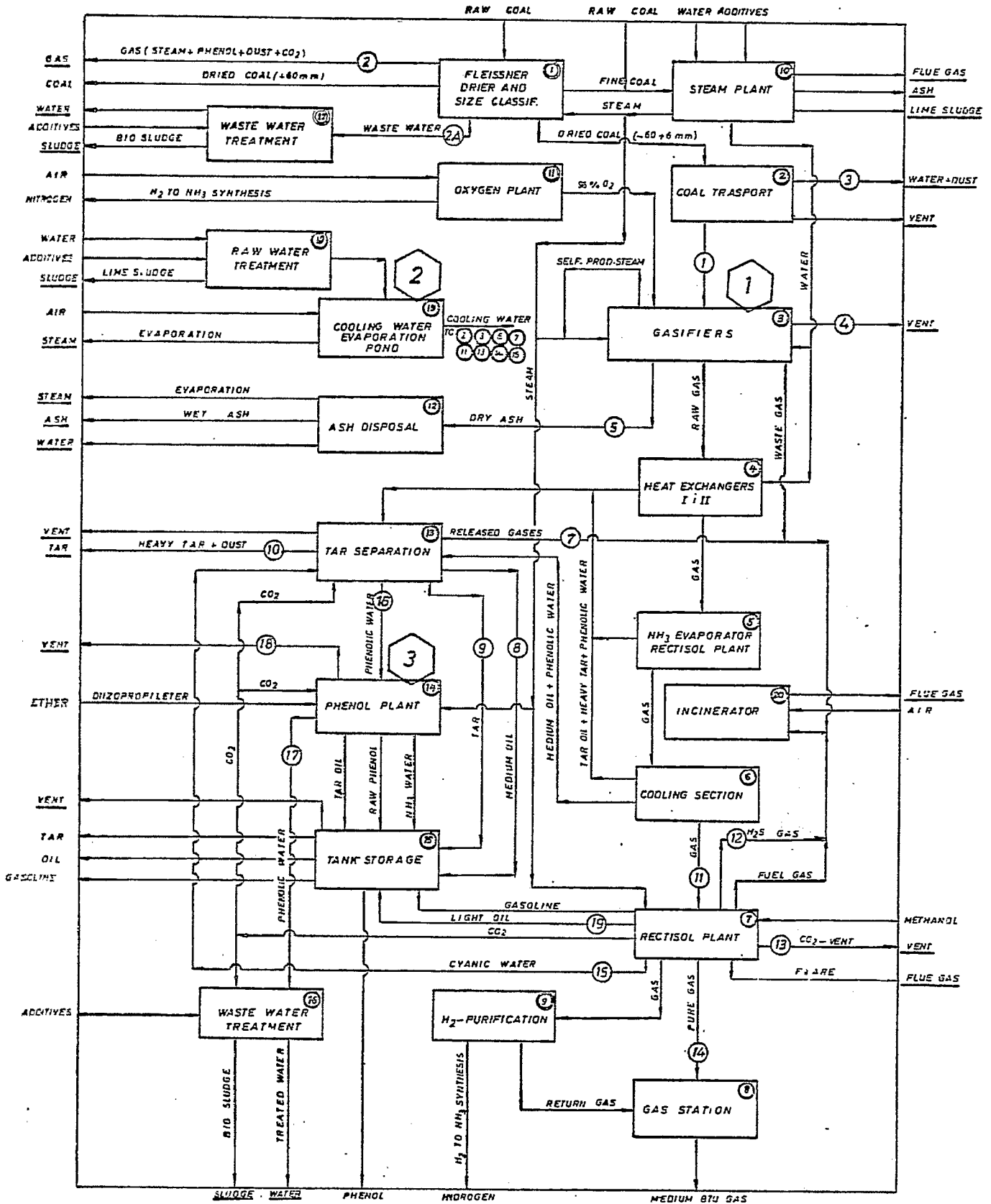


Figure 1. Process flow diagram for gasification process in Remhk Kosovo.

TABLE 1
SAMPLE SCHEDULE

	Sample	Flow	Trace elements SSMS	Trace organics	GCMS	HPLC	AA	Particle size
1	Coal Feed	Composite	X	X	-	-	X	-
2	Coal drying - vent gases	F+C	-	X	X	-	-	X grain loading only
2A	Coal drying - condensate	Composite	-	X	X	-	-	-
3	Coal bin vent gases	F+C	X	X	X	-	-	X
GASIFIER								
4	Low Raw Gas	F+C	X	X	X	-	-	X
5	Ash	Composite	X	X	X	-	X	-
QUENCH SYSTEM								
7	Gas to incinerator	F+C	X	-	X	-	-	-
8	Oil	Composite	X	X	X	-	X	-
9	Tar	Composite	X	X	X	X	X	-
10	Heavy tar + solids	Composite	X	X	X	X	X	-
11	Raw gas after cooler	F+C	X	X	X	X	X	X grain loading only
RECTISOL								
12	H ₂ S vent gas	F+C	X	-	X	-	-	-
13	CO ₂ vent gas	F+C	X	-	X	-	-	-
14	Clean gas	F+C	X	X	X	-	X	-
15	Condensate	Composite	X	X	X	-	-	-
19	Benzene/light oil	Composite	X	-	X	-	-	-
PHENOSOLVAN								
16	Inlet water	Composite	X	X	X	X	X	-
17	Outlet water	Composite	-	X	X	X	-	-
18	Vent	C	X	-	X	-	-	-

X - If possible.

X - Particles shall be collected and analyzed only if particles are found in the product gas at Point 11.

F+C - Sampling train with filter and XAD-2 cartridge.

C - Cartridge only.

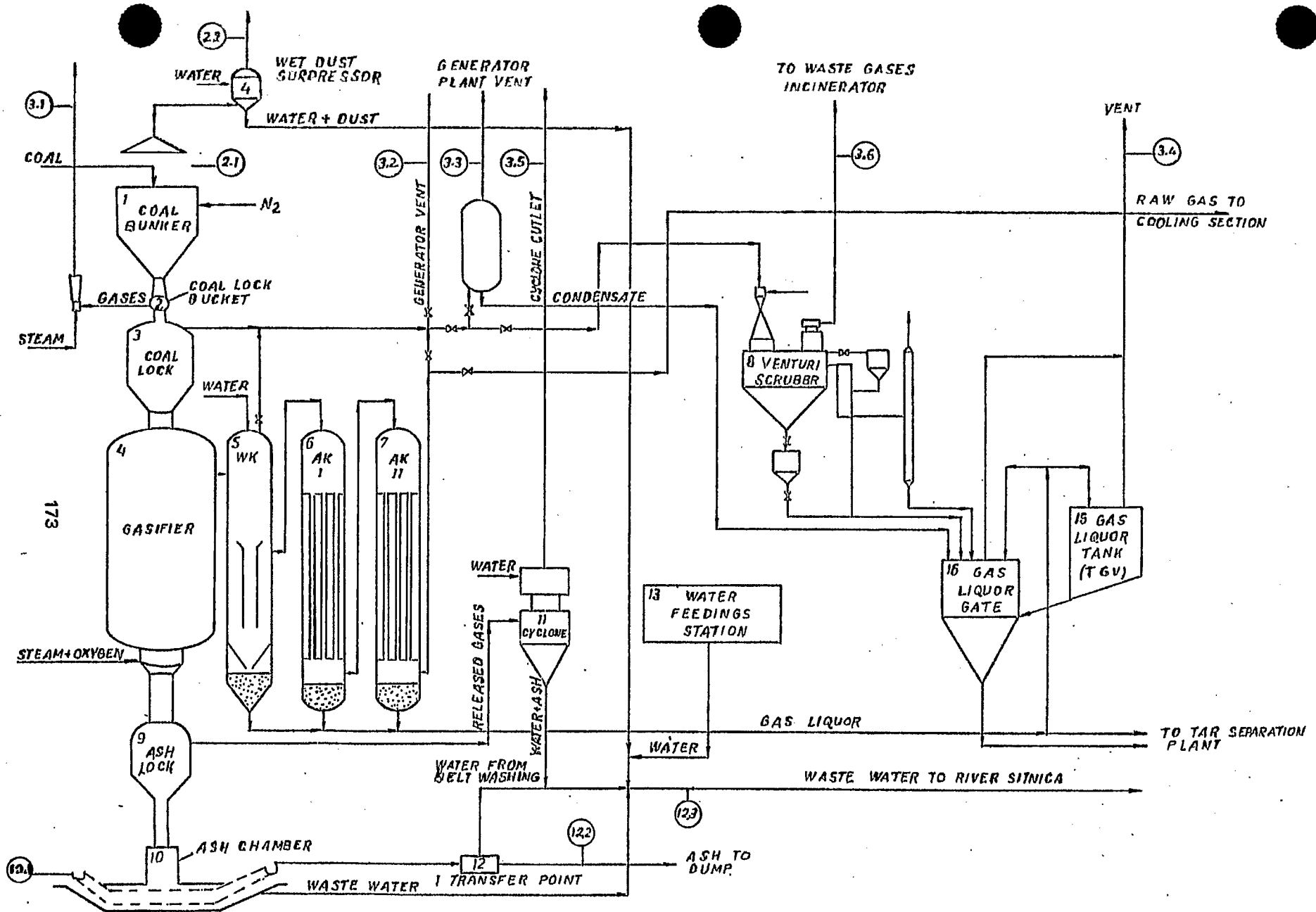


Figure 2. Process flow diagram and sampling points in generator plant.

decompression. During coal lock decompression, prior to charging with coal, the gases are lead through venturi scrubber (8) to waste gases incinerator (up to a pressure of about 2 atm), and then through generator vent (up to atmospheric pressure). Coal lock bucket decompression is carried out through a separate vent at each coal charge. Before ash discharge from the ash lock, decompression is carried out through wet dedusting cyclone (11). For the dedusting of transfer points during the feed of coal bunkers, a ventilation system is provided with wet dedusting of the suction gases in cyclone (14).

The wastewaters from cyclones (11), (14), ash quenching baths, belt washing at the I ash transfer point (12) and feed water station are collected in a common sump and delivered to the River Sitnica.

The grade of lignite - 60 + 6 mm, dried by "Fleissner" method, is as follows:

Proximate and ultimate analysis:

	Operating moisture	Operating moisture	Moisture free	Moisture & ash free
Moisture	26.62	22.0	—	—
Ash	14.78	17.71	20.14	—
S total	0.97	1.03	1.32	1.66
S bound	0.80	0.85	1.09	1.37
Coke	40.37	42.91	55.01	43.67
C fix	25.59	27.20	34.87	43.67
Volatiles	33.01	35.09	44.99	56.33
Combustibles	58.60	62.29	79.86	100.00
Heating value				
Gross Kcal/kg	3,647	3,877	4,970	6,223
Net, Kcal/kg	3,358	3,604	4,775	5,979
Carbon	40.17	42.70	54.74	68.55
Hydrogen	2.91	3.10	3.97	4.97
S combustion	0.17	0.18	0.23	0.29
N + O	15.35	16.31	20.92	26.19

Low-temperature carbonisation analysis according to Fischer at 520° C:

(Dried Kosovo lignite, size - 60 + 6 mm)

	%	%
Operating moisture	7.20*	—
Tar	5.82	6.27
Gas water	9.00	9.70
Semi coke	62.30	67.13
Gas + losses	15.68	16.90

*Partly dried sample.

Analysis of dried Kosovo lignite ash, size - 60 + 6 mm:

Analysis of dried Kosovo lignite ash, size -60 + 6 mm:

Components	%
SiO ₂	25.01
Fe ₂ O ₃	6.84
Al ₂ O ₃	6.73
CaO	36.03
MgO	6.33
SO ₃	16.13
P ₂ O ₅	0.34
TiO ₂	0.51
Na ₂ O	1.58
K ₂ O	0.40
MnO	0.14

Base-to-acid ratio = 1.58

Fe₂O₃/CaO = 0.18

Ash fusibility:

(oxidative atmosphere)	
Initiation of sintering	970° C
Softening temperature	1130° C
Hemisphere temperature	1290° C
Flow temperature	1300° C

Each generator unit consists of six generator vessels, 1, 2 through 7, 9, and 10, an ash bath, vents of coal lock buckets and generator vents, two dedusting cyclones 14 and one vessel 8, 15, 16, 11, one ash transfer point, one feed water station and one generator section vent (forced expansion vent).

The research program includes determinations of the composition of gases from:

- Coal lock bucket vent (3.1)

- Dedusting cyclones (2.2)
- Generator vents (3.2)
- Generator section vent (3.3)
- Ash lock expander cyclone (3.5)
- Tar gas water vent (3.4) and gases to waste gas incinerator (3.6).

Pollution determinations will also be made for coal supply rooms (2.1) and the surroundings of uncomplete ash lock decompression (12.1). In addition, determinations will be made of the amount and composition of ash (12.2), and quality of wastewater from the generator section (12.3).

Information on the sampling points in the plant is given below.

Sampling points - Section Generators

1. Sampling point No. (2.1): in coal supply room:

- major pollutants: escaped dust and possibly gases from coal bunker,
- cause of pollution: supply of finer coal fractions and insufficient efficacious dust removal system from critical points,
- measurement magnitudes: dust content in the air and air analysis,
- measuring points: transfer point on level 37 m, transfer point on level 35 m.

Note: Periodically pollution is very high.

2. Measurement point No. (2.2): Dedusting cyclone discharge into the atmosphere:

- major pollutants: as under item 1,
- cause of pollution: insufficient efficacious dedusting and possible escaped gases from the generators,
- measurement point: on fan house roof, two fans, discharge tube Dia 1500 mm, and
- measurement magnitudes: dust concentration and air analysis.

Note: Current system of six united and connected suction points on a single fan insufficiently efficacious, resulting in low discharge into the atmosphere.

3. Measurement point No. (3.1): coal lock bucket decompression:

- major pollutants: water vapour, gases from generators, and coal

dust,

- cause of pollution: technological solution of discharging the gases into the atmosphere,
 - measurement point: outlet into the atmosphere designed on building roof, but current outlet on level 25 away from the building on the platform. Sampling point pipe Dia 3". Steam discharged under pressure.
- ##### 4. Measurement point No. (3.2): Generator vent (small flare):
- major pollutants: flue gases upon treatment inclusive cooler AK II 2 h after start, gases from generators during coal lock expansion from 2 kp/cm² to atmospheric pressure and flue gases upon generator extinguishing (burning out after water vapour action in absence of air or oxygen about 24 h after shut down), gases from coal lock during every coal charging,
 - measurement point: outlet into the atmosphere on generator section roof, but more suitable sampling point on level 25 in pipe straight run, requiring fitting.
- ##### 5. Measurement point No. (3.3): Generator Section vent (large flare):
- major pollutants: gases from generator during startup feeding the first amount of coal into the generator and until pressure reaches 6 atm. (up to 7 days), and waste gases from tar gas liquor tank into which the condensed products are returned collecting all spoiled waters from the Generator Section,
 - cause of pollution: technological solution of discharging the gases into the atmosphere,
 - measurement point: platform on level 35 m outdoors, and
 - measurement magnitude: gas composition.
- Note:* According to the design, the Generator Section vent is used for all the six generators and collects all other gases from leaking valves.
- ##### 6. Measurement point No. (3.4): Vent

from tar gas liquor and all Generator Section waste waters tanks:

- major pollutants: phenols and higher hydrocarbons, H₂S,
- cause of pollution: technological solution of discharging the gases into the atmosphere, and
- measurement point: on Generator Section roof (unsuitable) or TGV outlet.

7. Measurement point No. (3.5): Vent from lock expander cyclone:

- major pollutants: gases from ash lock expander and finer ash,
- cause of pollution: technological solution providing the discharge of ash lock expander cyclone into the atmosphere,
- measurement point: on Generator Section roof, or outlet of cyclone on 9 m level, and
- measurement magnitudes: gas composition.

Note: Technological design provides one expander for six ash locks with cyclone dedusting.

8. Measurement point No. (3.6): Coal lock expansion gases— major pollutants: generator gas during start (above 6 atm) and gases from coal lock during expansion to 2 atm:

- measurement point: ahead of venturi scrubber, and
- measurement magnitude: gas composition.

9. Measurement point No. (12.1): Pollution due to incomplete ash lock decompression:

- major pollutants: gases from ash lock and ash,
- cause of pollution: inadequate solution of the system for ash lock pressure control,
- measurement point: ash quenching bath, level O, and
- measurement magnitude: gas composition and ash content in the gas.

10. Generator Section wastewaters (12.3): water from ash quenching baths, dedusting cyclones, expander cyclones, ash lock, ash belt washing

water at I transfer point and cleaned water from fire hydrant system are combined in a very unsuitable sump, so that wastewaters' quantity determination is impossible, but the quality may be determined quite readily.

11. Gasification slag (12.2): Measurement of the amount of slag may be performed by removing from the belts or at the first transfer point, when sampling can be made.

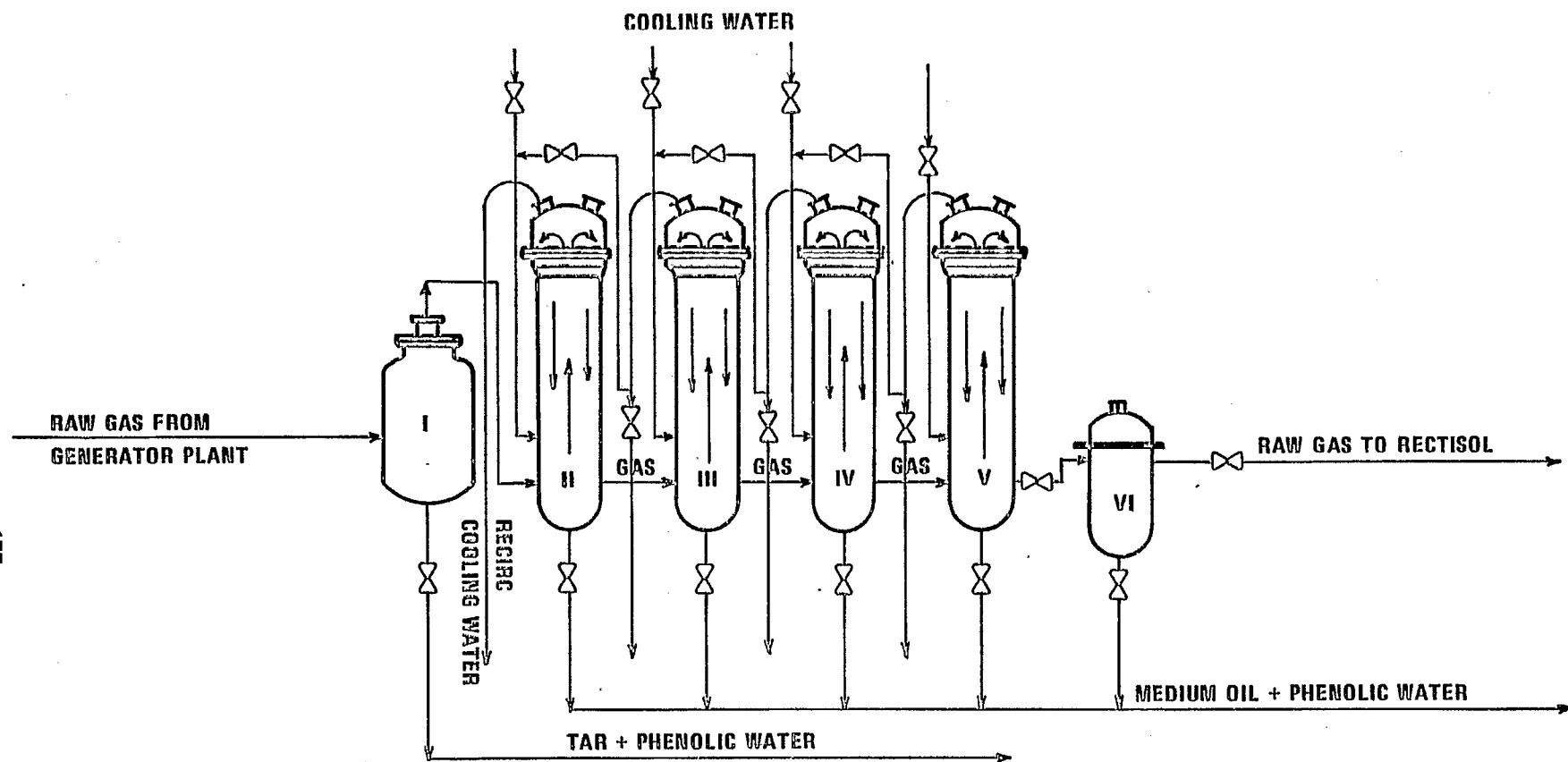
Gas composition at AK II outlet

CO ₂	29 - 32 vol. - %
H ₂ S	0.6 vol. - %
C _m H _n	0.75 vol. - %
CO	12 - 15 vol. - %
H ₂	40 - 42 vol. - %
N ₂	3 vol. - %
O ₂	0.25 vol. - %
NH ₃	5 - 7 g/100 Nm ³ on dry basis
NCH	5 - 7 g/100 Nm ³ on dry basis
S _{org}	20 g/100 Nm ³ on dry basis
Gasoline	7 g/100 Nm ³ on dry basis
Tar	21 - 25 g/100 Nm ³ on dry basis
Medium oil	18 - 20 g/100 Nm ³ on dry basis
Dust	0.1 g/100 Nm ³ on dry basis
Water	400 - 500 g/100 Nm ³ on dry basis

Condensation Section

In the Condensation Section, Figure 3, cooling and cleaning of the generator gas takes place. The section consists of three identical units, each containing a tar separator, four parallel countercurrent coolers, and a drop separator. The gas is further fed to the Rectisol Section, while the two separated intermediate products are supplied for tar, i.e., medium oil extraction.

According to the technological flow-sheet there is no direct environmental



I TAR SEPARATOR
 II, III, IV, V COOLERS
 VI DROP COLLECTOR

Figure 3. Cooling section process flow diagram

pollution, except in the case of natural expansions and possible leakages.

Tar Separation Section

In the Tar Separation Section, Figure 4, liquid products from the Generator, Condensation, and Rectisol sections are separated. Tar and phenolic water of high pressure (from WK, AK I, and AK II) flow through preexpander (1) and expander (2) into the tar separator (3), while the other waters, including the cyanidic water from Rectisol Section, are fed directly to the tar separator. From the tar separator, the lightest tar fraction is delivered to the tar tank (4). In case of the inflow of impure fractions, a "slop" tank is available - impure tar tank (5), primarily used for recirculation to the tar separator. The medium fraction - phenolic water is fed into two phenolic water tanks (6), and then to the Phenosolvan Section. If required, a part of the liquid from phenolic water tank may be recycled to the tar separator through the impure tar tank. For the removal of heavy tar containing dust from tar separator, a surge tank (7), mixer tank (8) and mixture tank (9) are provided, but since this fraction is still not used for gasification in the generators, the heavy tar and dust are discharged directly through a bypass, loaded into a cistern and disposed outside the Kombinat grounds. The expansion gases from units 1, 2, 3, and 12 are passed through cooler (10) to the point of combining with other waste gases from the Generator Section and lead to the waste gases incinerator. The cooler condensate gas liquor is collected in a separate tank (12) and then treated in medium oil separator (12) (two units are available). This separator also collects the medium oil and phenolic water condensation products from the Condensation Section, and gas liquor from the Rectisol Section. From the medium oil separator the oil is delivered to medium oil tank (13), and the phenolic water to the phenolic

water tanks.

In the case of emergency, a "slop" tank for impure oil (14) is available, and its content may be supplied to tar separator or to the storage. The tanks (4), (5), (6), (11), (13), and (14) are connected with the atmosphere by vents, so the program of activities envisages the determination of discharges composition. In addition to above samples, the composition of expansion gases ahead of cooler (10) will be determined as well as the amount of heavy tar.

Data on sampling points in this Section follow below:

Sampling Points - Tar Separation Section

Tar separation section major pollutants are higher hydrocarbons, volatile phenols, and H₂S.

The cause of pollution is the technological solution providing the connection of all units by vents with the atmosphere.

Measurement magnitude: gas composition

1. Measuring point No. (13.1): Tar tanks (4) on Figure 4 - measurement point: vents on level 0, Dia 50 mm.
2. Measuring point No. (13.2): Impure tar tank (5) on Figure 4.
3. Measuring point No. (13.3): Medium oil tank (13) on Figure 4 - measurement point: vent on level 0, pipe Dia 50 mm.
4. Measuring point No. (13.4): Impure oil tank (14) on Figure 4 - measurement point: vent on platform on level 3 m, pipe Dia 150 mm.
5. Measuring point No. (13.5): Gas condensate tank (11) on Figure 4 - measurement point: vent on level 0, pipe Dia 50 mm.
6. Measuring point No. (13.6): Expansion gases to waste gases incinerator - measurement points: valve on the bend before combining with expansion gases from the generators, level 5 m, pipe Dia 100 mm.
7. Measuring point No. (13.7): Phenolic water tanks (two) - measurement

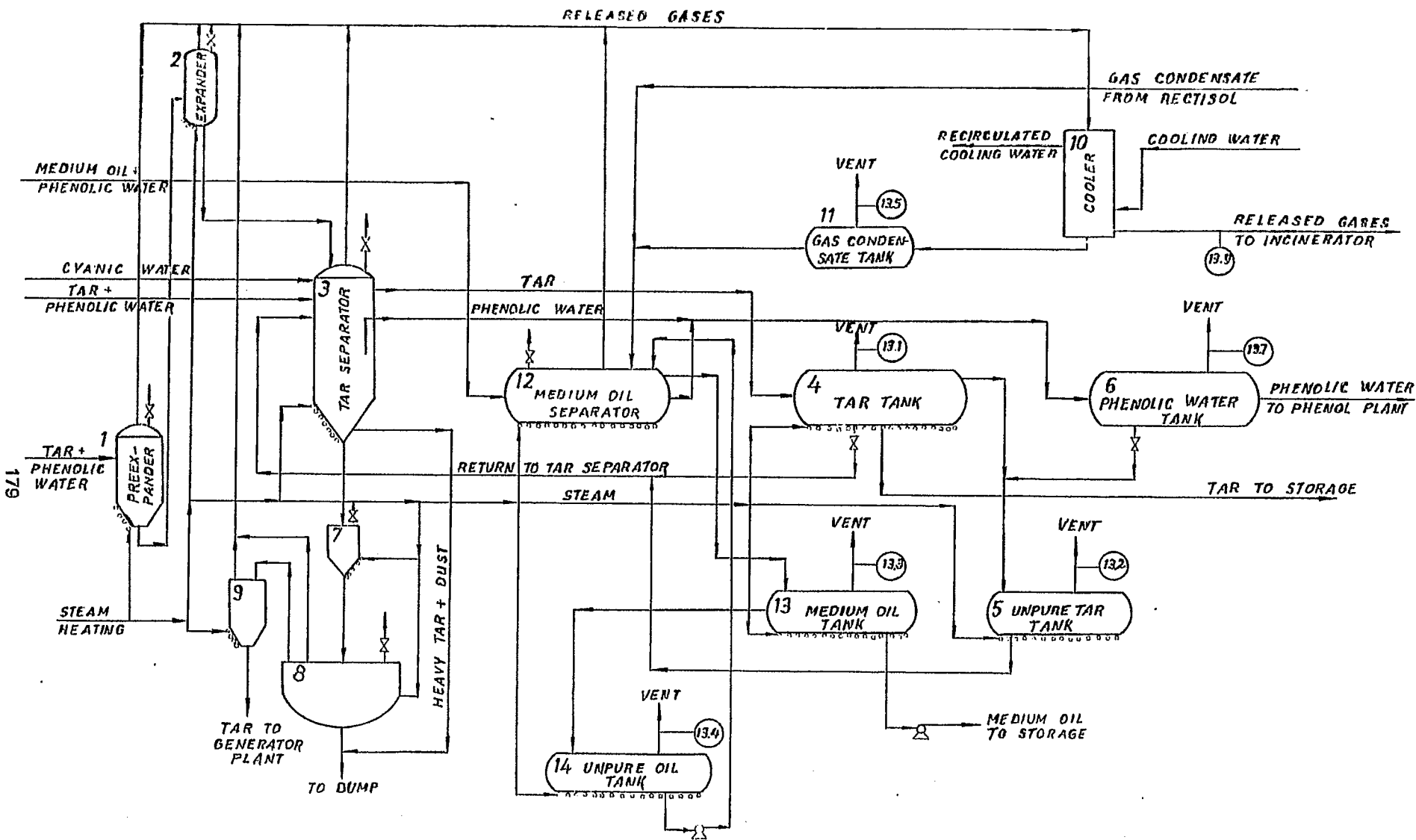


Figure 4. Process flow diagram and sampling points in tar separation plant.

point: vent on platform on level 3 m,
pipe Dia 150 mm.

RECTISOL SECTION

The Rectisol Section (Figure 5) performs gas cleaning with water and methanol primarily from gasoline, CO_2 and H_2S , as well as the regeneration of spent methanol.

The gas delivered from the Condensation section passes through the drop separator (1) and flows into first stage gas cooling in the bottom section of column (2). According to the design, the gas should be washed with a mixture of gasoline and water, but currently only cold water is used. From the bottom section of column (2), the gas flows to the second cooling stage with methanol and purified gases in cooler (3) and column (2) upper section. Methanol with gas condensates from the lower part of column (2) upper section serve as the cooling and antifreezing agent in cooler (3) where the clean gas is heated. The cooling methanol for column (2) upper section comes from the bottom of column (5). The cooled gas freed of gasoline is fed for further cleaning (primarily from H_2S) to column (4). The methanol for above washing also comes from the bottom of column (5). Further gas cleaning develops in column (5) primarily of CO_2 . The methanol for cleaning in column (5) comes from the bottom of regeneration column (14), i.e., from the bottom of the fourth stage of regeneration column (15) and the bottom of column (6). The clean medium heating value gas may be delivered from column (5) to the gas station being previously heated in heat exchanger (3), or fed for purification in column (6). The methanol for gas purification in column (6) is freshly added, or supplied from the bottom of column (14) and the fourth stage of column (15).

The water containing gasoline from the lower part bottom of column (2) is fed to separator (7), and the gasoline is delivered through tank (8) to the storage, and the water together with cyanic water to the tar separation section. The expansion gases from separator (7) are lead to the collection line of rich waste gases.

The methanol containing gasoline from the

bottom of heat exchanger (3) is supplied to expander (9) and then to extractor (10). The gasoline fraction is separated from the water-methanol solution in the extractor. The gasoline is fed to tank (8) and the methanol water solution first to distillation column (11) to remove the residual gasoline, and then to the rectification column (12) to separate the methanol from water. Stripping nitrogen is fed to the top of column (12), and NaOH through the bottom primarily to neutralize the free hydrocyanic acid. The impure methanol vapours are fed to expander (9), and the clean methanol fumes to column (14).

The methanol from the bottom of column (4) is supplied to column (13) for regeneration in succession to stages I, II, III, and IV. The expansion gases from column (13) first stage are combined with those in the rich waste gases line, and the waste gases from the remaining stages into the common H_2S gases line. Into the upper section of column (13) fourth stage the gas-released waste gas in column (14) is included. The methanol from column (13) fourth stage bottom, the condensed methanol from column (14) waste gases and water vapour and methanol fumes from the top of column (12) are fed to column (14). The purified methanol from the bottom of column (14) serves for gas cleaning in columns (6) and (5). The waste gases from column (14) are fed the upper part of column (13) fourth stage. The methanol from column (5) bottom is partially supplied to columns (2) and (4), and partially to regeneration column (15). Column (15) is divided into four stages, and the methanol passes through all the stages in succession. The expansion gases from column (15) first section are lead to the common rich waste gases line. The waste gases from remaining stages are combined and fed to the CO_2 waste gases vent. The amount of above waste gases may be obtained by summation of the amounts of gases from FR 39 and measured amounts at fitted measurement points FE 33 and FE 28. The rich waste gas amount consisting of expansion gases from column (9), separator (7) and first stages of columns (13) and (15) may be read on recorder FR 27. The amount of H_2S waste gas may be determined by summing the measurements at fitted points FE 21, FE 22, and FE 23.

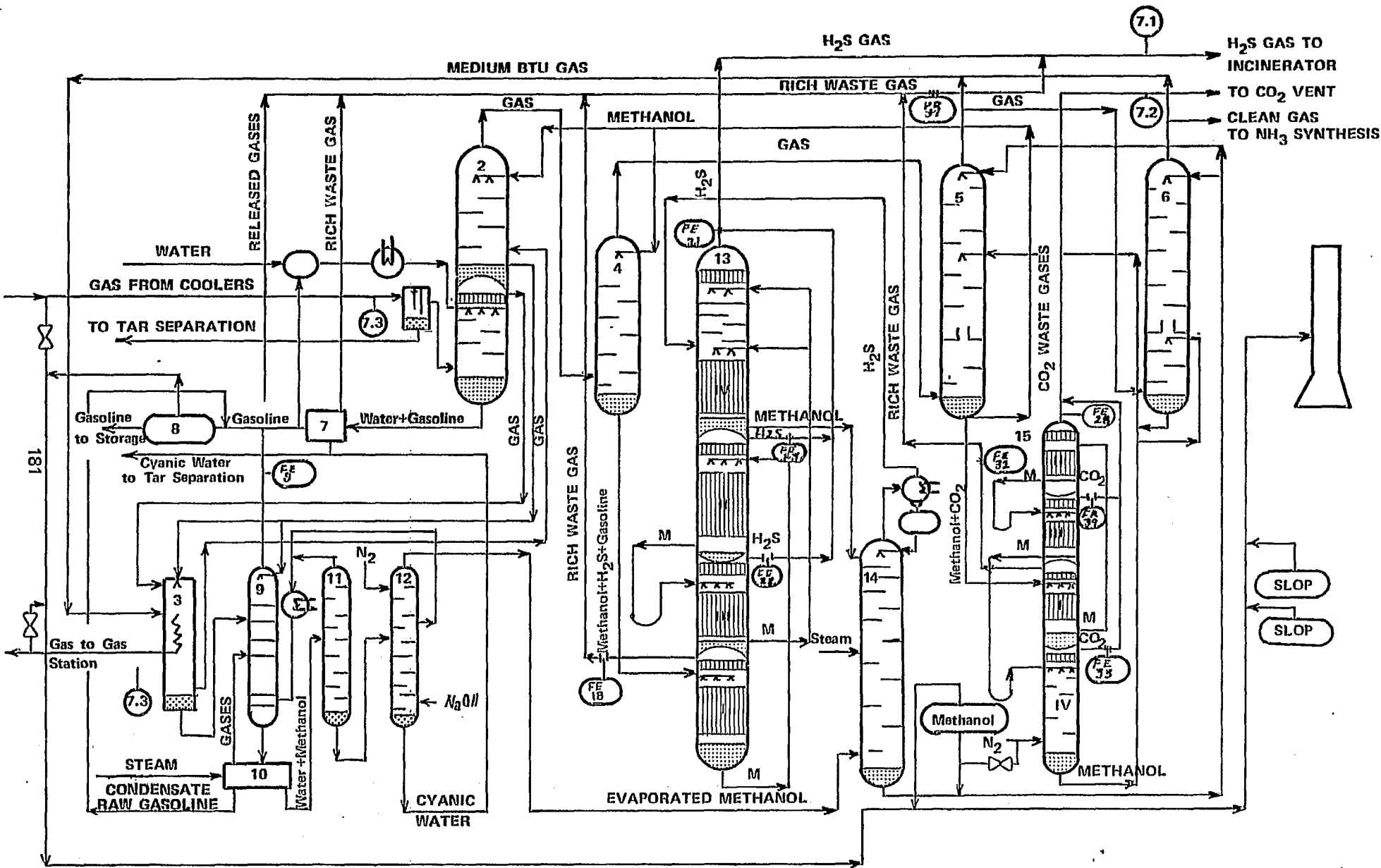


Figure 5. Process flow diagram and sampling points in Rectisol plant.

Having in view that the lines of rich waste gas and waste H₂S gas are combined and lead to the waste gases incinerator, their amount may be obtained by summing individual gas streams. The program of activities provides for the determination of the quality of inlet and outlet gases of Rectisol Section, CO₂ waste gases, H₂S waste gases, and waste gases under Rectisol Section incinerator.

Sampling points data are as follows:

Sampling Points--Rectisol Section

1. Measurement point No. (7.1): H₂S waste gas:
 - major pollutants: H₂S, methane, and other hydrocarbons,
 - cause of pollution: technological solution providing combustion of the gases by waste gases incinerator before discharge into the atmosphere,
 - measurement magnitudes: gas composition and volume, and
 - measuring point: methanol recycle line at E4/5, level 0, connection line on valve dia 8 for analysis. The amount of gases obtainable by summing the amounts of gases measured at fitted measurement points FE 23, FE 22, and FE 21. Platforms available on level 10 for mounting the measurement instruments.
2. Measurement point No. (7.2): CO₂ vent line:
 - major pollutants: in addition to CO₂, methanol, H₂S and higher hydrocarbons may be present,
 - cause of pollution: direct discharge of the gases into the atmosphere,
 - measurement magnitudes: gas composition and amount,
 - measuring points: analysis sample at G5, Dia 10 mm. The amount of gases obtainable by summing the values measured at fitted measuring points FE 28, FE 33, or by measuring the total amount by a Pitot tube in the line at G5, dia. 1000, level 0 (fitting required).
3. Measurement point No. (7.3): Rectisol Section incinerator:
 - major pollutants: during proper incinerator operation no pollutants should be generated,
 - cause of pollution: technological solution provided burning the gases from generators if Rectisol Section out of operation, or cleaned gases if further gas transport prevented, burning of evaporates from gasoline, methanol, and two "slop" tanks,
 - measuring points: (when incinerator unoperative) gas at rectisol inlet - sample at PRCX, dia. 10, i.e., clean gas at E1, dia. 10, i.e., methanol and benzene fumes, and
 - measurement magnitude: gas composition.

The Rectisol Section has no direct discharges of waters into the surroundings.

Expected H₂S waste gases composition at measurement point 7.1.

CO ₂	57.25 - 49.75 vol. - % i.e.	37 - 88 vol. - %
C _m H _n	0.575 - 0.675 vol. - % i.e.	0.5 - 1.2 vol. - %
O ₂	0.175 - 0.3 vol. - % i.e.	0.1 - 0.3 vol. - %
CO	3.225 - 7.050 vol. - % i.e.	0.9 - 7.2 vol. - %
H ₂	18.35 - 36.9 vol. - % i.e.	1.4 - 39.6 vol. - %
CH ₄	9.45 - 15.6 vol. - % i.e.	6.6 - 15.6 vol. - %
N ₂	1.8 - 2.2 vol. - % i.e.	1.8 - 2.2 vol. - %
H ₂ S	1,034 - 629 g/100 Nm ³	682 - 1,920 g/100 Nm ³
NHV	2,170 - 2,252 Kcal/Nm ³	970 - 2,680 Kcal/Nm ³

Expected composition of gases to CO₂ vent at measurement point 7.2.

CO ₂	54 - 86 vol. - %
C _m H _n	0.4 - 1 vol. - %
O ₂	0.1 - 0.3 vol. - %
CO	6.6 - 2.8 vol. - %
H ₂	19.8 - 3.8 vol. - %

CH ₄	17.4 - 6.7 vol. - %
N ₂	2.8 - 0.2 vol. - %
H ₂ S	400 - 1,200 g/100 Nm ³

Designed composition of the gas at Rectisol Section inlet: measurement point 7.3.

CO ₂	29 - 86 vol. - %
H ₂ S	0.60 vol. - %
C _m H _n	0.75 vol. - %
CO	12 - 15 vol. - %
H ₂	40 - 42 vol. - %
CH ₄	11 - 13 vol. - %
N ₂	3 vol. - %
O ₂	0.35 vol. %
NH ₃	5 - 7 g/100 Nm ³
HCN	5 - 7 g/100 Nm ³
S	20 g/100 Nm ³
Gasoline	7 g/Nm ³
Medium oil	2 g/Nm ³
Dust	0.1 g/Nm ³
Water	1.3 - 1.4 g/Nm ³

Designed quality of pipeline gas at measurement point 7.3.

CO ₂	2.0 vol. - %
H ₂ S	2.0 vol. - ppm
CH ₄	16.1 vol. - %
C _m H _n	0.5 vol. - %
CO	19.4 vol. - %
H ₂	58.2 vol. - %
N ₂	3.8 vol. - %
NHV	3,800 Kcal/Nm ³

Expected composition of gases from expander (7) and separator (7) combined:

CO ₂	approx. 61. - 37 vol. - %
H ₂	approx. 24 - 39.6 vol. - %
CH ₄	approx. 10.4 - 15.6 vol. - %
C _m H _n	approx. 0.6 - 0.5 vol. - %
O ₂	approx. 0.2 - 0.3 vol. - %
CO	approx. 4 - 7.2 vol. - %
H ₂ S	1,100 - 682 g/100 Nm ³
NHV	approx. 2,000 - 2,680 Kcal/Nm ³

Expected composition of gases from column (13) and column (15) first stage:

CO ₂	46 - 88 vol. - %
C _m H _n	0.5 - 1.2 vol. - %
O ₂	0.1 - 0.3 vol. - %
CO	0.9 - 6.6 vol. - %
H ₂	1.4 - 28.8 vol. - %
CH ₄	6.6 - 15.6 vol. - %
N ₂	1.8 - 2.2 vol. - %
H ₂ S	835 - 1,910 g/100 Nm ³
NHV	2,680 - 970 Kcal/Nm ³

PHENOSOLVAN SECTION

The Phenosolvan Section (Figure 6) serves primarily for the removal of a major part of phenol from phenolic waste water prior to final biological treatment. According to the design, butylacetate should be used as the extracting agent, but currently diisopropylether is used in REMHK Kosovo for phenol extraction.

The phenolic water is fed into cyclone (1) for treatment with CO₂ (currently no CO₂ injection) and then passed to tank (2) for the separation of residual oil and tar from phenolic water. The impure oil is delivered through tank (3) to the storage, while the tar is directly fed to the Tar Separation Section. The phenolic water is supplied through sand filters (4) to two surge tanks (5) and then upon heating in heat exchanger (6) to degassing column (7). Reheating of phenolic water takes place in column (7) lower section. Prior to entering column (9) upper section,

where additional gases release is completed, the phenolic water is cooled in cooler (8). The phenolic water from "slop" tank (10) is also fed to column (9) upper section. The cold phenolic water, free of gases, is fed for extraction to extractors (11), and then to heat exchanger (12) for heating and distillation from conveyed diisopropylether in distillation column (13). From column (13) the cleaned phenolic water is delivered through cooler (14) to the section for biological waste waters treatment. The diisopropylether fumes are condensed in cooler (15) and fed combined with the diisopropylether from surge tank (21) to the extractor. The raw phenol extracted in diisopropylether is supplied through surge tank (16) for heating in heat exchanger (17) and then to rectification columns (18) and (19). The diisopropylether fumes are condensed in cooler (20). The condensed and fresh diisopropylether supplied from tank (22) are fed to tank (21) and supplied to the extractor. The raw phenol from the bottom of rectification column (1) is delivered through cooler (23) and tank (24) to the storage.

The gases from column (7) lower section are partially condensed in cooler (25) and ammonium fumes in column (26). Tank (27) is provided for aqueous ammonium solution. Currently, units (26) and (27) are inoperative and a water vent was fitted between units (25) and (26). Condensate water fraction is recycled to column (7) lower section, and the oil one to tank (3). Units 1, 2, 3, 5, 7 (upper section) directly and the lower one through cooler (25), (9) (upper section), 10, 22 and 24 are connected by vents with the atmosphere, and our program of activities envisages the determination of discharge gases composition.

Information on section sampling points:

Sampling Points--Phenosolvan Section

- Cause of pollution: technological solution providing the discharge of the gases into the atmosphere through separate vents.
- 1. Measurement point No. (14.1): Cyclone vent (Figure 6):
 - major pollutant: phenol fumes,
 - measuring point: cyclone vent at

top of K2, and

- measurement magnitude: gas composition.
- 2. Measurement point No. (14.2): gas liquor tank (Figure 6) separation of tar, oil, and phenolic water:
 - major pollutants: phenol, oil, tar, and ammonium evaporations,
 - measuring point: tank roof lid, Dia. 500 mm, and
 - measurement magnitude: gas composition.
- 3. Measurement point No. (14.3): Impure oil tank (Figure 6):
 - major pollutant: oil evaporations including H_2S ,
 - measuring point: filling funnel, level 0, Dia. 200 mm, and
 - measurement magnitude: gas composition.
- 4. Measurement point No. (14.4): Phenolic water tank (Figure 6):
 - major pollutant: volatile phenols,
 - measuring point: lid on tank roof, dia. 500 mm.
- 5. Measurement point No. (14.5): column vent (Figure 6):
 - major pollutants: ammonium, H_2S phenols,
 - measuring point: vent on column top, dia. 250 mm, and
 - measurement magnitude: gas composition.

Note: The amount of gaseous products is also determinable from the material balance on the basis of water composition. According to our free assessment, column K1 vent is the major pollutant of Phenosolvan Section.

- 6. Measurement point No. (14.6): vent (Figure 6 between 25 and 26):
 - major pollutant: ammonium fumes,
 - measuring point: vent at section top, dia. 50 mm, and
 - measurement magnitude: gas composition.
- 7. Measurement point No. (14.7): column vent (Figure 6):
 - major pollutants: similar as at K1,
 - measuring point: vent on column top, dia. 250 mm, and

- measurement magnitude: gas composition.
8. Measurement point No. (14.8): Phenosolvan Section waste waters tank (Figure 6/10):
 - major pollutants: volatile matter of oil, tar and phenol,
 - measuring point: vent on level 0, dia. 3", and
 - measurement magnitude: gas composition.
 9. Measurement point No. (14.9): raw phenol tank (two units) (Figure 6/24):
 - major pollutants: phenol fumes,
 - measuring point: lid on tank roof, dia. 500 mm, and
 - measurement magnitude: gas composition.
 10. Measurement point No. (14.10): diisopropylether tank (Figure 6/22):
 - major pollutant: diisopropylether fumes,
 - measuring point: tank vent, level 0, dia. 3", and
 - measurement magnitude: gas composition.

According to the design, the Phenosolvan Section has no discharge into the sewerage system.

Note: The section for biological waste waters treatment is inoperative. The amount of water currently discharged directly into River Sitnica stream is measurable at the inlet into aeration pools. (Attention to be paid to the amount of diisopropylether.)

STORAGE

The storage, Figure 7, consists of seven tanks and a pump station. The gasoline, tar, impure and medium oil may be used for the mixture for burning supplied to the Power Generation Plant via a pipeline, or individually supplied for shipment. All tanks are connected with the atmosphere directly by vents, and the program provided the determination of discharge gases composition.

Phenol is stored in the ammonium tank, and other changes are also made as required.

Approximate composition of medium oil:

- water content	0.5 - 1.5%
- creosates content	28 - 32%
- paraffine content	0.3%
- naphatalene content	2 - 3%
- NHV	8,500 - 8,700 Coal/kg

Approximate composition of tar:

- asphalt content	13 - 23%
- paraffine content	3 - 4%
- creosate content	26 - 32%
- NHV	8,500 - 8,600 Coal/kg

Sampling points data follow below:

Sampling Points--Storage

1. Measurement point No. (15.1): vent on tar tank (two units):
 - cause of pollution: designed connection with the atmosphere by vents,
 - major pollutants: H₂ higher hydrocarbons,
 - measuring point: lid on tank roof, dia. 500 mm, and
 - measurement magnitude: gas composition.
2. Measurement points No. (15.2) and (15.5): vents on medium oil tanks (two units):
 - cause of pollution: designed connection with atmosphere by separate vents,
 - measuring point: lids on tank roofs, dia. 500 mm,
 - measurement magnitude: gas composition, and
 - major pollutants: medium oil fumes, H₂S.
3. Measurement point No. (15.3): Gasoline tank:
 - cause of pollution: designed discharge directly into the atmosphere,
 - major pollutants: highly evaporable gasoline fractions,
 - measuring point: lid on tank roof, dia. 500 mm, and

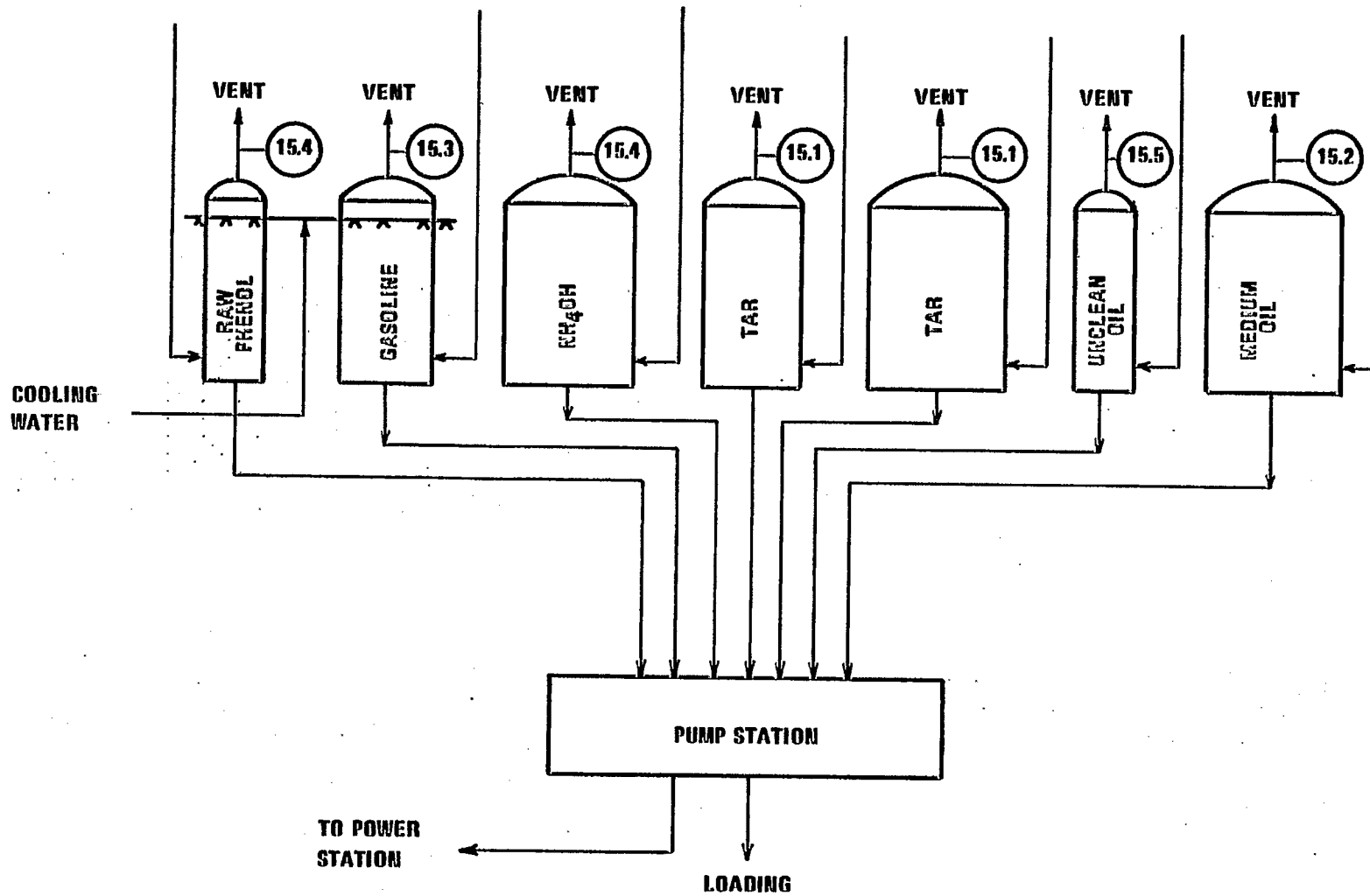


Figure 7. Process flow diagram and sampling points in storage.

- measuring magnitude: gas composition.
4. Measurement point No. (15.4): Phenol tanks (two units):
- cause of pollution: designed connection with atmosphere by vents,
 - major pollutants: highly evaporable phenols,
 - measuring point: lid on tank roof, dia. 500 mm, and
 - measuring magnitude: gas composition.

Cooling Water Coolers--Sampling Points

1. Measurement point No. (19.1): air discharge from the coolers:
- cause of pollution: leakage from exchangers in gasification plant sections,
 - major pollutants: evaporable components,
 - measuring point: air outlet from the coolers, and
 - measurement magnitude: gas composition.

Expansion Gases Main Incinerator--Sampling Points

1. Measurement point No. (20.1): Gases to main incinerator:
- cause of pollution: designed burning of expansion gases from Generation Section, Tar Separation, and H₂S waste gases from Rectisol Section,
 - major pollutants: higher hydrocarbons, H₂S (SO₂),
 - measuring point: line before the incinerator at the location of condensate separation, level 0, incinerator inlet, and
 - measurement magnitude: gas composition.

Expected composition of expansion gases at incinerator:

CO ₂	40 vol. - %
H ₂	35 vol. - %
CO	12 vol. - %
CH ₄	10 vol. - %
N ₂	2.5 vol. - %
C _m H _n	0.7 vol. - %
H ₂ S	0.6 vol. - %
O ₂	0.2 vol. - %
Gasoline	7 g/Nm ³
S _{org}	20 g/100 Nm ³
NH ₃	5 - 7 g/100 Nm ³
Water	70 g/Nm ³
Tar	21 - 25 g/Nm ³
Medium oil	18 - 20 g/Nm ³
Dust	0.1 g/Nm ³

Area Samples (Figure 1)

Area samples will be taken at three points on plant site:

1. Measurement point No. (1): Area around the Generator Section:
 - cause of pollution: gas production according to "Lurgi" procedure,
 - major pollutants: CO, NO_x, SO₂, H₂S, COS, CS₂, mercaptans, CH, particulates and organics,
 - measurement point: level 0 around Generator Section, and
 - measurement magnitude: air composition.
2. Measurement point No. (2): Area around the water cooling section:
 - cause of pollution: exchanger leakage in Gasification Plant sections,
 - major pollutants: volatile components,
 - measurement point: level 0 around water cooling section, and
 - measurement magnitude: air composition (CO, NO_x, SO₂, H₂S, COS, CS₂, mercaptans, CH, particulates, and organics.

3. Measurement point No. (3): Area surrounding Tar Separation Section:

- cause of pollution: technological design providing direct connection of all vessels with atmosphere by vents,
- major pollutants: volatile phenols, H₂S and higher hydrocarbons,
- measurement point: level 0 near tank vents or level 3 on the platform near the vents, and
- measurement magnitude: air composition (CO, NO_x, SO₂, H₂S, COS, CS₂, mercaptans, CH, particulates, and organics).

PROBLEMS

As already stated, the reported program of research should be completed over a 3-year period. In accordance with this and by gaining insight into all problems connected with the designed works, a Dynamic Time Schedule was made for the realization of the program and enclosed here in table form.

By to-date investigations the following was observed:

Kosovo lignite falls into a group of younger coals and has high contents of moisture (50 percent) and ash (about 30 percent at 105 °C). The coal substance consists of macerals textinite, ulminite, atrinite, and densinite and it is banded by mineral matters the principal representatives of which are clay, marly limestone, and locally pyrite. When exposed to atmospheric precipitations over a longer period, the coal substance decomposes to dust.

Prior to use in the gasification process, Kosovo lignite is dried by the "Fleissner" process down to a moisture content of approximately 24 percent and screened, so that "Lurgi" generators are fed with class--60 + 6 mm. The dried coal--60 + 6 mm contains about 20 percent of ash and some 1.4 percent of total sulfur (at 105 °C).

The content of volatiles in the product amounts about 56 percent, that of carbon 68.5 percent, hydrogen approximately 5 percent, and nitrogen + oxygen about 26 percent, calculated on pure coal substance (moisture

and ash free).

In the process of transportation and transfer, substantial amounts of dust are formed due to its high fragmentation propensity. Its Micum test equals 74 percent. Consequently, particles below 0.5 mm are predominant in undersize - 6 mm. Due to above facts, a large quantity of fine dust occurs in our plant prior to generator feed. This dust causes difficulties in the generator during the gasification process. At generator discharge, thick masses of tar and dust are formed, as well as Ca phenolates, decreasing the diameter of raw gas discharge lines.

The produced raw gas contains a high percentage of various solid, liquid, and gaseous pollutants (dust, tar, lower, and higher hydrocarbons, NCN, H₂S, NO, etc.). The realization of the designed program will result in accurate data on the amounts and kinds of pollutants discharged into the air, water, and solid wastes.

Fusibility of dried Kosovo lignite ash occurs at approximately 1290 °C in oxidative atmosphere. Consequently, the slag is discharged from the generators in unmelted form. Chemical composition of the slag is such that it reacts with water and forms a basic medium of about pH = 11. It is particularly interesting that it contains, in addition to various trace elements, 0.4 percent of strontium oxide and 0.27 percent of manganese oxide.

The tar produced starts to distill at 264 °C, and the fraction yields are as follows:

264 - 300° C	9.0 percent (water free)
300 - 335° C	23.0 percent (water-free)
+ 335° C	68.0 percent (water free)

The tar solidification temperature is 48 °C. The rate of pollution in the Tar Separation Section is very high due to discharges from the tanks through vents directly into the atmosphere.

The analyses of clean gas used for separating the hydrogen required for ammonium synthesis indicate that clean gas contains hydrocarbons (C₃H₆, C₃H₈) and nitrogen oxides, so that its use for ammonium production is questionable.

The cause of environmental pollution from Kosovo Coal Gasification Plant in Obilic should, naturally, primarily be looked for in the grade of available raw material which we are forced to process, as well as in the technological processes and facilities designed and selected at the time when little consideration was paid to environmental pollution, i.e., when preventive solutions were not required.

We are sure that the results of our investigations will be of overall usefulness and advan-

tage, and particularly for us in Socialist Autonomous Province Kosovo, since this knowledge will enable us to improve the operation of individual existing facilities and processes, as well as to select more efficient and more adequate procedures in possible future construction of gas production plants leading to efficacious protection of our living environment.

Thanks for your attention!