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Effectiveness of developing heating energy out of wood by products

There are a lot of problems with energy resources in Ukraine. The solutions can be finding in using local bio-resources.

Bio-resources such as the wood byproducts and fast-growing trees have the highest priority among renewable sources of energy. The primarily reasons for this are: wood and its byproducts can generate both heat and high energy-yielding (solid, liquid, gas) fuels; wood is ecologically clean fuel which does not contain sulfur, chlorine and other harmful substances; the amount of CO_2 generated by burning wood is equal to the amount of CO_2 consumed by the tree during its life; wood fuels are easily accessible, and others.

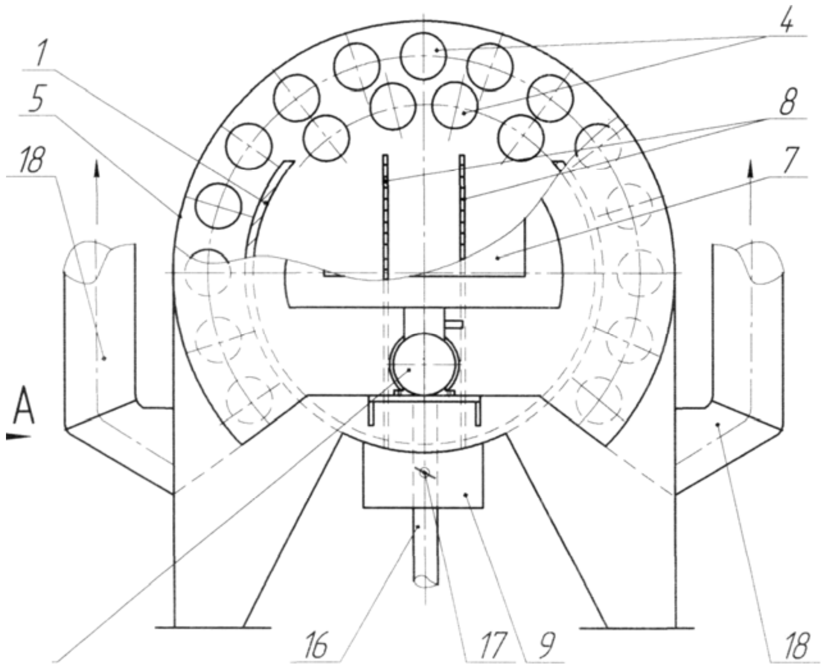
Potential of wood by products is near 0,7 mln.t.c.f. in Ukraine. Today we can see the increasing tendencies of creating and improving devices for utilization of biomass and wood by products.

The goal of this work is to substantiate the optimal design of the device for generating of heat energy out of local fuels (fast-growing trees, wood by-products, peat, etc).

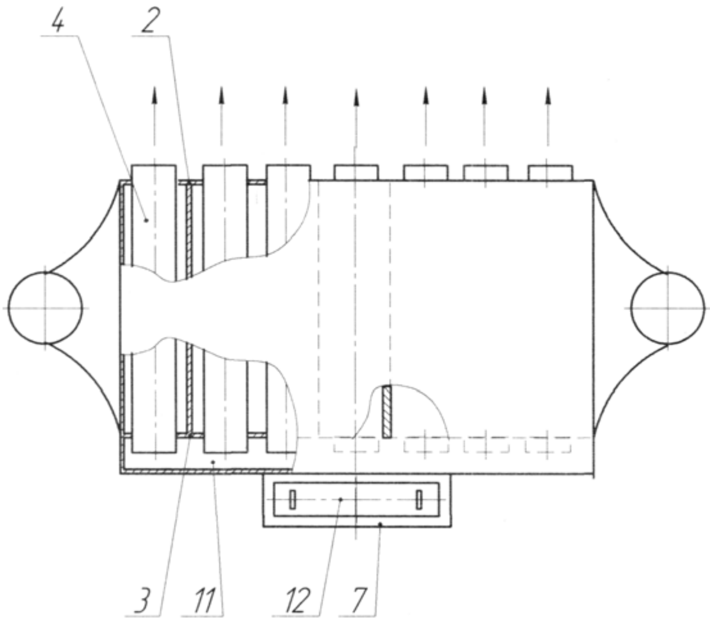
Results of this work: we developed a design of heat generator which works on the local types of fuel and can be used for heating non-living quarters such as warehouse, greenhouses, hangars, mechanical shops, etc or for drying building materials.

Description of the construction. Developed heat-generator consists of a cylindrical case (1) placed horizontally, in which the top is cut off parallel to the case axis. The case is closed on both sides and contains the heat-exchanging pipes (4) inside. In the top part of the case the pipes (4) are placed closer together because it is where the hottest gasses pass through. All the other pipes (4) are placed concentrically relative to the case axis (1) and are covered by external shell (5) to form gas-removing chamber (6). Inside the shell (1), along its axis, we install horizontal walls symmetrically to the loading mouth (7). The vertical walls (8) contain small holes or are made out of metal netting which separates the fuels during loading. The ash removing device (9) is placed at the bottom of the case. In the front of the heat-generator mounted a fan (10) which directs flow of air into heat-exchanging pipes (4) via designated paths. A rippled cover (13) is placed at the loading mouth and at the bottom of the case there is a pipe with a valve (17) to regulate the flow of air into the combustion chamber. Finally, the smoke is removed via chimney pipe (18).

The heat generator works as follows: the fuel is loaded into the combustion chamber, via the loading mouth up to the cut-off level of the cylindrical case; the flow of air is regulated by the corresponding cover; hot gases, generated by burning fuel between the walls, travel into the upper portion of the cylindrical case where the heat-exchanging pipes are located. After that, smoke moves into the gas-removing chamber heating up the pipes between the case and the external shell and exits via the chimney pipe into the environment. The cold air supplied by the fan travels via the designated path to enter the heat-exchanging pipes, where it is heated up and forwarded to warm the building.



Pic.1 Teplogenerator (view from a loading side)



Pic.2 Teplogenerator (view from the top)

Conclusions: Proposed heat-generator design increases the effectiveness of supplying hot air into the buildings by placing the heat-exchanging pipes in the hottest part of the generator and by completely burning provided fuels. The heat-generator is intended for heating non-living quarters such as warehouse, greenhouses, hangars, mechanical shops, etc., drying building materials, and can also be used in many other areas of a national economy. The proposed heat-generator is much cheaper to build in comparison to other similar designs. We accept orders for building and supplying heat generators of different types, varying the exit temperature of the hot air out of the heat generator from 85 to 100 degrees Celsius.

Research of work heat generator gave us criteria dependence for counting coefficient of heat release from surface of pipes to air:

$$Nu = 0{,}485 \cdot Gr^{0,4} \cdot Pr^{0,25}$$

, where: Nu – Nuselt factor, Gr – Grashoff factor, Pr -Prandtel factor.

We found average speed of movement air in pipes by using equation:

$$W = \sqrt{\frac{2 \cdot g \cdot H \cdot (\rho_{вх} - \rho_{вих})}{\rho \cdot \sum \xi}}, \text{ m/sec;}$$

,where H – height of pipe; $\rho_{вх}$, $\rho_{вих}$, ρ -density of air on inlet and outlet pipes, and medium. $\Sigma\xi$ -Total loses of resistance

We found mass losses of hot air by using equation:

$$m = \rho \cdot W \cdot \sum F \text{ , кг/с}$$

We developed heat generator with such parameters: diameter 600mm and height 1100mm, temperature of air on entrance from pipe heat generator equals 55…100 ^{0}C. The heat area of location equals 100m^2 when the height of heat generator is 3 m. The heat power of heat generator is 4 MW.

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