ЦІЛЬОВА КОМПЛЕКСНА ПРОГРАМА НАУКОВИХ ДОСЛІДЖЕНЬ НАН УКРАЇНИ

Розвиток наукових засад отримання, зберігання та використання водню в системах автономного енергозабезпечення

ОТРИМАННЯ ІНЖЕНЕРНО-ТЕХНОЛОГІЧНИХ ПОКАЗНИКІВ ЕКСПЕРИМЕНТАЛЬНО-ПРОМИСЛОВОЇ ТЕХНОЛОГІЇ СИНТЕЗУ БІОВОДНЮ

Final report

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TARGET COMPREHENSIVE PROGRAM OF SCIENTIFIC RESEARCH NAS of UKRAINE

Development of scientific principles of obtaining, storage and use of hydrogen in autonomous energy supply systems

OBTAINING OF FERMENTATION PARAMETERS OF EXPERIMENTAL-INDUSTRIAL TECHNOLOGY FOR SYNTHESIS OF BIOHYDROGEN

Final report

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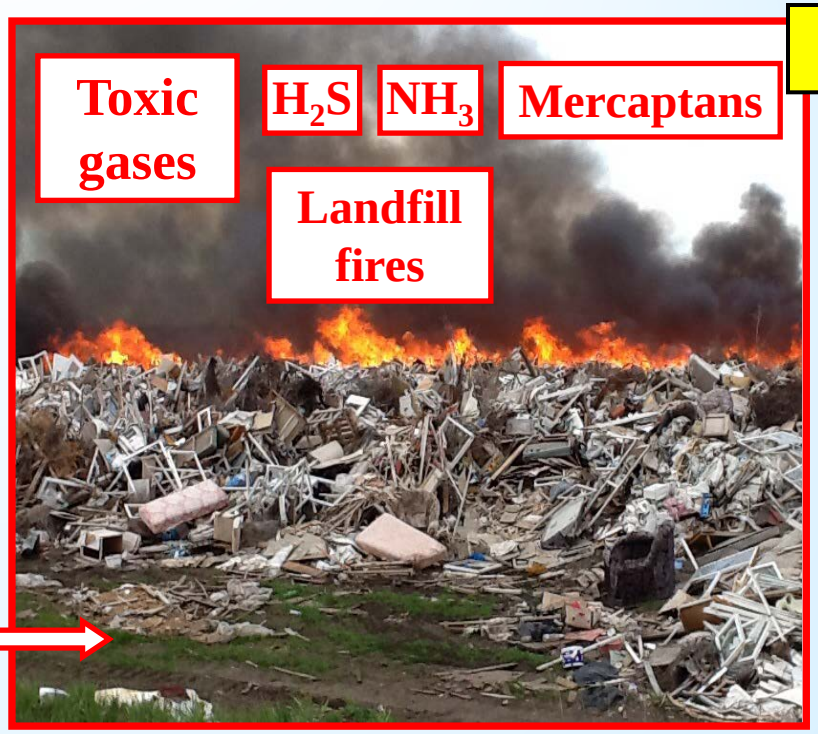
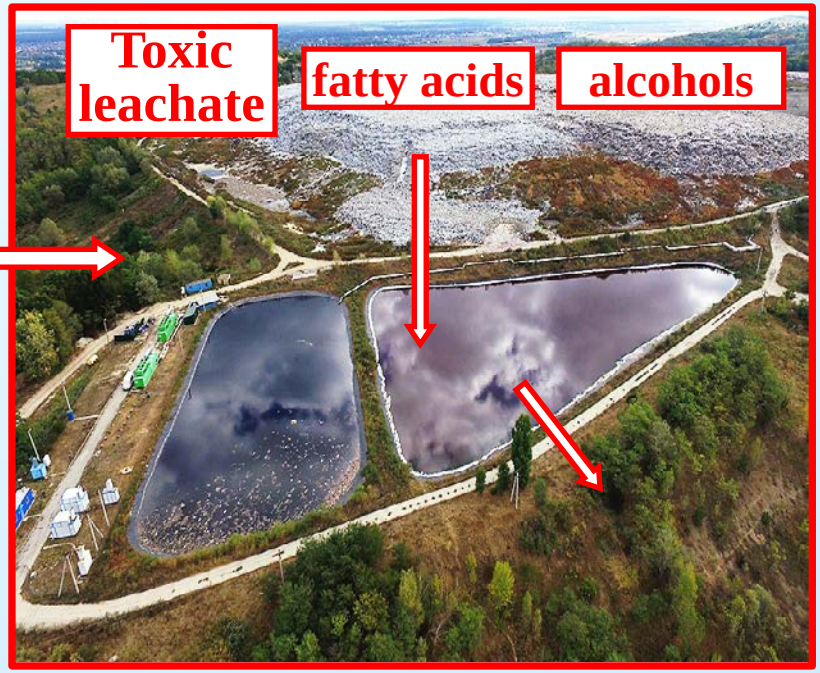
The goal of the work

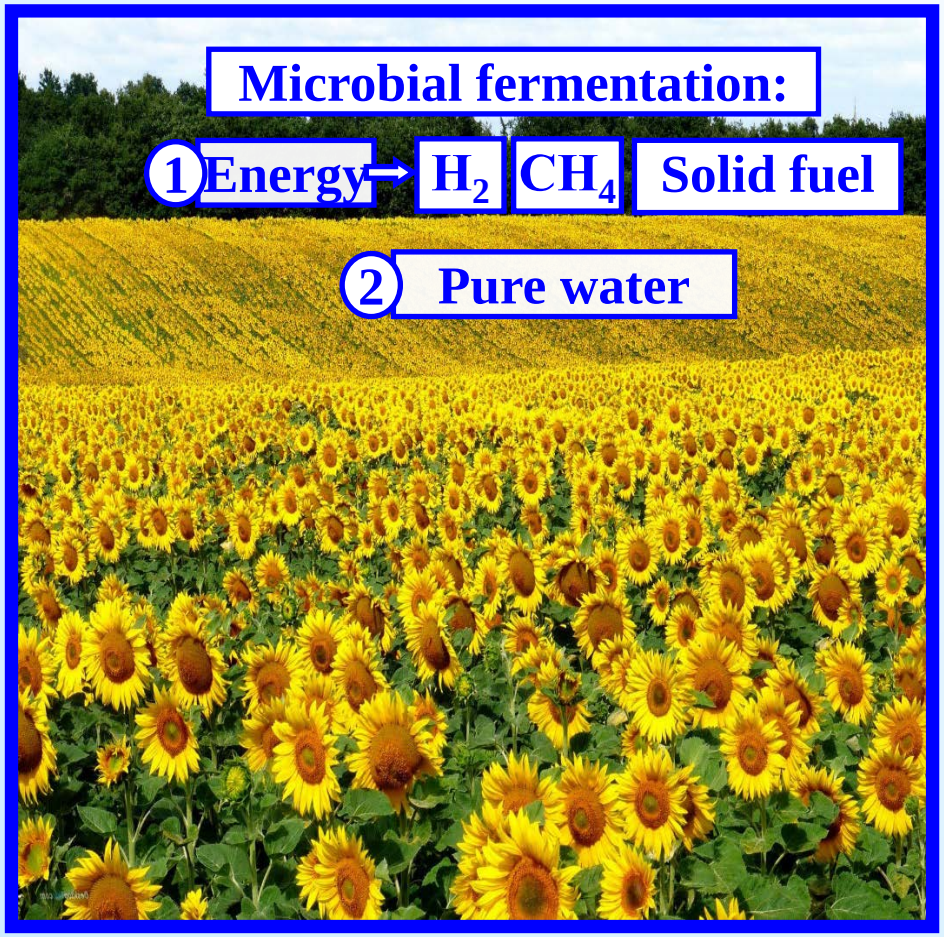
The improvement of the efficiency of molecular hydrogen synthesis by optimizing the process of fermentation of environmentally hazardous multicomponent food waste, as well as purification of associated toxic filtrate

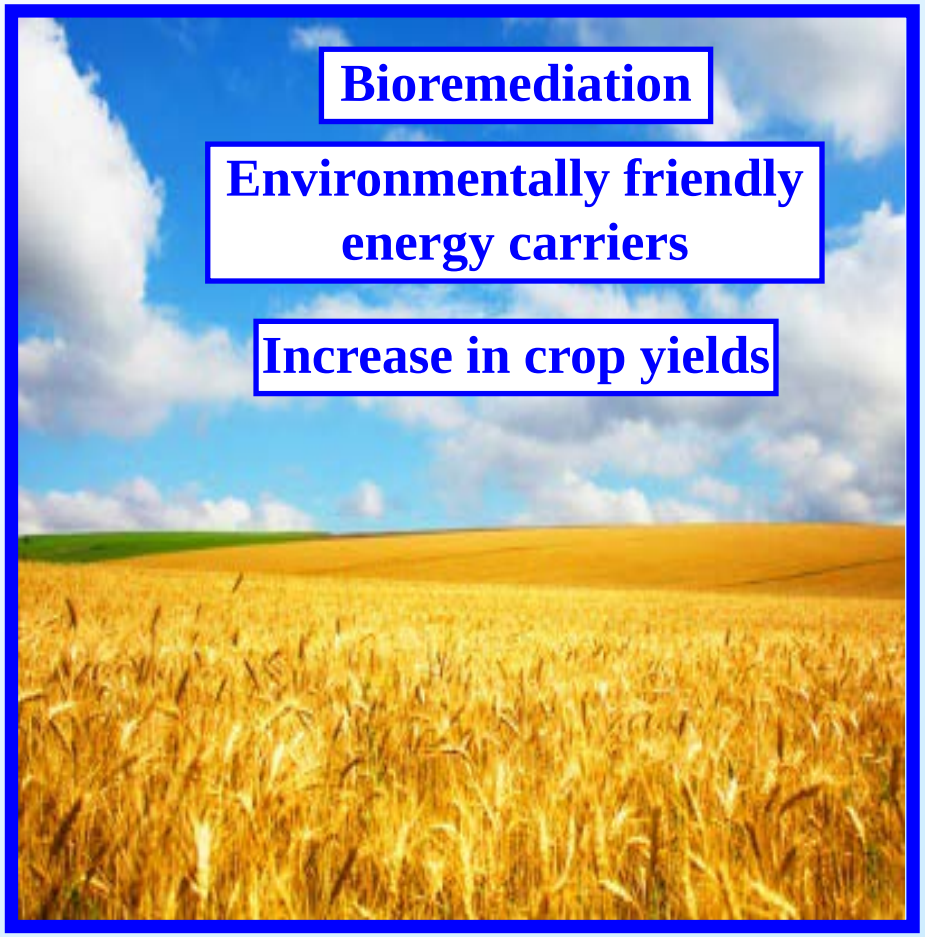
Multi component food waste – 1.3 billion tons/year in the world





Prospects for the application of our Universal Environmental and Bioenergy Microbial Technologies





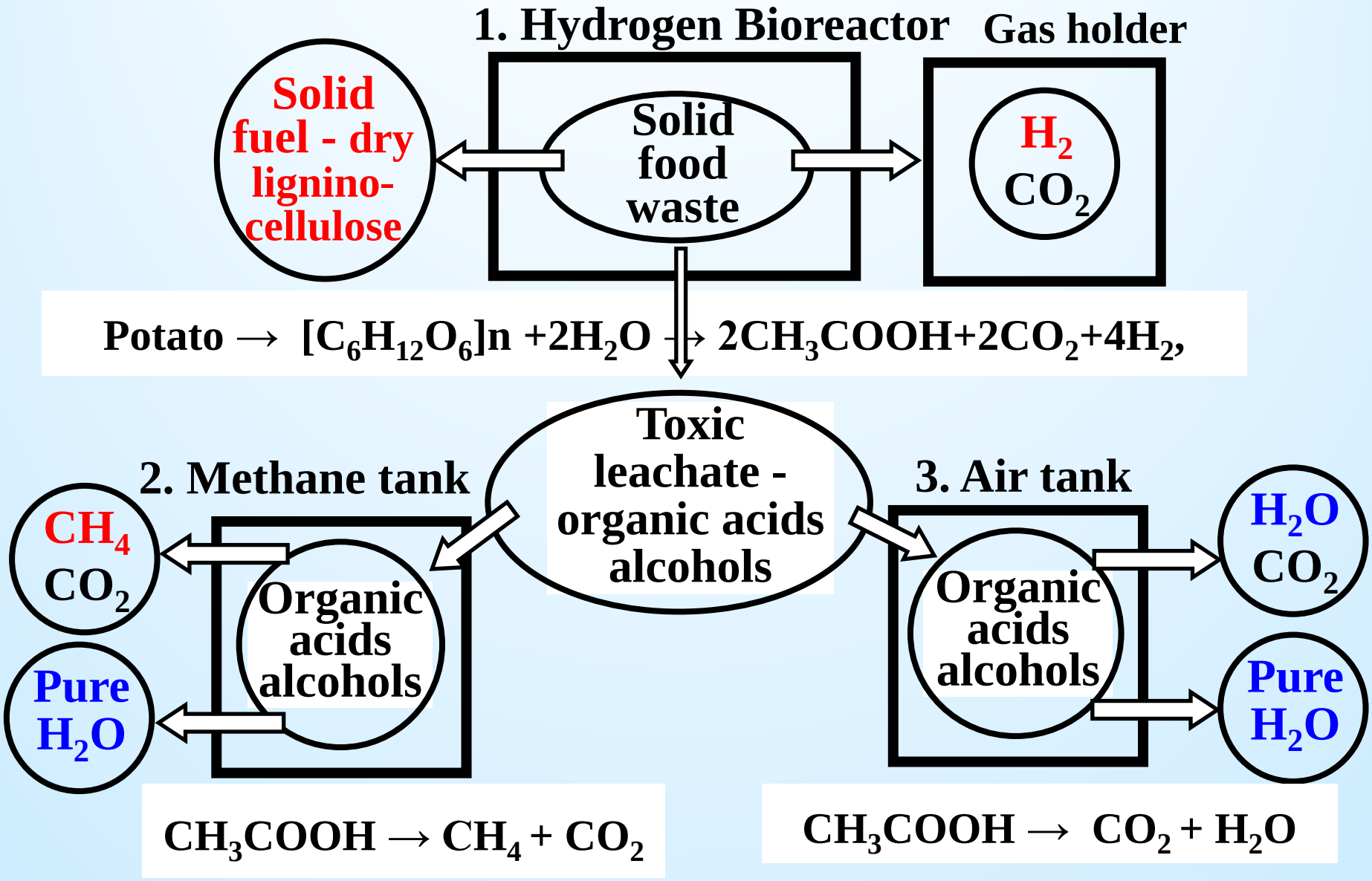
The purpose of the work was to solve two groups of problems:

1. Environment protection
   - Anaerobic degradation of decaying solid food waste
   - Purification of toxic leachate that consists of organic acids and alcohols (end products of hydrolysis of solid food waste)
2. Obtaining of energy carriers from environmentally hazardous waste:
   - H_2 from solid food waste
   - CH_4 from organic acids and alcohols of leachate

Solving these problems allows obtaining a number of valuable products from environmentally hazardous waste.

1. Gaseous energy carriers: H_2 and CH_4;
2. Solid energy carrier - dry ligninocellulose - undigested residues of solid food waste;
3. Pure water (from toxic leachate).

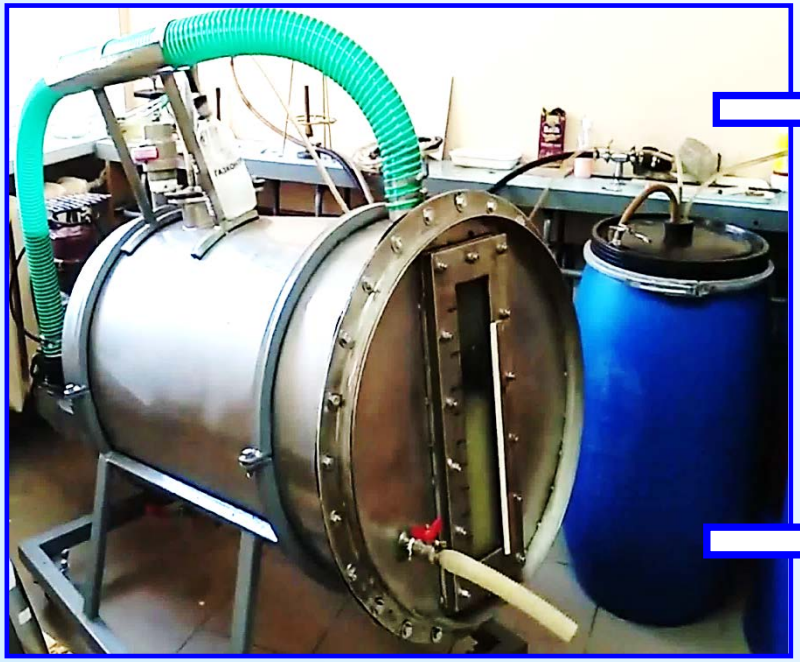
Strategic Approach: Sequential degradation of Solid and then Liquid organic waste with obtaining of Energy carriers and Pure water



The sequence of Biotechnology Stages

Installations:

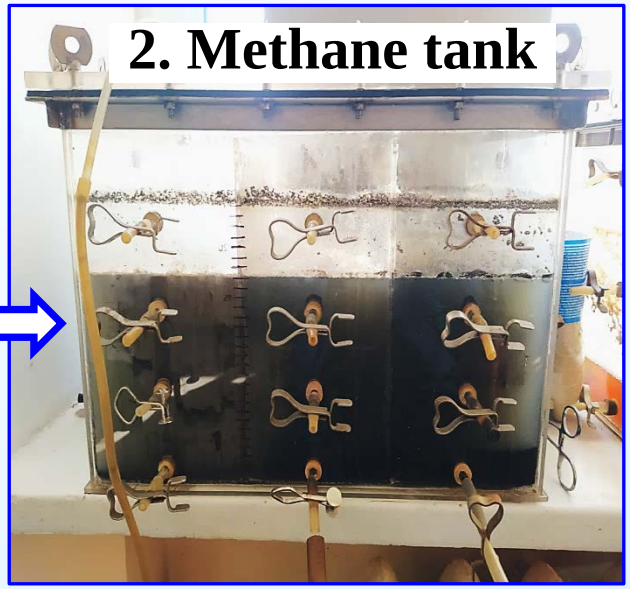
1. Hydrogen Bioreactor



Process -
Degradation (hydrolysis) of solid food waste

End Products -
H_2, organic acids, alcohols

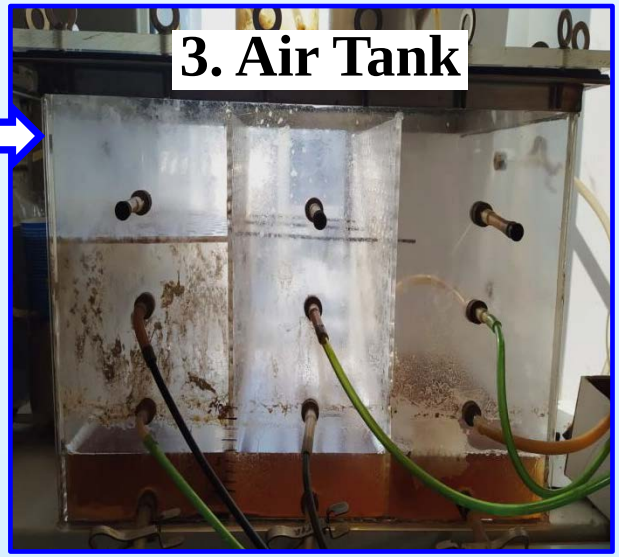
2. Methane tank



Process -
Methanogenic fermentation of organic acids and alcohols

End Products -
CH_4 and CO_2

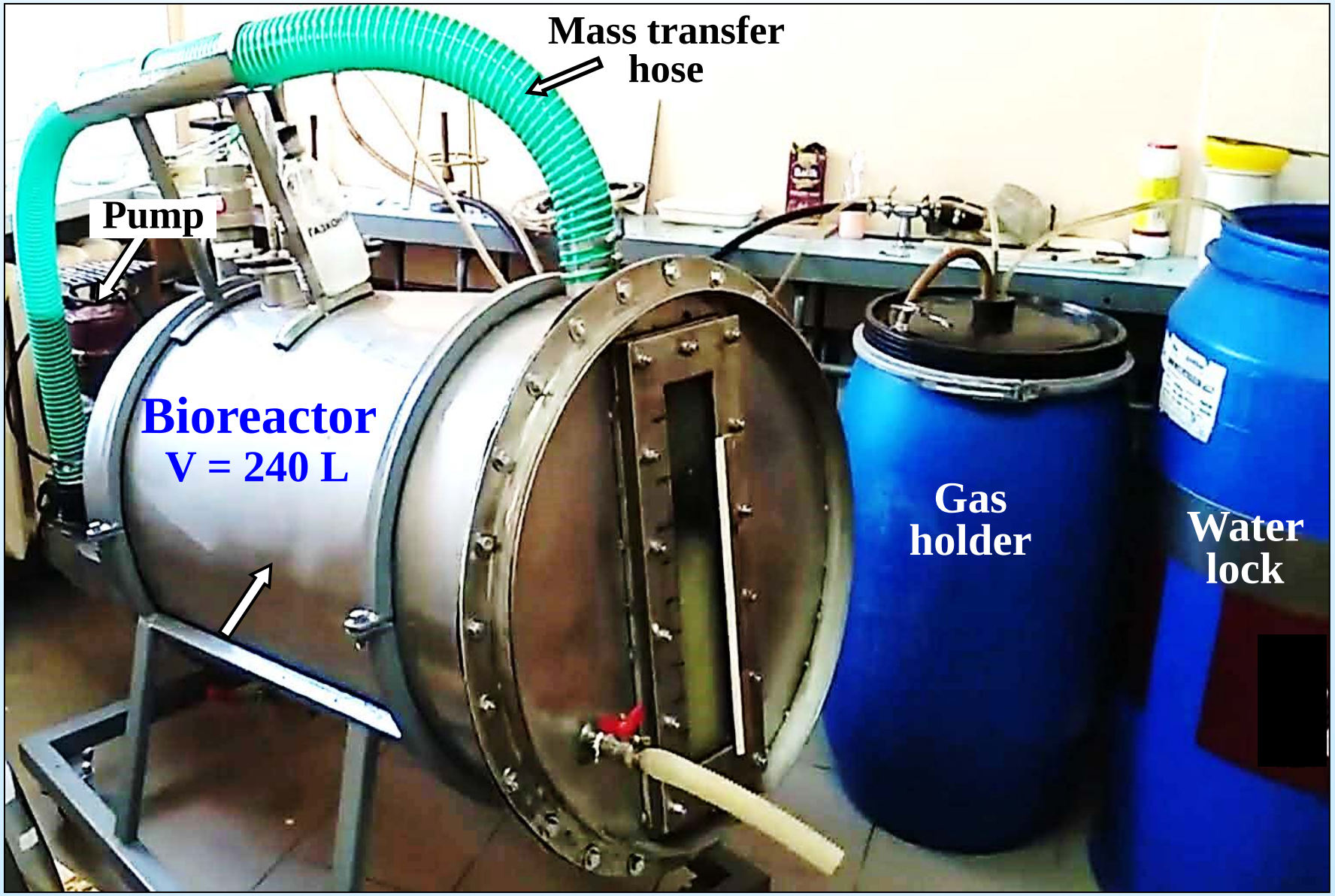
3. Air Tank



Process -
Aerobic oxidation of organic acids and alcohols

End Products -
CO_2 and H_2O (pure water)

1. Anaerobic Bioreactor for Hydrogen Fermentation of Multicomponent Solid Food Waste



Multicomponent Decaying Food Waste

Granular Microbial Preparation (GMP)

Inoculum for effective H_2 waste fermentation

Consists of:

- alive microorganisms

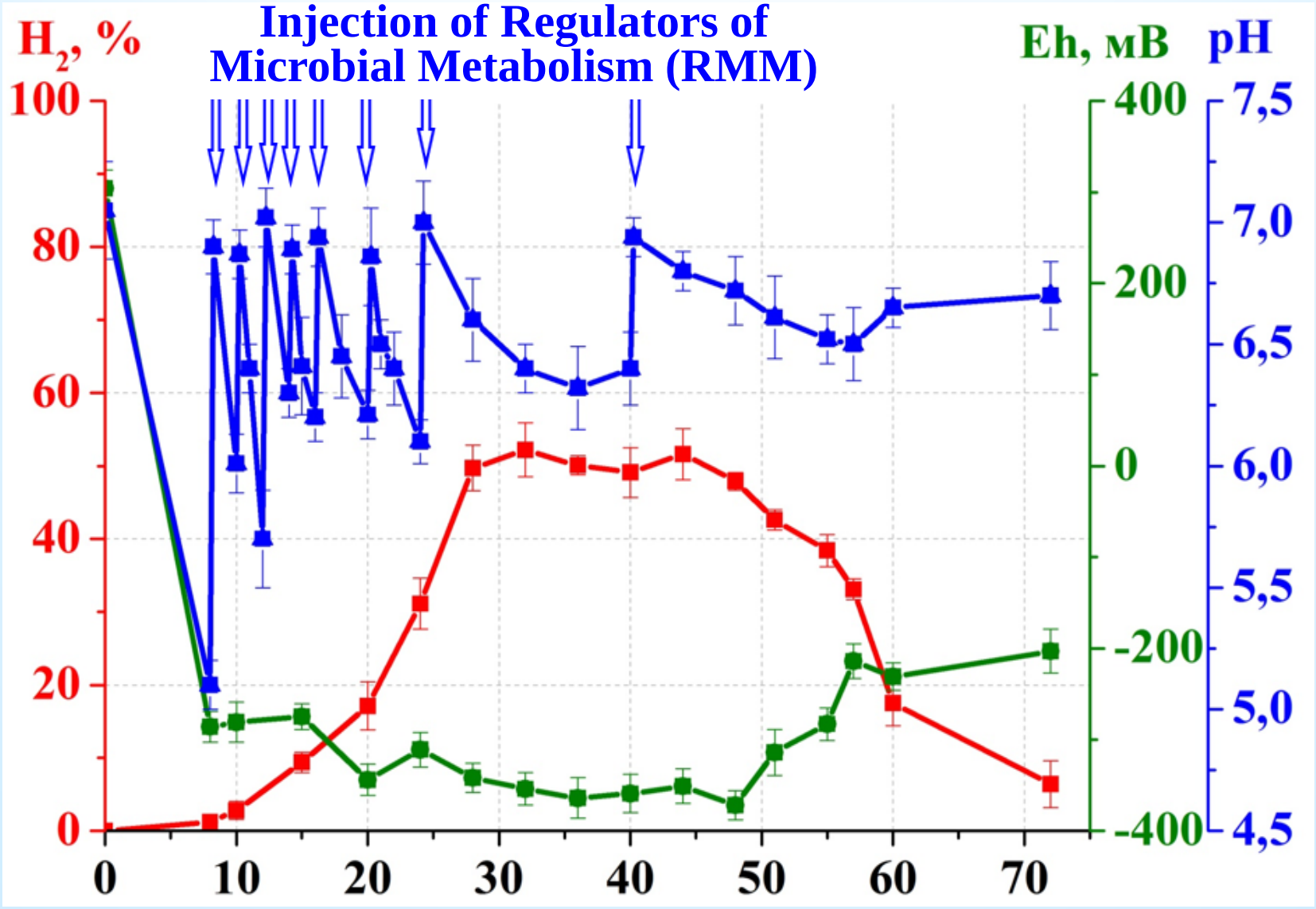
- initial carbon and energy sources

- regulators of microbial metabolism

Optimized technological parameters of hydrogen fermentation:

- **pH = 6.0-7.0**
- **Eh = -350…-380 mV;**
- **The ratio of solid phase (waste) to liquid (water) - 1:4 (36 kg of waste: 144 L of water)**
- **Mixing mode of the fermentation medium - 1 min mixing : 60 min pause.**

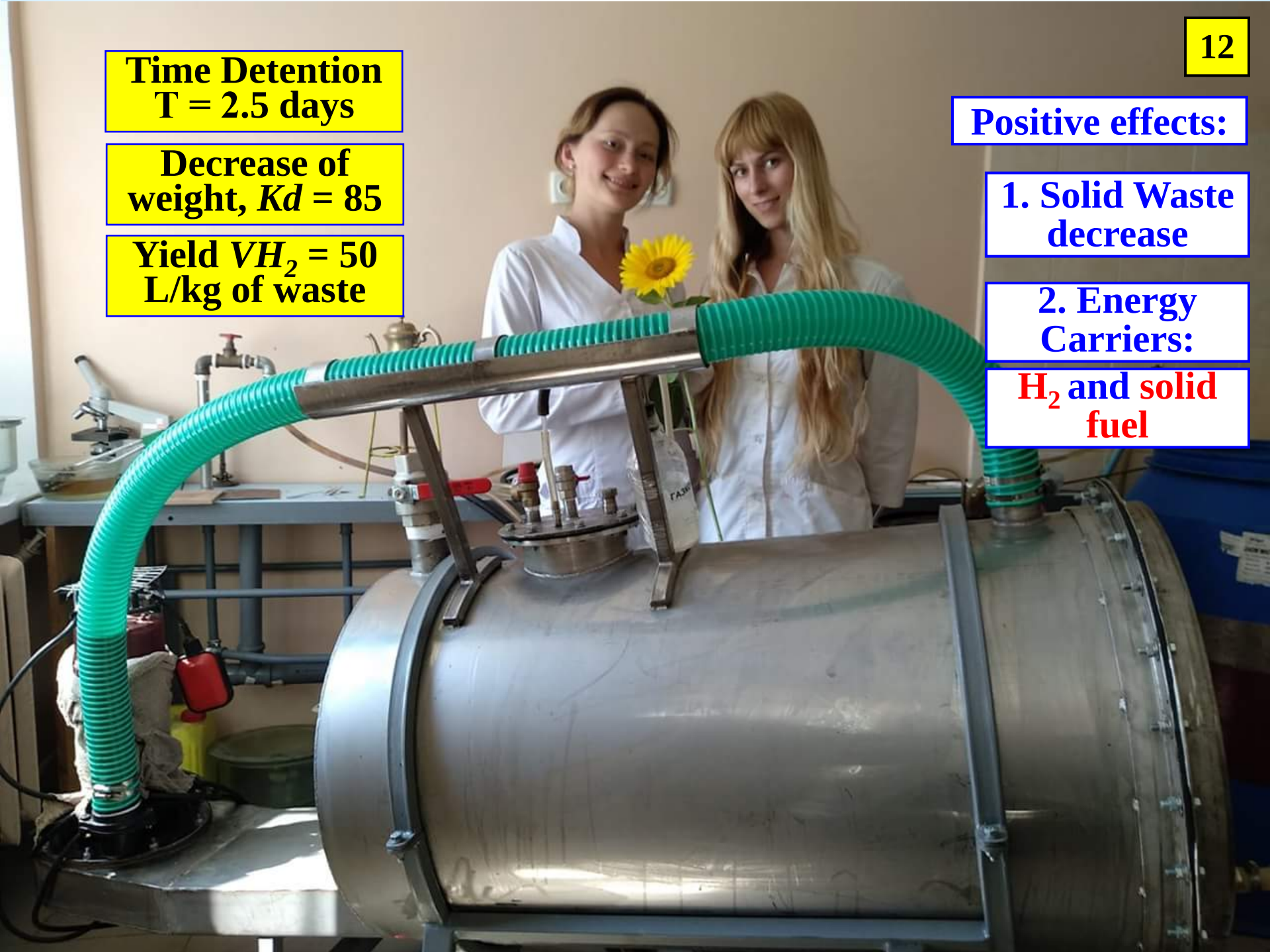
Metabolism Regulation in the Process of Hydrogen Fermentation



Time Detention
T = 2.5 days

Decrease of weight, *Kd* = 85

Yield VH_2 = 50 L/kg of waste



Positive effects:

1. Solid Waste decrease

2. Energy Carriers:

H_2 and solid fuel

Direct combustion of H_2 at the outlet of Gasholder

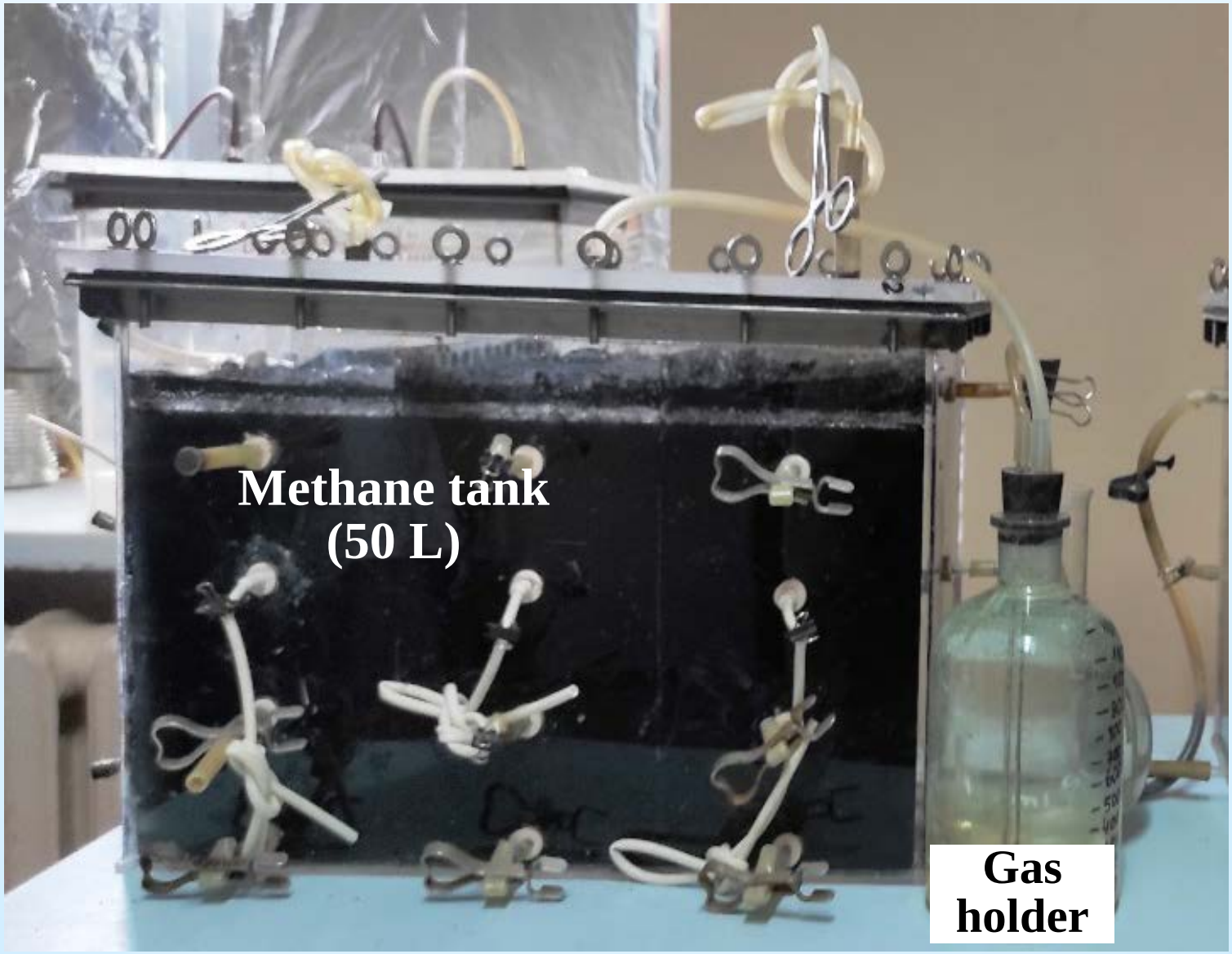
40…50% H_2

50…60% CO_2

Combustion of Solid Fuel

(undigested dry lignocellulosic residues)

2. Methane tank for sequential fermentation of acids and alcohols in leachate to CH_4, CO_2 and H_2O



2. Methane tank: sequential fermentation of acids and alcohols in leachate

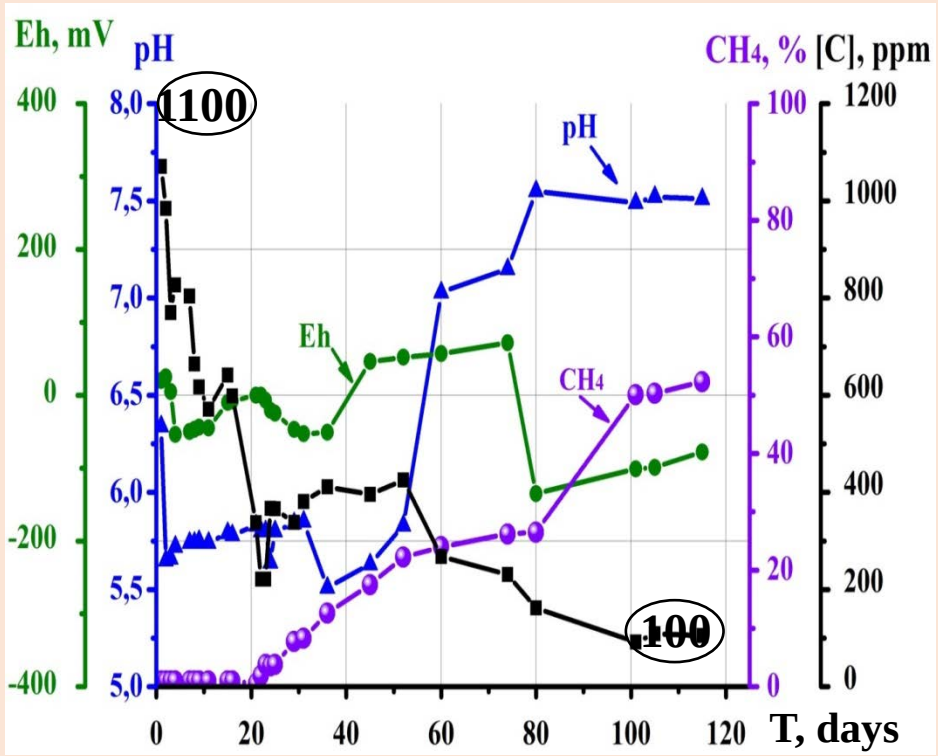
Effective synthesis of CH_4 and complete purification of leachate

Sequence of Fermentation

1 Step:

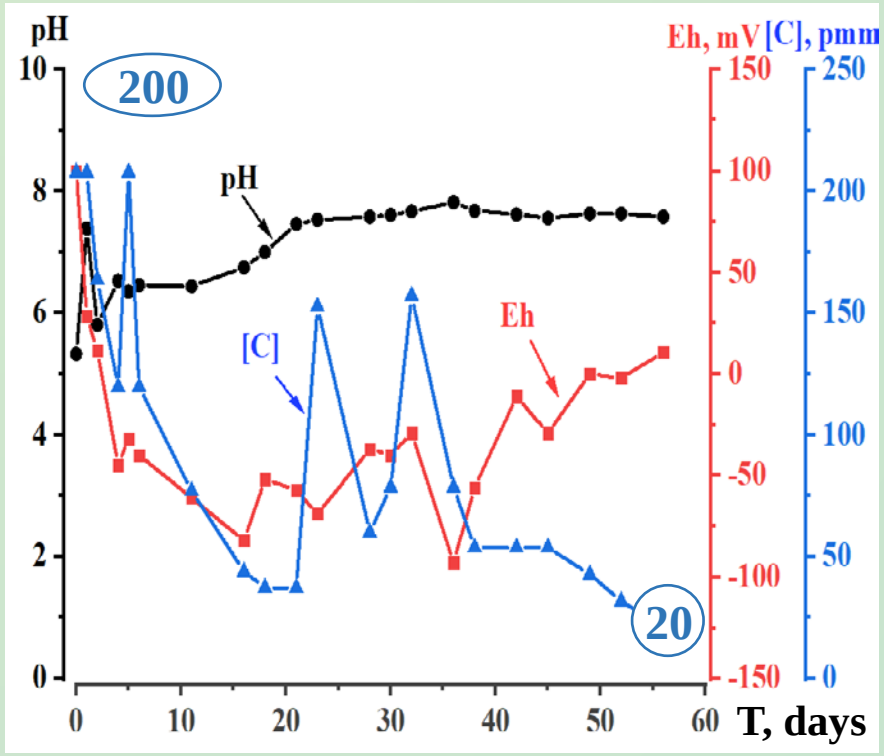
- 1 order decrease in the concentration of soluble organic compounds (from 1100 to 100 ppm C)

- Synthesis of 1 L of CH_4 from 1 L of leachate

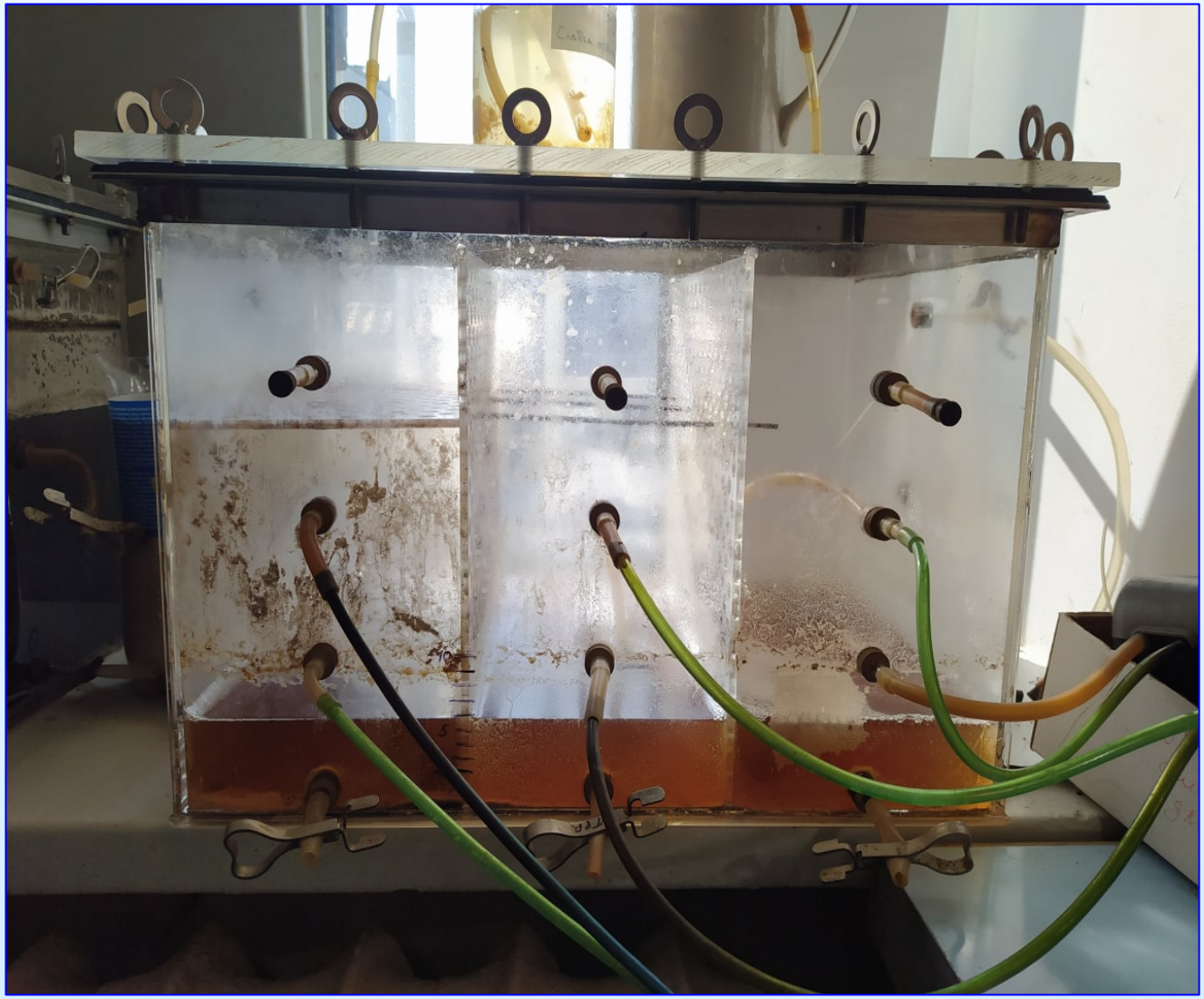


2 Step:

- 1 order decrease in the concentration of soluble organic compounds(from 200 to 20 ppm of C)

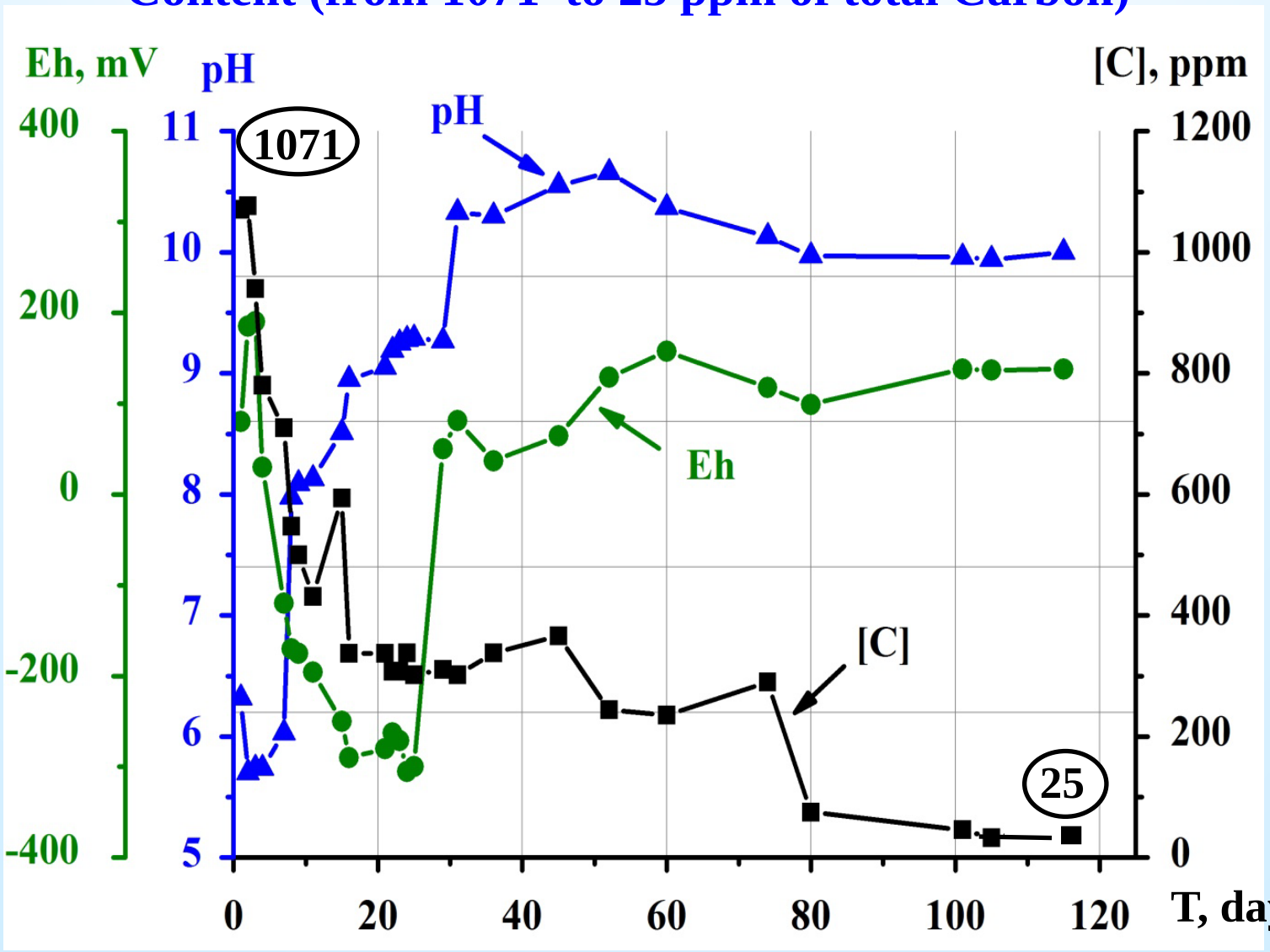


3. Air tank for aerobic oxidation of acids and alcohols in leachate



3. Air tank: aerobic oxidation of acids and alcohols in leachate

Complete purification of leachate: 43-fold decrease in Carbon Content (from 1071 to 25 ppm of total Carbon)



Conclusions

We have developed universal biotechnologies that provide:

1. Fast and efficient fermentation of decaying solid organic waste

2. Purification of toxic leachate from organic acids and alcohols

3. Obtaining of valuable products from the degradation of solid and liquid waste

3.1. Energy carriers:

– H_2 and solid fuel (lignocellulose) via the fermentation of solid waste

– CH_4 via the fermentation of liquid waste

3.2. Purified water:

– via anaerobic and aerobic liquid waste treatment

4. High efficiency of the biotechnology is achieved due to thermodynamic prognosis of microbial degradation of waste, as well as the application of GMP and regulators of microbial metabolism

5. The universal biotechnologies developed by us are strategically promising for environment protection, as well as for the obtaining of energy carriers and purified water from solid and liquid waste.

Thank you for Attention!