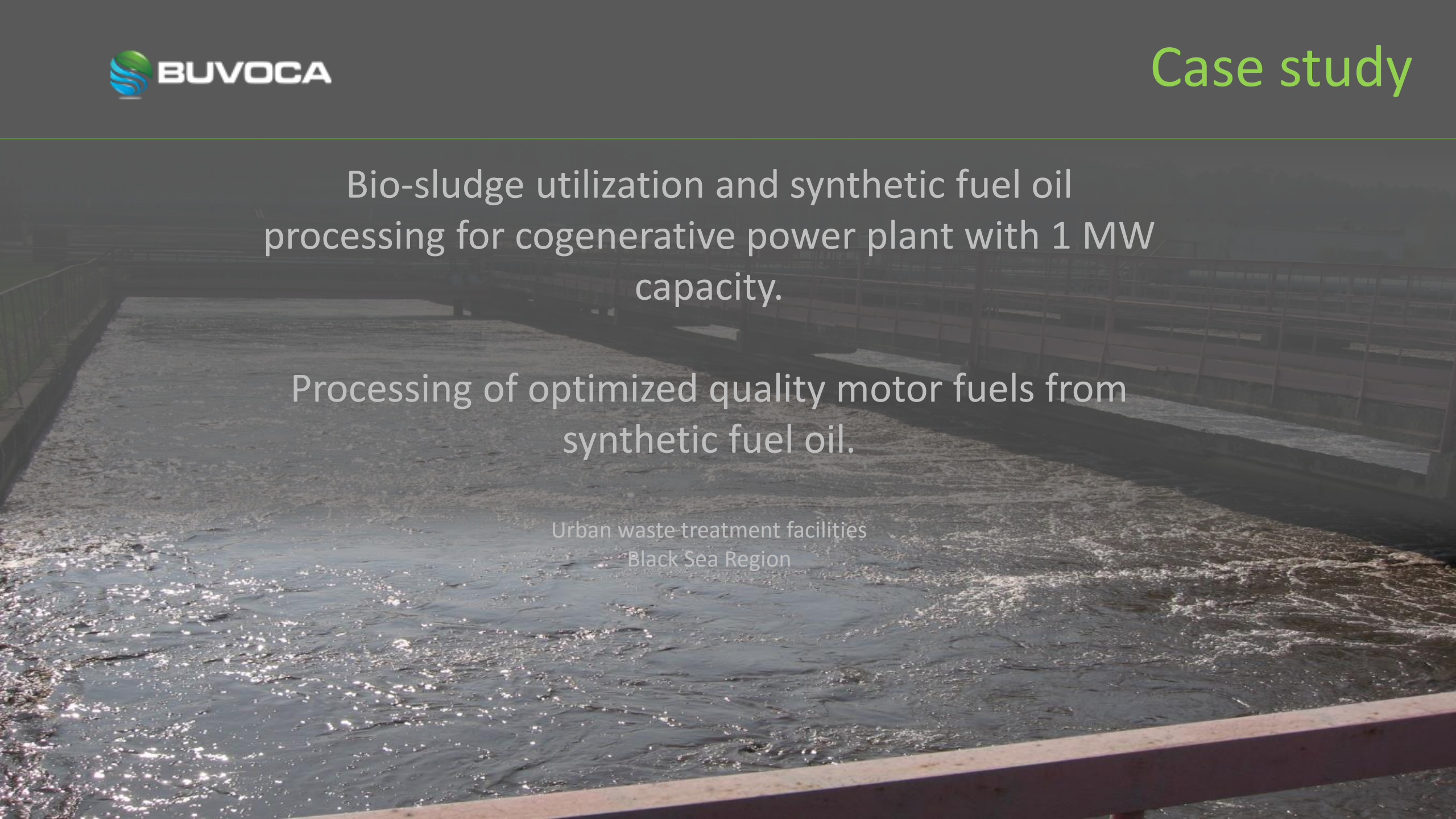
BUVOCA

Case study



Bio-sludge utilization and synthetic fuel oil processing for cogenerative power plant with 1 MW capacity.

Processing of optimized quality motor fuels from synthetic fuel oil.

Urban waste treatment facilities
Black Sea Region

The Technology

The technology is based on the organic suspension by pyrolysis.

High-temperature pyrolysis is destructurazation of organic matter by means of temperature and pressure in the conditions of the absence or lack of oxidizing agent (oxygen).

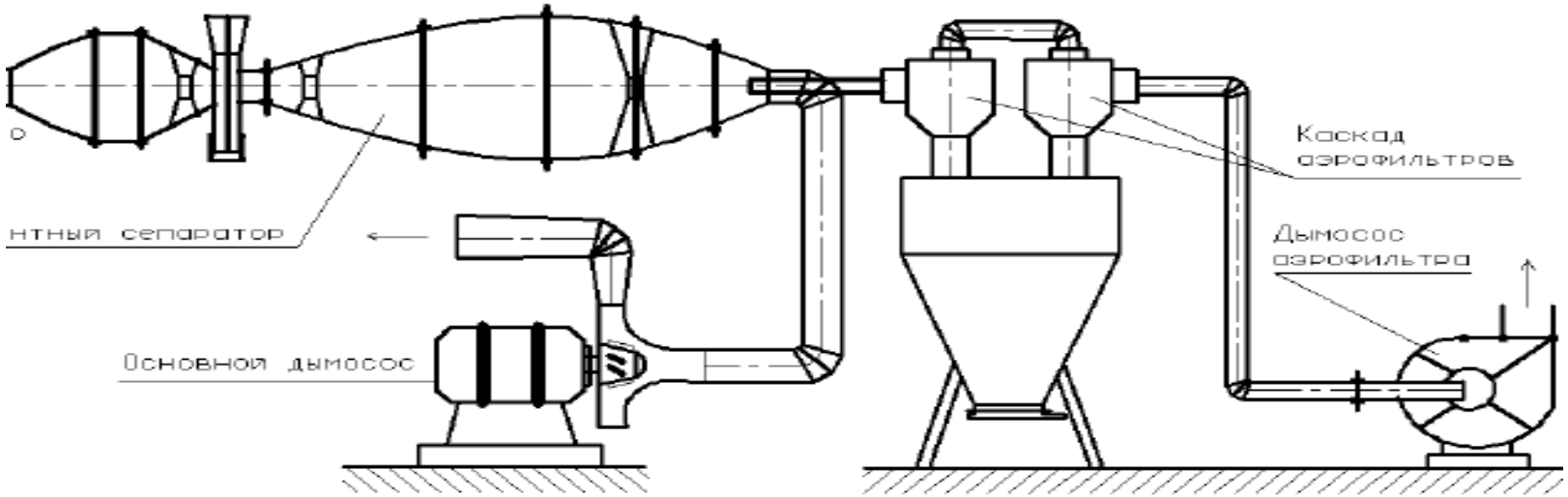
Refinable raw materials

Sewage sludge, after secondary sedimentation tank, achieve humidity levels of up to 95%. Currently they are mostly being kept at the disposal facilities, which has negative impact on the environment.

Chemical composition of the dry portion of sewage sludge is close to $C_{92,7}H_{22,4}O_{97,9}N$

Sludge dehydration

Raw matter with humidity of 85-95% goes through the process of dehydration in a graded separator with the resulting suspension with humidity of about 40%. The separator is manufactured to separate moister mist from mechanical impurities.



Sewage sludge after dehydration

	Test Type	Symbol	Value	Deviation
1	Moisture content	W_t^f	48,7	3%
2	Moisture of analysis sample	W^a	6,2	0,4%
3	Ash on the dry basis	A^d	11,7	3%
4	Ash on the moist basis	A^r	6,2	0,3%
5	Volatile yield on the combustible matter	V^{daf}	62,3	-
6	Sulfur on the dry basis	S^d	0,67	0,05%
7	Sulfur on the combustible matter	S^r	0,35	0,05%
8	Hydrogen in the combustible matter	H^{daf}	5,58	0,04%
9	Carbon in the combustible matter	C^{daf}	66,7	0,6%
10	Nitrogen in the combustible matter	N^{daf}	0,69	0,2%
11	Heating value as fired	Q_i^r	6,16 mJ/kg	0,4 mJ/kg
12	Heating value on dry ash basis	Q_i^d	12,04 mJ/kg	0,4 mJ/kg

Mechanochemical activation of the Sewage Sludge dehydrated slime

Mechanochemical activation meets the following challenges:

- Change solid matters' reactive capacity, speed heterogenic reactions, synthesize matters and so on.
- Achieve qualitative and quantitative changes in the type of chemical bonding and formulation of solid matters. This may enable development of non-thermal ways of mineral processing.
- Stimulate heterogenic reactions. This will make it possible to carry out some synthesizing processes by means of solid-phase reactions.

Mechanochemical activation of the Sewage Sludge dehydrated slime

(cont.)

- At the preparation of mechanoactivated combustible liquid (MCL), water is divided into drops of 1-3 micron each. The drops are equidistributed over the whole fuel volume and turns into a dipole. The fragments of hydrocarbon molecules attach to the dipole, creating micelles, which explains the suspension's resistance to layering.
- When MCL reaches the gasification zone, it starts heating. The steam point and hydrocarbon oxidizing temperature differ considerably. While water reaches the boiling point, hydrocarbon remains in the solid form and prevents evaporation of the water drops. A micro-explosion occurs when critical pressure is reached within the micelle.

Mechanochemical suspension activation block

Fuel storage and delivery

From the preparation block, the fuel is delivered to the emergency collection tank for storage. Then, with sludge pumps, it is pumped over to the gasification block.

High-speed pyrosysis

High-speed suspension pyrolysis is carried out by heating the mixture in the pipes of uniquely developed gas producer unit.

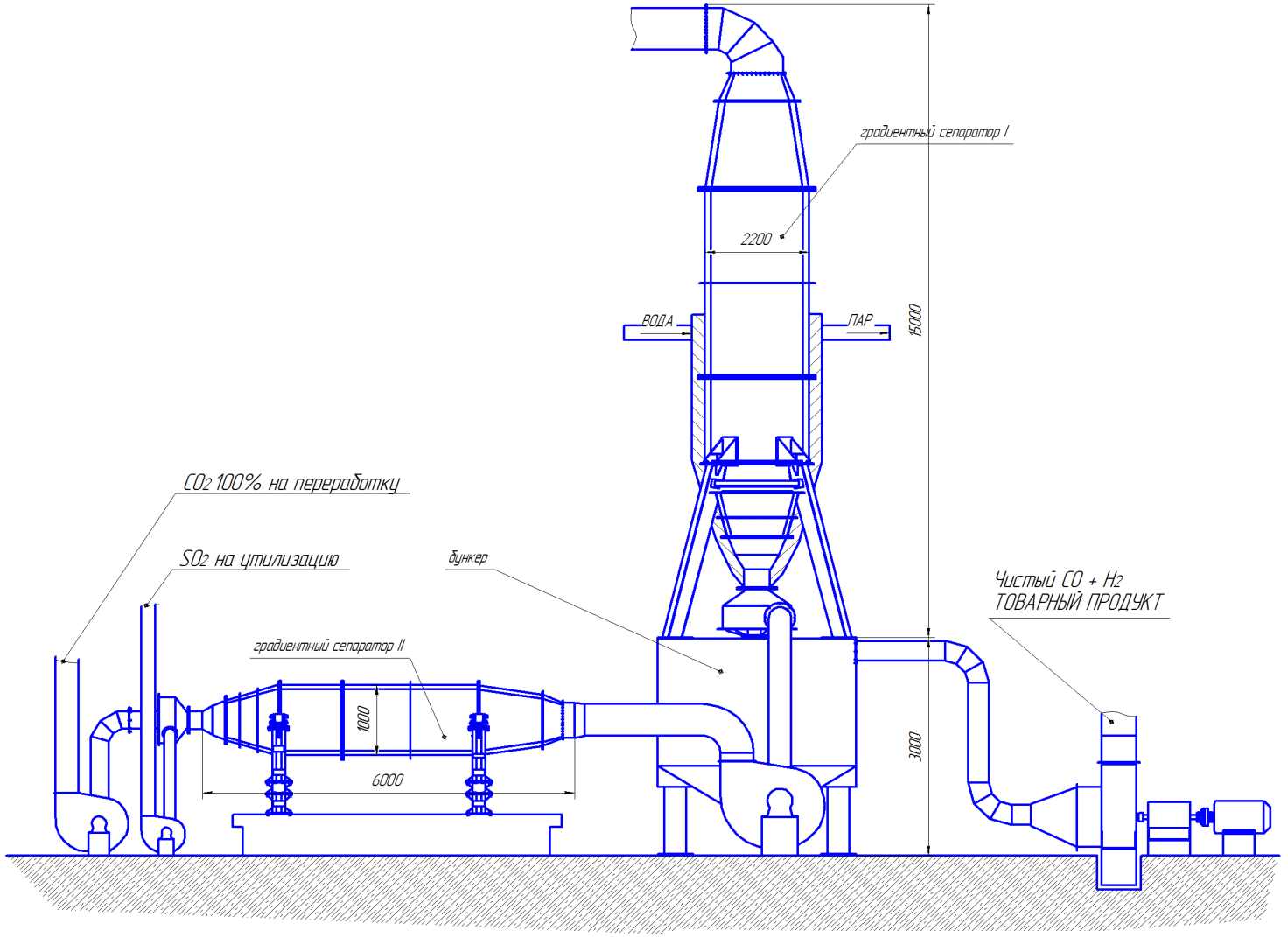
Synthesis gas purification

From the gas producing unit, gas is delivered to a hyperfine gas treatment system based on the grade separator and vacuum-inertia aero-filter.

The graded separator implies separation of base sediments in the form of suspended particles and purification of waste gases from sulphur anhydride. Separation of gas components is based solely on the gas-dynamic, with no catalyzers.

Graded Separator and aero-filter

Graded separator and aero-filter with the waste-heat recovery system.



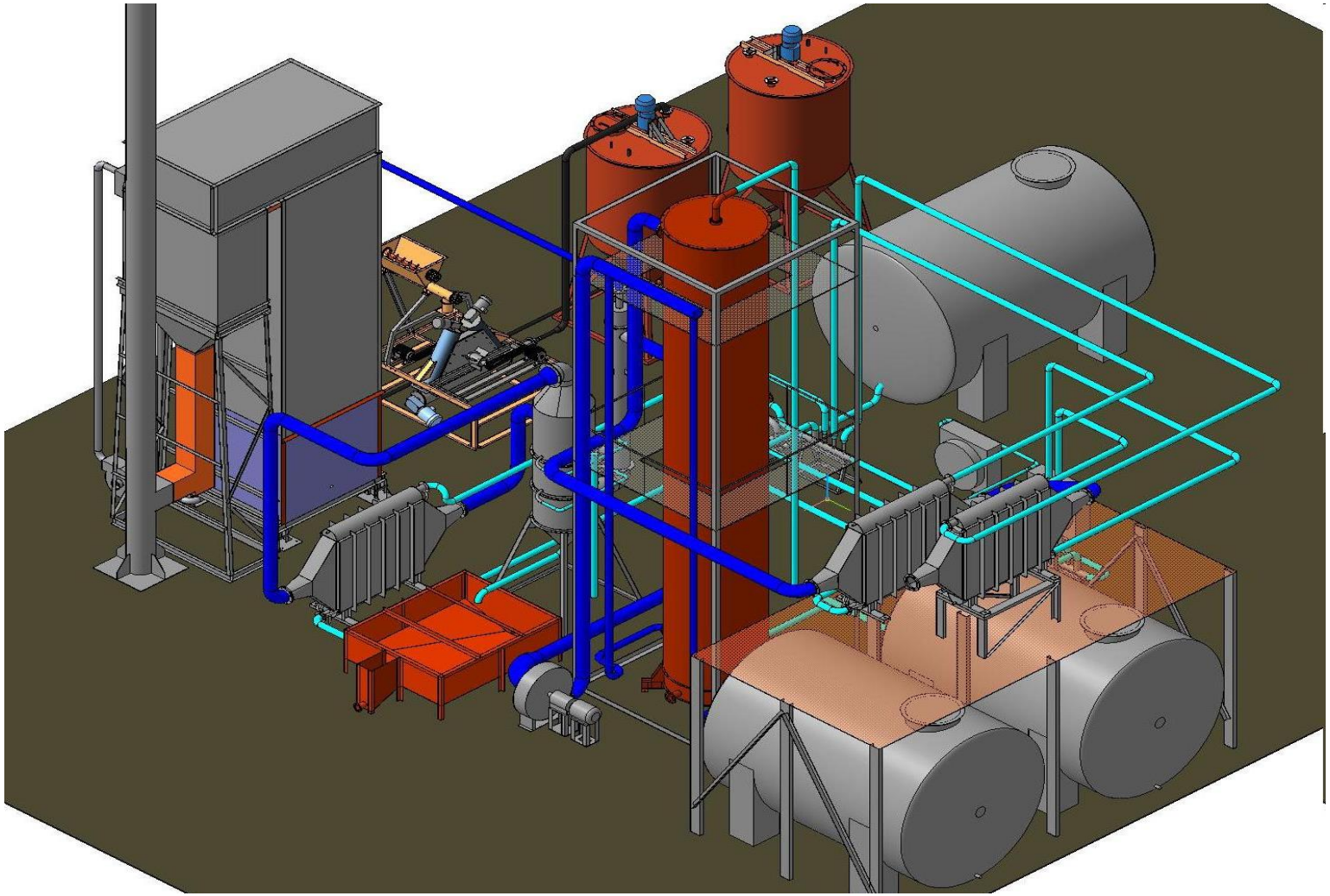
Synthetic crude oil (SCO) Process

SCO Process or Fischer-Tropsch Synthesis occurs in iron-based or cobalt catalysts under the pressure of 25-30 atm. and temperatures of 230-240^{o}C with application of WHSV of 600 h-1. The outcome is synthetic crude oil that consists of olefins, paraffins, and oxygenate compounds.

SCO: chemical makeup

Elemental Composition, %	SLF Values
Alkenes (C_2-C_4), % diesel cut	39,6
Alkenes (C_5-C_{11}), % gasoline cut	33,4
Alkenes (C_{12}-C_{20}), % gas cut	5,1
H	12
N	>12
S	-
Hydrocarbon content, %	
Paraffins (C_nH_{2n}+2)	40-60
Naphthenes ($C_{n-}C_n$)	20-25
Aromatics ($C_{16}H_{16}$) and their homologous compounds	20-25
Viscosity ${}_cC_t$ at 20°C	5,0
Density kg/m^3	840
Low heat value, mJ/kg	42-45
Fractional composition, °C	180-300
Pour point, °C	-40

SLF equipment layout



Electricity production

A portion of SLF in the volume of 6 t/24h is redirected to the diesel-electric unit for electricity production.

Synthetic gasoline and diesel fuel processing

The remaining 4 t/24 h SLF are processed in the Alfa-Paltin unit for generation of synthetic motor fuel.

The project economic indicators

Annual Sales Revenues	
SLF for electrical power	$1 080 000
Gasoline and diesel fuel	$1 152 000
Total	$2 232 000
Annual expenditures	$554 400
Income from sales	$1 677 600
Cumulative investment	$3 000 000
Pay-back period	3 years
Profit margin	30%