European Ecodesign Directive
2016 and 2018 Heat Recovery Requirements

Oxycom Fresh Air BV*

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Abstract

The Oxycell is Oxycom's highly efficient counter-flow heat exchanger, combining heat recovery, indirect evaporative cooling and dew point cooling. It satisfies all the 2016 and 2018 heat recovery ventilation requirements established in the European Ecodesign Directive/Ökodesign-Richtlinie.

1 Introduction

1.1 Company overview

Oxycom is a Dutch company specialized in the development and production of products and components for adiabatic cooling, indirect evaporative cooling, dew point cooling, air humidification and heat recovery.

Oxycom developed, engineered and manufactures the Oxycell Indirect Evaporative Heat Exchanger and the Oxyvap Direct Evaporative Cooling pad.

The Oxycell is the base of highly efficient all season fresh air systems that provide dew point cooling, indirect evaporative cooling, heat recovery and ventilation. The Oxyvap is the base of highly efficient cooling-only systems that provide direct evaporative cooling, humidification and ventilation.

1.2 Scope of the paper

The European Union published the new European Ecodesign Directive to reduce the energy consumption and environmental impact of various products from more than 40 product groups. For ventilation units, the established efficiency requirements will come into force in the near future.

This paper shows an analysis of the heat recovery ventilation performance of the Oxycell heat exchanger against the new requirements.

2 Oxycell heat exchanger

2.1 Introduction

The Oxycell is a highly efficient counter-flow heat exchanger, consisting of aluminum fins covered with a hydrophillic coating, designed to combine heat recovery, indirect evaporative cooling and dew point cooling.

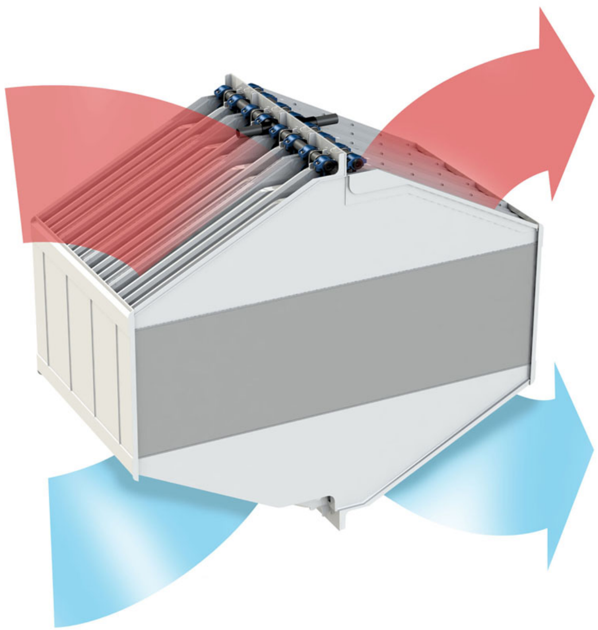
2.2 Models

The Oxycell product portfolio contains a variety of models, only differing in size. This paper focuses exclusively on the Oxycell 1000, the model designed to supply a maximum airflow of 1000 m^3/h. At equal air velocity, performance-related properties (heat recovery efficiency and pressure drop) are independent of the dimensions of the heat exchanger, making the analysis valid for the entire Oxycell product portfolio.

It should be emphasised that the maximum possible airflow is used in cooling mode only (indirect evaporative cooling or dew point cooling); in general, heat recovery ventilation can suffice with a lower airflow rate, typically 250−350 m^3/h for this specific Oxycell model.

*Oxycom Fresh Air BV - P.O. Box 212, NL-8100 AE Raalte - Phone: +31(0)572 349 400 - E-mail: info@oxy-com.com

Figure 1 — Oxycell 1000



Dimensions as seen in the orientation above:

- Height: 639 mm including air dividers, 200 mm for the heat exchanging material only (shown in dark grey).
- Width: 702 mm.
- Depth: 384 mm.

2.3 Validation

The airflow-dependent heat recovery efficiency and pressure drop of the Oxycell 1000 heat exchanger have been tested by TNO in The Netherlands [1], under non-condensing conditions in accordance with EN 308 [2].

Table 1 — Non-condensing EN 308 conditions

Condition	Value
Supply inlet dry bulb temperature	5 °C
Supply inlet wet bulb temperature	Any
Exhaust inlet dry bulb temperature	25 °C
Exhaust inlet wet bulb temperature	14 °C

3 Directive 2009/125/EC

3.1 Introduction

The European Parliament and the Council of the European Union formed the European Ecodesign Directive 2009/125/EC [3] as a framework for the setting of ecodesign requirements for energy-related products. One of the corresponding Regulations [4] relates specifically to ventilation units.

In German literature, the directive is referred to as the Ökodesign-Richtlinie (ErP) für Raumlufttechnische Geräte (RLT-Geräte).

3.2 Definitions

The Regulation distincts between two types of ventilation units (VU):

- Residential ventilation units (RVU) either have a maximum flow rate of 250 m^3/h or have a maximum flow rate between 250 m^3/h and 1000 m^3/h but are exclusively designed for residential use.
- Non-residential ventilation units (NRVU) have a maximum flow rate exceeding 250 m^3/h.

Furthermore, the Regulation makes a distinction based on the direction of the airflow:

- Unidirectional ventilation units (UVU) produce an airflow in one direction only.
- Bidirectional ventilation units (BVU) produce both an ingoing and an outgoing airflow, and as such, are equipped with two fans.

Bidirectional ventilation units may contain a heat exchanger:

- A heat recovery system (HRS) means the part of a bidirectional ventilation unit equipped with a heat exchanger designed to regain heat that would otherwise have been lost.
- A run-around HRS is a heat recovery system where the heat recovery device on the exhaust side and the device supplying the recovered heat to the airstream on the supply side of a ventilated space are connected through a heat transfer system where the two sides of the HRS can be freely positioned in different parts of a building.

The Oxycell 1000 heat exchanger can be categorised as an HRS, designed to be integrated into a BVU/NRVU.

3.3 Requirements

The Regulation introduces two sets of specific ecodesign requirements: the first to come into force on 1 January 2016, the second on 1 January 2018. The requirements shown below are exclusively valid for an HRS integrated in a BVU/NRVU.

As of 1 January 2016:

- The (non-condensing) heat recovery efficiency should be at least 67%.
- The maximum internal specific fan power of ventilation components ($SFP_{int,limit}$) expressed in W/(m^3/s) is $1200 + E - 300 \times \frac{q}{2} - F$.
- E is an efficiency bonus of 30 W/(m^3/s) per percentage point above the minimum required value; this number is 0 W/(m^3/s) when the minimum required value is not met.
- q is the airflow rate expressed in m^3/s, with a maximum of 2 m^3/s (7200 m^3/h).
- F is a filter correction of 360 W/(m^3/s) to incorporate the influence of a fine filter in the supply airstream (e.g. class F7) and a medium filter in the return airstream (e.g. class M5).

As of 1 January 2018:

- The (non-condensing) heat recovery efficiency should be at least 73%.
- The maximum internal specific fan power of ventilation components ($SFP_{int,limit}$) expressed in W/(m^3/s) is $1100 + E - 300 \times \frac{q}{2} - F$.
- E is an efficiency bonus of 30 W/(m^3/s) per percentage point above the minimum required value; this number is 0 W/(m^3/s) when the minimum required value is not met.
- q is the airflow rate expressed in m^3/s, with a maximum of 2 m^3/s (7200 m^3/h).
- F is a filter correction of 340 W/(m^3/s) to incorporate the influence of a fine filter in the supply airstream (e.g. class F7) and a medium filter in the return airstream (e.g. class M5).

4 Analysis

4.1 Assumptions and remarks

- The Oxycell is not a complete heat recovery ventilation unit; it is the heat exchanging component, designed to be integrated into a ventilation unit. As such, the Oxycell itself is not equipped with fans. Instead, to be able to perform the analysis, a 50% overall fan efficiency is assumed, comparable to that of the best fans available on the market.
- Once certain filters for the supply and return airstream would have been selected, the pressure drop over the filters would vary exponentially with the airflow through the unit. However, the Regulation specifies a fixed SFP_{int} value of 360 W/(m^3/s) and 340 W/(m^3/s) in the 2016 and 2018 requirements, respectively, implying an influence on power consumption independent of the airflow rate. Although this may not be true in practice, in this paper it is regarded as a "worst case" approach.

4.2 Results

In the analysis, the airflow rate through both channels of the Oxycell 1000 heat exchanger has been varied between 200 m^3/h and 500 m^3/h.

Figure 2 — Pressure Drop

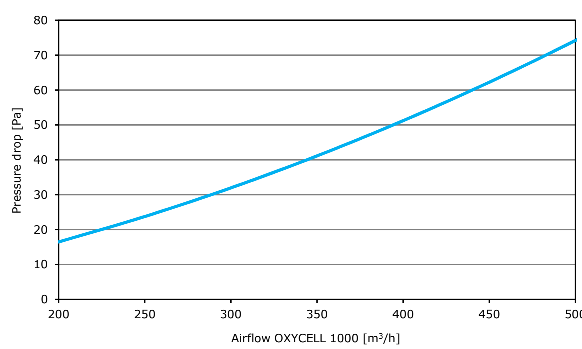


Figure 3 — Heat Recovery Efficiency

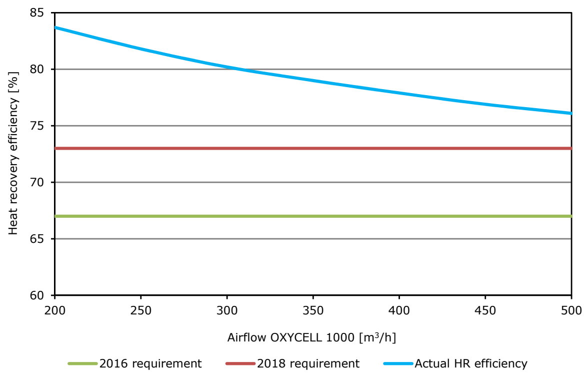
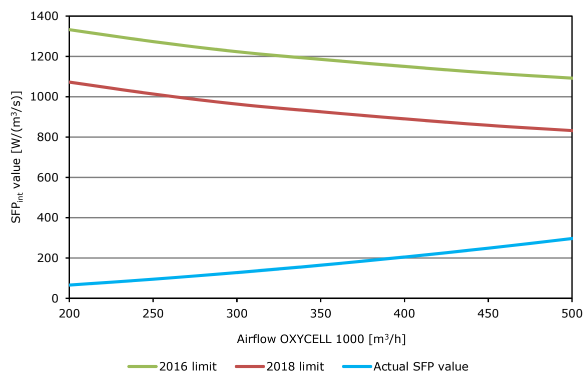


Figure 4 — Specific Fan Power



Note: The 2016 and 2018 SFP_{int} requirements will be satisfied within the aforementioned airflow range as long as the overall fan efficiency is higher than 14% and 18%, respectively.

5 Conclusions

The following can be concluded for the Oxycell 1000 heat exchanger in the 200—500 m^3/h airflow range:

- The European Ecodesign Directive 2016 and 2018 (non-condensing) heat recovery efficiency requirements are both satisfied along the entire airflow range.
- The European Ecodesign Directive 2016 and 2018 SFP_{int} requirements are both satisfied along the entire airflow range, providing that the overall fan efficiency is at least 14% and 18%, respectively, while commercially available high-end fans can achieve values of over 50%.

Additional remarks:

- The same conclusions are valid for the entire Oxycell product portfolio, providing that the airflow range is scaled proportionally to the dimensions of the Oxycell heat exchanger (i.e. at equal air velocity range).
- The Oxycell has the unique property that it combines the ability to perform heat recovery, indirect evaporative cooling and dew point cooling into a single heat exchanger. Since evaporative cooling generally results in a higher supply temperature compared to conventional vapour compression air conditioning technology, a larger airflow rate is required to cool against a certain heat load in order to maintain the desired indoor air conditions. However, when performing heat recovery ventilation, the unit only has to supply sufficient air to satisfy the fresh air ventilation requirements related to indoor air quality. For example, although the Oxycell 1000 has been designed to supply up to 1000 m^3/h of cooled air, the airflow during heat recovery ventilation is more likely in the order of 250—350 m^3/h.

References

[1] Netherlands Organisation for Applied Scientific Research TNO, Determination of the energetic efficiency of the counter-flow heat exchanger "Oxycell", Test report in accordance with EN 308, TNO 2013 R11237 (2013).

[2] Nederlands Normalisatie-instituut, NEN-EN 308, Warmtewisselaars, Beproevingsprocedures voor het vaststellen van prestatie-eisen van warmteterugwinningsapparatuur (1997).

[3] Official Journal of the European Union, DIRECTIVE 2009/125/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products (2009).

[4] European Commission, COMMISSION REGULATION laying down ecodesign requirements for ventilation units, D030784/02 (2014).