Improving of efficiency expense fuel and energy resources in the sugar production

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Annotation. The fuel and energy resources use analysis in the sugar production on the Bekovo sugar factory was conducted in this paper. The fuel use efficiency was determined from costs of fuel for recycling 1 ton of raw compare received findings with European Level of sugar producers was done. The influence different kinds of using fuel to volume carbon dioxide emissions was explored in this work. The calculation CO\(_2\) - equivalent by the method of Intergovernmental Panel on Climate Change (IPCC) and analyses of discharge of greenhouse gases at growing, at transportation and at processing of sugar beet was done.

1. Introduction
The Sugar beet is a raw for sugar industry in Russia. The raw is grown in the agricultural sector. The process of cultivation, harvest and transportation of raw is made with application machines and tractors [1]. Automobiles and tractors use the diesel fuel, which is the most energy, intensive and expensive. About three tons CO\(_2\) is emitted to the atmosphere in the burnings process 1 ton of motor fuel. The sugar beet is grown on the huge territory. The transportation of the raw from fields is made on distance about 100 km. The discharges CO\(_2\) are distributed on the large territory and absorbed by plants.

Discharges of gases with the direct greenhouse effect are considered in assessing ones of greenhouse gases from fuel combustion with the aim of production the electric energy and heat for technological use and own needs of the enterprise. They are dioxide CO\(_2\), methane CH\(_4\) and nitrous oxide (N\(_2\)O). The dioxide is the result of the release the carbon from fuel during its oxidation at fuel combustion.

Automobile transport and machine and tractor park produce a lot of greenhouse gases too. Discharges of greenhouse gases from automobile transport are connected with fuel combustion.

The Automobile transports to the model "Energy activity" from method IPCC . Carbon not oxidized remains as particulate matters soot or ash. Soot mass excluded from common indicators of discharges greenhouse gases multiplying by a factor oxidation of carbon. The discharges of methane (CH\(_4\)) and nitrous oxide (N\(_2\)O) didn’t consider in assessing the discharges greenhouse gases by a boiler house of enterprise.

2. Research methods and materials
Analysis of efficiency usage fuel - energy resources (FER) was done for example of Becovo Sugar factory. Main technical and economic indicators usage FER in the production activity of enterprise in 2017 are presented in the table 1. The desing capacity of the factory is 4000 tons of sweet beet per day, and after the reconstruction it will be about 8000 tons of sweet beet per day.
Table 1. Volume of expensing FER.

| №  | Name                          | Unit Measure       | Value |
|----|-------------------------------|--------------------|-------|
| 1  | Electric energy              | Thousand kW · hour | 2448  |
| 2  | Natural gas                  | Thousand m³        | 28046 |
| 3  | Motor fuel                   | Thousand liters    | 443   |
| 4  | Solid fuel                   | tons               | 1516  |
| 5  | Thermal energy - technological | Gcal             | 186725|
| 6  | Electric – energy - technological | Thousand kW · hour | 18778|
| 7  | Consumption of energy resources in total | tons of fuel equivalent (t.f.e.) | 34805 |
| 8  | Consumption of water, in total | thousand m³       | 1124  |
| 9  | The part of the payment from the FER in the cost of production | percent | 5.27  |

Table 2. Specific consumption FER per ton of raw materials processing.

| №  | Name                                      | Unit Measure       | Value |
|----|-------------------------------------------|--------------------|-------|
| 1  | Thermal energy                            | Gcal/thous         | 1.593 |
| 2  | Electric energy                           | kW · hour/thous    | 160.2 |
| 3  | Motor Fuel                                | liters/thous       | 3.8   |
| 4  | Solid Fuel                                | kg/thous           | 12.9  |
| 5  | Motor Fuel for growing of raw materials   | liters/thous       | 4.4   |
| 6  | Motor Fuel for transportation of raw materials | liters/thous    | 8     |
| 7  | Motor Fuel for procurement of raw materials | liters/thous     | 12.4  |
| 8  | The part of payment from the FER in the raw mat | percent | 22    |
| 9  | The part FER tons of fuel equivalent from raw mass | percent | 4.5   |

The Complex index - energy intensity is presented in the line № 9. It is 4.5% for applied equipment. For 1 ton of raw materials need 0.045 tons of fuel equivalent. This indicator equal 0.025-0.03 for sugar factories of Germany and France [2]. Our technologies by the indicator of energy efficiency lose to the European level in 2 times. There are we have reserve and we must find ways for its implementation.

Restriction distributes of CO₂ to the atmosphere for weakening of greenhouses effect and for reducing the impact of enterprises to the environment was got the support of the State Level. In dependence of volumes consumption different kinds of fuel required to calculate indicators of CO₂-equivalent at filling the energetic pasport of the enterprise. The annual volume of the discharges CO₂ and the dynamics of its change is presented in the tables.

When filling out the energy certificate of an enterprise, depending on the consumption of various types of fuel, it is required to calculate the CO₂-equivalent. The tables indicate the annual volume of CO₂ emissions and the dynamics of its change. In accordance with [5], Table 2 “Information on emissions of CO₂-equivalent when using energy resources for the reporting (base) year” and Table 3 “Information on emissions of CO₂-equivalent when using energy resources and on its changes” are introduced in Appendix 7.

3. Research results
Sugar production is the most intensity in the Food industry. The cost FER in finished product is 22 %. Technological processes of producing of sugar are included operation of mechanic and heat treatment of raw materials and demand a huge volumes of heat and electric energy. All processes of transportation raw, finished products, pumping solutions are mechanized. The electric drive of the
equipment is applied. In the technological processes of supply raw and shipment of production are used machinery and transport park.

The main part in the EFR contents the motor fuel.

All operations are grouped into complexes. Evaporation water from surup in the most energy intensive. Complex of evaporation on Becovo Sugar factory consumes 112 thous. Ccal of thermal energy per season. The diffusion department is the second in volume of consumption - 24% of heat for heating and scalding of chip. Complexes of juice - cleaning have significant shares - 13%, evaporation - 9% and finished product - 21%. Sugar syrup has high viscosity in compare with water. Operations of pumping, mixing, filtration of syrup need costs of mechanical energy. Electric drive of equipment determines costs of electricity for these complexes.

Menthol of calculation of discharges CO$^2$ - equivalent was used for different branches of national economy. The calculation of CO$^2$ -equivalent emissions was carried out using the built-in E-pass application, based on the specified methodology. Results of calculation is presented in the table 3.

| №  | Types of fuel                      | Unit Measure | Volume | tons of fuel equivalent | CO$_2$ – equivalent | Share % |
|----|-----------------------------------|--------------|--------|-------------------------|---------------------|---------|
| 1  | Electric - energy                 | thou.s. kW - | 2448   | 301                     |                     |         |
| 2  | Natural gas                       | thou.s. m$^3$| 28046  | 32365                   | 51811               | 184     |
| 3  | Motor fuel                         | thou.s.l     | 443    | 634                     | 1377               | 310     |
| 4  | Soil fuel                          | tons         | 1516   | 708                     | 2535               | 167     |
| 5  | Thermal energy (technology)       | Gcal         | 186725 |                        |                     |         |
| 6  | Electric energy (technology)      | thou.s. kW - | 18778  |                        |                     |         |
| 7  | Motor fuel to the field            | thou.s.l     | 512,9  | 733                     | 1594               | 310     |
| 8  | Motor fuel to the transport        | thou.s.l     | 932,6  | 1333                    | 2897               | 310     |
| 9  | Consuming the energetic resources, in total | tons of fuel equivalent | 35774  | 60214                  |                     |         |

Analysis of data is presented that the largest volume of discharges CO$_2$ gives natural gas. Share of emissions CO$_2$ by the mass of the burnt fuel is presented in last column. The dirtiest fuel is motor. The main share gives soil fuel into the total volume of discharges CO$_2$ to the atmosphere. Relevance of problem of discharges CO$_2$ is discussed by large volumes and small territory for enterprises.

The concentration CO$_2$ on the nearest territories are increased as result. The conditions to its distribution and recycling more worse, than for similar processes in the fields and roads.

4. Conclusion
The main reasons of high expenditure of energy resources and low ecological indicators Becovo Sugar factory and sugar industry are:
1. Outdated equipment for processing of sugar beet.
2. Small fraction of modern technologies.
3. High cost FER and raw materials in the finished product.
4. Poor quality of raw materials, sugar content of beet is not more 14%.
5. Low production capacity is not more 10 000 tons per day.
6. Long storage the sugar beet in the storehouse up to 5 mouths.
7. Cyclic model of operation. Factories don’t work long time.

All of the above is presented main directions which need. To depend the branch for increase technical - economical and ecological indicators for modern European level [6].
Solving of the accumulated problems requires a comprehensive approach, a lot of investments, effect usage FER and using, modern technologies.

Nowadays the technology of physical and chemical separation of sugar - content raw is the most effective. This technology is developed in Russia by a team of scientists under the leadership of T.M. Shimanskaya [6].

This technology allows to reduce energy consumption, for production 1 tons of sugar almost 2 times. Therefore, volume of generation of thermal and electric energy and, volume of the burn fuel is lowered. So, volume of discharges CO$_2$ to the atmosphere is lowered up 2 times.

References
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