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Ministry of Education and Science of the Russian Federation
Federal Agency of Science and Innovation

**Collaborative project (Russia - EU) for technology development and design of equipment for energy production from biomass
(governmental contract dated 24 June 2008 г. № 02.527.11.0003)**

**ASSEMBLY AND INITIAL BENCH TESTING OF POWER PLANT FOR HEAT AND POWER GENERATION FROM BIOFUEL AVTAB-1
Brussels, 08.11.2011**

Final Presentation

Work is done on the instructions of and with financial support of Ministry of education and science of Russian Federation

2011 г.

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Project Goal

Development of compact autonomous systems for decentralized heat- and power supply for small-scale communal and social facilities, based on environmentally sound technologies for biomass conversion to biofuel

Summary of staff effort

#	Name	WP0 Manag.	WP1 Prod.	WP2 Upgr.	WP3 MGT	WP4 DE	WP5 Exh.	WP6 Ass.	Total
1	BTG	8	15	20	2	8	2	2	57
2	ECT	4	2	1	2	23	2	2	36
3	UFL	2	2	2	44	4	2	4	60
4	BIC	10	10	40	20	120	360	10	570
5	NAMI	4	5	15	10	440	60	10	544
6	UAS	2	2	2	1	1	1	36	45
7	ZIL	2		3	5	60	20	10	100
Total		32	36	83	84	656	447	74	1412



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Bioliquids-CHP
Power generation from Biomass

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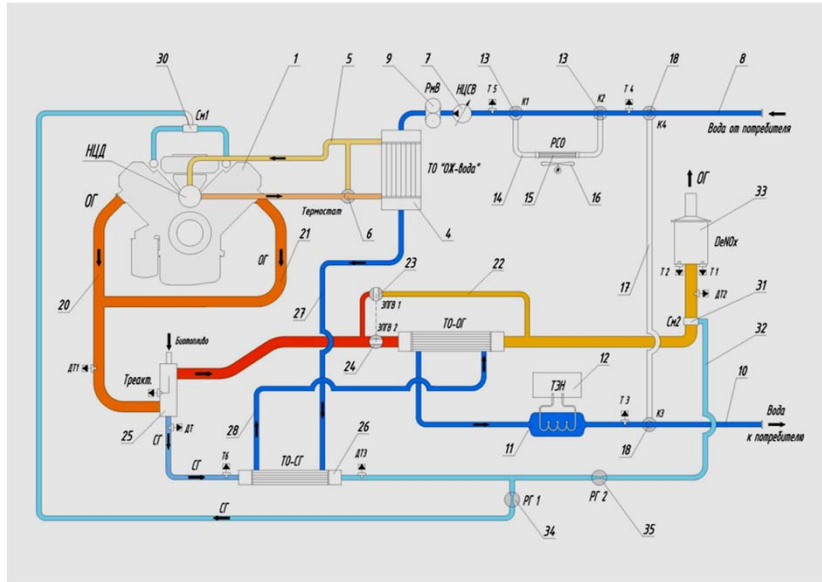
SEVENTH FRAMEWORK
PROGRAMME

WP-4 Central Tasks

The main objective is to develop engine components that are tolerant towards the fuel mixtures (bio-liquids and diesel fuel) and (eventually) the upgraded fast-pyrolysis oils

1. Application of modified diesel engines.
 - fuel feeding (pump, injection system, new materials or coatings);
 - thermal regime (preheating of air, increasing compression ratio).
2. New engine concepts
 - hot bulb engines;
 - new external combustion engines.
3. Catalytic air pollution control.
 - DeNOx.

Schema of ЭБТЭБ-1 Power Plant on the base of Diesel Engine ЯМЗ-238М2



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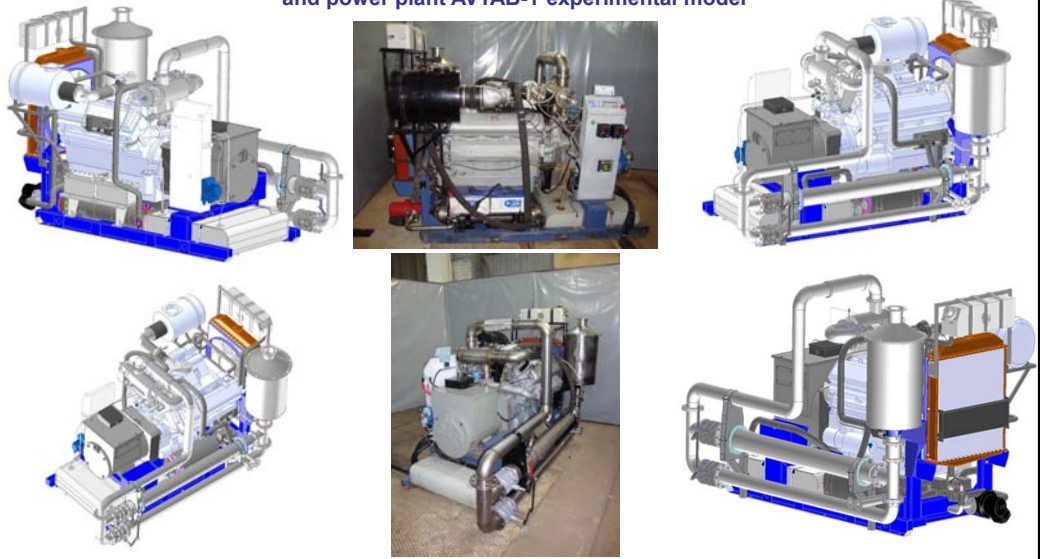
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SEVENTH FRAMEWORK PROGRAMME

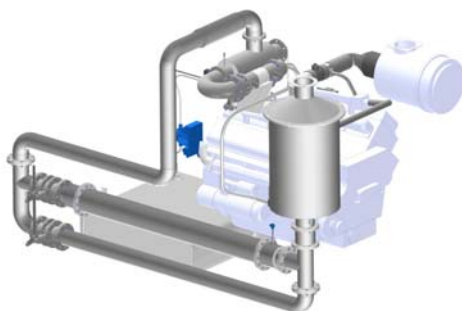
НАЧИСЛЕНА ДИОДИКА
38736-1
Объемное черчение

№	Изменение	Ассигновка	Исполнитель
1	ИЗМЕНЕНИЯ	Объемное черчение	
Исполнитель:			
1	ИЗМЕНЕНИЯ	Исполнитель	
2	ИЗМЕНЕНИЯ	Исполнитель	
3	ИЗМЕНЕНИЯ	Исполнитель	
4	ИЗМЕНЕНИЯ	Исполнитель	
5	ИЗМЕНЕНИЯ	Исполнитель	
6	ИЗМЕНЕНИЯ	Исполнитель	
7	ИЗМЕНЕНИЯ	Исполнитель	
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16	ИЗМЕНЕНИЯ	Исполнитель	
17	ИЗМЕНЕНИЯ	Исполнитель	
18	ИЗМЕНЕНИЯ	Исполнитель	
19	ИЗМЕНЕНИЯ	Исполнитель	
Апробация:			
1	ИЗМЕНЕНИЯ	Исполнитель	
2	ИЗМЕНЕНИЯ	Исполнитель	
Исполнитель:			
1	ИЗМЕНЕНИЯ	Исполнитель	
2	ИЗМЕНЕНИЯ	Исполнитель	
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17	ИЗМЕНЕНИЯ	Исполнитель	
18	ИЗМЕНЕНИЯ	Исполнитель	
19	ИЗМЕНЕНИЯ	Исполнитель	

Power plant 3-D models in SOLIDWORKS and power plant AVTAB-1 experimental model



Tested component: NOx reduction system



Purpose of testing:

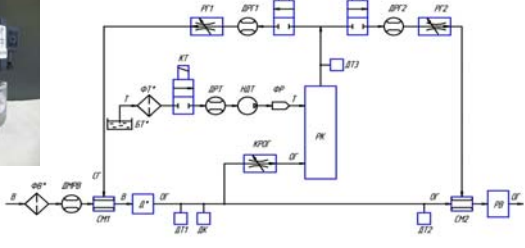
- Study technical characteristics and find ways to achieve target parameters set by the technical requirements for research and development works "Development studies of catalytic systems for biomass refining into fuel. Development of catalytic system for NOx reduction in the exhaust gas of the power plant», attachment # 1 to the contract, including:
- Reduction of NOx components in the exhaust gas after its transit through NOx reduction system;
- Achievement of conversion level (NOx reduction) of at least 80 %.

Testing results:

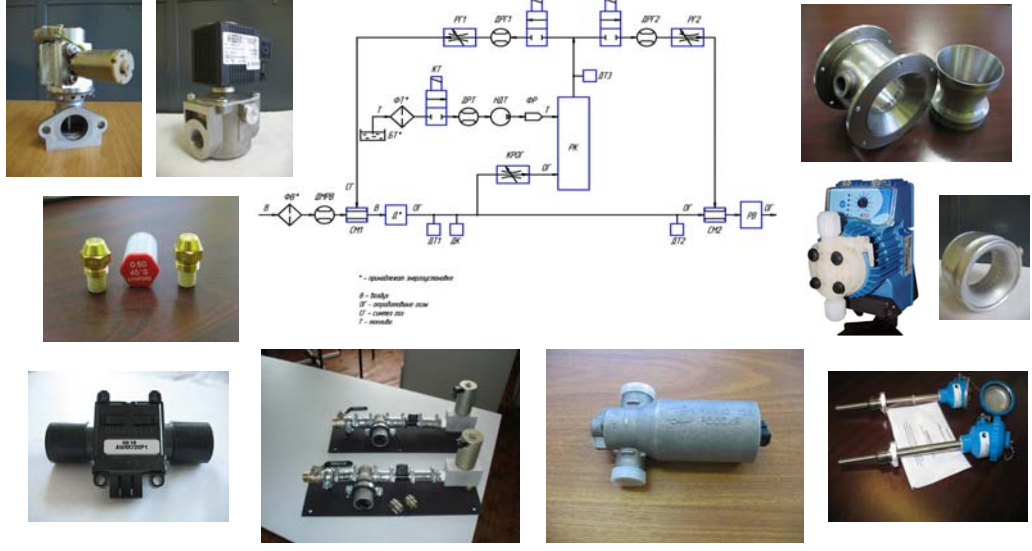
- Tested component: NOx reduction system has passed testing;
- Conversion level (Reduction of NOx components) is 84%.



Nox reduction system diagram and its main components



- конденсатор парогенератора
 Б - блок
 ДР - дробилка
 Д - дробилка
 Т - теплообменник



Reactor for generation of synthetic gas




DeNOx Reactor






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SEVENTH FRAMEWORK
PROGRAMME

Heat exchanger "Cooling fluid-Water"



Heat exchanger "Synthetic gas-Water"



Heat exchanger "Exhaust gases-Water"




Heaters unit




Assembly works






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SEVENTH FRAMEWORK
PROGRAMME

Initial bench testing of the power plant for heat and power generation AVTAB-1.

**Tested component:
Engine with generator.**

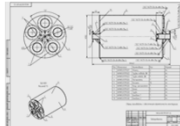
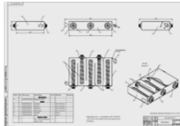


Purpose of testing

- Study technical characteristics and find ways to achieve target parameters set by the technical requirements;
- Initial conformance evaluation of tested component to the technical requirements, readiness review of the tested component for the governmental acceptance testing, and determination of the necessary follow-up changes.

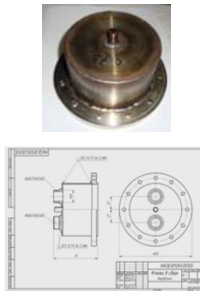
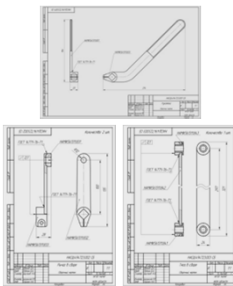
Corrections done to the technical papers

➤ Instantaneous waste gas heater (NASSH.065191.001) construction was changed to decrease hydraulic friction in the secondary tuned circuit of power plant AVTAB-1.

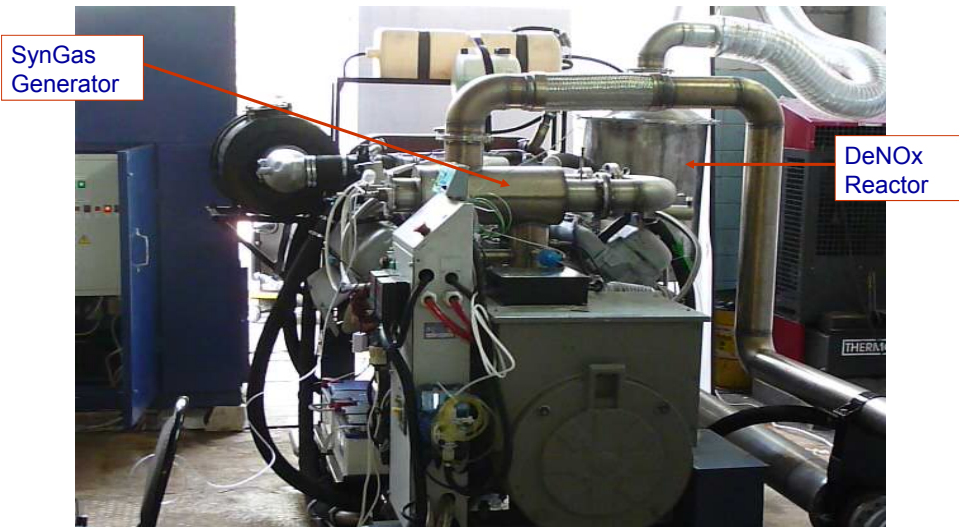


➤ Unified high temperature turning gas door control mechanism was developed to ease control of synthetic gas distribution over heat exchanger of the heating module necessary to maintain desired exhaust gases temperature preceding the neutralizer of NOx reduction system.

➤ Heat exchanger (NASSH.065111.003) "Synthetic gas-Water" outlet flange (NASSH.302679.001) construction was changed to allow easy assembly and connection reliability of synthetic gas flow line.



**Power Plant with DeNOx System.
(Heat Power 150 kW, Electric Power 100 kW)**



Test equipment

Electric Bench with capacity up to 120 kWt



Liquid ultrasonic counter «Dnepr-7»

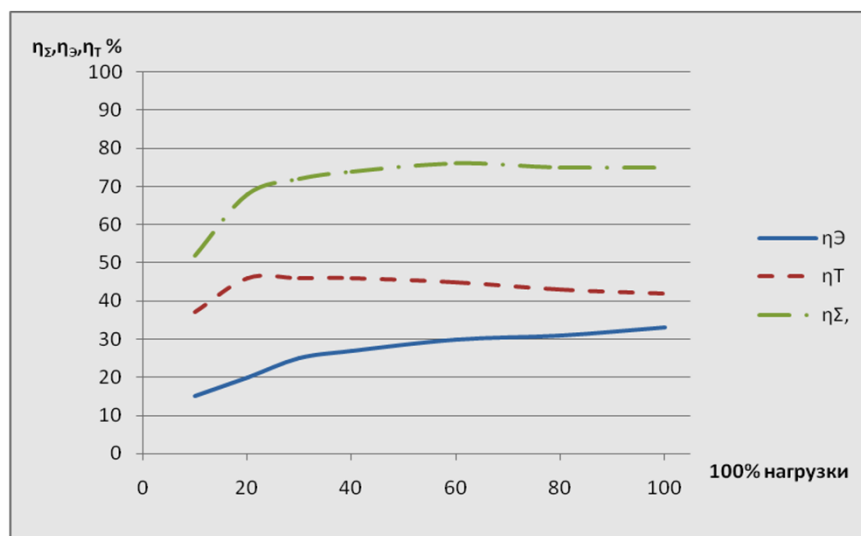


Heating Bench with capacity up to 160 kWt

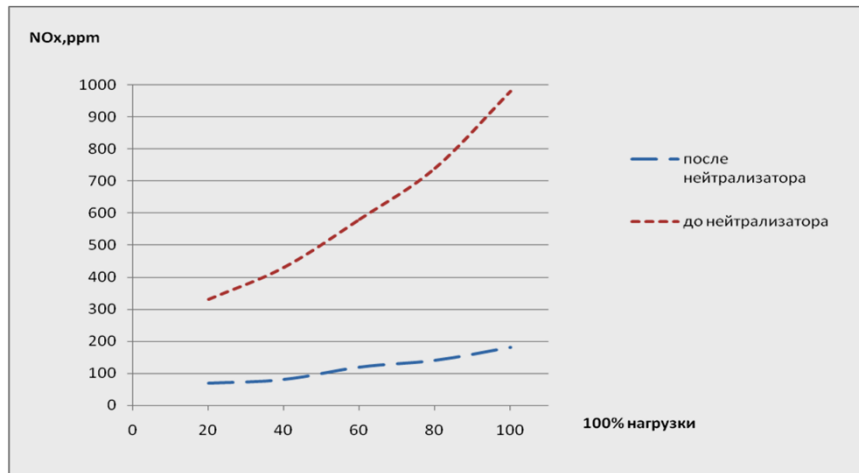
Hydrogen gas analyzer «Test-1.1»




Impact of Loading for Power Plant Efficiency



Impact of Engine Power for NOx Emission



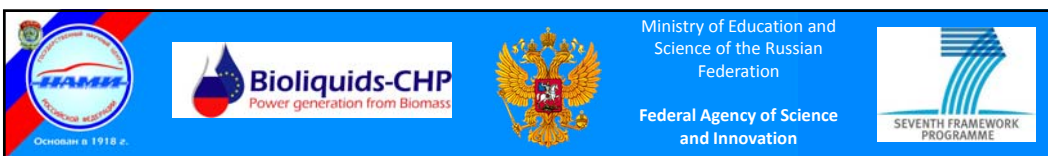
Parameter description	Technical Requirements	Testing and Estimation results
Coefficient of efficiency for transformation into electric power %	More than 15	32
Coefficient of efficiency for transformation into heating power, %	More than 30	39
Overall System Coefficient of efficiency, %	not less than 45	71
Electric power generation, kWt	from 30 to 100	100
Heating power generation, kWt	up to 150	150
Reduction of NOx components in exhaust gas of power plant, in % from initial concentration	80	81



Testing results

Bench testing has proved that the power plant AVTAB-1 can provide:

- Capacity at designed conditions -100 kWt (30-100 kWt in accordance with Technical Requirements);
- Voltage at designed conditions -400 V (400 V in accordance with Technical Requirements)
- Frequency at designed conditions -50 Hertz (50 Hertz in accordance with Technical Requirements);
- Quality of electric power in accordance with norm GOST 50783-95;
- Heating power at designed conditions (without heaters) 129 kWt (up to 150 kWt in accordance with Technical Requirements);
- Heating power (with heaters) 150 kWt;
- Coefficient of efficiency of chemical fuel energy transformation into electric power at the most energy efficient regime - 32,0% (more than 15% in accordance with Technical Requirements);
- Coefficient of efficiency of chemical fuel energy transformation into heating power at the most energy efficient regime 39,0% (more than 30% in accordance with Technical Requirements);
- Overall Coefficient of efficiency at the most energy efficient regime 71,0% (not less than 45% in accordance with Technical Requirements).



The following exercises were completed in the first half of 2010 in frame of governmental contract № 02.527.11.0003:

1. NOx reduction system has been manufactured.
2. Test routine and methods of bench testing of the NOx reduction system were developed.
3. Bench testing of NOx reduction system was performed.
4. Power plant assembly has been completed.
5. Test routine and methods of bench testing of the power plant were developed.
6. Bench testing of power plant was performed.
5. Correction of technical papers based on the results of the bench testing was performed, "I" mark was assigned.

THANK YOU FOR YOUR ATTENTION!!!



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