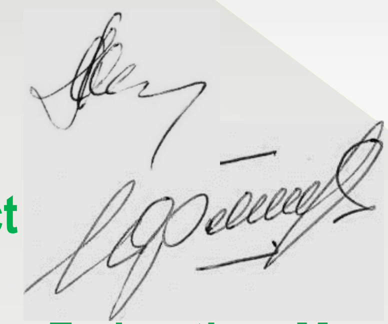
Association "International Development Institute»
Department of Production Projects

The PROJECT
create a unique plant for the production of energy, construction products, "pure" metals using the complex of Russian technologies 100% processing of solid communal waste (TKO) in amount of 200 000 tons per year

President of AMIR Viktor Aleshchanov



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Innovative factory of the future
Unsurpassed technological solutions

RECYCLING AS AN ALTERNATIVE TO INCINERATION

Conceptual provisions:

The basis of the project laid down the principles governing the objectives, functions and the place of the factory social system environment:	
1.	The plant is a component of urban utility infrastructure providing full processing and, in some cases, the elimination occurring and accumulated waste.
2.	The plant is a factor that ensures environmental safety for the surrounding environment of the selected residential area of the settlement.
3.	The factory is a production and technological complex non-waste (zero waste).
4.	The plant is a source of production of commodity products:
	❖ **energy (hot water, steam, electricity);**
	❖ **energy (fuel gas, the basic fractions of motor fuel);**
	❖ **building materials and products (tiles, bricks, blocks and panels...);**
	❖ **additional raw materials (minerals, metals, etc.).**

THE ESSENCE OF THE PROJECT

1. The plan of production and sales of products based on MSW:

№	Product	Price, RUB/ton	The volume of production and sales	
			ton	Thousand. RUB
1.	Energy carrier	20 000	102 600	2 052 000
2.	Building products	600	40 000	24 000
3.	Metal products	40 000	4 500	180 000
	Итого:			**2 256 000**

2. The plan to create a factory for the queue:

№	Stage a plant	Tasks stage	Productivity, tons/year	Expenses, thousand RUB.	Period, month
1.	I stage	Starting	100 000	3 600 000	18
2.	II stage	Full project	200 000	2 000 000	12
		In total		**5 600 000**	**48**

3. Efficiency of investments, thousand RUB.:

1.	The cost of creating complex:	
1.1.	**The amount of investment**	**5 600 000**
1.2.	Annual interest rate, 12% from 1.1	336 000
2.	**The amount from the sale of marketable products per year**	**2 256 000**
3.	Operating costs per year,10% of the claim 1.1	280 000
4.	Taxable profit p. 2 – p. 3	1 976 000
5.	Income taxes and other deductions, 20% of p. 4	395 200
6.	**Profit at the disposal of the company, p. 4 – p. 5**	**1 581 800**
7.	Payback, p.1.1 : p. 6	**3.6 year**

A. JUSTIFICATION of the PROJECT

1. Commercial basis:

Based on the creation of the plant waste disposal is a commercial the idea consists in the following:

1. The production of more products on commodity markets and energy markets with the required quality and at competitive prices.
2. Profit for the participants and the initiators of the project.

2. Background:

1. The presence of a constantly renewable source of raw material - municipal waste.
2. Multicomponent composition of the raw materials, allowing to obtain and have the chemical ingredients and components required to support production processes.
3. Low cost raw materials sourced from waste (30% to 50% lower than those obtained from natural resources).
4. Availability of technological equipment, allowing to produce products of specified quality which has been proven in other industries, embodying the most advanced achievements of Russian science and technology.

3. Main provisions:

1.	The plant, which produces the ultimate, commercially viable products based on waste, accepts waste from virtually any source they arise;
2.	The plant that provides the entire production cycle of production, starting from raw material preparation to the finished product, completely independent from external energy resources and energy carriers;
3.	Each item contained in the waste included in the production of commercial products. Exception: radioactive substances and chemical weapons;
4.	All the processes in the plant was intense in nature and exceed on the order of traditionally prevailing in other sectors;
5.	The economic return of the plant does not exceed 5 years from the date of commissioning

4. Economic situation:

In order to obtain the maximum possible profit, the project participants are interested in maximizing the added value of the products, in this regard:

1.	Received at the plant organic raw materials and semi-finished product constituting the bulk mass of the waste processed up to the maximum possible end product and/or products;
2.	Additionally obtained in the process of recycling chemical elements and their compounds, the most used in the manufacture of basic products.

5. Operational decisions:

1. The plant accepts for recycling and recycles waste in different phase States: solid, liquid, gaseous and intermediate.
2. The production process ensures the recycling of different morphological composition:
   - ❖ multicomponent, such as municipal solid waste;
   - ❖ homogeneous, such as peat, coal, gas, shale, tires, etc.
3. The production capacity of the plant allows operational transition from production of one product to another, based on maximum and minimum intake of waste.
4. Production resource provides a permanent year-round, non-stop reception and processing of the waste in the given volume.

6. Production decisions:

1. Factory for its production function is a factory fuel cycle, producing the most commercially popular products: energy – fuel gases and the motor fuel fractions based on the most massive part of household waste is organic.
2. Due to the multicomponent nature of waste, the plant is a diversified production structure, comprising:
   - ❖ the manufacture of products on the basis of the organic part of waste;
   - ❖ manufacture products based on mineral waste;
   - ❖ manufacture of products based on metal-containing waste component.

7. Production facilities of the plant:

1.	The facility is comprised of the following basic production:
	❖ manufacture of reception, control and preparation of waste for recycling;
	❖ the production of waste gasification and synthesis-gas;
	❖ production of fuel gases and fractions of motor fuels;
	❖ manufacture of construction products;
	❖ production metal production and products;
	❖ the production of heat and electrical energy.

8. Regulatory processes:

1.	Control of incoming waste composition and mass, toxicity and radioactivity.
2.	Crushing and softening of the received waste to a predetermined size.
3.	Waste separation on the morphological components (parts):
	❖ organic;
	❖ mineral;
	❖ metal-containing component;
4.	Deactivation and detoxification of waste.
5.	The production of synthesis gas from the organic waste component.
6.	The synthesis of fuel gases and fractions of motor fuels from syngas (CO + 2H).
7.	Activation of mineral elements and hyperpressing building products.
8.	Recovery of ferrous and nonferrous metals from metal-containing waste component.
9.	Purification of extracted from waste waters up to requirements of sanitary norms and rules (standards).
10.	Electrical power generation using energy sources: steam, synthesis gas.

9. Key technological processes:

1. Crushed solid material to be treated is fed into the bath (salt reactor) via a pneumatic system;
2. Liquid waste is pumped by the pump, with advanced moisture reduction;
3. The reaction of neutralization and oxidation of the waste occurs at 700-950 ° C in a bath filled with molten salt (usually sodium carbonate or a eutectic of carbonates of alkali metals), the most preferred salt is sodium carbonate;
4. Efficient heat transfer to organic compounds coolant - eutectic mixture of salts and alkalis;
5. Performs the action of dispersants and specially selected catalysts;
6. Simultaneous heating, drying and thermal impact destruction of waste;
7. Dynamic activation of physical and chemical processes acting on the rupture of molecular bonds of organic compounds due to gas-dynamic characteristics of the reactor design;
8. The presence of the pressurization system removal of inorganic residues from the reactor makes it possible to remove it without draining the entire volume of the melt;
9. Present in the processed waste radionuclides, metals, and other inorganic components remain in the molten salt and can be easily separated for subsequent removal;
10. Fusible the components of MSW as a result of chemical reactions are transformed into the body of the melt, devoid of toxins.

10. The distinctive features of the recycling:

Distinctive from foreign factories - analogues of the production and technological features of the proposed plant:

1. Waste feedstock is fed directly to the recycling, namely, waste separators fraction and composition, and not stored at the plant, as it is everywhere.
2. Rotary separators for the first time in world practice, are equipped with bactericidal lamps, as well as aspiration systems and fire extinguishing equipment that allows you to quickly and effectively disinfect the incoming waste for recycling and to prevent ignition of the waste.
3. Drying of waste is performed by electrokinetic separation of water from waste together with dissolved salts of heavy metals and does not evaporate as it is accepted everywhere, leaving heavy elements in the waste mass, thereby reducing the toxicity of the raw semifinished product is not less than 50%.
4. Disposal of waste and the production of synthesis gas is carried out by oxidation reaction of an organic waste in molten carbonates of alkali elements (technology molten salt oxidation process) without the formation of volatile harmful compounds such as dioxins, and is not subjected to high temperature treatment, up to plasma, as it is everywhere.
5. Restore the specified metals from the waste is performed in one stage, followed by refining in salt baths, with a directional solidification; waste treatment plants-analogues of this process is virtually nonexistent.

10. The distinctive features of recycling (continued):

6. The mineral part of the waste, purified from heavy metals and toxic compounds that are crushed, mechanically activated, pressed into a predetermined shape of the construction product, in factories-analogues of this process is virtually nonexistent.

7. The motor fuels are produced from environmentally friendly synthesis gas by standard methods and techniques used in gas-chemical plants-analogues of this process is virtually nonexistent.

8. In the process of generating electric power of the standard power equipment, exhaust gases and heat are fully utilized at the plant-analogues this process is virtually nonexistent.

9. Purification of extracted from waste water produced without the use of chemicals, making the facility environmentally friendly production.

10 The planned plant recovers secondary raw material in primary raw material quality comparable to natural raw materials, deep uses up to 97% recycling of waste into marketable products and products, making the facility out of the total number of waste treatment plants.

11. Factors influencing the activity of the plant:

1. **Plant the WRC is a dynamic system,** regulated by production and commercial processes on the basis of two critical factors:

- received during the day the waste should be processed;
- manufactured products must be during the day is implemented, otherwise overstocking of finished products leads to the cessation of acceptance of waste, and this is unacceptable.

2. **The efficiency of the plant, based on its following features:**

- quick processing (within 24 hours) waste generated in the district during the day;
- the possibility of using the plant as a backup source of electricity and heat;
- the possibility of reducing tariffs for waste disposal and landfill maintenance waste;
- the possibility of obtaining additional marketable products for the needs of municipal services and companies associated with the plant in a joint venture.

3. **Assessment of the impact of technology on the environment:**

- very high level of destruction (>99,9999%) of toxicants such as dioxins, furans and other toxic compounds, provide the highest feasible environmental indicators on air emissions;
- most mass waste in the production of plant – water treated to water, fisheries or technical use;
- obtained in the production process emissions, solid and liquid waste are commercial sub-products and are used in recycling.

12. The chemistry underlying the process:

1. The goal of the physical system:

Restore of the primary chemical elements and substances from the recycled waste.

2. Tasks:

Decarbonizing waste: extraction of carbon and carbon compounds from the waste mass by the method of oxidation with the transfer of the gas connection form CO, CO2, CH4 etc.

3. Applied technological processes:

Gasification is a process similar to pyrolysis, high temperature thermochemical process of interaction between organic waste with the gasifying agents (air, oxygen, water vapor, carbon dioxide or mixtures thereof) in the reaction medium of molten catalyst.

4. The output of final product in the gasification processes:

The average composition of the Synthesis gas, wt. %

H_2	**41**	H_2O	**0.04**
CO	**50**	CH_4	**0.04**
N_2	**8.9**	CO_2	**0.02**

5. The stages and characteristics of the reaction process:

5.1. Gasification:

- ❖the oxidation of carbon and its separation from raw pulp in the form of volatile compoundsthe type of CO, CO2, CH4, etc.;
- ❖the decomposition of chemical compounds and recovery of metals from raw mass.

5.2. Activation of the gasification process is provided by:

A. ***The eutectic melt of the alkali metals, selected as a heat transfer fluid, having:***

- ❖ high redox ability to engage in chemical reactions;
- ❖ high ability of heat and mass transfer of particles in the environment;
- ❖ high electrical conductivity;
- ❖ high capacity to keep heat balance of the reaction medium.

B. ***The impact of cavitation on the reaction environment to encourage it at the expense of cavitational micro discharges in the nanosecond period of the raw material mass:***

- ❖ temperatures up to 10,000 degrees C;
- ❖ the pressure is over 1,000 atmospheres;
- ❖ high discharge pulse.

5.3. Products of the process:

- ❖ the synthesis gas, recoverability of carbon from the raw mass ≥95%;
- ❖ metal concentrate, recoverability of metals from the raw mass ≥ 93%;
- ❖ highly porous mineral slag suitable for construction products.

6. The processes of decarbonisation:

6.1. The molten salts of alkali and alkaline earth metals is a powerful redox environment, where under the action of gas-dynamic processes and high temperature recovery of basic chemical elements from the oxides, the carbon is oxidized, entering into reaction with H2O and CO2 with the formation of gas components H2, CO, CO2, CH4 etc.

6.2. Organic and inorganic structures are destroyed with the simultaneous formation of new chemical compounds.

6.3. The melt is a zone of high temperature processing with a temperature range of 850 to 1 200 0C. It happens:

- the final breakdown of the raw materials;
- thermal impact destruction processes
- the destruction of unsaturated hydrocarbons and of aromatic cycles with almost complete absence of reactions of formation of the latter;
- purification of the formed gases from liquid and solid components of the processing;
- the beginning of the catalytic process of carbon gasification on the main reactions:

$$CO_2 + C \leftrightarrow 2CO \quad \Delta H = 162\ \text{kJ/mol}$$

$$H_2O + C \leftrightarrow CO + H_2 \quad \Delta H = 119\ \text{kJ/mol}$$

$$2\,H_2O + C \leftrightarrow CO_2 + 2H_2 \quad \Delta H = 77{,}46\ \text{kJ/mol}$$

$$2\,H_2O + 2C \rightarrow CH_4 + CO_2 \quad \Delta H = -8{,}8\ \text{kJ/mol}$$ and to a lesser extent

$$C + 2H_2 \leftrightarrow CH_4 \quad \Delta H = -86{,}28\ \text{kJ/mol}$$

12. The chemistry of the underlying process (continued)

Along with this, in the working area due to the dynamics of the melt stronger reaction with reagents (Ca2CO3, CaO, K2O, Na2CO3, Na2O, NaOH, KOH, etc.) supplied to the reactor together with the raw materials or formed in it.

One of the functions of these chemicals - accepte CO2, for example:

$$CaO + CO_2 = CaCO_3 \ \Delta H = -176{,}5 \text{ kJ/mol}$$

$$Ca(OH)_2 + CO_2 = CaCO_3 + H_2O \ \Delta H = -283{,}1 \text{ kJ/mol}$$

In the environment of molten metals are recovered, at the same time begin to exert influence on the formation of mainly saturated hydrocarbons, mainly methane CH4, and to a lesser extent, ethane C2H6 and propane C3H8 from a mixture of hydrogen and carbon monoxide:

$$2n\ CO + (n+1)\ H2 \rightarrow Cn\ H2n+2 + n\ CO2$$

When a sufficient amount in the raw mass of the H2O (or water vapour is introduced) and entered the respective catalysts at a given temperature also is in the process of steam conversion of hydrocarbons with the formation of the gas mixture, the maximum consisting of H2 and CO, the most suitable for further synthesis of hydrocarbon fuel.

7. Subsequent transformations of the obtained product. The synthesis gas:

The produced synthesis – gas range is compressed, shifted and then used:

- as the fuel gas for the production of its own electrical energy;
- as a basic raw material for the production of basic fractions of motor fuels;
- as an additional reagent for oxidation-reduction reactions;
- as a raw material for producing carbon and other compounds.

B. The ESTIMATED PORTION of the PROJECT
1. The calculation of the resource potential in waste

1. The planned morphological the composition of MSW:		
№	Average morphological composition	% wt
1.	Paper, cardboard	28.0
2.	Food waste	38.0
3.	Screenings of less than 16 mm	7.0
4.	Textiles	4.0
5.	Polymeric materials	5.0
6.	Glass	7.0
7.	Other	1.5
8.	Tree, leaves	1.8
9.	Bones	0.5
10.	Leather, rubber	3.0
11.	Stones, ceramics	1.5
12.	Metal	2.2
13.	Садовые отходы	0.5
	Total:	**100%**

2. Planned nutritious (organic) materials in MSW:		
№	Average morphological composition	% wt
	Organic materials	**80.3**
1.	Food waste	38.0
2.	Paper, cardboard	28.0
3.	Polymeric materials	5.0
4.	Textiles	4.0
5.	Leather, rubber	3.0
6.	Tree, leaves	1.8
7.	Садовые отходы	0.5
	Inorganic material	**19.7**
8.	Screenings of less than 16 mm	7.0
9.	Glass	7.0
10.	Metal	2.2
11.	Stones, ceramics	1.5
12.	Bones	0.5
13.	Other	1.5

1. Calculation of resource potential in the waste (continued)

3. Planned physical and chemical composition of MSW:

№	Parameter	measure unit	value
1.	Ash on working mass	%	15
2.	Ash content on dry basis	%	20
3.	Organic matter on dry weight	%	65
4.	Moisture content	%	25
5.	Density	kg/m3	190
6.	The lowest heat of combustion to the working mass	kJ/kg	6 000

4. The planned release of organic substances (hydrocarbons):

№	Parameter	%	The yield of organics from MSW mass, tons:		
			1	**1 000**	**200 000**
1.	Out of water on the working masses	25	0.25	250	50 000
2.	The calculation of the dry weight of MSW (Mass – p. 1)		0.75	750	150 000
3.	The calculation of the total organic matter on dry weight:				
3.1.	The yield of ash (% of item 2)	20	0.15	150	30 000
3.2.	The yield of total organic matter (p. 2 – p. 3.1)		0.60	600	120 000
4.	The calculation of the net organic matter (hydrocarbon)				
4.1.	The organic matter content in related substances (% of p. 3.2)	10	0.06	60	1 200
4.2.	The output of the hydrocarbon (section 3.2 – p.4.1)		0.54	540	108 000
5.	The adopted error in the direction of decreasing	5	0.027	27	5 400
6.	The planned release of hydrocarbons (p.4.2 –p. 5)		0.513	513	102 600

1. Calculation of resource potential in the waste (continued)

5. The planned content of certain substances and elements in the waste:

№	Substance	Formula	%	The output of substances from the MSW mass, tons:			
				1	100	1 000	200 000
1.	Total nitrogen	N	1.00	0.01	1.00	10.0	2 000
2.	Phosphorus	P	0.25	0.0025	0.25	2.5	500
3.	Potassium	K	0.40	0.004	0.40	4.0	800
4.	Calcium	Ca	1.50	0.015	1.50	15.0	3 000
5.	Metal	Me	2.20	0.022	2.20	22.0	4 400

6.The targets of output of commodity production, of the 200 000 t/year:

№	Target figure	measure unit	value
1.	The amount received for processing MSW	m3	840 000
2.	The volume of processed plant MSW	tons	200 000
3.	The amount of recoverable water	tons	50 000
4.	The quantity of ash-slag masses	tons	30 000
5.	The amount of extractable organic matter, including:	tons	120 000
5.1.	**The recoverable amount of the net hydrocarbon mass**	**tons**	**102 600**
5.2.	The amount of recoverable Metal	tons	4 400
5.3.	The quantity of Nitrogen	tons	2 000
5.4.	The amount of extractable Phosphorus	tons	500
5.5.	The amount of Potassium extracted	tons	800
5.6.	The amount of extractable Calcium	tons	3 000
5.7.	Other substances and elements	tons	6 000

2. The stages and duration of the Project

№	The name of the stages and works	Cycle, working days
	I stage - initial: 100 000 tons per year	456
1.	Land and obtaining rights of possession of the land under building Facility	31
2.	Engineering surveys on the allocated ground area	30
3.	**Development of the preliminary design documents:**	**31**
3.1.	Development of terms of reference (TOR)	31
3.2.	Feasibility studies, BP (business plan)	31
3.3.	Developing the EIA (impact assessment on environment)	31
4.	**Development of the Technical project:**	**118**
4.1.	Develop preliminary Design for major process equipment	59
4.2.	Development of technical project, approved part	59
4.3.	Detail design	59
5.	**Construction and installation works:**	**153**
5.1.	Construction of engineering networks and communications	92
5.2.	Construction of buildings	104
5.3.	The construction of technical installations	92

2. The stages and duration of creation of the Project (continued)

№	The name of the stages and works	Cycle, working days
6.	**Design and fabrication of process equipment:**	**245**
6.1.	Manufacturing and supply of process equipment	184
6.2.	Manufacture and supply of components of machines, mechanisms	214
6.3.	Installation supervision and commissioning	184
7.	**Trial operation of the Facility**	**48**
8.	**Object delivery in operation**	**13**
9.	**II stage: output capacity of 200 000 tons per year**	**351**
9.1.	Manufacturing and supply of process equipment	326
9.2.	Manufacture and supply of components of machines, mechanisms	296
9.3.	Installation supervision and commissioning	208
10.	**Phase III: development of production of 500 000 tons per year**	**350**
10.1.	Manufacturing and supply of process equipment	325
10.2.	Manufacture and supply of components of machines, mechanisms	295
10.3.	Installation supervision and commissioning	269
	TOTAL in the whole Project:	**540**

Note: 100 000, 200 000, 500 000 tons per year – the amount of recycled MSW

3. The relevance of the project

1. Factors of commercial success:

1.	The availability of cheap raw material: MSW	
2.	The ability to generate its own energy	at least 10 MW
3.	The presence of a unique Russian technologygasification, recovery and purification of substances, elements	at least 12
4.	The availability of state support of the project	at all levels of government

2. Factors relevance of the project:

1.	The growing demand for energy, metals and minerals of high quality
2.	The ever increasing demands and fines services of state environmental supervision at the place of waste deposits
3.	The ever-increasing need to create jobs
4.	The ever-increasing need of obtaining the maximum possible profit

3. Expected results:

№	Practical results	Indicators
1.	Reducing the mass of MSW generated at the site	≥ 200 000 tons per year
2.	The reduction of the area under the disposal of waste	≥ 2.0 hectares in the year
3.	The production of energy, metals and their alloys, as well as construction products	≥ 150 000 tons per year
4.	The creation of additional jobs	≥ 400 jobs

4. Competitive advantages of the Project

1. Primary:

1.	***Unique:*** ***- gasification** of the raw mass of carbon with the degree of its extraction up to 98%;* ***- single-stage** recovery of minerals and metals from rocks and wastes through the use of gas reactions and processes.*
2.	***Energy:*** independence from foreign energy sources through the production of own energy.
3.	***Price***: the release of commercial products to the markets at competitive prices due to the low cost of manufactured commercial products and high performance manufacturing processes in compliance with the specified quality.

2. Additional:

1.	***Complexity:** the use of wastes as valuable raw materials. That is, the beneficial use of both organic and mineral with a metallic part of the raw materials.*
2.	***Versatility***: the possibility of stable operation of plants for waste of different types and quality.
3.	***Zero waste***: production of all types of obtained raw materials and semi-finished product, as well as the related sub-products.
4.	***Agility***: is the ability to control process performance in a wide range and possibility of production of different composition.
5.	***Scalability***: ability to increase production capacity without shutting down existing production facilities due to the modular lines and equipment.
6.	***Environmentally friendly:*** no emissions into the atmosphere and liquid effluents into the ground.

The initiator of the project

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