Research on improving the technological parameters of industrial heat tube boilers by intensifying heat transfer by radiation

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The global population is growing at an annual rate of 1.05%, and at this rate, it will surpass 10 billion by 2057 (Shah *et al.,* 2021). Consequently, the waste generation is also growing proportionally. Municipal solid waste is growing fast. So, we need quick and effective solutions how to reduce waste accumulation worldwide.

Moreover, apart from the increasing number of people, every person needs more and more energy. The last 30 years have seen a worldwide increase in energy consumption, which has risen exponentially from 8588.9 million tons (Mtep) in 1995 to 13 147.3 million tons (Mtep) in 2015 (Dong, Dong, & Jiang, 2019). The average consumption of electricity in European Union was about 7.409 kWh in 2008 (Esposito, 2023).

Energy efficiency is in itself a key element of any policy to ensure economic, inclusive, and sustainable growth.

We can produce heating energy by burning large quantities of fuel or we can constantly look for ways to use fuel burning more efficiently and reduce waste heat and make fuel burning more efficient.

Some of widely used methods of heat improvement and solid waste reduction are combined heat and power (CHP) systems, the using of economizers, gasification etc. It is necessary to use these methods and perpetually upgrade them.

The users of industrial heat tube boilers needs lower costs which is possible by reducing equipment prices and fuel costs. That's why we need to use solid waste as a fuel.

Heat production by burning solid waste is not a new technology and scientists are constantly searching for new ways to make it more effect.

There is a need to constantly increase the efficiency of heat transfer. In order to reduce waste heat and to produce smaller boilers there are widely used turbulators/inserts. Mostly used turbulators are twisted tape, wire coil, swirl flow generator and others. Main feature of turbulators is to create swirls and secondary flow, in general to increase heat transfer by convection.

However, as we know from the basics of thermodynamics, heat is transferred by convection, radiation and conduction. The effect of radiation from the turbulator itself on the heat transfer coefficient has not been studied much. We found only a few articles where the heat transfer coefficient of radiation is mentioned, but its influence is not examined in detail.

In this work we studied the overall effect when using turbulator is a tape inserted into the tube. The effect of radiation only appears in high temperature.

We created a balance equation when a radiation-intensifying plate is placed between two infinite plates, and smoke flows between the plates. Also, we simulated modeling and calculations in the MATLAB program. We created a program that allows us to simulate the total heat flow, which consists of the heat flow by convection from the smoke, by radiation from the smoke, and also we estimated heat flow from the heated tape/insert.

The development of the MATLAB model will be further developed and applied to turbulator calculations where a tape inserted into the tube is analyzed.

References

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