Thermal Storage Structure

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Abstract

Structures, which are able to accumulate thermal energy, cause lower air temperature oscillation in adjacent rooms. Thermal energy is accumulated at the structure's surface layer and is then conducted to deeper layers. The structure changes its own temperature and in comparison with air it has high thermal capacity and reacts more slowly to temperature changes. This attribute is suitable for fitting buildings with very low thermal stability induced by light building construction or thermal insulation positioned above all to internal surfaces.

This article deals with thermal storage walls for waste energy preservation. The system is based on a solid double layer internal wall with an air canal. Warm air flowing around a fireplace is used for charging wall storage capacity. The energy is emitted to the zone with some time-delay.

1. Introduction

What effects do thermal storage structures have on thermal stability and energy consumption?

It is universally accepted that massive buildings have lower energy consumption if the operating time is permanent. This influence is taken into account in standardized calculations; there is a thermal difference reduction in heat loss calculations. This effect is helpful during the summer because internal air temperature does not increase so much and a massive structure substitutes or supplements a cooling system.

2. Construction description

2.1. Storage wall

An active thermal storage wall is an appliance for increasing thermal stability in low-energy buildings and for excess energy storage. The main heating system is warm-air heating with very a quick start. A warm-air fireplace is placed in a living room and internal thermal storage wall. The fireplace is used for quick short time heating or for air temperature increase. The fireplace is closed, the fuel is wood. Exhaust gasses go to a separate chimney from the fireplace. The thermal storage wall is used for increasing thermal inertia and for excess energy storage from the fireplace. This system supplements central warm-air heating in the building and increases local thermal comfort.

2.2.Fireplace

The fireplace is placed in the main living room, which vertically reaches the first floor. The thermal storage wall is in frontal view on the right from the fireplace and divides the space between the living room and the bedroom. The wall is made from ceramic bricks in this case. The wall construction may

be also made from concrete and the construction can be cheaper. Ceramic bricks were chosen for aesthetic reasons. The wall has a hollow space inside and warm air flows in this space. Partitions are placed elongated so that it is better to transport energy to the wall. Energy transport is made by forced convection.

2.3 Thermal inertia

The basic attribute of the wall is its thermal inertia. The inertia causes the thermal energy supplied by hot air to the wall to be transported to the room with some time delay. The delay is dependent on wall thermal inertia and temperature. A thermal storage wall may be used for low temperature changes in interiors.

3. Construction operation

The style of operation is the following: a warm-air fireplace warms up the air and it flows above the closed fire-place in the room. Warm air heats the room until the time, when the temperature stops rising or when the requested conditions are reached.

If we still want to continue heating, a flap to the thermal storage wall is opened, the output to the room is closed and a fan then pushes forced air through the wall. In this case we charge the wall with energy which it normally takes out of the building. Window openings and airing are not efficient from an energy point of view. The accumulated energy warms the air in the room with a delay which is normally sufficient and when the fireplace is not used.

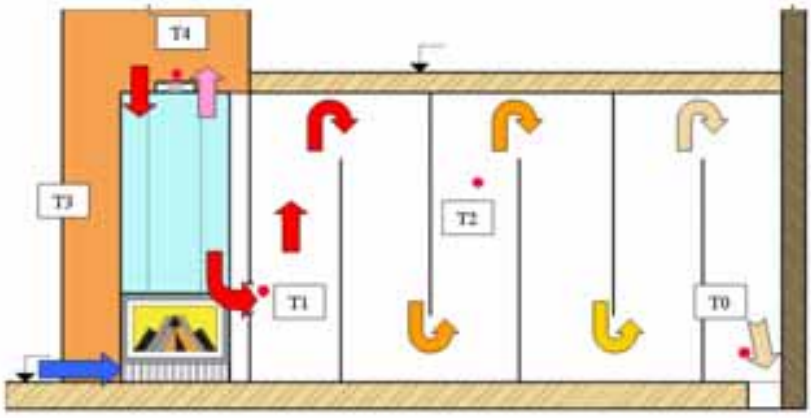

Figure 1. Active thermal storage wall

The wall may be charged during intermittent operating times during slow temperature decreases or for protracted main source heating. The source can be used for minimal temperature arrangement. An electric boiler is used for safety reasons. The boiler is simple and there is a low fire risk. A thermal storage wall prolongs the slow decrease in temperature.

The economical assessment of a single storage wall without bearing or screening is not positive because energy savings are low. But the wall can improve thermal comfort inside a building. This was verified by measurement.

4. Experiment description and discussion

The storage wall operation was analysed. Warming up and slow cooling is described. The building shape is compact; building ground floor plan is in Fig.2. Building envelope is very good insulated, total design heat load (external design temperature -12°C) is 3,6 kW. Design heat load of living room is 1,1 kW, relative air humidity in room is 60%.

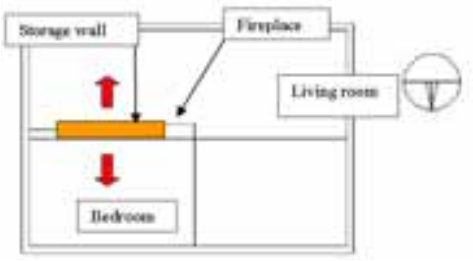

Figure 2. Ground floor plan

Figure 3. Storage wall photo

Active length of thermal storage wall is 6 m length, height is 2,5 m, thickness 2 x 105 mm with 120 mm air hollow. Internal space is divided into 5 connected segments. Overall wall weight is 5800kg (two parts of wall).

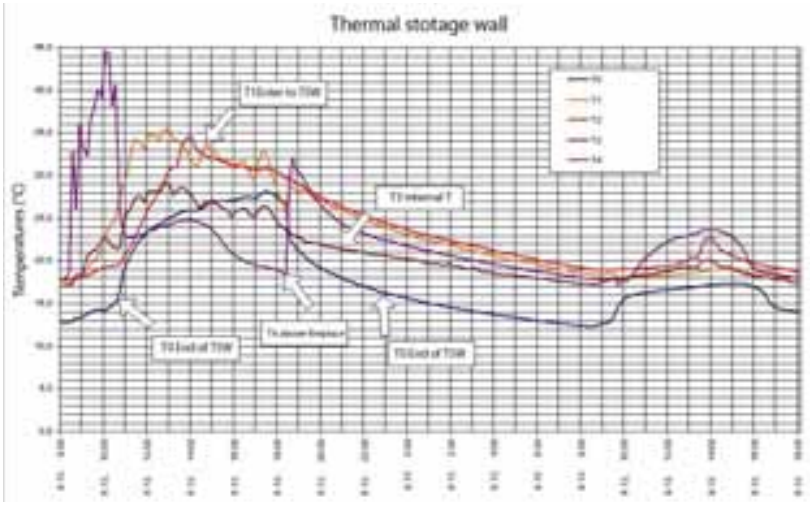

Figure 4. Temperatures and time behaviour

The temperature sensors are placed to wall for monitoring purpose of impact thermal storage wall to air in the interior. Temperatures in the wall enter, in the interior and inside the wall were measured. The interior temperature was measured near the wall and the sensors were partly radiated. The correct air temperature was lower in average about half degree Celsius.

The firewood with energy content 54kWh was used for heating from 9am to 6pm.

Table 1: Firing description

Time	Activity
8.12.	
09:00	Fire the fireplace Room heating
10:40	Flap to wall open Flap to room close
18:00	Stop firing
18:20	Flaps to room open
9.12.	
--:--	Without heating

This energy was used for air warming up which charges the wall. The wall temperature is slow dropping and has influence to interior thermal stability. The solar air collector was used for wall charging too in this example. The solar air collector was made from doubled south windows and solar gains may be simplified transported in the interior. The radiation portion of the heat supplements friendly convective air heating system.

5. Conclusion

A thermal storage wall is construction with significant effect on thermal stability. Thermal storage wall can be used profitably for waste energy utilization. The thermal effect is pleasant especially in combination with warm air heating because the wall adds a radiation part of the heating and the efficiency of the heating system is increased. If the wall is part of the building construction the economical assessment is positive. Separate construction with storage purpose is not recommended. Thermal storage wall can be installed in a low energy houses.

Acknowledgement

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