CASE STUDY OF ENERGY EFFICIENCY IN AIR HANDLING UNITS WITH HEAT EXCHANGERS FOR RESIDENTIAL APPLICATION IN LATVIA

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ABSTRACT

This paper presents a case study of the heat recovery of air handling units with heat exchangers for residential application in Latvia. The paper will be summarizing the measurements of configuration for air handling units with air-to-air heat exchangers. The research carried out analytical studies analyzing an optimum variant of the energy savings with regard to different type of the air-to-air heat exchangers and their technical performances. The results show that basic methods of air handling unit's optimization should be encouraged due to the potential of energy savings in Latvia's residential area. Reduction of consumption of energy, improvement of energy efficiency and optimization of air handling units for the residential area are important issues to address the improvement of indoor air quality.

Key words: heat exchanger, energy efficiency.

INTRODUCTION

The European Union's (EU) as well as Latvia's energy consumption is increasing each year, thus increasing the dependency on external oil and gas suppliers. EU buildings consume 40% of the total energy consumption in Europe. It has been predicted that by the year 2020 energy consumption of air-handling systems will increase two times, and it should be limited to a higher standard for air handling units (AHU). In private houses mechanical ventilation with heat recovery has become common. Natural ventilation is not suitable for use in cold climates due to the cold supply of air that creates drafts and heat losses of ventilation. According to researchers in Scandinavian countries, mechanical ventilation with heat recovery is compared to natural ventilation and extract fans. It is found to be the most effective system for maintaining a low humidity level. But the biggest challenge is to find solutions to avoid ice forming in the heat exchangers reduce electricity consumption for the fans and deal with pressure drop reduction in ventilation systems (J. Laverge, A. Janssens, 2012; Kragh J., Rose J., Svendsen S. 2013; Borodiņecs, A., Kresliņš, A., Dzelzitis, E., Krumiņš, A. 2007).

This paper presents a case study of available types of air-to-air heat recovery in air handling units for residential houses in Latvia. In the article test data from measurements of pressure, air flow tests for three different types of heat exchangers and measurements of power consumption have been presented. Comparison was made of heat exchangers to search for an optimum variant of the energy savings and optimization. Reduction of energy consumption, improvement of energy efficiency and optimization of air handling units in residential area is important to address the improvement of indoor air quality.

MATERIALS AND METHODS

According to statistics, new standard private houses in Latvia have an average area of 200 square meters - 2 floors, a living room and a kitchen and toilet on the first floor, on the second floor - 3 bedrooms, one toilet and bathroom, usually combined. The air handling units with 400 cubic meters of air per hour and heat exchanger of air-to-air type were usually selected. Using equipment sales data collected from 2000, it can be concluded that since 2000 originally only air handling units equipped with plate heat exchangers were used, that can be explained by a limited offer from manufacturers and building technologies. Since 2005, setting up air handling units with rotary heat regenerator has become popular in Latvia. But in recent years, statistics showed a significant increase in the units with rotary heat regenerator- 75%, in 24% of cases with a counter flow heat exchangers that are associated with the European Union's goals to reduce energy by 20% by 2020, and support programmes, and only in some cases the equipment with plate heat exchangers will be used.

According to one of Latvian internet surveys- during the winter time most of the population, 70% of people spend less than one hour a day in the open air. It shows the importance of indoor air quality of houses.

The measurements were performed in Systemair AB Research& development laboratory. The test setup was in accordance with BS 848, AMCA standard 210-99 and DIN 24 163.

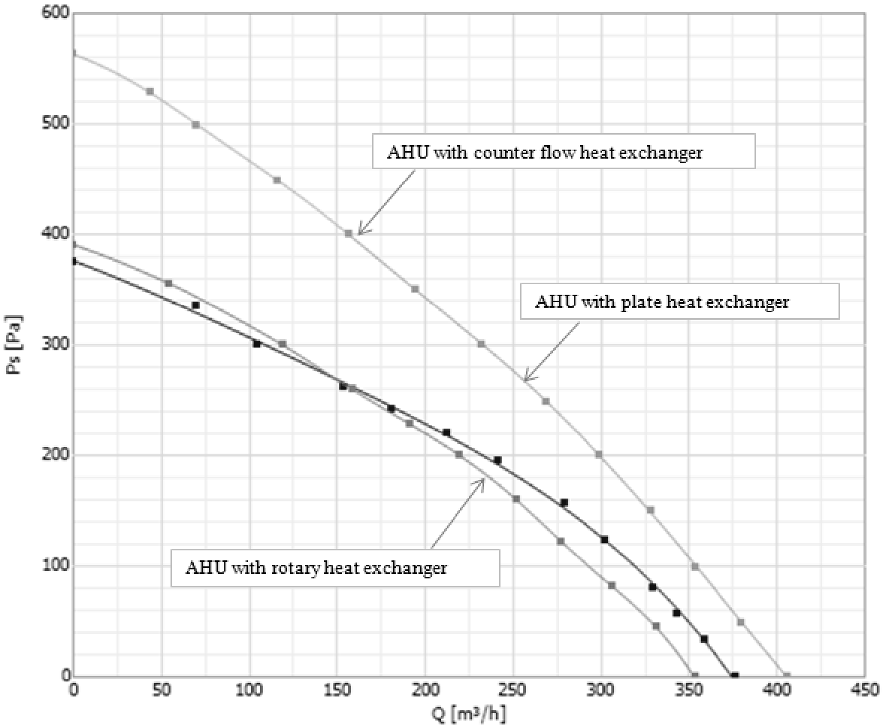

Figure 1. Supply side air flow and pressure diagram for air handling units with different type air-to-air heat exchangers, where Y – pressure, P_s (Pa); X – air flow, Q (m^3/h)

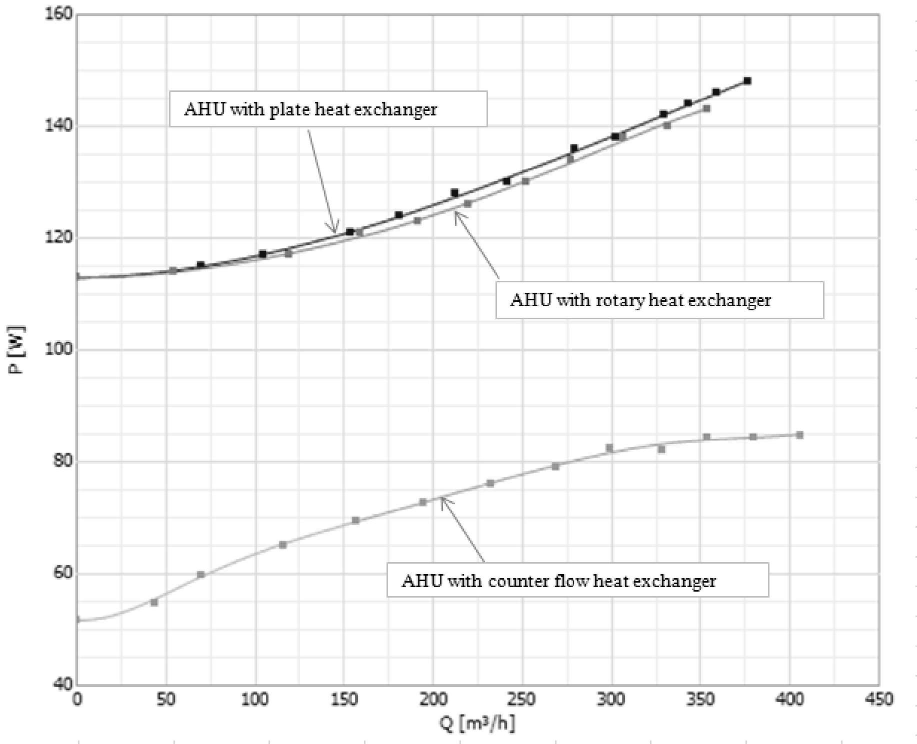

Figure 2. Power consumption and air flow of supply side air flow for air handling units with different type air-to-air heat exchangers, where Y – pressure, P (W); X – air flow, Q (m^3/h)

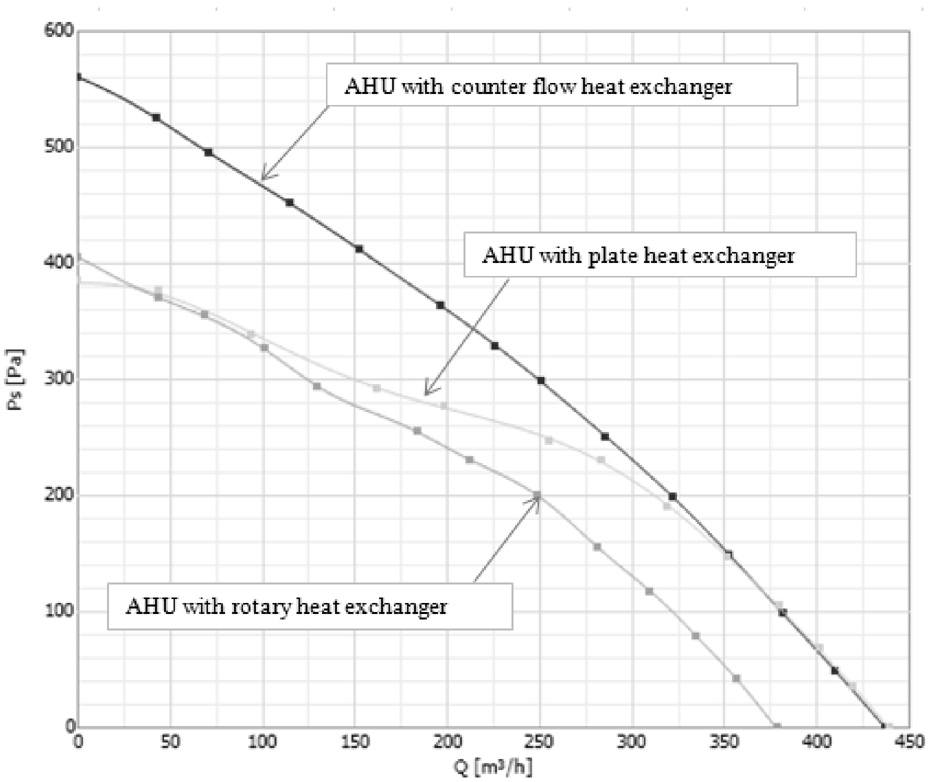

Figure 3. Exhaust side air flow and pressure diagram for air handling units with different type air-to-air heat exchangers, where Y – pressure, P_s (Pa); X – air flow, Q (m^3/h)

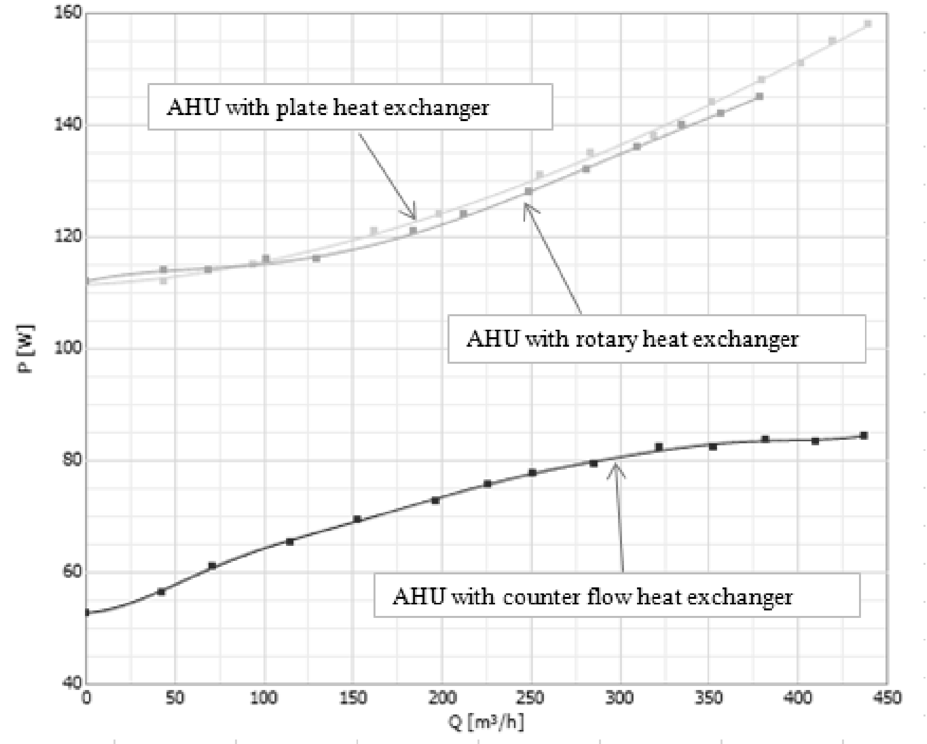

Figure 4. Power consumption P(W) and air flow Q (m^3/h) of exhaust side air flow for air handling units with different type air-to-air heat exchangers, where Y – pressure, P (W); X – air flow, Q (m^3/h)

Air handling units with different type heat exchangers were measured, separately for supply and exhaust units as well as power consumption at the air flows.
In the current research the calculations of heat transfer were made for three air-to- air types of heat exchangers- plate and counter flow heat exchangers and rotary regenerator as well. Calculations were made for Riga area 5 coldest days air temperature -20°C. Heat transfers were calculated base on distance between plates for all three type heat exchangers. The calculations were made in accordance with the European norm EN308 and its sub documents. The selection programs of Heatex AB and Klingenburg Gbmh were used.

Table 1

Heat transfer of heat exchangers

Heat transferred, kW	Nominal plate distance, mm	Type of exchanger
4.3	3.3	Plate heat exchanger
3.8	4.2	
3.2	5.0	
2.7	6.5	
5.2	1.5	Rotary heat regenerator
5.2	1.7	
5.0	2.0	
4.7	2.0	Counter flow heat exchanger

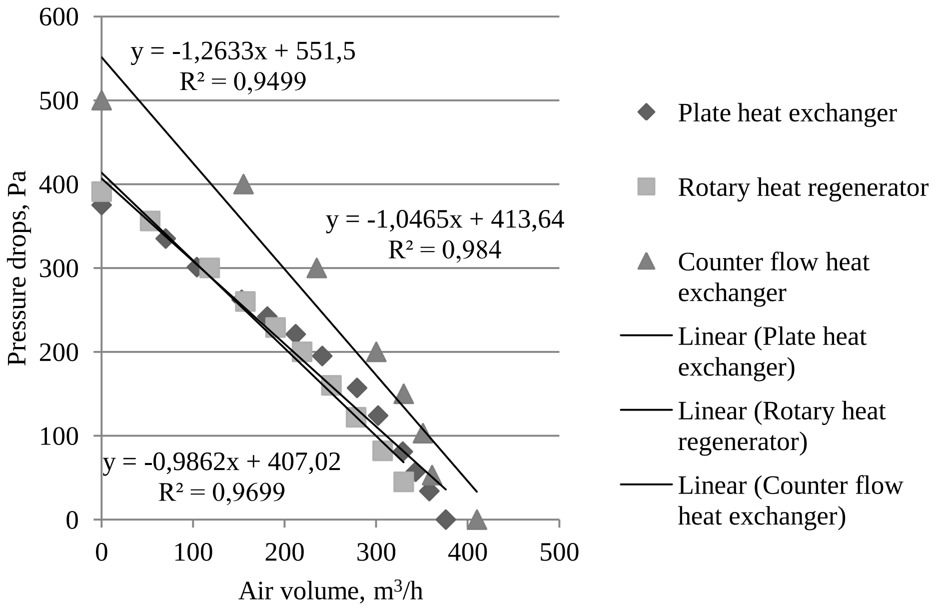

Figure 5. Air flow rate for three different types of heat exchangers

Summarizing the literature sources, calculations and technical options, we can create the optimal air processing for air handling unit configuration, which would be suitable for use under the climatic conditions of Latvia:

1. Air handling units have to be on supply and exhaust fans equipped with electronically communicated motors. It is connected with low energy consumption of this type and it is important if the scenario of electricity price increasing will take force in the future.
2. Rotary regenerator and counter flow heat exchanger provide higher efficiency from heat recovery viewpoint compared to plate heat exchanger.
3. Lower class filters which allow outdoor air pollution. Latvia is environmentally green country with low outdoor air pollution. Usually residential areas are located away from high pollution sources. Low level of outdoor air pollution allowed reduced SFP value for air handling units due to low pressure drops in supply filters.

RESULTS AND DISCUSSION

Within this research analytical studies on three types of air-to-air heat exchangers were carried out. The main focus was to compare air flows at the pressure drops of heat exchangers equipped air handling units. Analyses of diagrams showed significant power reduction due to using new type of fans with EC motors comparing to asynchrony motors used in residential area. Air handling units with counter flow heat exchangers have a good air flow performance. The best air flow performance was provided by air handling unit with counter flow heat exchanger as can be seen in Figures 1 to 4. Table 1 shows the data calculated heat transfer in kW for three different types of air-to–air heat exchangers depending of plate distance.

CONCLUSIONS

According to data from table1, we can see that heat recovery of plate heat exchanger is from 57% to 91% comparing to counter flow heat exchanger. Heat recovery of plate heat exchanger is from 53% to 84% comparing to rotary regenerator. Heat recovery of counter heat exchanger is practically the same comparing to rotary regenerator. All calculations were made for Riga area 5 coldest days by air temperature -20^{o}C at the air flow 400 m^{3}/h. As a result of the test and analysis on the most effective combination of air handling units suitable for Latvia's climate, it can be concluded that the unit with heat recovery rotary regenerator and counter flow heat exchanger combination with fans having electronically communicated motors, proved to be the best.

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