EuroPHit

D5.1.20_Decentralized_ventialltion_unit

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INTELLIGENT ENERGY – EUROPE II

Energy efficiency and renewable energy in buildings

IEE/12/070

EuroPHit

[Improving the energy performance of step-by-step refurbishment and integration of renewable energies]

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0 Abstract

This document describes the new equipment for decentralized ventilation which is designed specifically for educational institutions. However, it can also be used in other types of buildings, such as offices, waiting rooms, auditoriums and others.

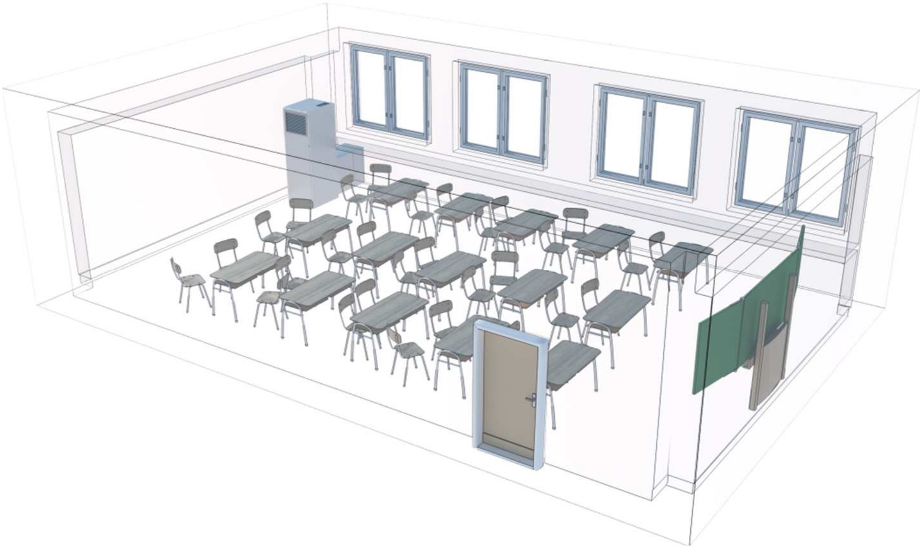

Figure 1: Class overview with decentral ventilation unit

From the perspective of a step-by-step reconstruction it is a very interesting alternative which fully complies with the gradual reconstruction. Particularly, it is possible to realize only part of larger objects with minimal interference with the building layout and the eventual possibility of only preparation of penetrations at the initial stage of the reconstruction.

1 Decentralized ventilation for school or office.

1.1 Product requirement

Requirements and testing procedures for ventilation units suitable for Passive Houses, available for download at www.passiv.de. Thus an effective heat recovery rate must be higher than 75% in combination with power consumption including any controls and auxiliary drives must be lower than 0,45 W/(m^3h).The third very important parameter is acoustic because the maximum sound pressure must be lower the 30dB.

To ensure adequate supply of ventilation air into a typical class intended for 30 children and a teacher, it is necessary to bring at least 600 m^3/h. The unit output thus must meet this minimum level.

Another parameter, which is not subject to direct testing, is the aspect of the overall design. Visual aspect becomes very important in this case, especially for school buildings. Therefore, in the framework of the proposal, there will be an effort to keep simple lines and comply with the possibility of additional covering consistent with the interior.

For the decentralized units considered for the spaces with more people, products which fulfil their primary function very well are now available. So it is a good solution in terms of ventilation, however, sometimes with a higher cost. The last parameter for a comprehensive assessment of the product is then the price of the product; for the technologies now available it is in the range of € 5,000 - € 10,000 according to their equipment and technical characteristics.

2 Unit description - construction

Within the study, the final prototype of the equipment was designed and then tested in laboratory conditions and also in the context of real operating conditions for a pilot installation.

2.1 Unit topology

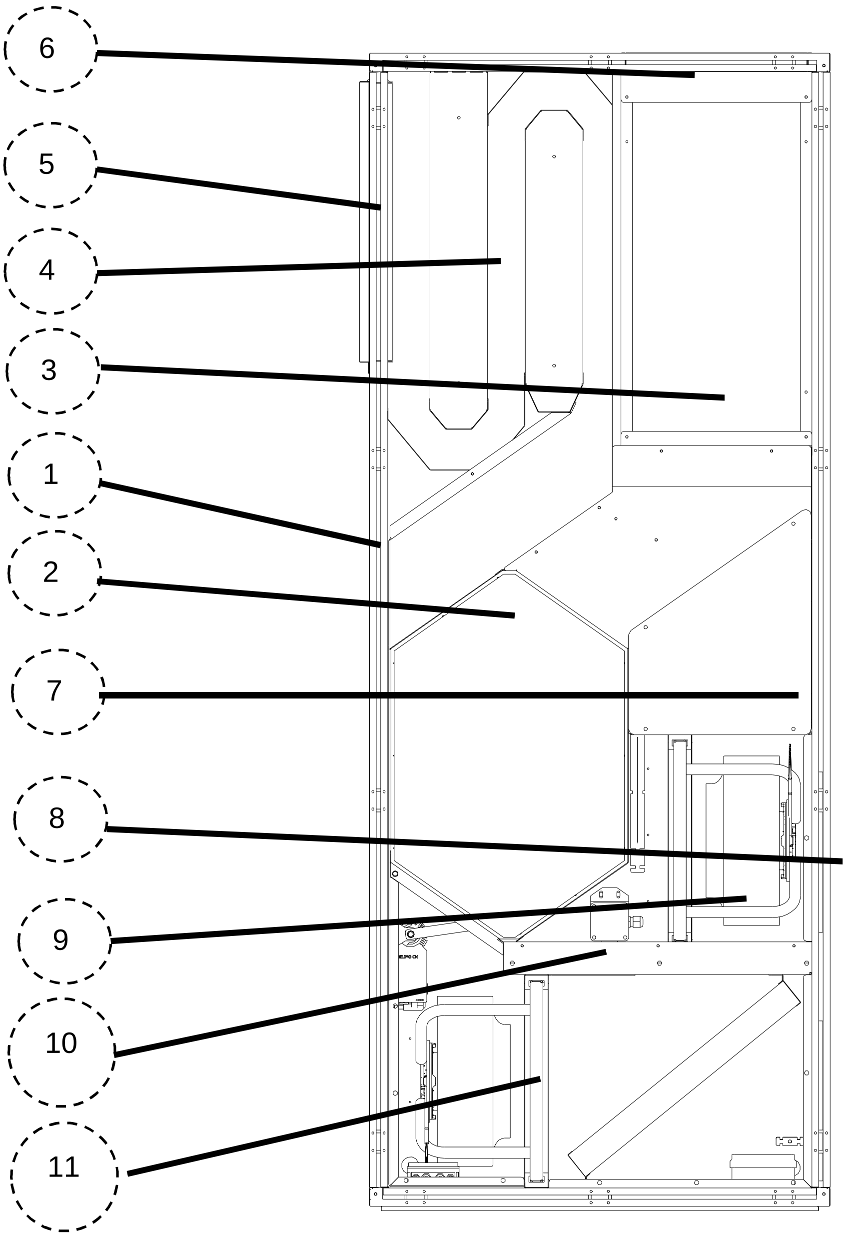

Figure 2: Description of the whole unit

Description: 1 – unit casing with mineral whole; 2 – counter flow heat recovery core; 3 – labyrinth silencer for supply side; 4 - labyrinth silencer for exhaust side; 5 – exhaust air intake grill with cartridge filter; 6 – supply air grill with adjustable blade; 7 – build in regulation module on rail system for easy access; 8 – round connection port for fresh air intake and exhaust air outlet; 9 – exhaust fan casing behind the doubled baffles; 10 – condensate drain with evaporated instrument 11 - supply fan casing behind the doubled baffles with supply air filter.

2.2 Heat recovery core

Countercurrent swirl flow heat exchanger designated as S4 was chosen for this equipment type. This is the type designation according to the manufacturer, the company ATREA s.r.o. The exchanger is characterised with a high efficiency heat recovery while maintaining a reasonable pressure loss.

The material hPS is used for the manufacture, the entire height of the recovery unit is composed of 135 panels while keeping the gaps of 3.2 mm between them, and thus the overall height of the unit is 430 mm.

The heat exchanger is designed for the heat recovery without moisture transfer. The heat exchanger is integrated into the structure of the unit so as to ensure easy service - removal of equipment and its maintenance. Measured efficiency according to EN 308 (the so-called dry efficiency) is in the range of 80-83% depending on air power.

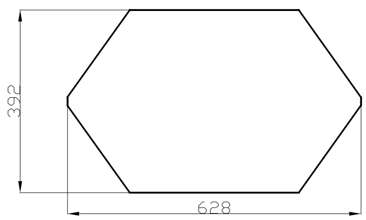

Figure 3: Size of the one plate from heat recovery core

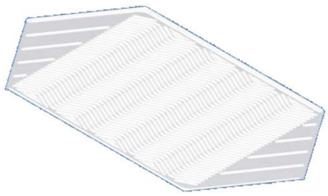

Figure 4: Detail of the plate from heat recovery core

2.3 Condensate drain

Due to the measured dry efficiency of the heat recovery, it is necessary to take into account the formation of condensation on cold days. For the purpose of the concept of this unit, atypical solution has been proposed that does not require additional connection to the sewer system.

The solution consists of a collector for condensate generated at the output of exhaust air from the unit, a level sensor and an electrical resistance element. The system starts automatically when reaching the level, and the excess amount of condensate is then evaporated by heating into exhaust air. The output of the whole assembly is only 200W.

In terms of operation, the whole system was tested under the operating temperature in the exterior from -3°C with a maximum discharge of 1.8 L of condensate. This test was successful.

Thanks to this system, the installation of the entire equipment is greatly simplified. Location of the system is shown in Fig. 2.

2.4 The fan

For a maximum operational efficiency, fans with EC motors type impeller and backward curved blades are used for the ventilation and air exhaust. This system is used due to a very low power consumption and maximum efficiency.

Control is performed using analogue signal 0-10V by which both motors are controlled simultaneously.

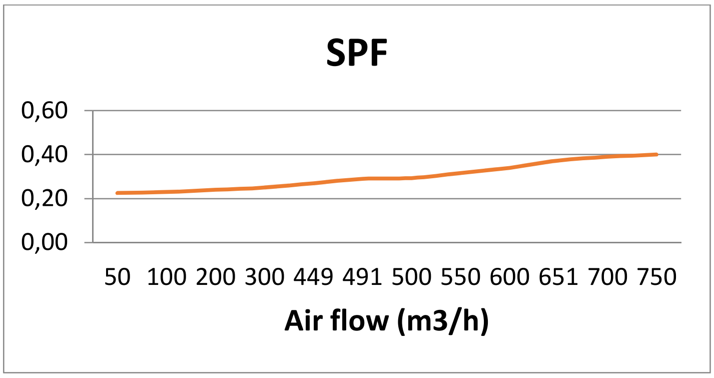

Figure 5: Power consumption for whole unit – two fans and regulation

2.5 Build in regulation module

Installed control module provides comprehensive operation so as to achieve the most economical operation and corresponding control options. The main control parameter is the concentration of CO_2 which is monitored by the integrated concentration sensor. Based on the measured value, the output of the unit is adjusted according to the analogue signal 0-10V.

It also includes a bypass valve, which allows, according to the set inlet temperature, to ensure passive cooling of the space. Also, it includes the function of night-time overcooling, which helps prevent indoor overheating during hot days.

Standard feature is a built-in web-server which allows remote management and control of the unit. The function can be used for the remote setting of a weekly program, checking the status of the unit incl. notification of fault conditions.

Figure 6: Comfortable rail system for easy access towards regulation module

2.6 Air filtration

The basic equipment of the unit includes a pair of air filters. The first is located on the fresh air intake in the class, filtering degree F7. The second is located on the exhaust air intake from the class, filtering degree G4. This ensures the filtered fresh air supply and protection of the recuperative heat exchanger.

2.7 Unit casing and size

To achieve the maximum attenuation of the casing, sandwich structure with the following composition: inside plate 0.8 mm/mineral wool insulation 30 mm/outside painted plate 0.8 mm is used. Within the details, thermal bridges were also solved, where individual contact parts are disconnected so that the structure exhibits the smallest possible burden in the form of thermal bridges. According to the legislative requirements, the casing meets classes T2 and TB2 without major reservations.

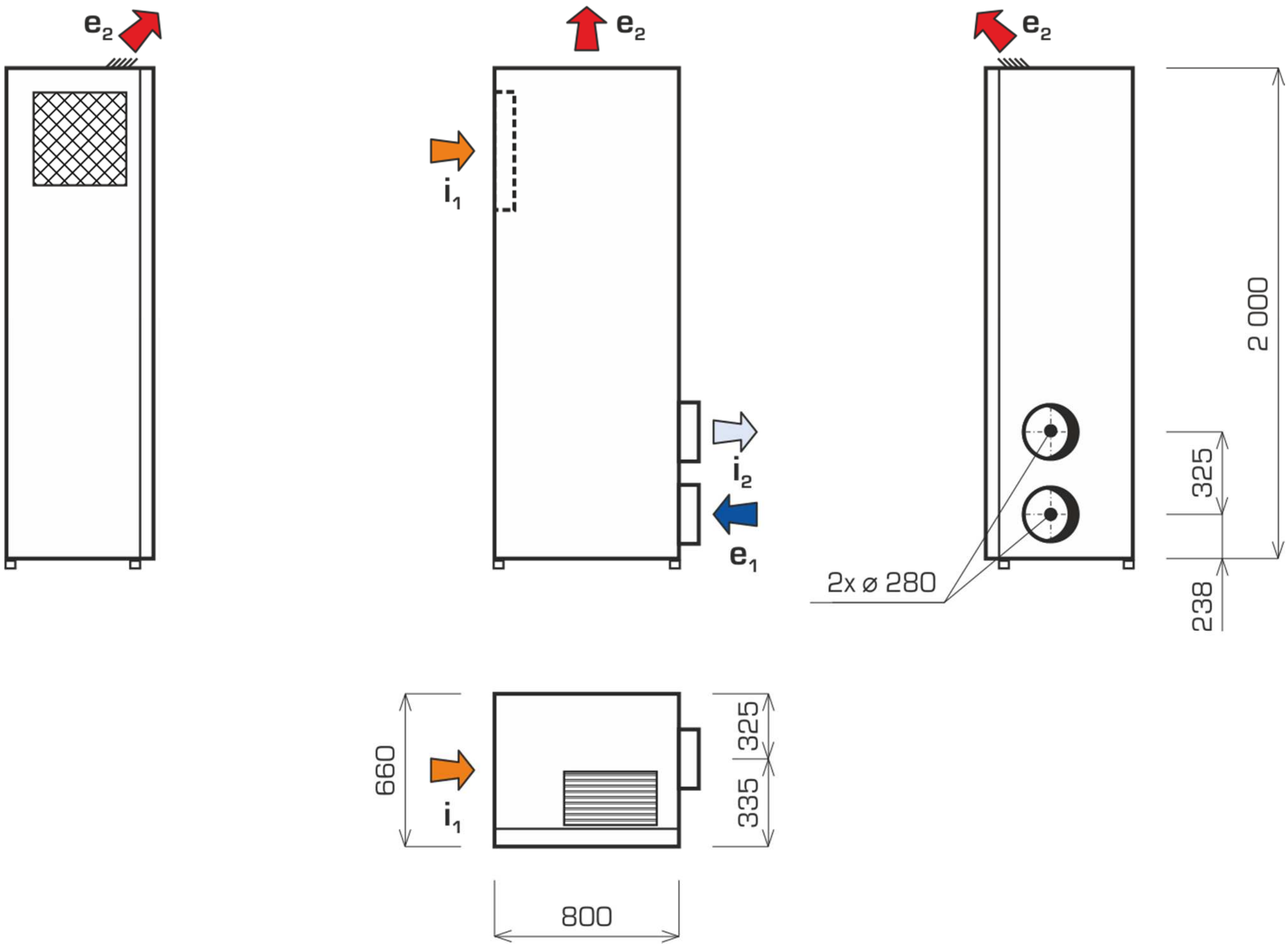

Figure 7: Unit size

Description of the connection port: E1 = ODA / E2 = SUP / I1 = EXT / I2 = EHA

3 Pilot project with unit porotype

For the best inspection of all functions of the unit, a pilot installation was implemented in a class at the primary school in Jablonec nad Nisou.

3.1 Unit installation

Stand alone structure allows to perform all hard work - internal penetrations through the perimeter construction - low above the floor. Furthermore it is not necessary to provide a sufficiently sized anchoring to the ceiling structure, as it is for the ceiling design, which is very difficult especially in older buildings, where sufficient static load of ceiling structures is not ensured. The entire installation has been completed within a few hours, which is one of additional benefits of decentralized ventilation units of this design.

Figure 8: Most important part of installation – drilling of holes through the façade

Figure 9: Final results of the installation

4 Most important parameters measurements

Within testing, a series of tests was performed during the construction of the prototype. The following are the outputs from the final tests performed by several methods.

4.1 Performance parameters – air laboratory

The test of the major parameters was performed as first - maximum output and acoustic values within the measurement lab. Through this measurement, the requirement to achieve at least **600 m3/h** of ventilation air was verified. Within the measurement, max. working point at the level of **700 m3/h** was used.

In the second part, sound pressure to the surrounding area measured at a distance of 1 m from the unit was verified in the laboratory conditions. The measurements showed that even in the laboratory the requirement to achieve $\mathbf{L_{PA} = 30\ dB}$ was satisfied.

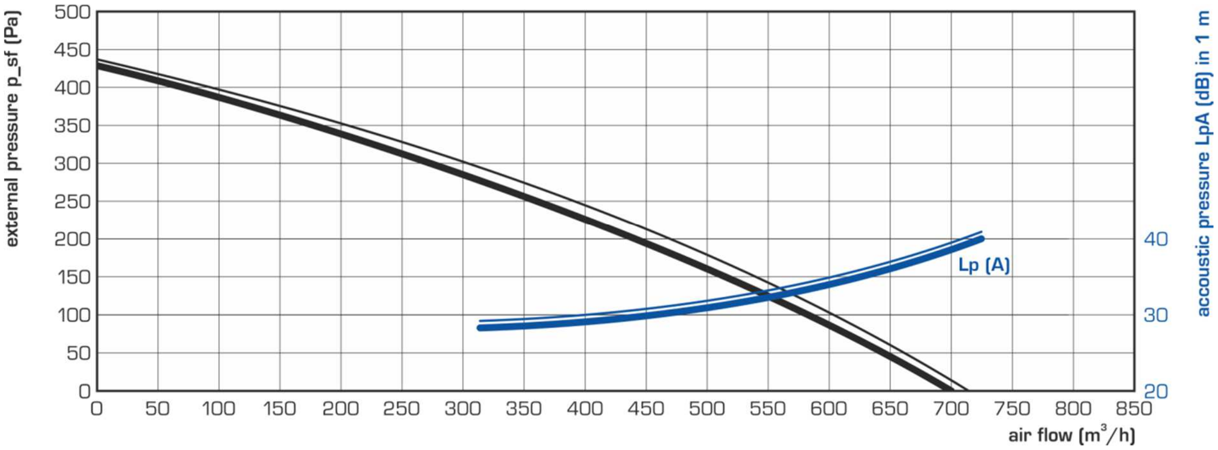

Figure 10: Graph for air performance and sound pressure

4.2 CFD simulation for air velocity and temperature

For proper and convenient function of the units, which are located directly within a ventilated space it is also required to comply with the maximum air velocity. To ensure the faultless operation, the velocity in the zone of movement of persons must be ranged from 0.15 to 0.2 m/s-1. For a comprehensive inspection of the function of the proposed concept, evaluation of the internal temperature was performed in simulated conditions.

<u>Boundary conditions of the calculation:</u>

- Air supply 500 m^3/hod at the speed of 2.85 m/s
- Inlet air temperature 18°C
- Classroom dimensions 6 x 10 x 3.75 m
- Number of users - 24 students + teacher
- Calculation day - February 15, 9:00
- Outer and inner walls made of solid firebricks (th. of 450 and 300 mm), without insulation

- Windows U_w = 2.4 W/(m^2.K), 30% glazing
- Only wall with windows is cooled, the remaining walls, ceiling and floor without heat flow

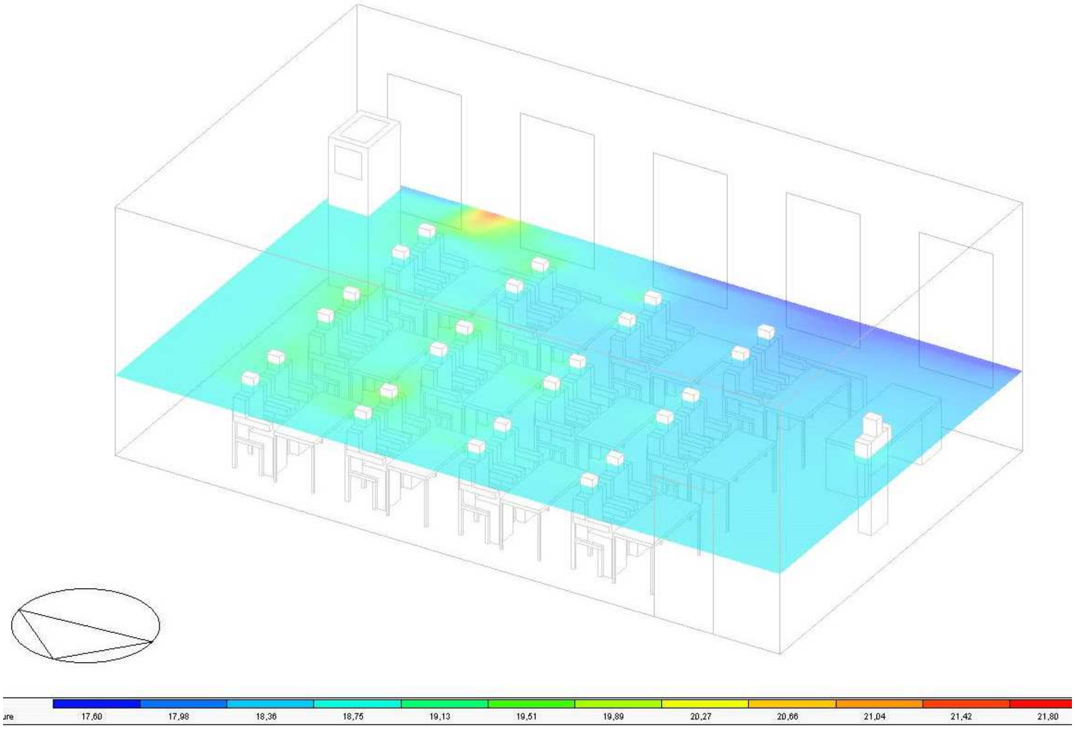

Figure 11: temperature CFD analysis for class temperature – at head high

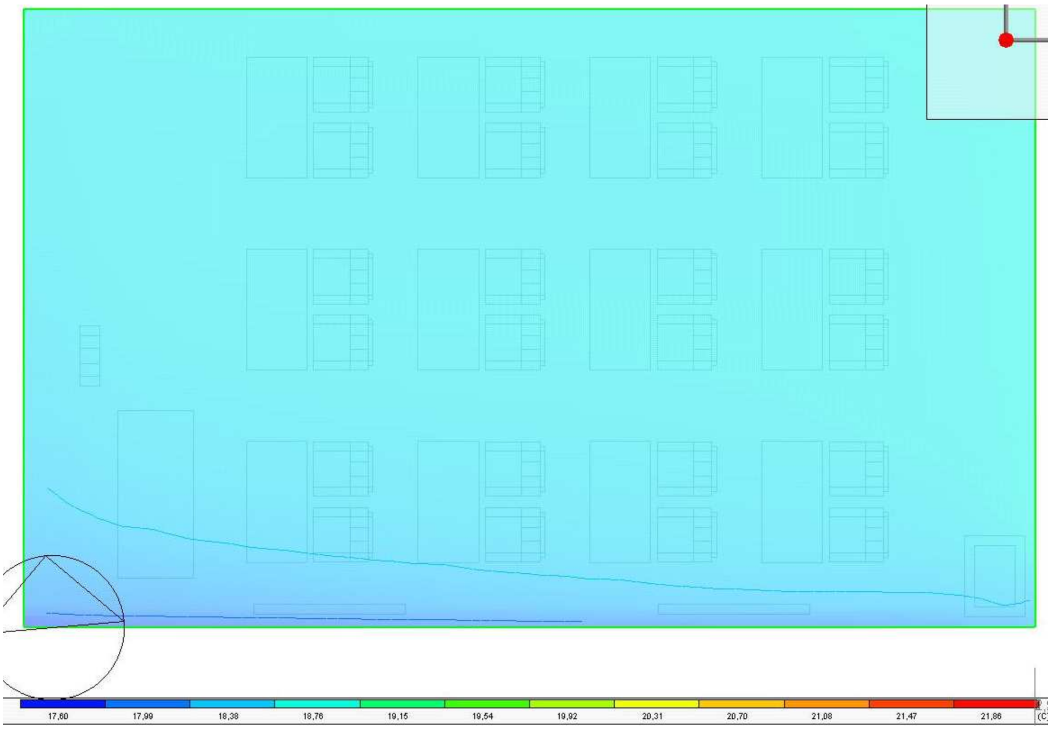

Figure 12: temperature CFD analysis for class temperature – under the roof

The results of the velocity profile confirm the specified maximum velocity values. These are ranging below **0.2 m/s-1** in the crucial area - the level of heads, shoulders of sitting students.

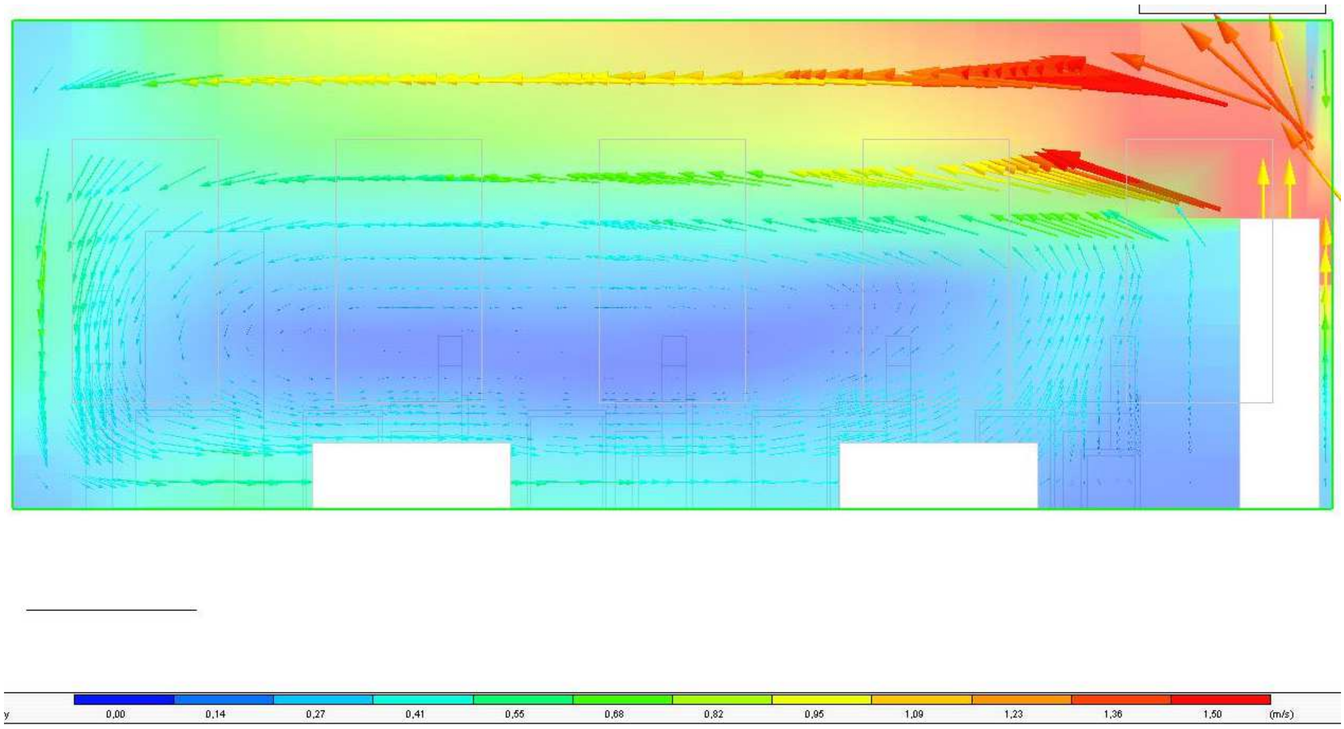

Figure 13: air velocity CFD analysis for class temperature – vertical class cut

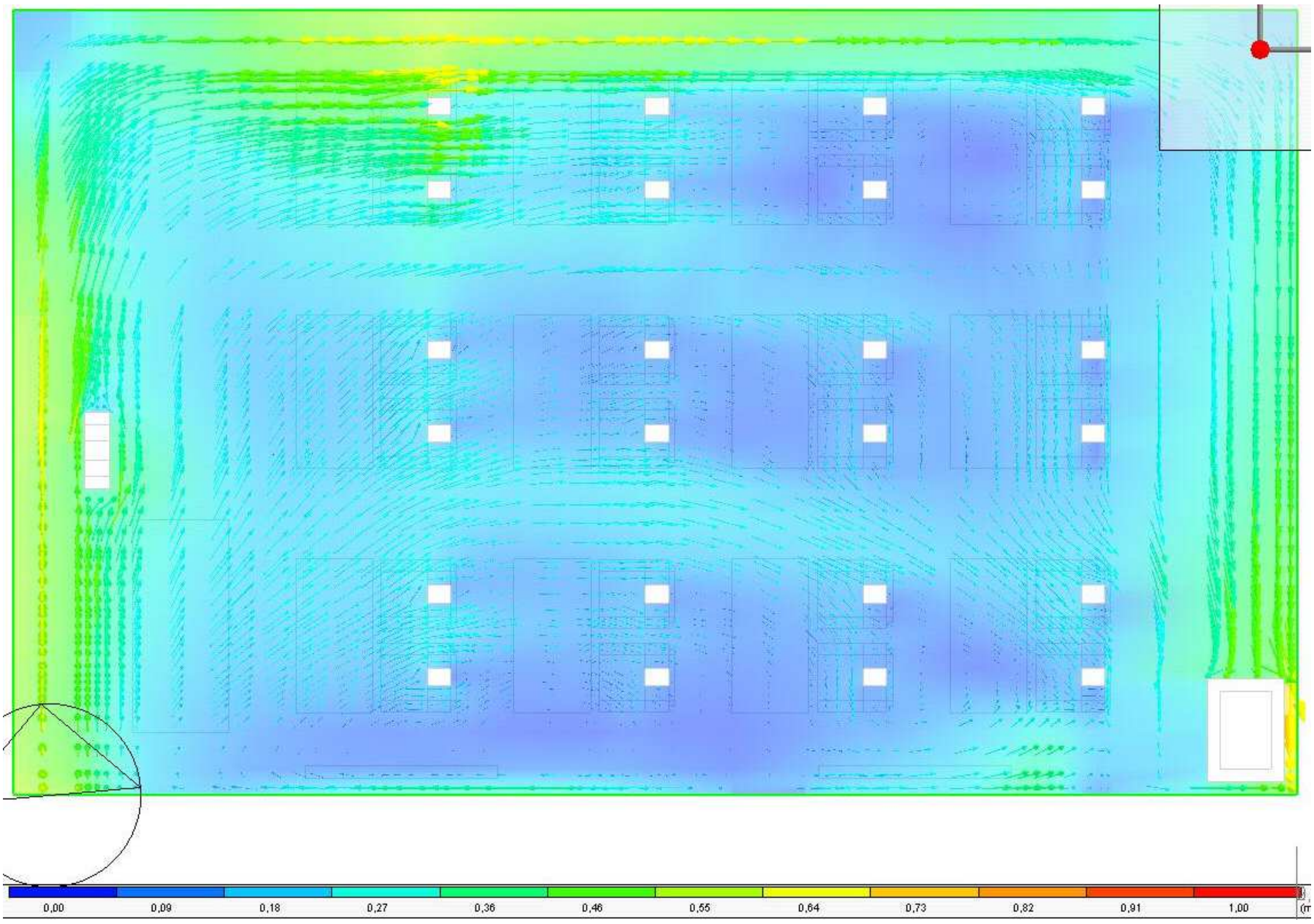

Figure 14: air velocity CFD analysis for class temperature – vertical profile

4.3 Confirmation from the real class – pilot project

As confirmation of the CFD analysis, the real measurement on the prototype placed in the pilot project class was also performed. The reason was a quite clear declaration of the technical parameters measured in the laboratory.

The measurement of acoustic parameters must certainly be indicated as the main parameter. **The class size is 6 x 10 x 3.75 m and max. capacity is 30 children** and one teacher, the capacity during the class usage is full.

Figure 15: professional approaches to the real measurement

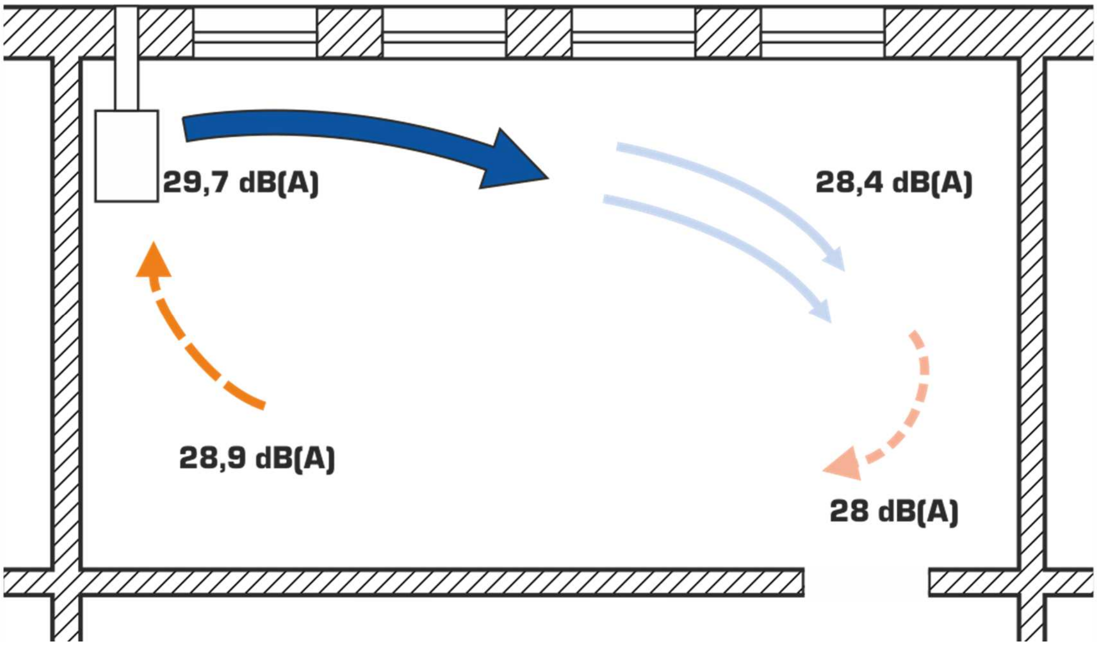

Figure 16: Real acoustic profile from class – acoustic beckground 27,4 dB

Two records of the CO_2 concentration were taken with the full class capacity (30 children); the records are shown below. During recording, when the unit was not operated, 2-4 windows were open during teaching and yet the concentrations limit was greatly exceeded!

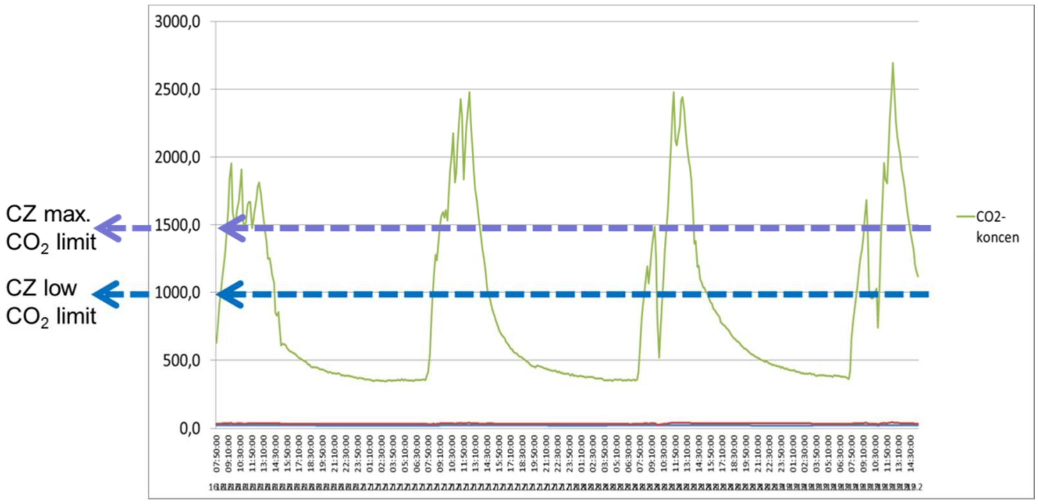

Figure 17: CO_2 concentration before the unit installation

After installing the unit, the situation was quite the opposite. During ventilation, the equipment output was limited to 80%, i.e. to 560 m^3/h. This is inconsistent with the requirements of Czech standards, but in terms of the CO_2 levels the state of the internal environment is absolutely satisfactory.

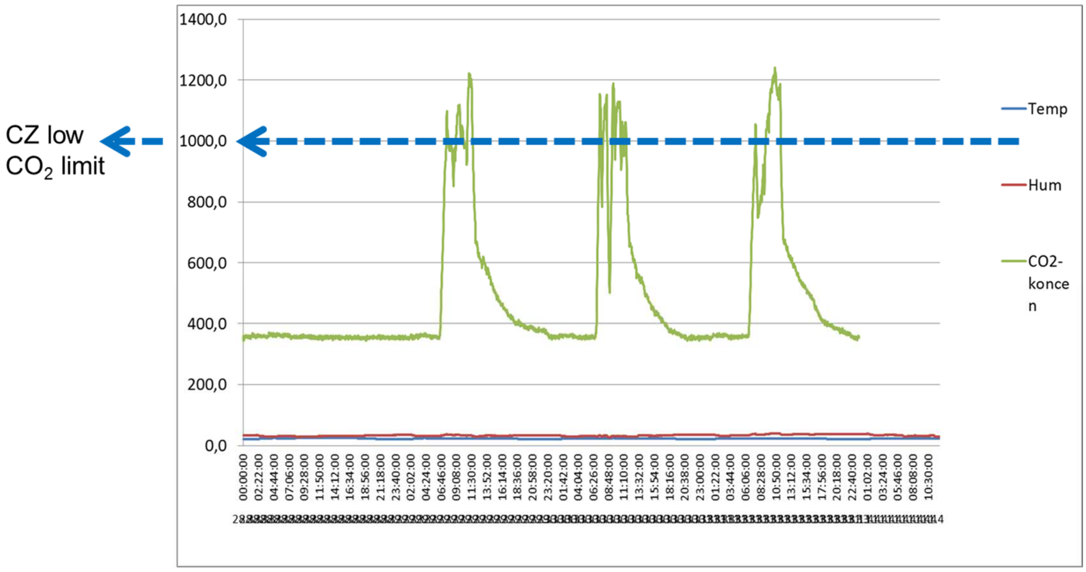

Figure 18: CO_2 concentration after the unit installation

5 Price for prototype

To succeed in a competitive market, competitive price is very important for each product. The initial price was set at € 5,000, and the new equipment should certainly fit.

Ventilation unit calculation				
Heat recovery core hPS - S4		kpl	1,0	143,-
Mechanical parts -casing		kpl	1,0	485,-
Fan - R3G280-RB02-03 (EBM)		ks	2	300,-
Nozzle for fan EBM		ks	2	13,-
Others mechanical parts for fan		ks	2	17,-
Filter - cartridge G4 500x500x12		ks	1,00	9,-
Filter - cartridge F7 400x400x48		ks	1,00	14,-
CO2 sensor ADS CO2 24V, 0,10V		ks	1,00	92,-
Smoke sensor		ks	1,00	13,-
Assembly		hod	12,5	122,-
Mechanical part overview				1 207,-
Regulation module RD5				281,-
Subtotal				**1 487,-**
Overheads				**667,-**
Total production price for porotype				**2 154,-**
Expected market price				**4 500,-**

The calculation confirmed the estimated production price, which means that the chosen design and the equipment level is more than competitive in the European markets.

6 The final results

While looking through the requirements of paragraph 1 and subsequently confronting them with the stated results, it is absolutely certain that the implemented prototype of the new equipment meets the requirements. Certainly, this represents a good direction, the foundation of the new product that will be certainly competitive on the European market. Due to its design and arrangement, the product is certainly suitable also for the reconstruction.

Final summary of advantages:

- Air volumes up to 700 m^3/h
- Condensate less concept
- Stand alone
- Integrated reheater
- Compact dimensions
- New unified design
- Duct less system – easy for installation
- Minimum requirement for project documentation
- Extra low acoustic parameters
- Excellent values of SFP
- High efficiency of heat exchange
- Integrated Plug & play regulation
- Integrated Webserver (RD5)
- Air quality sensors include
- Smoke sensor include
- Selection software

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