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On issue of a number of problems solving at utilization of poultry manure as biofuel

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The purpose of this work is to develop the foundations of technology for high-speed low-temperature pyrolysis of manure, as well as processing technologies for gaseous products formed during such pyrolysis

We suggested low-temperature pyrolysis of manure or poultry litter to be carried out in a fluidized bed. Superheated water vapor with 300° temperature was used as a fluidizing medium.

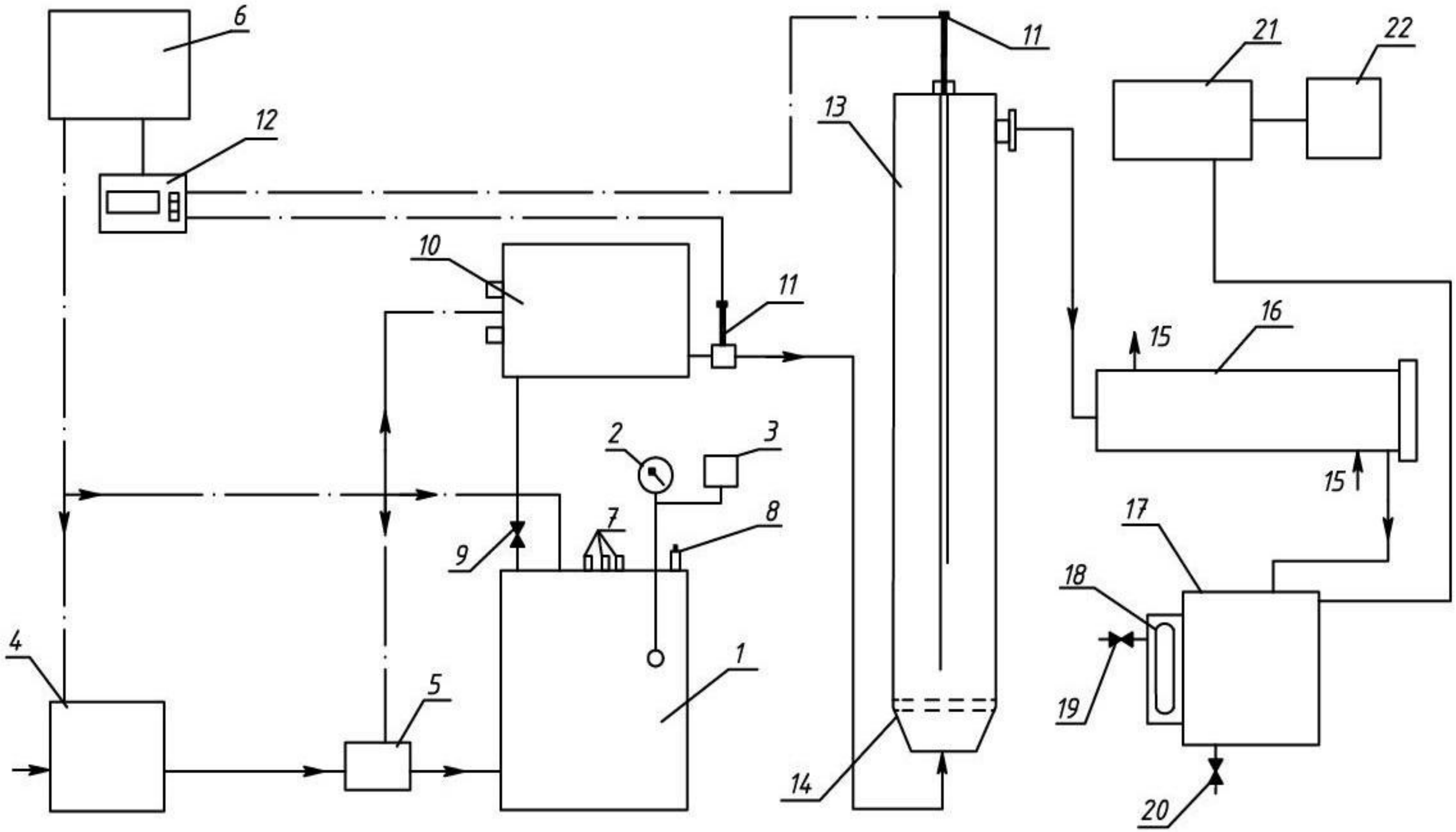
The implementation of our project required the following studies:

- study of the process of low-temperature pyrolysis of pellets from manure in a fluidized bed, liquefied by superheated water vapor;

- study of the process of thermal cracking of incondensable gaseous products of low-temperature pyrolysis of manure;

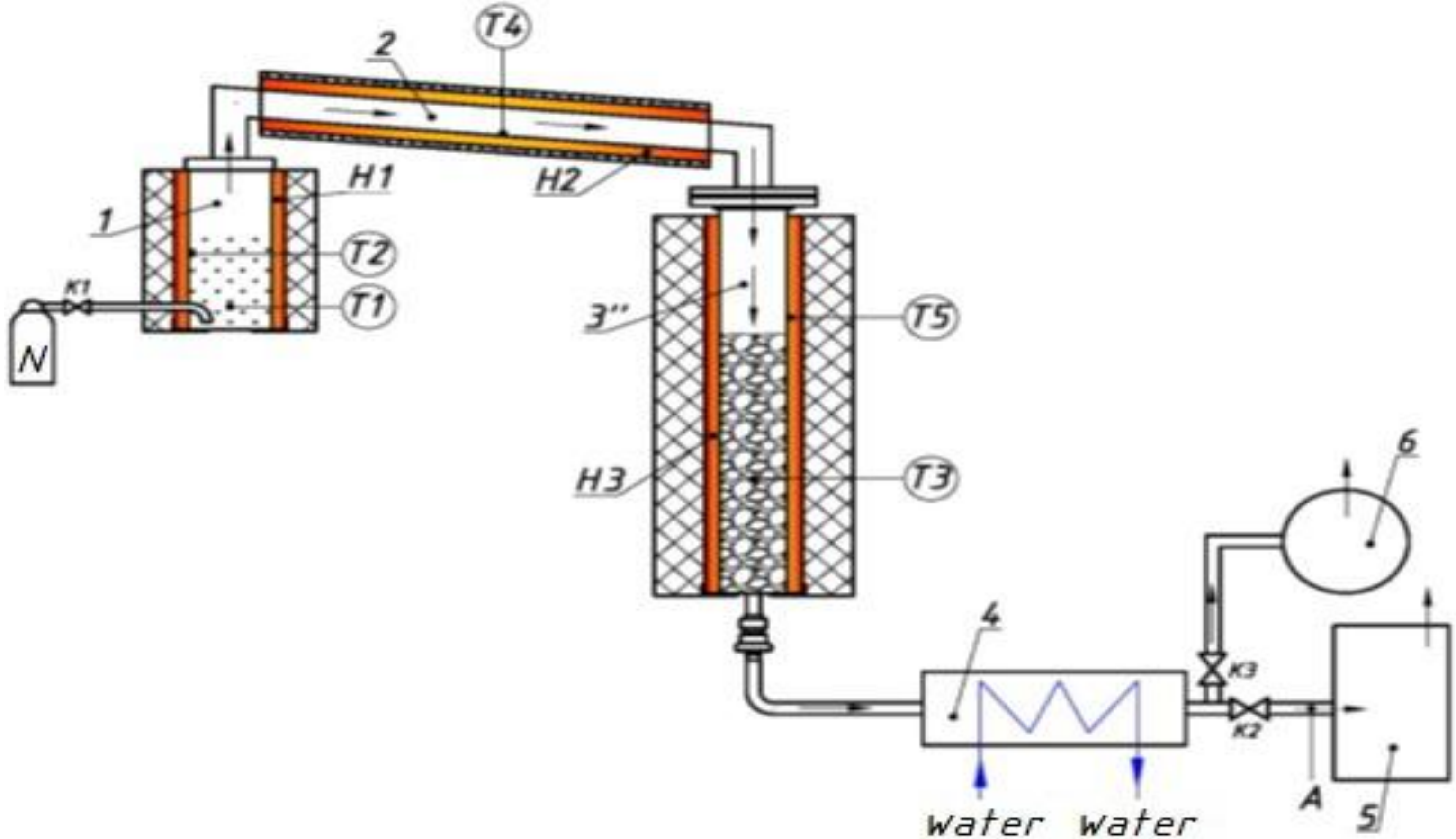
- study of the content of pathogenic microflora in the manure before and after its treatment by low-temperature pyrolysis.

Schematic diagram of the experimental setup for studying the process of low-temperature pyrolysis of PL



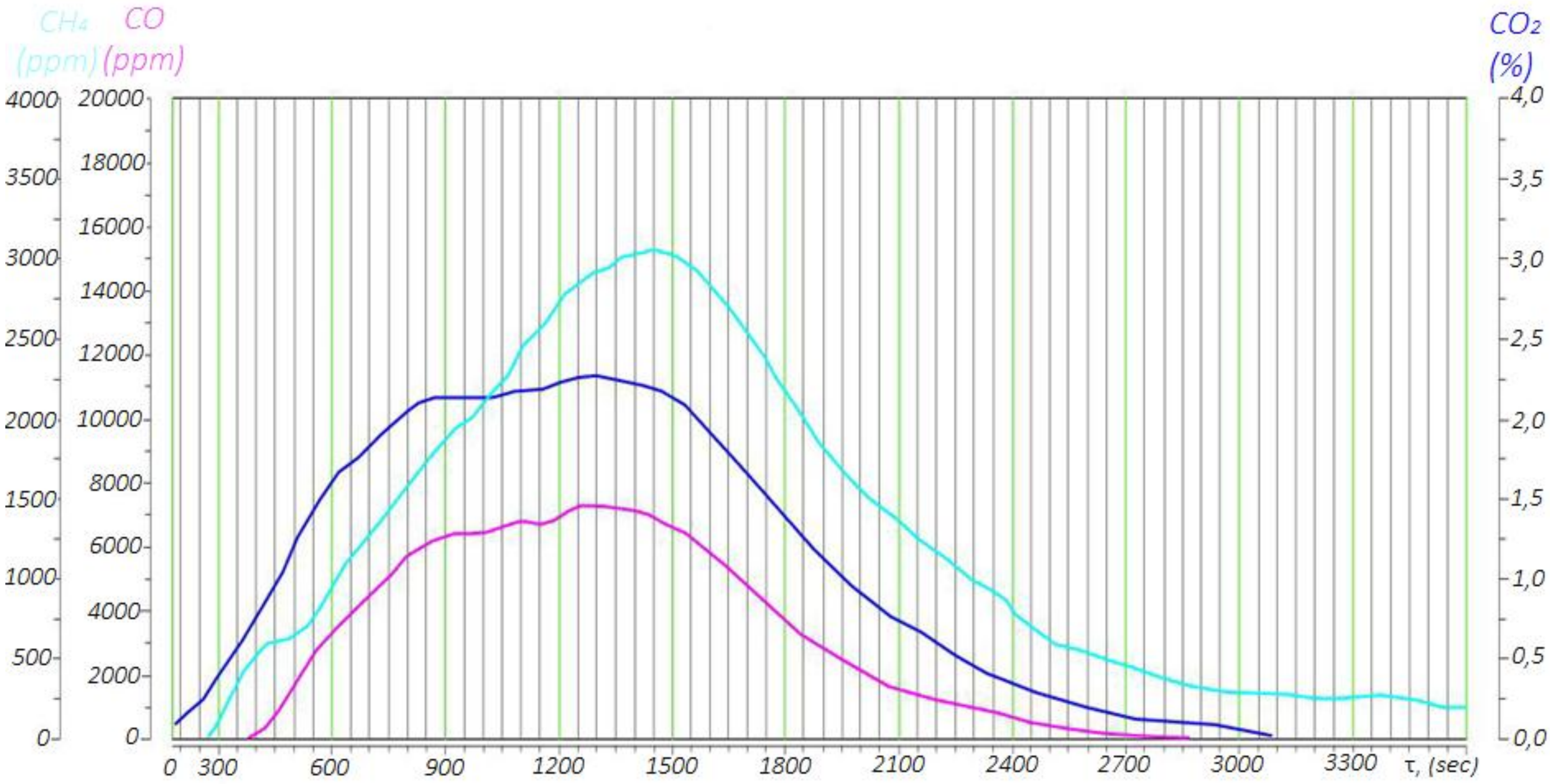
*1 – steam electric boiler; 2 – pressure gauge; 3 – steam pressure sensors; 4 – water supply line; 5 – valve; 6 – control system; 7 – sensors; 8 – safety valve; 9 – control valve; 10 – electric superheater; 11 – thermocouples; 12 – temperature controllers; 13 – reactor; 14 – gas distribution grid; 15 – conduits; 16 – refrigerator; 17 – vessel; 18 – inspection window; 19 – valve; 20 – valve; 21 – gasholder; 22 – gas analyzer “VarioPlus SinGaz”.

Scheme of installation for studying the process of heterogeneous thermal cracking of non-condensable gaseous products of low-temperature pyrolysis of manure

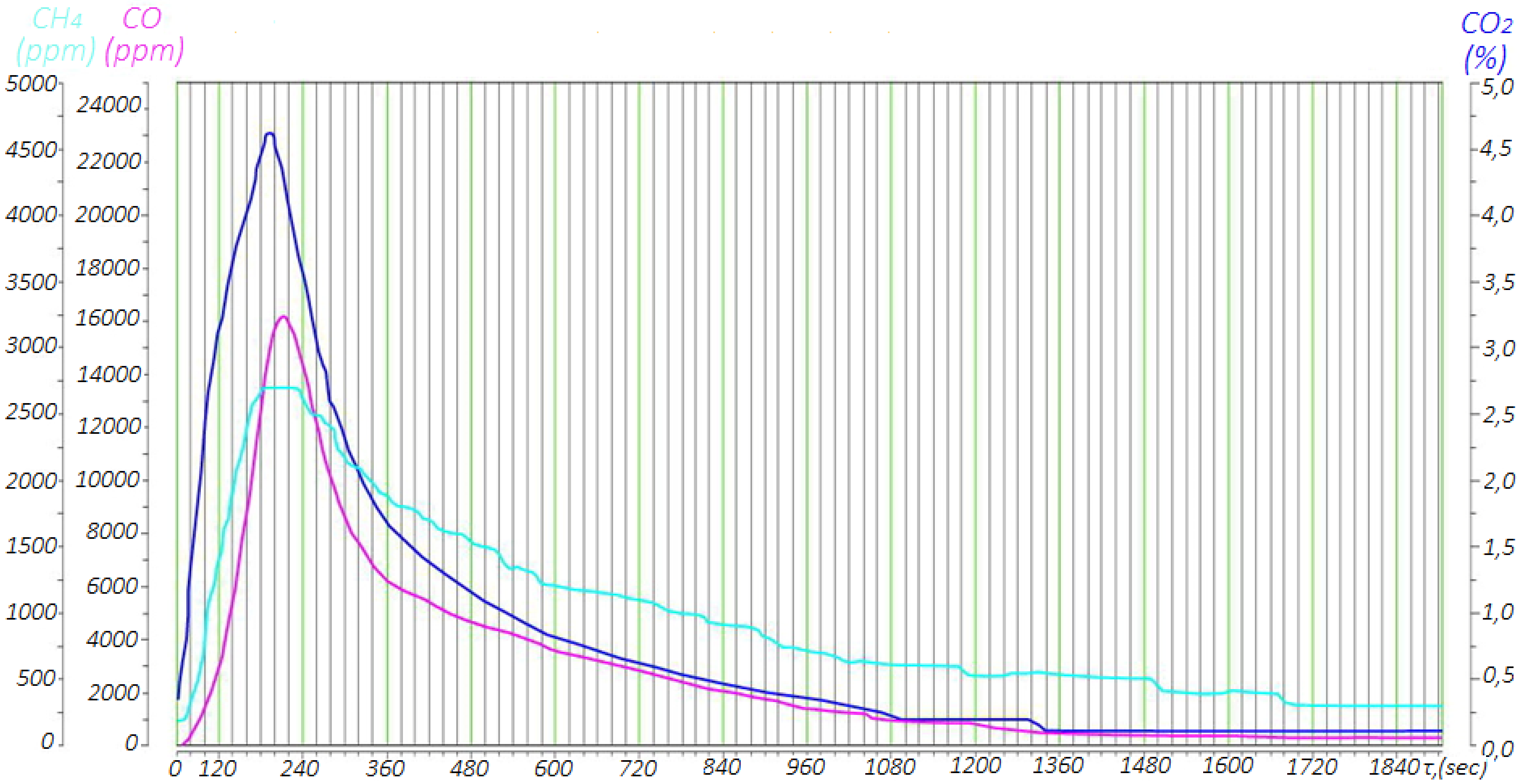


1 -pyrolysis reactor, 2 – gas flue, 3 - cracking reactor, 4 - laboratory refrigerator, 5 - gas meter, A - sampling point of gas, К 1, К 2, К 3 - valves, H1, H2, H3 – heaters, T1-T5 – thermocouples, N – balloon with nitrogen

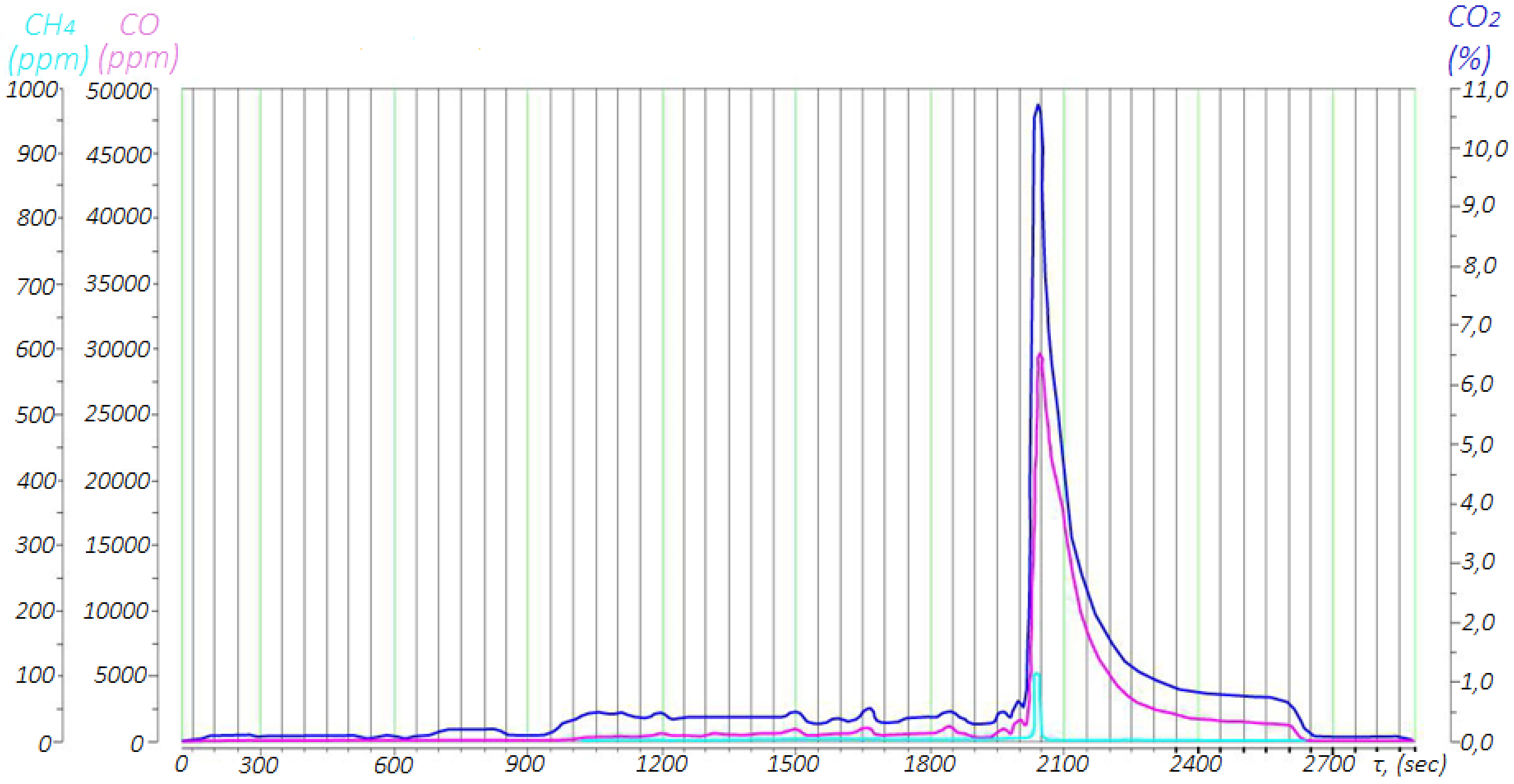
Curves of changes in the concentration of CO_2, CO and CH_4 in non-condensable gases at the unit in the pyrolysis of chicken manure in the fixed bed of quartz sand particles, purged with nitrogen at an average temperature of 300 °C



Curves of changes in the concentration of CO_2, CO and CH_4 in non-condensable gases at the unit in the pyrolysis of chicken manure in the fluidized bed of quartz sand particles, blown by nitrogen at an average temperature of 300 °C



Curves of changes in the concentration of CO_2, CO and CH_4 in non-condensable gases at the unit in the pyrolysis of chicken manure in the fluidized bed of quartz sand particles, blown by superheated water vapor at an average temperature of 300 °C



The main characteristics of manure before and after treatment by low-temperature pyrolysis

Material	Determined characteristics						
	C, %	H, %	N, %	S, %	O_2, %	Ash A, %	Lowest calorific value MJ/kg
Initial manure	41,4	5,7	4,8	0,8	30,7	16,6	16,7
Manure after treatment in a fixed bed of inert material in nitrogen medium	47,6	3,7	6,3	0,96	10,9	30,5	18,9
Manure after treatment in fluidized bed of inert material in nitrogen medium	46,7	3,7	6,3	0,98	11,6	30,7	18,5
Manure after treatment in fluidized bed of inert material in superheated steam	48,2	3,63	4,65	0,9	12,48	30,1	18,8

The ratios (H/C) and (O/C) for the initial and thermally treated manure in comparison with similar characteristics for other fuels

Name of material	H/C	O/C
Initial manure	0,138	0,74
Manure after low-temperature pyrolysis at temperature of 300 °C in nitrogen medium in layer of immobile particles of inert material	0,078	0,228
Manure after low-temperature pyrolysis at temperature of 300 °C in nitrogen medium in fluidized bed of particles of inert material	0,079	0,248
Manure after low-temperature pyrolysis at temperature of 300 °C in superheated water vapor medium in fluidized bed of particles of inert material	0,075	0,258
Peat	0,105	0,655
Lignite	0,077	0,299
Anthracite	0,019	0,02

Content of pathogenic microflora pellets from manure

Name of microorganism	The average number of colonies in the initial pellets			
	Initial pellets	Pellets after pyrolysis in a fixed bed	Pellets after pyrolysis in a fluidized bed in nitrogen medium	Pellets after pyrolysis in a fluidized bed in superheated steam medium
Mucor (colonies)	1,0	0	0	0
Penicillium (colonies)	1,6	0	0	0
Aspergillus (colonies)	0,3	0	0	0
Cladosporium (colonies)	0	0	0	0
Fusarium (colonies)	0	0	0	0
Trichoderma (colonies)	1	0	0	0
Bacterial microbiota	0	0	0	0
The average number of colonies in the sample	0,56	0	0	0
Total microbial number in 1 g of sample	$2,8 \times 10^5$	0	0	0

Integral content and properties of non-condensable gases after low-temperature pyrolysis and heterogeneous thermal cracking

Integral content of gases, volumetric %					Lowest calorific value MJ / Nm^3	Specific volume output, m^3 / kg
H_2	CO	CO_2	CH_4	N_2		
47,79	51,04	0,63	0,49	0,00	11,78	0,38

Conclusions

- The received results of researches allow drawing a conclusion that the offered technology of processing in biofuel of the bird droppings and a poultry litter permits to carry out such processing practically without a waste. Moreover, according to its characteristics, the biofuel obtained is essentially a bio-coal corresponding to lignites.

- As for the bird droppings processing into biofuels, it should be noted that the pyrolysis process in the fluidized bed of inert material allows a five-fold reduction in the duration of the process, but at the same time obtain the same characteristics of the recycled manure as in the pyrolysis of manure in the inert material fixed bed.

- The application of superheated water vapor as a fluidizing agent for the fluidized bed makes it possible to obtain gaseous pyrolysis products that do not contain ballast in the form of inert gases. However, the duration of the pyrolysis process and the characteristics of the manure after pyrolysis are the same as for pyrolysis in a hot nitrogen medium.

- Further processing of gaseous products of pyrolysis of manure in the fluidized bed of inert material in a superheated water vapor by heterogeneous thermal cracking makes it possible to obtain a synthesis gas consisting of almost 100% of a mixture of hydrogen and carbon monoxide.

- The energy spent on producing superheated water vapor can be recovered by condensing this vapor. The water heated by steam condensation can be used as a primary coolant in a power generation plant using the Rankine organic cycle.