MATEC Web of Conferences 23, 01061 (2015)
DOI: 10.1051/matecconf/20152301061

Numerical research of heat transfer in gas heat exchanger

Eugene O. Khomutov, Andrey V. Gil[a]

National Research Tomsk Polytechnic University, 634050 Tomsk, Russia

Abstract. The article presents a numerical study of heat and mass transfer based on the finite volume method. Researched by installing a tubular heat exchanger for heating of natural gas. The results according to changes in temperature of the natural gas depend on the initial temperature of the heating flow. The results can be used in the analysis of further effective combustion.

1. Introduction

Heat exchangers are widely used in various industries. The most cases directly connected to the other units of the process. Accordingly, changes in the parameters of the heating and heated medium can significantly affect the processes in subsequent installations. The main changes in the parameters may be temperature variations and fluid flow rate. The literature presents a broad description of analytical methods for solving problems of heat and mass transfer in a variety of heat exchangers [1–3]. To solve the problems, and presenting the results in the entire volume of investigation the most effective use of numerical simulation techniques [4, 5].

In recent years, the role of gas as the most environmentally friendly fuel is greatly increased. Drying and heating gas is an integral part of the fuel before combustion. For heating and natural gas dehydration tube heat exchangers are often used with different mutual flow. Changing thermal conditions and mass flow rate can further affect the stability of ignition and combustion of fuel and consequently the efficiency of operation of the system as a whole.

2. Object of study

The object of investigation adopted by the heater natural gas. This heater is installed in many oil and gas processing plants, as well as before the plants burning natural gas. As the heating medium in the heat exchanger is steam. Countercurrent heat exchanger circuit movement of working substance. Heater gas (figure 1) heats the purified fuel gas with an initial temperature of 30°C to the desired value prior to feeding it to the oven burner nozzles.

Software package ANSYS Fluent was using for investigate the heat transfer in the installation. When building a grid computational domain were identified disadvantages of using ANSYS tools in the division into cells. The tube bundle is very tight with a minimum distance between the tubes, which does not allow to break this area into multiple cells of very small size. Therefore, the model has

[a] Corresponding author: andgil@tpu.ru

been simplified. Because of the volume allocated to a pipe which moves natural gas and its surrounding annulus, in which moving the vapor stream. Computational grid is shown in figure 2.

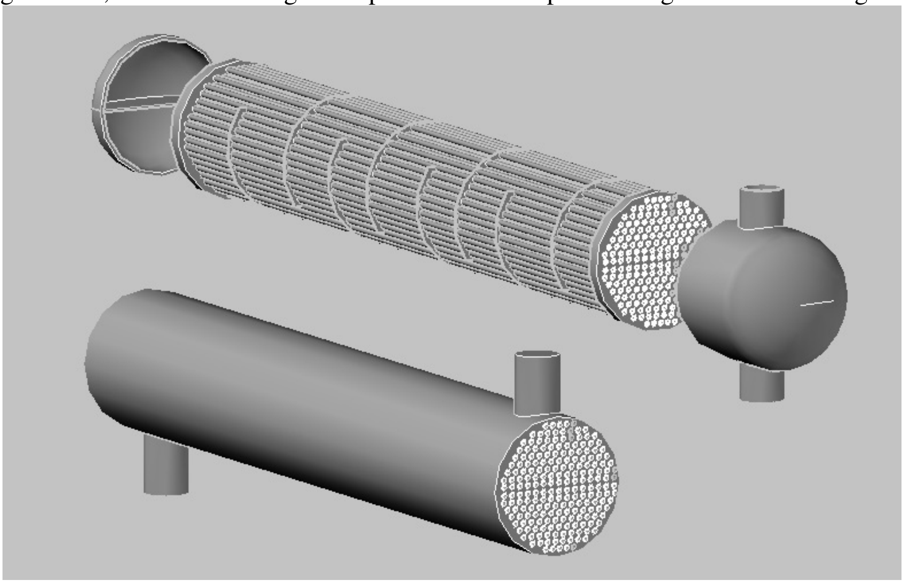

Figure 1. The fuel gas heater

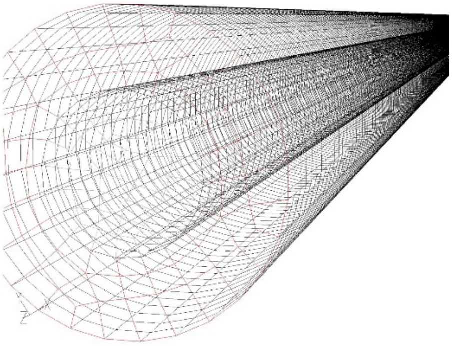

Figure 2. Computational grid

3. Calculation results

Consider figure 3, it shows the dependence of the gas temperature from the heating steam temperature.

According to the accepted initial conditions with increasing temperature from 300°C to 400°C significant changes in temperature begins about mid-length of the heat exchanger (figure 3).

The calculation results shows that by increasing the temperature of steam increases the temperature of the gas. This is because with increasing steam temperature the temperature drop increases, and, consequently, the heat transfer coefficient. In consequence, the heat transfer rate increases. By increasing the steam temperature at the temperature of the natural gas 100°C increases by 32°C (figure 4).

In order to estimate the influence of gas velocity on temperature in the calculation were taken three values of gas velocity 4, 7 and 17 m/s. The results are presented on figure 5.

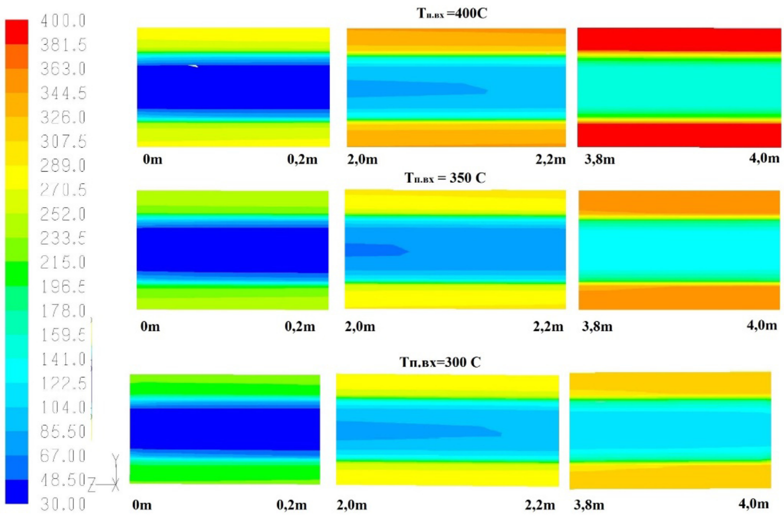

Figure 3. The dependence of the gas temperature from the heating steam temperature

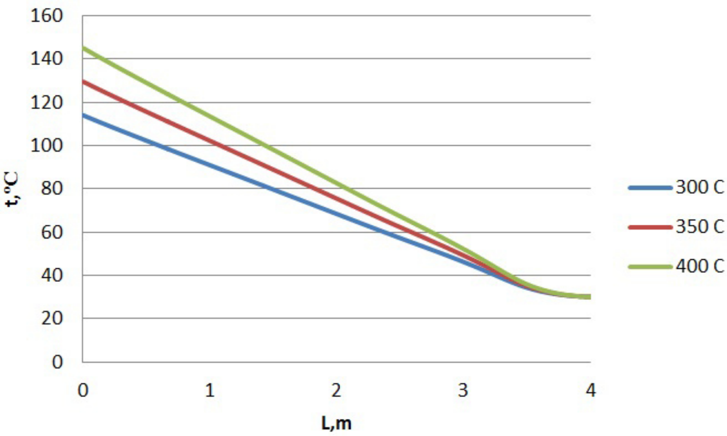

Figure 4. The distribution of the gas temperature along the length of the heat exchanger

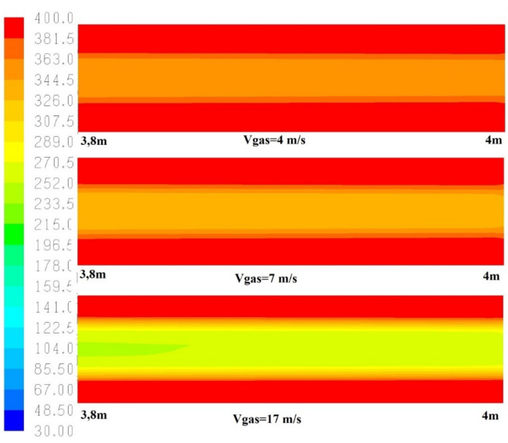

Figure 5. The dependence of the gas temperature from its velocity

Figure 5 shows that decreasing the speed of the gas, its temperature increases. Because a counter flow scheme of movement of the gas it moves constantly in the zone of higher temperature and with decreasing speed the time of its stay in the heat exchanger increases, hence, he manages to heat up more than at higher speed. Figure 6 shows a graph of the distribution of the gas temperature along the length of the heat exchanger.

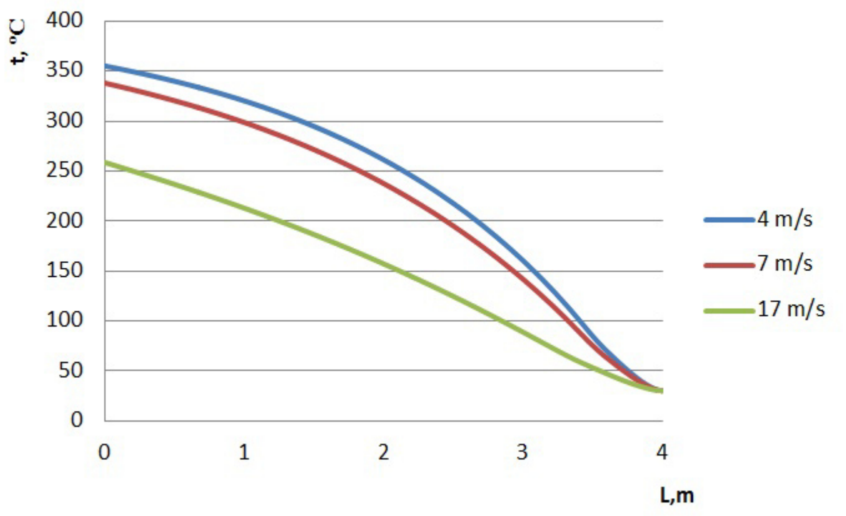

Figure 6. The distribution of the gas temperature along the length of the heat exchanger.

4. Conclusions

In this work were carried out for investigation of heat transfer in gas heater. Namely, was evaluated the influence of steam temperature and gas velocity on its temperature. According to the obtained results, it is evident that to increase the gas temperature (the heat transfer enhancement) it is necessary to increase the temperature of heating media, in our case a pair of, or reduce the velocity of the gas.

References

1. L.I. Korobeynikova, A.Y. Gil. Bulletin of the Tomsk Polytechnic University, **316**, 105 (2010)
2. G.A. Ryabov, O.M. Folomeev, D.A. Sankin, K.V. Khaneev, I.G. Bondarenko and D.A. Mel'nikov. Power Technology and Engineering, **44**, 137, (2010)
3. A.V. Gil, A.V. Starchenko. Thermophysics and Aeromechanics, **19**, 503 (2012)
4. Gil A.V., Zavorin A.S., Starchenko A.V., Obukhov S.V. Power Technology and Engineering, **45**, 42 (2011)
5. A.M. Bubenchikov and A.V. Starchenko**,** *Numerical Models of the Dynamics and Combustion of Aerodisperse Mixtures in Channels*, (Tomsk State Univ., Tomsk, 1998)
6. A S Zavorin1 A V Gil1 P S Khaustov1 R B Tabakaev1 and D A Buslov. IOP Conf. Series: Materials Science and Engineering **66** 012038 (2014)