A trip to Europe

01/09/2006 Igor Kuznetsov

From August 1st to August 17, 2006 I made a trip to France by invitation of Jean Claude Raybaud. Jean Claude is a businessman from France, who has been dealing with questions concerning the use of energy for several years. In particular he carries out works connected with heating and hot-water supply of houses using solar energy. He became interested in our works regarding stove heating and hot-water supply. Our cooperation started about a year ago. During that period Jean Claude has carried out a lot of work and organized a production of stoves based on the principle of our System from modular fireclay components.

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The aim of his work was construction of multifunction stove capable of heating the house in winter and ensuring hot-water supply. He wanted to install it in the uniform system of hot-water heating and hot-water supply using two energy sources, i.e. using solar energy and energy received during wood burning. Besides the stove should be nice in appearance and should also be used for cooking. He coped with the task nicely. Within short period he managed to organize manufacture of baking stove with water heating registers.

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The double bell stove has overall dimensions of 0,8 x 0,9 x 1,7 m. The thickness of external walls is 60 mm. The stove is provided with a closed chamber used for cooking. Inside two registers are fitted made of 1" and 1,5" pipes with developed circumference of 1,76 m^2. The stove dimensions are in conformance with European standard EN 15250. Due to that reason to install a catalyst and ensure secondary air supply was not possible due to insufficient height of the firebox. The firebox capacity is 86 liters. The square of the firebox walls is 0,88 m^2, the square of the hearth and the beam is 0,15 m^2. The entire air necessary for combustion is supplied through adjustable opening into the ash-pit from the outside. From here secondary air comes to the crevice in front of the door and to three rows of rectangular openings in the rear wall of the stove. Making crevice in front of the door was caused due to the fact that the firebox door is not provided with openings from the top and from the bottom for supply of secondary air. The crevice width (dry joint) is 2 cm. For test purposes and for stove development various instrumentation of Testo Company have been purchased (www.testo.com).

The calorific power of registers was not checked due to absence of waterflow meters. The registers are connected to the same circuit with heat accumulating tank of 2,5 t capacity and also looped back over the small loop "direct – and back pipe" via thermostat opening the way over a large circuit at heat carrier temperature of 55°C. After that circulating pump is switched on. During stove test the heater radiators were getting warmer.

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The stove is designed in such a way that it can be disassembled and assembled at any time, as the elements are connected without using cement mortar. Due to that it became possible to perform several experiments and tests of the stove during my stay.

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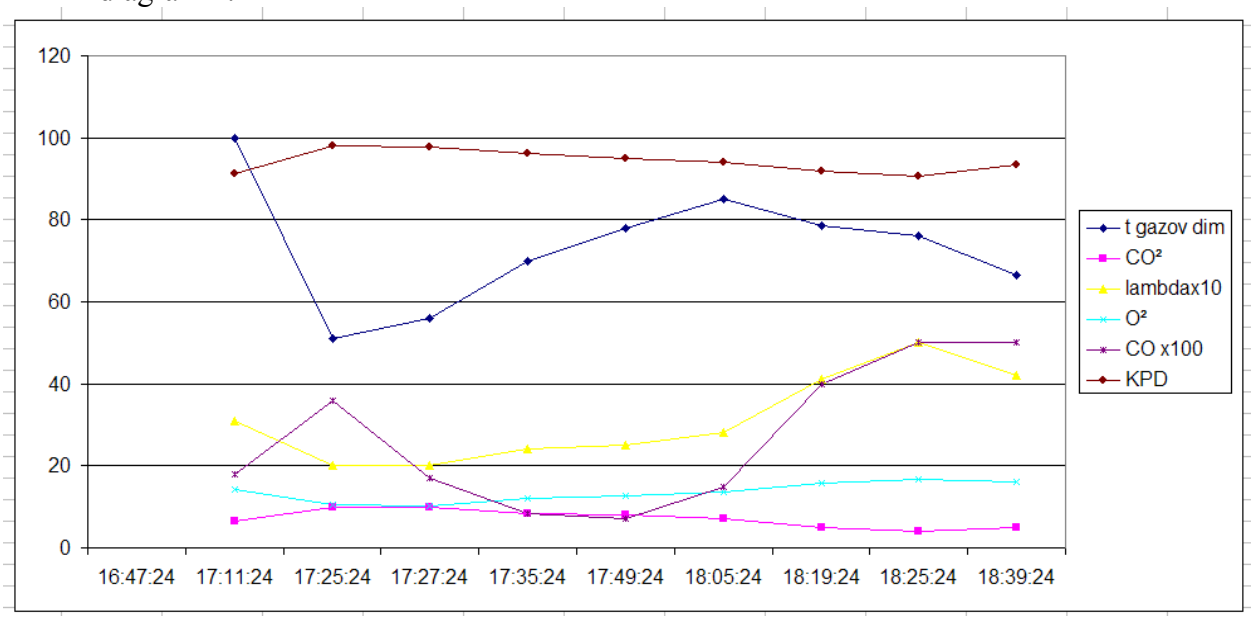
In particular the following burning modes were tested:

1. Without supply of primary air;
2. With supply of excess primary air through grate-bars:
3. With primary air supply through openings having total area of 5-10% of the hearth square.

The best performance of the stove was achieved in the last case. During the tests we changed the total volume of the supplied air. Besides we performed a test with different thickness of the external walls of the stove. The lower bell was lined with fireclay plates, 60 mm thick, and clay brick laid on the rib from the other side. There was no chimney

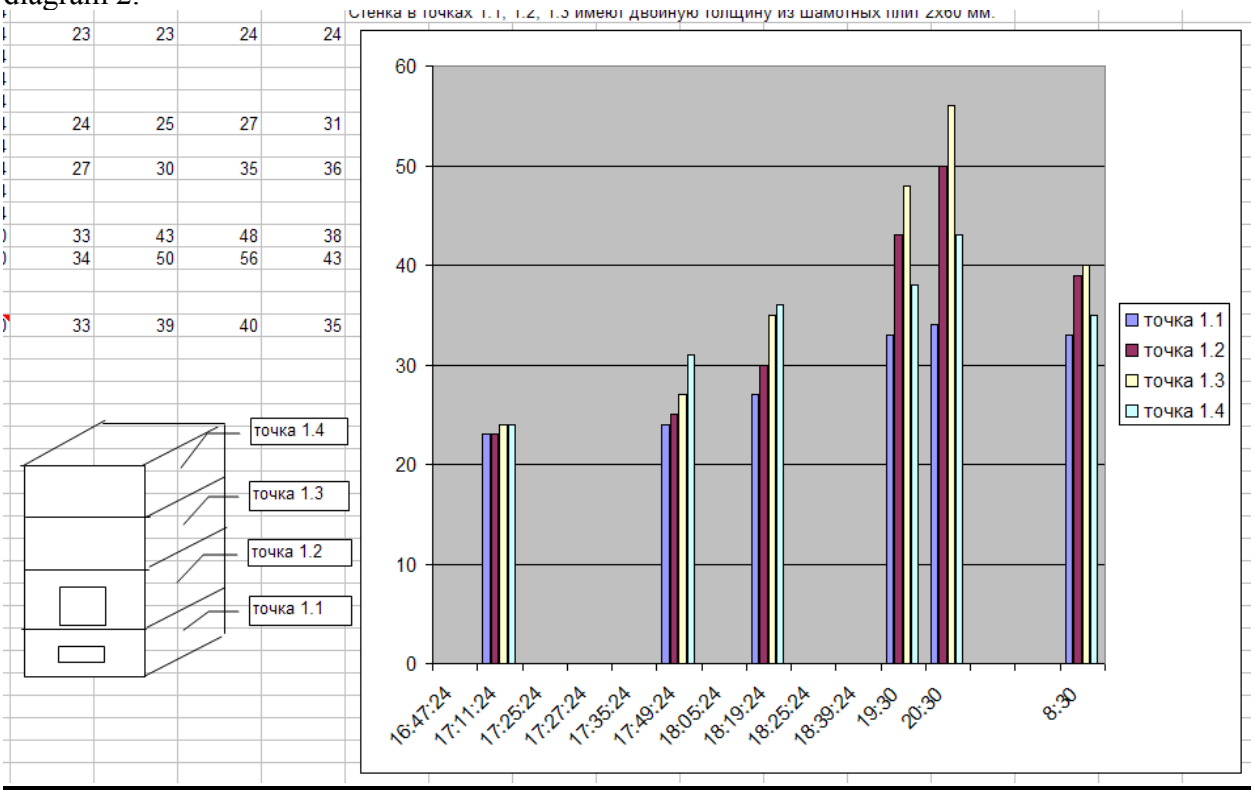
smoke and no smoke smell practically during the entire period of tests. The stove was proper functioning during vacuum in the firebox 10 Pa and there were no fumes with the door open. The tests were carried out in the mode of operation by general consumer. That means that we used various sorts of wood of various length and diameter that was not cut into pieces and we also used woodworking waste. In this case large distances were formed between the logs. We set fire to the wood from the top. We burnt one layer of wood without additional laying. During the tests we roasted potatoes in their jackets in the cooking chamber and ate it with pleasure. The test result is given below (Feuil 1, 2 and 4):

diagram 1.



We also measured temperature changes of the external walls of the stove. The results of temperature changes of the right wall in four points are attached:

diagram 2.



When performing tests with single walls (17.12.05) the wall temperature between points 2 and 3 reached temperature of 125 ° C, which is inadmissible. The temperature of the second bell in point 4 reached up to 48°C. True, as Jean Claude put it, the tests were carried out in conformance with the regulations in force, that is the quality of wood was better and more wood was used during the test. The above said means that in case of stove with double walls heat transfer is taking place. The registers are better heated and the walls get heated to permissible temperature and remain warm longer.
It shall noted that we slightly opened the firebox door several times to watch the change in the character of combustion. We also opened the firebox door and turned over the carbons. In both cases we did not fix the time.
The following conclusions can be made on the basis of the test and observation results:
In case of fuel combustion without supply of primary air the fuel burns slower, clean burning takes place at relatively low temperatures. This type of fuel combustion can be used in thin-walled heating stoves.
When primary air is supplied in greater amount than the secondary air in the total volume of supplied air "dirty" burning takes place. When primary air is supplied in the amount less than that of secondary air in the total amount of air supplied clean burning takes place at a relatively higher temperature than in the first case.
It should be pointed out that at the end of combustion when gluing carbons remain in the firebox, the amount of carbon monoxide (CO) increases, although it is not revealed by carbons color change or any other external signs. This question should be studied. In all the tests decreased temperature of exhaust gases in the chimney was noticed.
As practice shows, the use of catalyst with supply of secondary air in it and under it as well as in the case of primary air decrease in the total volume of air supplied, improves gasification of fuel and increases temperature in the firebox approximately by 1,5 times in case of clean burning.
For example, in steam bath stove БИК (steam bath stove of Igor Kuznetsov) burnt by wood the temperature is more than 1060 °C. Stone jadeite, the melting temperature of which is 1060 °C melts. This could be seen here:
http://www.stovemaster.ru/viewtopic.php?t=1292 Stove craftsmen.
Such combustion of fuel makes it possible to build any multipurpose stoves, including industrial ovens for fulfilling process tasks to be solved in high temperature field, water boilers, steam sauna stoves etc. The temperature of exhaust gases is being optimized.
Besides the above-mentioned tests we tested another stove, similar to the first one, in which wood was laid vertically with a slight inclination aback. The stove is built without dry joints and registers. In this stove the grate is made of four fired elements in the form of triangles mounted on the base with a vertex on top. Between the elements there are crevices about 10 mm for primary air supply. At the beginning of fuel combustion when carbons don't clog up slots between the grates combustion takes place quickly, and smoke and fumes come out from the chimney (dirty burning). When the slots become clogged combustion becomes cleaner. The firebox door should not be open due to the fumes.
Summing up the above information one can derive at the following conclusion:

- In our System optimum combustion is combustion with adjustable supply of both primary and secondary air. In this case the volume of primary air supply shall constitute a smaller part in the total amount of air supplied. In large heating units air supply can be automated depending on the content and temperature of exhaust gases at all combustion stages. In this case the fuel burning can be optimized. It is important that the supply of the secondary air shall be organized in a proper way. I this case excess of air contributes to clean burning and practically does not influence much the change of efficiency.

- The firebox in height shall be restricted by a catalyst in the form of grate made of fired refractory material with supply of secondary air to this area.
- One should use firebox doors that are provided with a possibility to adjust the air supply both in the lower and in the upper part.
- The walls of the lower bell shall be doubled.

I'm grateful to Jean Claude Raybaud and fate for the possibility to take part in some stove experiments and tests. I don't have possibility to carry out such work in Russia due to absence of laboratory, instrumentation, experts on testing and financing.

It's a pity but during my stay we had no possibility to measure temperature and analyze gases at various height in the firebox and the bell, as we had no respective tools. These data are necessary for many scientists to study the laws of "System of free gas movement". In this field we can make an important discovery.

It would be important to carry out test regarding total heat transfer of the stove from combustion of measured amount of wood. In my opinion, during combustion of fuel in our System the energy emission is 1,5-2 times as much than energy released in the system of "forced gas movement", special case of which is the system of "Counterflow" used in the West. This is to be explained by the fact that the heat obtained in the result of combustion reaction in the " System of forced gas movement" is diluted by ballast gases (nitrogen, excess air, water vapors) taking up heat for their own heating and in mixed condition comes for heat exchanger heating. The heat emission plant of the "system of forced gas movement" consists of a firebox and convective system represented by chimney ducts over which gases move upward, downward, to the right or to the left giving up their heat for heating the channel walls. All the products of combustion in this system (including cold ballast gases) and heat are transferred by unique flow through the chimney ducts. It is similar to the case when in hot water flow cold water is added, which decreases its temperature, and this diluted water is used for heating of the heat exchanger. If we make a chamber of larger volume for placing the heat exchanger, the gas flow coming through this chamber dissipates its energy and it becomes impossible to heat the heat exchanger to high temperature, therefore the only place for placing the heat exchanger is the firebox. However in this case cold surfaces of the heat exchanger decrease the temperature in the firebox and worsen the condition of combustion reaction, in other words, the efficiency of energy release from the fuel decreases.

In our System the heat exchanger is placed not in the firebox but in the bell, in which the gas flow is accumulated in its upper area and its high temperature affects the heat exchanger. The firebox is placed in the bell. As there are no cold surfaces of the heat exchanger in the firebox, the temperature in it becomes higher. The firebox is designed in such a way that the cold ballast gases are separated from the gas flow and transferred to the pipe or to the second bell past the heat exchanger through the lower part of the bell.

As the ballast gases are cold and heavy, they cannot go up to the upper area of the bell to cool the gas flow.

Similar to this practice, buoyancy force expulses substances with smaller specific weight from water. Such design makes it possible to create high-temperature field in the firebox, in which gasification of fuel and its optimum combustion takes place. High-temperature gas flow containing no ballast gases moves towards upper area of the bell and affects the heat exchanger.

Boilers built in conformance with this technology show fantastically amazing results. This fact is confirmed by the results of operation of wood-burning boiler of our System in heating season of 2005-2006 built by *VIST JSC* in Perm, tel.+7 (342)2530164, vist-k@inbox.ru. The boiler has overall dimensions 195x 169 and is 210 cm in height. It heats the shop having the size 36 x 16 m and 9m in height, including 60 m^2 of two-storied section. The walls are made of brick, 52 cm thick.

The square of the shop is: 36 x 16 + 60= 636 m^2. The volume of the building is: 36 x 16 x 9= 5184 m^3. The demand in piping is 57 x 5, (10 x 149+2 x 123) x 4 = 70 running meters for the boiler. The pipe heat surface is 3,14x 0,057x 70= 12, 52 m^2 which approximately corresponds to 126 kW. The output temperature was 65-70° C (could be higher), it was not measured at the output. Pine rough edge, not dried was used as fuel, 1 m^3 per day. The power achieved by combustion of wet pinewood was 57 kW. The representative of the company Mr. S.A. Mashyanov admitted that the boiler maintained temperature of 18°C in the workshop while the outside temperature was almost – 40 ° C. This fact should be confirmed or denied by performing tests. Other customers admit good operational features of the boilers as well. It is probable that it might be impossible to perform such tests using instrumentation of *Testo Company*.

During my stay in France I was invited to visit a German company www.wolfshoehe.de Wolfshöher Tonwerke, that is 150 years this year.

The company is located near Nürnberg and incorporates three enterprises in various cities. The company produces high quality fired refractory materials for home stoves using wood for fuel and also some materials necessary for brickwork, such as mortar and bonding plasters, ecologically clean with preset features. We went there with Jean Claude and Friedrich Motovitski, who met us and accompanied us during our stay in Germany (from 13.08 to 15.08.06). Director of the company Konrad Kügel kindly acquainted us with the production facilities.

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I was pleasantly surprised at high automation level at the facilities. Most of the operations in the workshops are done by robots. It is surprising that the company uses four different types of clay, which features change in the process of quarry development, but the preset features of refractory materials are strictly observed. This activity is led by Johann Reis who is also in charge of laboratory management. He is graduate of the Ural Polytechnical Institute (Ekaterinburg) of 1977, Department of Technology of Silicates. I also graduated from the same institute. The company uses CAM system in production facilities. The product range includes thousands of different components and materials of high quality. Many stove-men in Germany and neighboring countries use the product of the company in stove-making. Practically using such components it is possible to design and to build any stove of our System. We can only dream about that.

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After we got acquainted with production facilities a meeting with the leading experts of the company was arranged. The following people took part at the meeting: Mr. Konrad Kügel, the head of the company; Mr. Axel Wolf, technical director; Mrs. Ulrike Wolf, who is in charge of new developments; Mr. Friedrich Motovitski, an engineer; Mr. Johann Reis, the head of the laboratory; Mr. Jean Claude and me. I ‘ve been speaking about our System for several hours and answered questions. Our System of stove design aroused great interest and was highly appraised by the people present. Mr. Konrad Kügel called it ingenious and great. We also changed our opinions concerning the ways of possible cooperation. Mr. Kopanev V. N., General Director of National Masonry League, also gave high evaluation of our System after my report on extraordinary meeting of stove-men of Masonry League and masonry guild of Moscow held on 16.06.06.

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