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ҒЫЛЫМ ЖӘНЕ ЖОҒАРЫ БІЛІМ МИНИСТРЛІГІ

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КӨЛІК – ЭНЕРГЕТИКА ФАКУЛЬТЕТІ

«КӨЛІК ЖӘНЕ ЭНЕРГЕТИКАНЫҢ ӨЗЕКТІ МӘСЕЛЕЛЕРІ: ИННОВАЦИЯЛЫҚ ШЕШУ ТӘСІЛДЕРІ» XI ХАЛЫҚАРАЛЫҚ ҒЫЛЫМИ-ТӘЖІРИБЕЛІК КОНФЕРЕНЦИЯСЫНЫҢ БАЯНДАМАЛАР ЖИНАҒЫ

СБОРНИК МАТЕРИАЛОВ XI МЕЖДУНАРОДНОЙ НАУЧНО – ПРАКТИЧЕСКОЙ КОНФЕРЕНЦИИ: «АКТУАЛЬНЫЕ ПРОБЛЕМЫ ТРАНСПОРТА И ЭНЕРГЕТИКИ: ПУТИ ИХ ИННОВАЦИОННОГО РЕШЕНИЯ»

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А43 Актуальные проблемы транспорта и энергетики: пути их инновационного решения: XI Международная научно – практическая конференция, г. Астана, 16 марта 2023/Подгот. Ж.Д. Курмангалиева, У.Ш. Кокаев, Т.Т. Султанов – Астана, 2023. – 709с.

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В сборник включены материалы XI Международной научно – практической конференции на тему: «Актуальные проблемы транспорта и энергетики: пути их инновационного решения», проходившей в г. Астана 16 марта 2023 года.

Тематика статей и докладов участников конференции посвящена актуальным вопросам организации перевозок, движения и эксплуатации транспорта, стандартизации, метрологии и сертификации, транспорту, транспортной техники и технологии, теплоэнергетики и электроэнергетики.

Материалы конференции дают отражение научной деятельности ведущих ученых дальнего и ближнего зарубежья, Республики Казахстан и могут быть полезными для докторантов, магистрантов и студентов.

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employer does not hope for any support from above. He himself or taking into account the opinion of the competent body authorized by the employees determines what needs to be done now, and what can be done later, based on financial capabilities. Under these conditions, the right solutions will not always be found, especially if, by tradition, labor protection is considered a costly element in the economic policy of an enterprise.

The Occupational Safety and Health Management System aims to reduce injuries and morbidity among employees by creating healthy and safe working conditions. The following tasks are required to achieve this goal:

- improve organizational and legal activities on labor protection issues;
- anticipate the emergence of harmful and dangerous production factors, identify existing ones, eliminate them, improving working conditions and increasing its productivity and safety;
- analyze the impact of working conditions on injuries and morbidity;
- carry out preventive measures to prevent fires;
- develop and implement science-based action plans for labor protection;
- improve the organization of training on labor protection.

Occupational safety should take its rightful place and not be an integral part of the organization of production, but be its goal. At the same time, the goal is not a psychosis of safety, but painstaking work at all stages of the preparation and functioning of production, ensuring a sharp increase in labor productivity.

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NUMERICAL SIMULATION OF AERODYNAMIC AIR FLOW IN A MICROMODULE GAS BURNER

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The article presents the processes of modeling the aerodynamic flow of air in a micromodule gas burner with a sudden expansion at the outlet. The aerodynamic flow is modeled in the COMSOL MULTIPHYSICS software package, which is reasonable in terms of availability and quality. The analysis of the micromodule gas burner revealed that the dynamic and geometric characteristics affect *the aerodynamics and velocity profiles. Different air flow velocities significantly affected the intensity of the formation of recirculation zones, which led to an increase in pressure in the circuit. Accordingly, the flow at different heights of the cylindrical nozzle has shown that the dimensions will affect the combustion processes and, as a consequence, the stabilization and formation of nitrogen oxides*.

Keywords: sudden expansion, software modeling, recirculation zones, velocity profiles, pressure contours.

1. Introduction

For the best gorenje process, it is necessary to ensure the stabilization of the torch and a decrease in the concentration of nitrogen oxides. Based on the results of theoretical and experimental data [1-7], the authors concluded that it is possible to achieve low emission gorenje by stabilizing microfakels. The patented micromodule air nozzle introduced into the production process has shown that the Venturi pipe provides complete mixing of gas and air, which is a good stabilizer with low formation of harmful emissions.

The burner includes input and output registers (or swirlers), a fuel tube and a cavity for mixing the fuel-air mixture, characterized in that the cavity is made in the form of a Venturi pipe, and fuel injection is carried out in the first narrow section after the input swirler. The disadvantages include the fact that the installed swirlers do not provide hydrodynamic resistance. The disadvantages include the fact that the installed swirlers do not provide hydrodynamic resistance.

Numerical simulation was performed on a micromodule gas burner, with a Venturi pipe and a cylindrical nozzle. Since the nozzle is of large diameter, a sudden expansion is formed at the junction of the nozzle with the Venturi pipe, which is a good stabilizer. In addition, secondary air enters through the slots to the nozzle, which ensures high gorenje, combined fuel-air mixture with low NOx output. The result is achieved by burning natural gas in a micromodule gas burner consisting of a Venturi tube, a fuel tube and a sprayer, characterized in that a large diameter cylindrical nozzle with outlet slots is installed to the diffuser part.

Thus, the burner can provide low-emission and sustainable combustion of natural gas in small hot water boilers. The article presents the results of numerical simulation of a micromodule gas burner at different air speeds, in order to determine the aerodynamic parameters of a cylindrical nozzle.

2. Methods

The construction of a model of the burner under study in three-dimensional space was carried out in the SolidWorks software package. The simulation result is shown in Figure 1.

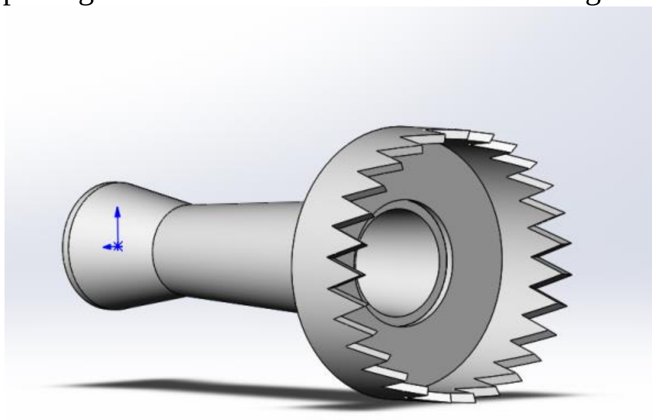


Figure 1 - Burner Model

The modeling object consists of a venturi pipe and a cylindrical nozzle with a larger diameter, input and output areas. The purpose of the simulation is to determine the pressure and velocity contours, to determine the recirculation zones, as well as their effect on the aerodynamics of the air flow.

Direct numerical simulation of the burner, according to the definition of the above parameters, was performed in the Comsol Multiphysics software.

In view of the fact that the article considered only the effect of fuel supply, the value of fuel consumption was not taken into account when modeling.

When solving flow turbulence, different turbulence models are used. In this case, the 3D model k-ε realizable (realizable) was applied.

Figure 2 shows a tetrahedral adaptive computational grid of the simulated area. The grid consists of a group of tetrahedra, with more than 5000 elements in it, which makes it possible to efficiently calculate various variations of the stress field and obtain a highly accurate result.

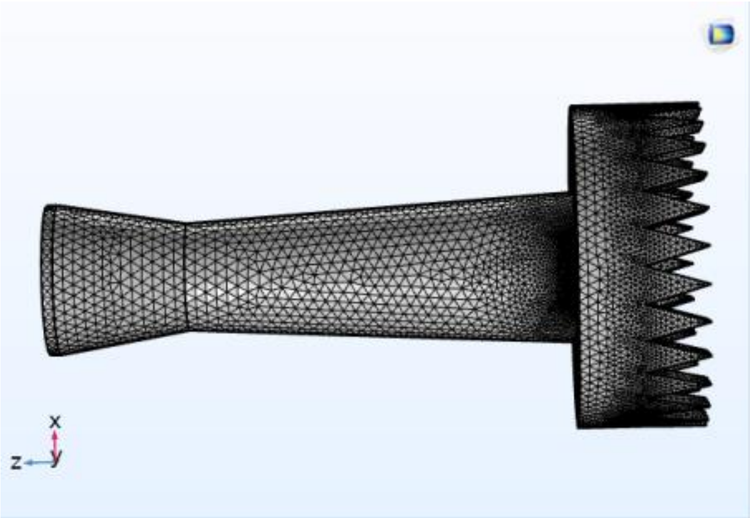
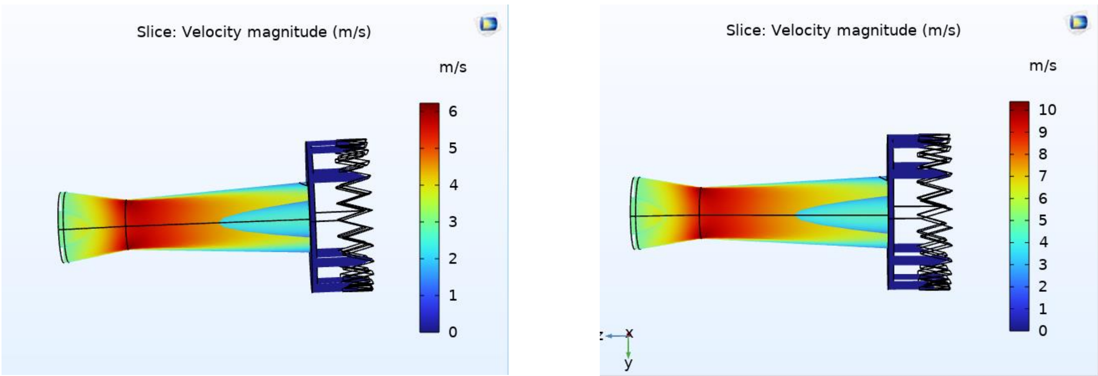


Figure 2 - Adaptive computational grid of the simulated area in COMSOL Multiphysics

3. Results and discussion

Speed contours. Figure 3 shows the velocity contours at different initial air velocities at the gas burner inlet. It can be seen from the figures that for all the initial velocities of the air entering the burner, acceleration is characteristic in the narrowing channel of the Venturi tube, after which, falling into the expanding part of the tube, the flow slows down, which gives time for effective mixing of gaseous fuel with air.



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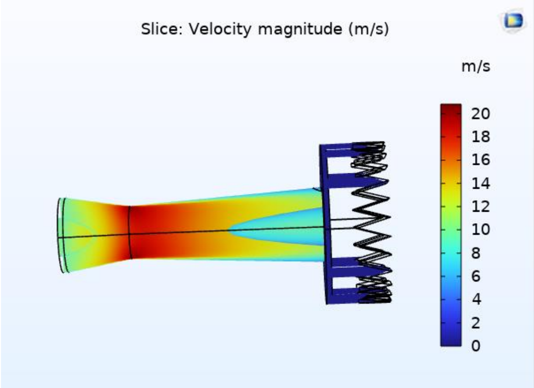
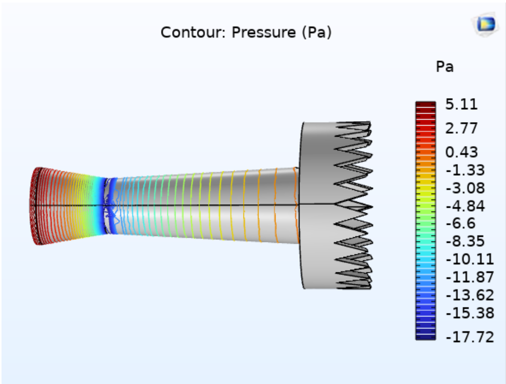


c)

Figure 3 - Speed contours:
3a – 3 m/s; 3b – 5 m/s; 3b – 10 m/s

Pressure contours. Figure 4 shows the pressure contours of a micromodule gas burner at different speeds. As can be seen from the figures, zones with negative pressures are formed in the cylindrical nozzle at minimum speeds, and at high speeds, the formation of zones with high pressures at the outlet of the cylindrical nozzle is observed, which characterizes the stabilization in the recirculation zones.



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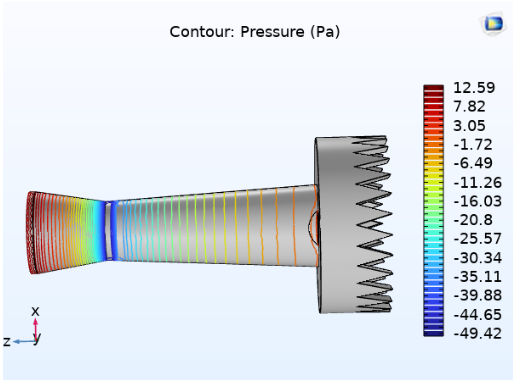

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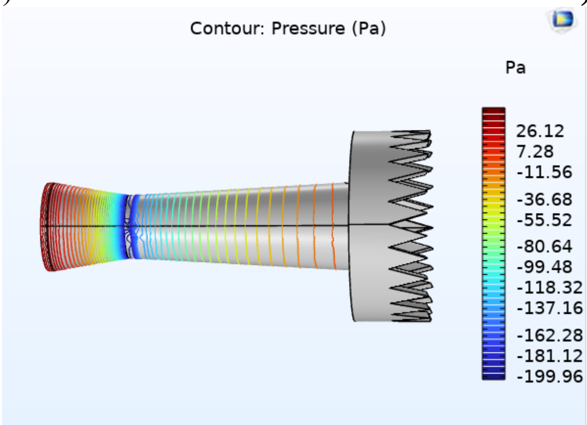

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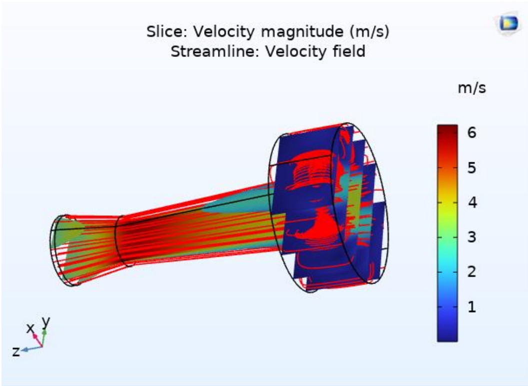
Figure 4 - Pressure contours
4a – 3 m/s; 4b – 5 m/s; 4b – 10 m/s

Recirculation zone. Figure 5 shows the recirculation zones at different speeds. Vortices are visible in the large diameter nozzle, which clearly demonstrates the formation of an extensive recirculation zone of the fuel-air mixture. At the junction of the nozzle with the Venturi pipe, a sudden expansion is formed, which leads to a high stabilization of the fuel-air mixture. Thus, the aerodynamic parameters of the cylindrical nozzle are determined.



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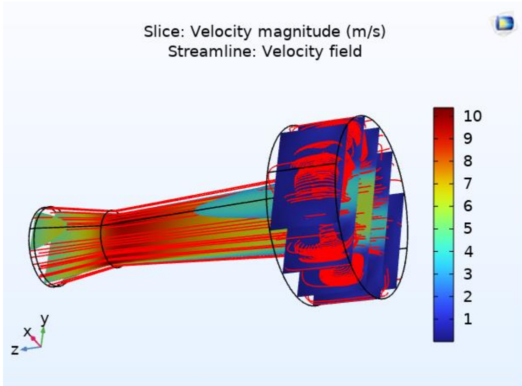

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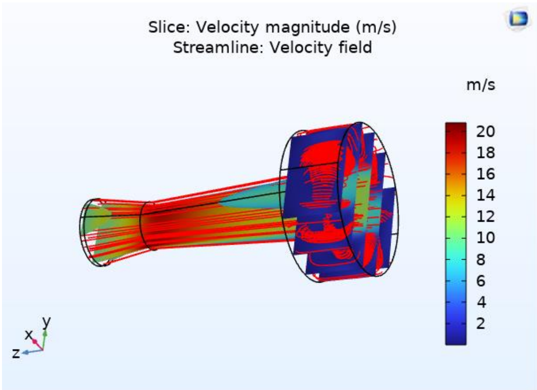

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Figure 5 - Recirculation zone
5a – 3 m/s; 5b – 5 m/s; 5b – 10 m/s

4. Conclusions

The analysis of the micromodule gas burner revealed that the dynamic and geometric characteristics affect the aerodynamics and velocity profiles. The use of numerical modeling methods allows us to visually illustrate the complex aerodynamic processes occurring in the burner device.

Based on the data obtained, the authors concluded that the design of the Venturi tube, where the air flow in the lending-expanding channel of the tube first expands and then stabilizes, affects the efficiency of mixing gaseous fuel with air.

3. It can be seen from the drawings of the velocity contours that an extensive zone of reverse currents is observed at the highest initial air velocities (5-10 m/s).

4. At high initial speeds, there is also an increase in pressure in the narrowing channel of the burner tube and a decrease in the expanding channel, thereby increasing the time for more complete mixing of the fuel-air mixture, as a result, efficient combustion occurs.

In conclusion, I would like to note that further developments and research in the field of microfakel technology of fuel combustion will serve to improve the environmental situation around the world and solve the problem with the lack of capacity in the energy systems of different countries.

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УДК 621.3

ВЛИЯНИЕ ТВЕРДЫХ НАКИПНЫХ ОТЛОЖЕНИЙ НА ВНУТРЕННИХ ПОВЕРХНОСТЯХ ТРУБ НА ЭФФЕКТИВНОСТЬ ТЕПЛООБМЕННИКОВ

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Введение. Одним из главных приоритетов развития современной теплоэнергетики и производства является проблема энергосбережения посредством экономного использования топливно-энергетических запасов. Это в свою очередь обуславливает необходимость разработки и внедрения эффективных методов интенсификации тепло- и массообмена, уменьшения гидравлических и тепловых потерь при транспортировке рабочих сред в теплообменниках и др. Одним важным направлением представляет собой проблема разрушения и удаления твердых накипных отложений с теплообменных поверхностей [1-7].

Накипь (scum, scale) – твердые отложения, образующиеся на внутренних стенках труб теплотрасс, паровых котлов, теплообменников, водяных экономайзеров, пароперегревателей, испарителей и других теплообменников, в которых испаряется или нагревается вода. Различные примеси и соли, содержащиеся воде, при нагревании и испарении образуют твердую фазу в виде накипи на внутренних поверхностях парогенераторов, испарителей, подогревателей и конденсаторов паровых турбин. Накипные отложения со временем могут полностью заполнить всю внутреннюю полость трубы, вызвать образование трещин и разрыв. Теплопроводность накипных отложений в десятки, часто в сотни, раз меньше теплопроводности металла, из которой изготовляют трубы и поверхностей теплообменников. Наличие даже тонкого слоя накипи создает большое термическое сопротивление, ухудшает теплоотдачу. Поверхности при наличии накипи перегреваются, что приводит к сокращению сроков их службы. Данные аспекты приводят к снижению производительности теплообменного оборудования и увеличению расхода топлива, поэтому их удаление является актуальной проблемой для всех отраслей промышленности [2-4].

Многочисленный парк котлов, водо-подогревателей и теплообменных устройств малой и средней мощности зачастую использует обыкновенную сетевую воду, как правило, без проведения специальной обработки, что приводит к быстрому образованию накипи. На практике профилактические мероприятия связаны с удалением из питательной воды солей, поглощением их различными фильтрами, ионитами, добавлением химических веществ.