# Energy Safety in Russia as a basis for Regional and Municipal Development

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**Reliability of the centralized heat supply is bound with the problem of fuel supply in most Russian regions. Discrete supplies of traditional fuel result in the failures of heat supply systems. In the inclement climate of Siberia and Far East breaks in heat supplies are dangerous for people's health and safety. Therefore the topical is the development of renewable energy sources: solar and geothermal stations, tidal power plants and wind farms as well as power generating units using biofuel.**

**Annual volume of organic wastes in various Russian industries is more than 500 mln. tones of solid. Processing of such amount of wastes with existing bioconversion and thermochemical conversion technologies potentially results in up to 150 mln. tones of standard coal a year.**

**The prospective is biogas production on the basis of solid waste. Solid waste is "produced" by city population in large amounts: 200 – 400 kg per person a year. Incineration of such waste in the power plants of new type – complex rayon power plants (CRPP) [1]) may cover over 15 % of the annual norm of heat consumption at the conditions of Siberia. This figure can be significantly increased for the account of the use of solid combustible municipal and industrial waste.**

**Solid waste is an only fuel resource continually renewed and formed in any dwelling area, in any village, rayon or city.**

**Thus, solid waste can be considered one of the most important alternative fuel resources for the city. At that, the ecological problem of solid waste liquidation and the energy problem of heat utilization at waste incineration are solved simultaneously [2].**

**Hence, building of CRPP which basic fuel is solid waste and combustible industrial waste (CIW) will increase stability and reliability of centralized rayon heat and water supply, eliminate material, financial and other expenses caused by the necessity of long-term stocking of solid waste and CIW in the dumps and waste remainder burial in the grounds as well as annihilate most of harmful wastes and absolutely minimize pollution of the environment.**

## I. COMPLEX RAYON POWER PLANTS (CRPP)

Main function of CRPP (fig. 1) shall be production of thermal energy for centralized heat supply and hot water for sanitary domestic needs. The major principle of new power plant technology shall use two basic types of fuel. As a first basic fuel PP shall use solid waste, delivered on a daily basis, and combustible industrial waste. Natural resources shall be considered and used as the second basic fuel.

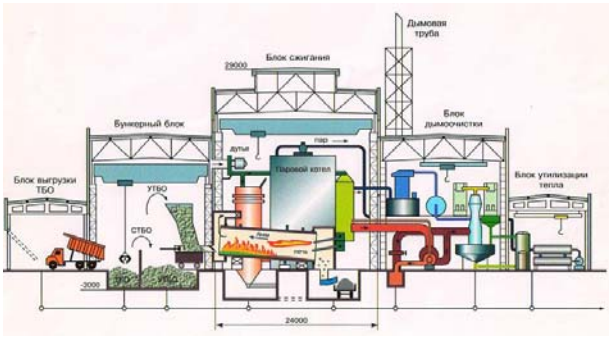


Fig. 1. Main technological equipment of the CRPP.

In the developed full technological scheme there is the solution to all listed technological problems providing for application of ideal waste incineration equipment: specialized furnace with inclined cylindrical body rotating around the cylinder axis, as a sort of large furnace of steam boiler-utilizer; heat pumps using heat of exhaust gases to increase total efficiency of CRPP. Besides, application of high-performance gas-cleaning devices is provided especially in the system of gas-removal from the waste incineration system.

The development of CRPP is based on new principles, technological schemes and equipment designs that can be realized in Russian enterprises. Specific composition and types of CRPP equipment depend on PP location, amount of waste, type of natural fuel

and problems of energy supply in the city and rayon.

The proposed solution to one of the main energy problems obviously serves to solve ecological problems that are of no lesser importance.

The concept of CRPP development is the most important part among the programs for the development and reconstruction of the all-the-year-round heat supply in the centers of the regions and other large cities as well as in the power strategy of Siberia.

As a whole the proposed CRPP can be attributed to the unconventional patterns of municipal power engineering where the renewable fuel resource is used. The principle newness of the concept and the project is the combined solution of the heat and power engineering and ecological problems of the city.

CRPP is designed for two types of basic fuel the most important of which is continually used. As the main basic fuel CRPP shall use solid waste and combustible industrial waste. The second type of basic fuel shall be some natural fuel.

The technological scheme of CRPP (Fig.2) includes the system of three-day stocking of solid waste and CIW in the bunkers with their further combustion in the furnaces and provides release of specific harmful waste from the sanitation cars directly to the loading units of combustion chambers of special furnaces. In the technological scheme of CRPP there are steam boiler-utilizers, heat pumps and other devices using heat of hot combustion gases released from the furnaces. As working chambers furnaces apply the devices that serve to any waste processing with needed efficiency.

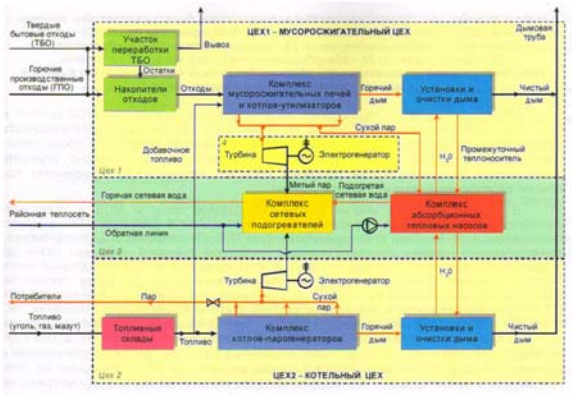


Fig. 2. Technological scheme of CRPP.

Use of solid and industrial waste as a main and basic fuel of CRPP is based on the following reasons.

1.1. Solid waste and similar waste of operating industrial enterprises contain combustible substance. Calorific value of "fresh" nonseparated solid waste is lower than the calorific value of peat and coals used in municipal power engineering. The graded solid waste can have calorific value up to 3000 kcal/kg.

1.2. Solid wastes are "produced" by municipal population in large volumes: 200-400 kg a year per person. Combustion of these wastes in CRPP may cover over 15 % of yearly norm of heat consumption in the conditions of Siberian climate. This indicator can be significantly increased for the account of the use of solid municipal and industrial waste.

1.3. Solid waste is the ONLY fuel resource constantly renewable and formed in any residential territory, in any village, rayon and city.

1.4. The system of collection and transportation of solid waste is well organized in the large cities: in the regional centers and the cities with the large number of various plants.

1.5. There is a vital need in the solution to the problems of the dumps and grounds for solid waste and industrial wastes burial as well as the solution of the problems of centralized disposal of nonutilizable industrial wastes.

1.6. There are diverse technical solutions, developments and operating units for solid waste and industrial wastes combustion for the production of heat (steam and hot water) and use of solid wastes of thermal waste processing.

1.7. There are technical proposals and individual developments of high-temperature scheme of solid waste combustion that serve to fully annihilate combustible solid and analogous industrial waste without any grading or treatment. Such option ensues from the application of plasma technology of combustion in the furnaces with liquid-slag bath and liquid slag removal. The effective products of high-temperature methods of solid waste and any other waste "utilization" will be: a) heat in power intensity of steam and hot water; b) sintered (melted) slag (granulated or as stonecast products and slag stones); c) ferrous and nonferrous metals in the parts that turned out to be in the wastes. The same products will result from combustion of solid natural fuel (or its mixture with solid fuel) on the surface of liquid slag bath of the boilers with special design.

1.8. All basic equipment for CRPP has been already developed and can be produced in Russia, in particular – steam boilers working on solid fuel, boiler-utilizers, plasma and arc electric furnaces – in the enterprises of Siberian region.

1.9. The problems of heat supply and waste disposal are similarly relevant for all cities of Siberia and Russia as a whole.

CRPP shall be located preferably near the motor roads along which solid waste is taken out of the city and provided with the railway branch line for solid fuel (coal, etc.) supply and sanitary and ecological requirements.

Systems of combustion gas release from the boilers and furnaces allow CRPP positioning in close vicinity of residential areas and motor-ways along which solid waste is taken out of the city territory.

## II. MAIN OBJECTIVES

Main objectives of CRPP development:

- heat production for the system of centralized heating and hot water consumption;

- disposal of solid and industrial wastes of each city rayon resulting in the improved ecological situation in the city;

- liquidation of dumps and release of territories; production of construction materials or their components from the products of sintered slag.

The listed objectives of CRPP development are based on the following:

2.1. The centralized heating is one of the major systems of the urban population life support in the conditions of Siberia.

2.2. Hot water supply is an important sanitary and hygiene factor of life support at high population density in modern cities and microrayons.

2.3. Solid waste removal from the dwelling urban areas is the most important factor of communal sanitary and hygiene in the residential and other buildings, in micro- and macrorayons of the city.

2.4. Waste removal (in particular their high temperature destruction) is also the most important factor of hygiene, sanitary and environment, however, these are the problems of the city and suburban area as a whole.

2.5. New types of productions (stoneslag cast, etc.) shall be designed according to the principle of emission minimization).

According to the conditions of large cities zoning the proposed system of new heat supply sources can consist of several CRPPs with different capacities and design depending on the local conditions.

Individual CRPP shall depend on the heat capacity up to 100-150 Gcal/h including up to 25-30 Gcal for the account of combustion of 15-20 tones/hour of "fresh" solid waste and CIW. Annual "production" of solid waste in the large cities is hundreds of thousand tones, and the combustible industrial ones – tens of thousands tones. For the account of their use for

heat supply many extra millions of gigacalories can be produced a year. Taking into account continuous work mode of CRPP equipment for waste combustion and change of monthly volume of heat consumption, heat produced from waste will exceed 45% of the annual production.

In the dumps surrounding large Siberian cities there are tens of millions tones of solid waste and CIW. Although heat capacity of old solid waste is lower (-1000 Gcal/kg), than the one of the "fresh" SW and continually decreases the total fuel-resource equivalent for all SW dumps of individual cities may come to million tones of conventional fuel. The specified capacities of CRPP provide waste combustion in the dumps in the amount of 15-20 tones an hour as well.

CRPP is a complex production with several types of products. The main products are as follows.

- steam and hot water for residential and other rayon facilities heating (individual residential areas, microrayons and enterprises) and for other sanitary, economic and industrial activities of the rayon);

- hot water for hot water supply to the population, for general sanitary needs of the city and other purposes;

- disperse slag for road construction, industrial and house-building;

- slag blocks and monolithic goods from sintered slag for construction and other purposes;

- secondary metal in scraps and ingots.

CRPP is a complex consumer of various types of fuel:

- basic fuel No.1 – solid wastes and combustible industrial wastes of the rayon;

- basic fuel No.2 – peat, combustible gas, mazut, etc.;

Administration and production subdivisions of CRPP:

- basic shop No. 1 – heat production by combustion of solid and industrial waste;

- basic shop No. 2 – heat production by combustion of natural fuel;

- heat pump shop;

- fuel and fuel supply shop;

- sanitary and ecological shop;

- the shop for slag construction and other goods according to the standard schemes and projects of power plants and boiler houses.

In the revolving furnaces practically all combustible wastes can be combusted but these furnaces are mostly designed for solid wastes and tars that can not be processed in the furnaces with liquid injection. The revolving furnace has rather long cylindrical design of the body. From inside the frame is protected by high-temperature heat-resistant material. Such furnaces are positioned with small incline from waste inlet to slag release and other noncombustible residues. Typical length to diameter ratio is from 2:1 to 10:1, and rotation velocity is up to 5 rev/min. Temperature in the solid waste combustion area is from 950ºC and somewhat higher; time of solid waste presence in the furnace is from several minutes to one hour and more depending on the volume of individual packs of solid waste. Furnace rotation results in relocation of the solid waste and its efficient mixing with air that provides complete burning. Noncombustible wastes (i.e. bricks, slag and metal ware) are mixed along the furnace inclination. In the end of the body noncombustible details are thrown off into special containers where cooled with water (Fig. 3).

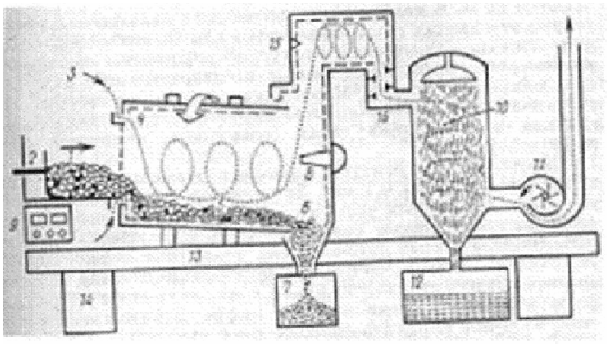

Fig. 3. Movable revolving furnace of CRPP
1 – waste supply for combustion; 2 – automatic supply system: batcher funnels, pneumatic batcher, gate; 3 – air supply; 4 – revolving

cylinder with heat insulation; 5 – revolving combustion zone; 6 – ashes; 7 – refrigerating container; 8 – ignition pilot burner; 9 – control; 10 – moist scrubber unit: stainless steel, moist scrubber, gas cooling system; 11 – blower for combustion products and tube; 12 – water for recirculation and system for flue ash collection; 13 – supporting structure; 14 – supporting columns; 15 – afterburning chamber; 16 – preliminary cooling.

## III. EXPECTED ECOLOGICAL AND ECONOMICAL RESULT

All furnaces in the shop No. 1 shall include individual or group afterburning and gas cleaning systems with equipment redundancy.

Typical boilers of the shop No. 2 are equipped with the systems of gas cleaning depending on the permissible ecological CRPP load on the city environment in their place of their positioning.

All solid wastes during “storage” become harmful and therefore incinerated without any preliminary treatment.

The circulating system of service water is provided for internal needs of the CRPP.

All sludge from the tanks of water treatment systems, wet purification of combustion gases and hydraulic ash removal are supplied for reprocessing in the high-temperatures furnaces of the shop No. 1.

Liquid remainder of solid waste combustion furnaces are not formed in CRPP.

In the feasibility study of CRPP development it shall be taken into account that the municipal solid waste is the PROPER fuel resource of the city that is continually renewable.

Failure to use this resource:

- imposes expenses for solid waste and industrial waste disposal;

- results in expenses for the long-term provision of the main safety conditions in the dumps and grounds of waste burial;

- results in the loss of benefit and profit due to land alienation for the use as dumps;

- principally worsens ecological situation in the city and the suburban territories;

- makes heat supply in the cities more complicated.

## IV. CONCLUSIONS

• Development of conditions for ecologically closed technology of the city activities.

• Absolute decrease of environmental pollution.

• Elimination of material, financial and other expenses bound with the necessity of long-term stocking of solid and industrial waste in the dumps and burial of their remainders in the grounds.

• Opportunity of complete annihilation of harmful wastes: industrial and laboratory, medical and

food, as well as special technical ones.

• Increase of stability and reliability of heat and hot water supply in the city rayons for sanitary needs of the population.

• Step-by-step investment and fast payback (~ 5 years).

List here, where applicable, funding sources for the work described and other contributors.

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## VI. BIOGRAPHIES


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