The heat-engineering section of the Interplant Technological Planning and Design Bureau (ITPDB) of the Ukrsteklo Combine has carried out some research with the aim of increasing the efficiency in use of tank furnaces. As a result of this research and an analysis based on Soviet and foreign experience, the authors have proposed some effective measures to save fuel. These measures have already been introduced in the industry or will be in the very near future.

It is well known that the use of diffusion burners, or atomizers in the case of liquid fuels, shows the greatest effect when the fuel is completely burnt in the flame space of the furnace.

In industrial furnaces fuelled by natural gas, when fuel burns in the regenerator checkers it is partly due to the incorrect choice of nozzle diameter for the diffusion burners. In spite of an increased consumption of gas in the furnaces, the specified heat loading is not reached and the useful life of the lining is shortened. In particular, this has a bad effect on the working of the vertical glass-drawing systems causing interruption to the working of the machine and flaws in the glass strip in the form of fine lines and gas bubbles.

In order to eliminate these faults the authors propose that the diameter of the nozzle be corrected, dependent on the loading, for each pair of ports in the tank furnace, with a rate of gas flow of 50 m/sec. This has been done in the vertical-drawing and nondebituse drawing systems at the Lisichansk Glass Plant thus making it possible to improve the working of the systems.

Some of the furnaces in the Ukrainian glass plants are fuelled by mazut through Shukhov atomizers for which the rated fuel consumption is 300-400 kg/h, i.e., it is insufficient for the required thermal capacity of the equipment. Uncontrolled, smoking burners develop in the furnaces and the fuel is not completely burned and consequently, the working of the glass-molding equipment becomes unstable.

Between 1972 and 1973 studies were carried out and recommendations made on the use of the UPI-K6 atomizers with supersonic rates of atomization (by vapor or air) in furnaces fuelled by liquid fuel [1]. The supersonic rates are provided by the flow of the atomizer from a profiled nozzle.

The advantages of the UPI-K6 over the Shukhov atomizers are the fineness of atomization of the fuel and the high velocity of the jet which gives a steady horizontal flame with a high thermal output to the tank.

These atomizers can be manufactured and mastered in existing furnaces using the available resources of the plant. Their use increases the duty factor of the glass. Thus, when the UPI-K6 atomizers were installed at the Babinets Glass Plant, the heat input to the melt increased by 15%; the output of additional production reached 2,100 bottles per shift from one machine; and the specific consumption of fuel per unit of production was reduced by 10%. In the furnace at the Peskov Glass Plant, the temperature of the hanging wall was reduced by 40-50°C as a result of the installation of the UPI-K6 atomizers and this lengthened the useful life of the lining.
The efficiency of the heat exchange in the flame space of the furnace depends also on the design of the fuel-inlet unit. A separate feed for the fuel and air is widely used abroad [2]; this is the so-called "auxiliary-port fuel supply" which is characterized by a horizontal flame with an increased area of coverage of the pure surface of the melt. In this case the heat exchange is intensified and the useful life of the lining increased.

As a result of the research carried out in industrial furnaces, the ITPDB has developed and installed a port with a separate gas and air supply [3] in a furnace with a horseshoe flame at the Zaporozh Glass Plant. The fuel consumption here has been reduced by 25%.

Moreover, port units for furnaces with a transverse flame, fuelled by gas or liquid fuel are being tested and prepared for installation. Tests are also proceeding on layouts with combined gas–oil fuelling which makes it possible to stabilize furnace operations during seasonal variations in the fuel supply.

It follows from an analysis of the thermal balances of furnaces that 20–22% of the heat provided by the fuel and air is lost through the tank and flame-space lining into the surrounding medium. When baddelyte-corundum refractories are used, the heat losses increase sharply and although the furnace campaign is prolonged, these losses have to be compensated by an almost five-fold increase in the amount of fuel used. Insulation of the tank walls is effective in this respect. The insulation of the lining according to the recommendations of the State Scientific-Research Institute of Glass [4] does not interrupt the production process and does not reduce the useful life of the furnace.

There has been some practical experience abroad with the installation in furnaces of double-layer tiles of the Combinal-40 type which have a thickness of 150–200 mm (the first layer is a mass with 38% Al₂O₃; and the second a light-weight chamotte with a density of 1 to 1.1 g/cm³) [5]. The fuel saving in these furnaces amounts to 10% or more. Insulation of the tank blocks is acceptable for all furnaces. However, for this to be done in the Soviet Union would require the setting up of production of similar tiles in our own industry.

In addition to the heat losses through the lining, there are also significant thermal–balance losses through the effluent gases. They can be reduced by the use of heat-recovery equipment. The efficiency of the process is increased with an increase in the performance of the latter.

A significant effect can be achieved by the use of high regenerators with large-form coefficients. The high regenerators at the Oktyabr'skaya Revolutsiya Konstantinov Glass Plant have made it possible to increase the heated-air temperature by 100°C and the thermal input to the tank by 10% [6].

The installation in furnaces of direct heating from radiation regenerators to the design of the Institute of Gas, Academy of Sciences of the Ukrainian SSR which provide air heating up to 400°C gives an opportunity to lower fuel consumption by 12–15%.

The thermal working of the furnace can also be significantly intensified by enhancing the convection of the melt using mixing equipment.

Thirty-five plants in the Ukrsteklo Combine have introduced intermittent and continuous bubbling of the melt using compressed air. In the near future this process will be mastered at all the glass plants under the Ministry of the Structural Materials Industry of the Ukraine. As a result, the duty fact of the melt will be increased 3–5% with a similar decrease in unit-fuel consumption.

Further intensification of the work of a glass-melting furnace can be achieved by enhancing the melt convection by supplying a gas–air mixture to the glass with a specific consumption per nozzle in the submerged port of 1 m³/h under normal conditions [7]. This method of fuel combustion is called contact burning.

The Kiev Glass-Container Plant has introduced a method of furnace fuelling developed by the ITPDB which combines the combustion of fuel in the flame space and in the melt. In this case the increase in furnace productivity and the reduction in the unit-heat consumption is achieved by intensifying the heat exchange between the flame and the melt by supplying additional heat in the melt itself and increasing the melting rate of the batch by stirring.

Further results of research done by the Institute of Gas of the Ukrainian Academy of Sciences, the State Scientific-Research Institute of Glass, and the Avtosteklo Scientific-Research Institute, it is possible to achieve a specific yield of glass of up to 4–5 ton/m² per day and to lower the unit fuel consumption by 65% in furnaces with contact heating. In this particular case, 4 to 7% of the total fuel consumption is sup-