Design office for the preservation of materials
French state aerospace

France, Puy de Dôme, April 2023

STUDY REPORT

SUBJECT : Study of solar heating panel with hot-air.

ATTACHMENT : ANNEX 1 – Daily hygrothermal charts
ANNEX 2 – Weekly hygrothermal charts
ANNEX 3 – Charts analysis

1. CONTEXT

1.1. Study

The need to preserve technical materials in areas without power supply, and the search for solutions to reduce the energy consumption of certain building infrastructures of French state aerospace has led our design office to look into solar panel heating with hot-air technology.

2. TECHNOLOGY STUDIED

2.1. Choice of panel

The solar panel heating with hot-air technology is not widespread in France, in contrast to the thermal solar panel with glycol heat transfer fluid. Among the French suppliers is the company Capt'Air Solaire, based in Dijon, importer and exclusive distributor in France since 2010 of the solar panels heating with hot-air of the Danish manufacturer SolarVenti®. The existing data informs us that the Danish manufacturer has 40 years of expertise in this technology for the residential, tertiary and industrial sectors. The specific technology of their models is patented.

The SV 20 R model was loaned by Capt'Air Solaire supplier for this study.

Installation carried out by the mandated installer company VentiSolaire, based in Bordeaux.

2.2. How it works

The outside air is heated by solar radiation in the panel enclosure. This heating is enhanced by the greenhouse effect of the polycarbonate glass and the heat absorption of the black filter material.

A solar cell integrated into the panel supplies power to a fan during periods of sunshine. The warm air produced is then blown into the room to be heated. (See Figure 3)

Figure 1. Residential range

Figure 2. Industrial range

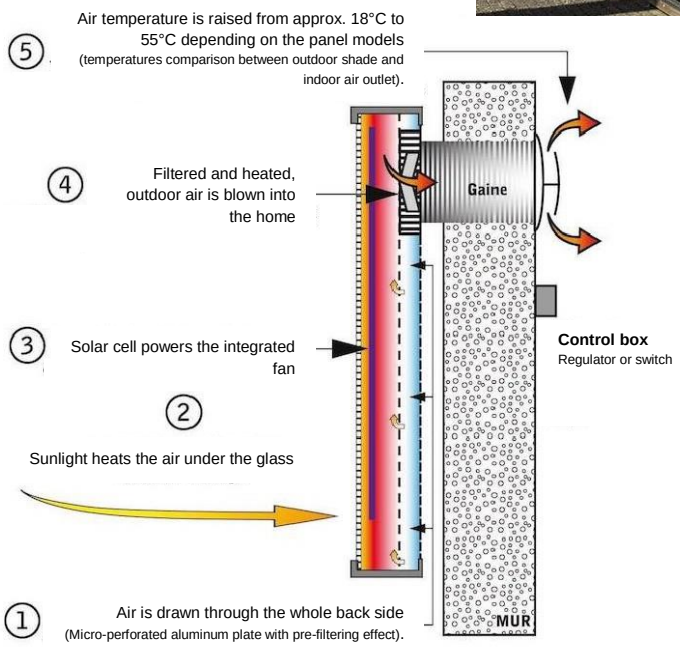

Figure 3. Capt'air Solaire's illustration

Figure 4. Pedagogical cut

3. IMPLEMENTATION OF THE STUDY

3.1. Model and accessories

- Brand : SolarVenti®
- Model : SV 20 R
- Power : 1300 Watt
- Size : 201 mm x 102 mm x 55 mm (L x W x D)
- Weight : 16 kg
- Stand-alone power supply : 12 Vdc 18 Watt solar cell
- Air flow : 80 to 140 m^3/hr
- Remote control unit : On/off, thermostat, airflow adjustment

- Hot-air valve : Prevents air circulation when fan is off
- Can be installed by a private individual or an installer

3.2. Study conditions

3.2.1. *Climatic period*

The winter period allows the effectiveness of this technology to be tested in the most unfavorable outdoor temperature conditions of the year. The study took place from the end of January to the end of March 2023.

3.2.2. *Panel location*

At the end of January, the panel was installed by the VentiSolaire company on the external cladding of the study building, located in the Puy de Dôme department in France.

The southern orientation of the cladding allows for optimal solar radiation capture by the panel.

During the winter period, there is no obstacles between the path of the sun and the panel.

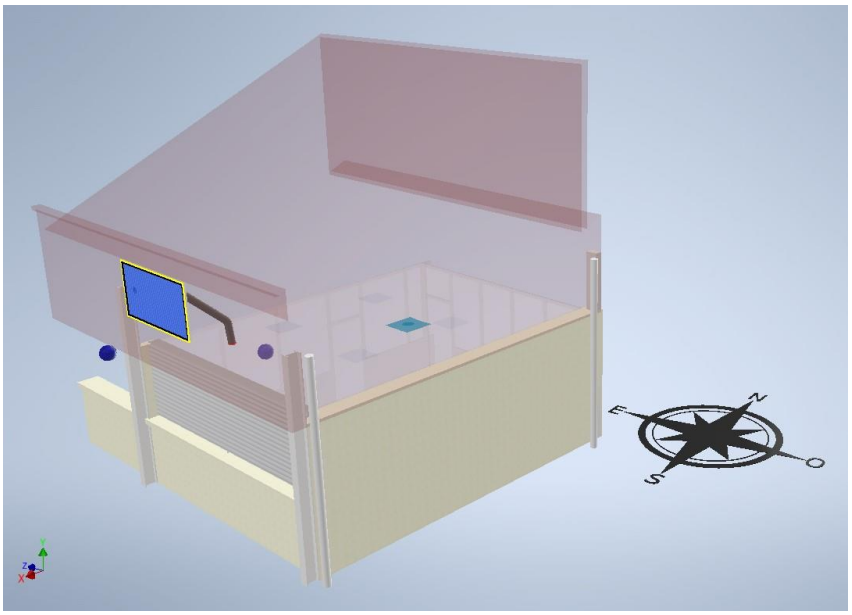

Figure 5.

3.2.3. *Heating zone*

The selected heating zone is an office with a surface area of 31 m² and a volume of 87 m^3 :

- **South side :**
  - Length 4.76 m
  - Windows (double-glazed, aluminium frame)
  - External adjustable blinds
  - Concrete block wall (approx. 370 mm)
  - 1 steel/water radiator (1200 mm x 600 mm x 100 mm)
- **North side :**
  - Length 4.76 m
  - Modular wall (single-glazed/composite sheet thick. 60 mm), adjacent to a storage area inside the building

- **East side :**
    - Length 6.54 m
    - Concrete block gable wall (Tick. 350 mm)
    - 1 steel/water radiator (1200 mm x 600 mm x 100 mm)
- **West side :**
    - Length 6.54 m
    - Modular wall (single-glazed/composite sheet thick. 60 mm), adjacent to a heated office
- **Ceiling :**
    - Height 2.8 m
    - Dropped ceiling tile 60 x 60 mm
    - Pre-existing air extractor

3.2.4. *Adaptations for the study*

- Installation of the SolarVenti® hot-air outlet ;

Figure 6

- Installation of the remote control on a wall jamb ;

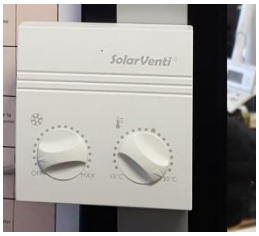

Figure 7

- Flow limitation of the air extractor ;
- Decreasing the temperature set point of thermostatic valves :
    - Setting to 1.5 (from 27/01/2023 to 28/02/2023)
    - Setting to 2.5 (from 28/02/2023 to 31/03/2023)
- South side, closing the blinds to drastically reduce the window sun heating.

3.2.5. *Hygrothermal measures*

Equipment / source:

- 6 hygrothermal loggers (THE) ;
- 1 laser thermometer ;
- Weather website www.infoclimat.fr, Aulnat city.

Measuring points (See Figure 8):

- Outside building THE, direct sunlight, height 2.8 m (mark **A**) ;
- Hot-air outlet THE, hanging from the ceiling, height 2.7 m (mark **B**) ;
- Middle office THE, placed on desk, height 75 cm (mark **C**) ;
- North/east end office THE, placed on a metal shelf, height 1.65 m (mark **D**) ;
- East side radiator THE, from 03/02/2023 (mark **E**) ;
- South side radiator THE, from 27/02/2023 (mark **F**) ;
- Laser thermometer, internal hot-air blower duct one-off measurements.

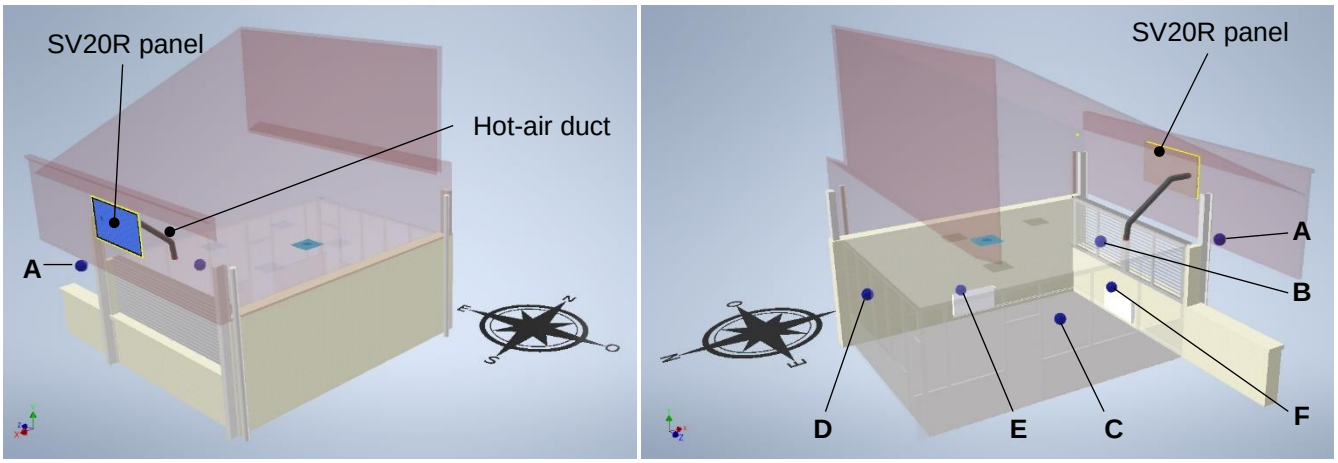

Figure 8

4. RESULTS

Hygrothermal data and operational analyses are detailed in the ANNEXES :

- ANNEX 1 – DAYLI HYGROTHERMAL CHARTS ;
- ANNEX 2 – WEEKLY HYGROTHERMAL CHARTS ;
- ANNEX 3 – CHARTS ANALYSIS.

4.1. Data interpretation

The outside THE (Figure 8, mark A) is exposed to the sunlight path, hence the temperature peaks during sunny periods. Website www.infoclimat.fr weather records are therefore used for comparisons with indoor temperatures.

The local weather from February to March was marked by extreme and varied weather phenomena (cold below zero °C, warm lightning skies, rain, wind gusts, cloudy skies, overcast).

4.2. Facts

4.2.1. *Operating start*

- The solar cell powers the fan as soon as solar radiation appears ;
- The panel starts to produce useful heat from a solar irradiance of about 200 Watt/m^2 (See ANNEX 3) ;
- A windy and cloudy but sparse sky is sufficient for a heat generation (See ANNEX 1, graph 17).

4.2.2. *Operating levels*

- Of the 58 days of operation, 47 days were observed where the panel delivered temperatures above 20 °C, including 30 days above 25 °C (See ANNEX 2, graph 5) ;
- One-off measures have repeatedly shown 47 °C in hot-air duct for 9 °C outside temperatures (Infoclimat Normalized data) (20° C from outside direct exposure hygrothermal logger data) (See ANNEX 1, graph 8 and 13) ;
- An average of 7 to 8 hours of heating is estimated, with peaks of 10 hours (See ANNEX 2) ;
- Temperature differentials between outside and hot-air outlet range from 3.2 °C to 23 °C (See ANNEX 3).

4.2.3. *Behavior of the heated volume*

Before installing the panel, radiator's thermostat set at 1.5, the temperature had stabilized at around 13 °C.

- The panel operations increase the low room temperature at night by 1 °C to 2 °C (See ANNEX 2, graph 2 and 5) ;
- Although each radiator's thermostat do not react at the same ambient temperature, a regulation of the hot water flow is observed when the panel heats the volume (See ANNEX 2, graph 3) ;
- A rise in moisture can be observed temporarily at the start of the fan. This is compensated when the panel begin to produce heat ;
- With a given airflow of 140 m^3/h, potential air renewal per operating hour is 1.6 times the office volume.

5. CONCLUSION

The current solar hot-air heating panel technology studied brings very interesting results.

A technology that can be used to reduce building heating energy costs in many sectors of French state aerospace in winter, spring and autumn. Night cooling mode in summer.