How to consider Air Handling Units in the Ecodesign preparatory studies ENTR Lot 6 and ENER Lot 21?

Introduction

Initial discussions between ENER Lot 21 and ENTR Lot 6 in September 2010, led to include Air Handling Units (AHU) in both lots, an AHU being a ventilation product but also potentially supplying heating and cooling via coils integrated into the product. This was justified with a system approach, i.e. comparing all heating systems in ENER Lot 21, including the ones using an AHU as the main terminal unit for heating, and comparing for instance {chiller + fan coil} cooling systems versus {chiller + AHU} in ENTR Lot 6. The rationale was to compare different heating/cooling systems and to evaluate the global heating/cooling performance for different systems, as was done in 2006/2007 in ENER Lot 1 study for heating systems.

In further discussion with stakeholders and considering the draft Commission measures on room air-conditioners and boilers (based on ENER Lot 10 and Lot 1 study), the system approach was abandoned in favour of an (extended) product approach. Consequently, the analysis of Air Handling Units (AHU) in ENTR Lot 6 and ENER Lot 21 should be reconsidered. The (extended) product approach for air conditioning and air heating systems will primarily evaluate the energy consumption of the heating/cooling generators. And the AHU characteristics will influence these consumptions. However, the AHU is primarily a ventilation product. As such, a potential implementing measure for AHU should only be studied in the frame of the ventilation part of the ENTR Lot 6 study.

Consequently, Armines (main contractor for ENTR Lot 6) and BIOIS (main contractor for ENER Lot 21) proposes not to include the AHU as one of the main products and base cases in the air conditioning study of ENTR Lot 6, nor in the heating study of ENER Lot 21 study, but only in the ventilation part of ENTR Lot 6. It will be still considered as a system component for heating generators in ENER Lot 21 and for cooling generators in the air conditioning part of ENTR Lot 6.

The reasons why are discussed in more details below.

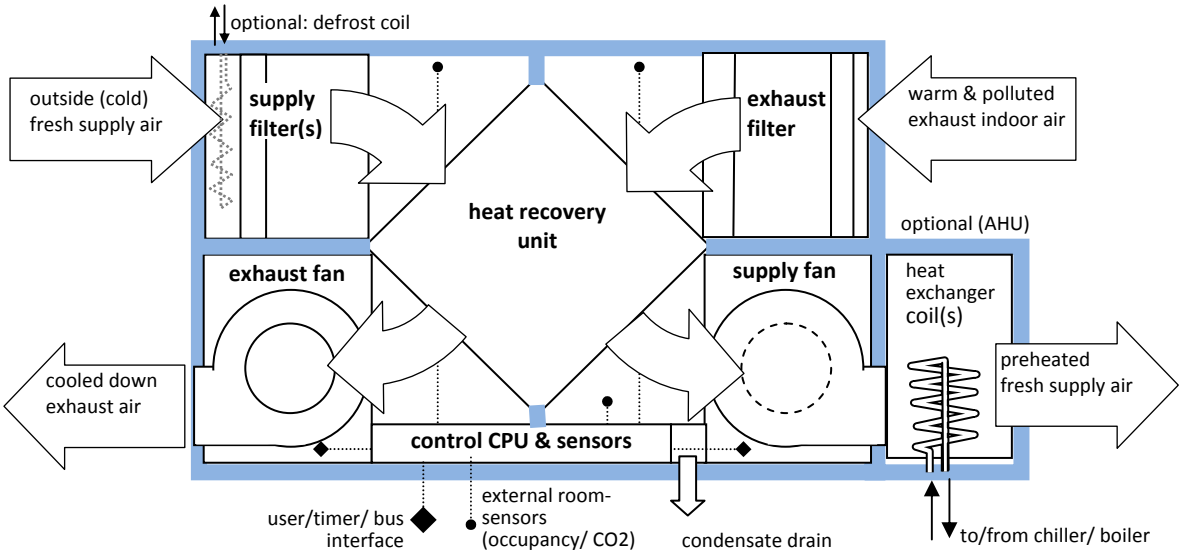
1. Air Handling Units' description

AHU's primary function is ventilation. Heating and cooling are possible secondary functions attributable mainly to a separate heating and cooling generator.

The definition of an air handling unit, given in the ENTR Lot 6 ventilation study, is :
« Factory made encased assembly consisting of sections containing a fan or fans and other necessary equipment to perform one or more of the following functions: air supply, air exhaust, filtration, heat recovery. Additional functions may be integrated (heating, cooling, circulation, (de)humidifying, air mixing). »

The figure below shows the figure of an AHU equipped with a heat recovery heat exchanger.

Figure 1. Air Handling Unit, with heat recovery (winter operation)



2. An Air Handling Unit is a Ventilation Product

In most cases the AHU's heating and cooling functions are not supported by the AHU itself, but by separate heating and cooling generators. The consequence for the AHU of the integration of heating/cooling coil is an increase in the fan energy consumption.

The interaction between ventilation and heating/cooling systems is limited. Most of the space cooling (and air heating) in today's modern buildings is done by water-based centralized systems (by chillers for cooling, and boilers for heating).

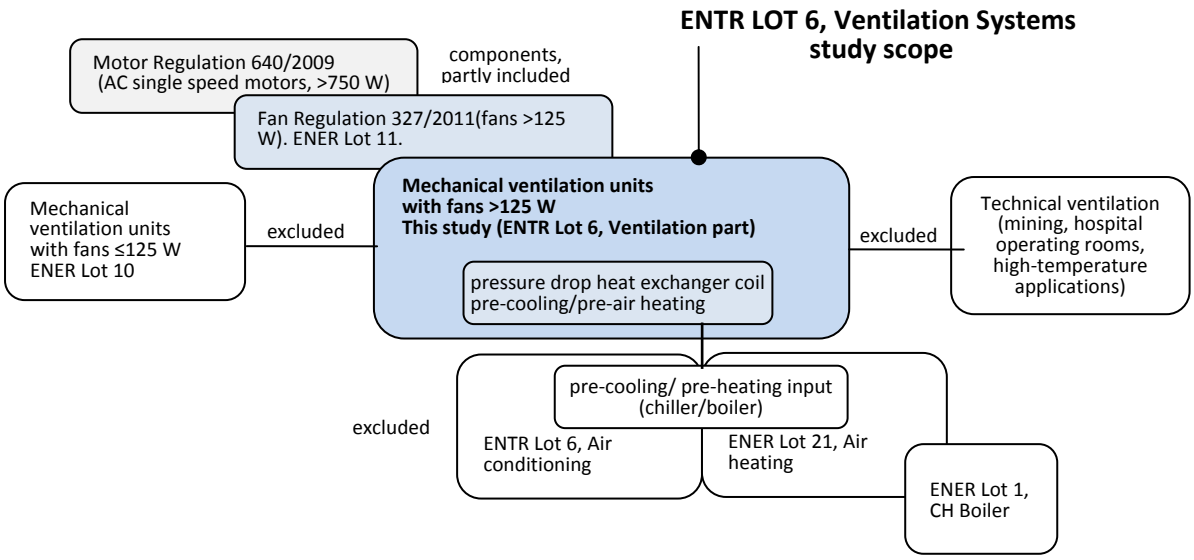
The AHUs provide pre-cooling (pre-heating) of the ventilation air and thus take care of only a relatively small part of the cooling (heating) load. In addition, the energy for pre-cooling (pre-heating) does not come from the AHU itself, but is provided by an external source, such as a chiller (boiler or furnace).

The energy consumption for pre-cooling and pre-heating is included in the energy balance of heating and cooling products in the Air Conditioning part of the DG ENTR Lot 6 study and in the DG ENER Lot 1 (CH boilers) and Lot 21 (central heating products using hot air) preparatory studies.

The energy use of the motor fan of the AHU attributable to the pre-cooling or pre-heating function comes from the extra pressure drop over the heat exchanger (the 'coil') that makes the fan motor work a little harder.

However, as most AHU products are equipped with cooling and heating coils, these extra pressure losses increase the energy load for ventilation that is to be taken into account in the ventilation part of the study in the description of the AHU base case, as it is the more likely situation.

Figure 2. ENTR Lot 6, Ventilation's study scope with respect of related measures and studies



Manufacturers rate AHUs on the basis of their electricity consumption and efficiency to recover heat lost while bringing outside air into the building for the ventilation function[1]. The consequence of the presence of cooling and heating coil is duly taken into account when assessing the AHU performance by the additional pressure loss linked to the heating/cooling coils in the AHU (which increases electric consumption). The ventilation part of ENTR Lot 6 preparatory study builds upon this existing rating scheme, adding the ventilation controls to minimize the heat losses due to the ventilation function while maintaining the Indoor Air Quality.

The stakes of the ventilation study are then, by order of importance:

- to foster the development of energy recovery in the ventilation units to save space heating/cooling energy; about ¼ of the building energy for heating is due to ventilation, a large share of which can be recovered using heat recovery ventilation, at the energy cost of providing mechanical ventilation,
- to limit the electricity consumption of the fan/motor/drive assembly; the electricity consumption, once converted in primary energy, is typically 1/3 of the recovered heating energy in modern AHUs.

3. Air Handling Units used in « all air » Air Conditioning systems

AHU may be used in « all air air conditioning » systems as the main heating/cooling terminal unit in addition to their ventilation function. However, the same product is used both for a ventilation AHU and for an « all air conditioning system » AHU, the difference between both system designs intervenes at the time of the installation and is then rather an EPBD issue than a product one. As the market share of these installations is decreasing steadily, their field of application being more and more restricted to specific situations as large halls, it is not necessary to consider a specific base case for AHU used in these systems in the ventilation part of ENTR Lot 6.

[1] See e.g. Eurovent Certification Programme for AHU: www.eurovent-certification.com/en/Certification_Programmes/Programme_Descriptions.php?lg=en&rub=03&srub=01&select_prog=AHU

AHU may be used in « all air air conditioning »[2] systems as the main heating/cooling terminal unit in addition to their ventilation function. In that case, the cooling/heating energy supplied by the cooling/heating coil of the AHU does not only serve the pre-cooling/pre-heating of the ventilation air, but also ensures the extraction of the room or zone load.

In that case, the fan, motor and drive of the AHU air flow are oversized as compared to the ventilation needs (by a factor of 2 to 8 depending on the specific building load and ventilation requirements). This enables the AHU to recirculate the local air in order to cool/heat more efficiently (e.g. recirculated air in peak summer conditions is at 26 °C and outdoor air at 35 °C). Because of the large fan power, the distribution aspect of the air conditioning system is rather inefficient, but these systems offer more scope for air-side free cooling or night ventilation to reduce loads. The distribution energy consumption can be improved by using a variable speed drive[3] in order to operate more efficiently when the air flow is reduced because of a low heating/cooling load. With this option, « all air air conditioning systems », so-called « Variable Air Volume » systems, may compete with water or refrigerant-based cooling systems.

However, in practice, the AHU product in this so-called « all air system » is the same AHU product as the one used only for the ventilation function. Simply, for design heating/cooling load requirements, the recirculation dampers are locked in a position so that the outside fresh air inlet required for ventilation purposes is only a fraction of the supplied air to the building, the remaining part of the supply air being recirculated air. The only product difference may be the incitation to add a variable speed drive in order to cope with lower loads. Nevertheless, the inclusion of variable speed drives is encouraged in ventilation AHUs by the development of more sophisticated indoor Air Quality controls (CO2 sensors for instance).

This type of so-called « all air systems » was common in the past but is declining: it represents about 30 % of the 2010 stock of cooled m^2 in commercial buildings versus only 5 to 10 % of the newly/retrofitted cooled m^2 in commercial buildings in 2010 (ENTR Lot 6 – Air conditioning report - Task 2). This also means about the same share of AHUs in total is dedicated to these all-air systems, i.e. about 10,000 all air systems compared to the total of 200,000 AHU units, though these are likely to be large AHUs because they are hanbling recirculated air.

In addition, the same AHU can be installed in practice as a ventilation unit or as part of an all air air conditioning system. As shown above, this is rather a system design issue falling into the field of the Energy Performance of Buildings Directive than a product issue. It then seems appropriate to base the ratings of AHUs on the most common situation, i.e. on the AHU design for ventilation and pre-cooling and pre-heating, and not on the design for the main heating/cooling loads.

4. What about Air Handling Units with an integrated cooling / heating generator?

The integrated cooling/heating products in AHU can be evaluated for their heating/cooling performance, independently of the ventilation performance of the AHU. A metric based on the prEN14825 project standard is planned to be used. For AHU sold with integrated air-to-air air conditioners/ air-to-air heat pumps, for which the ventilation function and the cooling/heating may

[2] In “all air air conditioning systems”, a chiller serves the cooling coil of an AHU which provides the cool air to the building to compensate for room loads and to the introduction of hot air in the building. There is no room terminal unit as in fan coil systems.

[3] To be noticed : variable speed drive do not fit all applications of all air systems as large halls where it is suitable to have high air flows to increase the air mixing of the zone to be conditioned.

interact, the performance metrics may be adapted to take into account those specific operating conditions..

Some AHUs may be equipped with a heating/cooling generator integrated in the product.

They can be electrical mechanical vapor compression cycles and then supply the cooling (resp. heating) coil with low (resp. high) temperature refrigerant to cool (resp. heat) the ventilation air. These generators can be either a « high temperature condensing unit » supplying a refrigerant-to-air cooling/heating coil, both products being fitted on site together or pre-assembled by the manufacturer once the coil specification is made available by the building/system designer; or it may also be sold as a single product with pre-chosen design for coils and for the cooling/heating generator, some of them, which may be located on the roof are generally called rooftops[4]. In the first case, the designer first selects the AHU for ventilation and then includes a cooling/heating system for pre-heating/pre-cooling. In the second situation, the rooftop is sold for its cooling/heating capacity and the fresh air rate is adapted to fit with the ventilation flow rate. But at the end, both are combined ventilation/heating/cooling units. Only the ratio of the cooling/heating capacity to the ventilation flow rate varies, depending on the application.

- « High temperature condensing units » supplying a refrigerant-to-air cooling/heating coil are used in less than 10 % of the AHU sold (versus a large majority of water coils) but this is a growing trend. Such cooling generators, reversible or not, are to be integrated in the air conditioning part of the ENTR Lot 6 preparatory study. There is no performance standard for these cooling machines. The refrigeration condensing unit standard could be adapted to include them or matched condensing units and coils proposed by AHU manufacturers could be rated in EN14511 and prEN14825.
- Rooftop heating/cooling generators are presently rated as cooling/heating product (EN14511) and not as a ventilation AHU. Cooling/heating tests are done for 100 % recirculated indoor air, as for split systems. EU sales are less than 10000 units, which represents about 6 % of the newly/retrofitted cooled m^2 in commercial buildings in 2010 (ENTR Lot 6 – Air conditioning report - Task 2). These products are integrated in the air conditioning part of the ENTR Lot 6 preparatory study. It should be discussed whether it is necessary (and then how) to consider the specific cooling/heating conditions due to the ventilation interaction. They should also be rated for their ventilation performance as other AHUs.

In heating mode, the coil may also be supplied with hot exhaust gas or water heated with hot gas by a gas heating generator integrated into the AHU. The heating integrated product can be judged regarding its heating function. It is worth noticing that for AHU including heating generators, different test standards are followed for the AHU (AHU (casing and ventilation): EN 1886) and for the heat generator (Furnaces: EN525, EN676). This supports the argument that the primary function of an AHU is not heating and that the heating generators of AHUs are to be integrated in ENER Lot 21.

Conclusion

In conclusion, it is advised to consider AHUs only in the ventilation part of ENTR Lot 6 study. The heating and cooling generators that could be integrated in part of AHUs, and products such as « rooftops » for which there are interactions between the heating/cooling function and the ventilation function of the product, will be considered in both ENER Lot 21 and in the air conditioning

[4] www.eurovent-certification.com

part of ENTR Lot 6. The analysis of product categories that exist in both studies will still be coordinated by the consultants in the further work.

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