Technical Installations in Properties

Henrik Källåker, 2011-01-17

Introduction

Introduction

Human beings have lived in different kinds of buildings throughout history. As development has moved forward the technical installation has grown more sophisticated. Today the requirements are quite high, especially in public buildings. The demand is for example that there should be a constant climate inside the building no matter what the temperature is outside. Furthermore, the properties should be equipped with elevators, door openers, lifting-tables, emergency evacuations-systems amongst others, in order to make the property safe and easy to live and work in.
All these kinds of technical installations require energy to function properly. This is the reasons that energy consumption has increased despite the fact that we build more energy efficient buildings. At the same time, the cost for energy will probably rise in the future due to stricter environmental regulations. These are two reasons why it is interesting to look at the new technology that will decrease energy-consumption in properties.

Demarcation
I will narrow this work to cover Exhaust Air Heating Pump technology, Waste Water Heat Exchange technology and Sensor Controlled Lightning technology in order to save energy in residential properties.

Exhaust Air heating Pump

Background
The first component that is highlighted is the Exhaust Air Heating Pump connected to the ventilation system. A normal ventilation-system in residential buildings is described as follows:
The air is taken in by spring-hill valves located in the windows in bedrooms and living rooms. The cold air is heated up by the radiators. The air goes through the apartment by-passing the kitchen and bathroom and finally leaves the apartment. The air has at this point a temperature of 20 degree Celcius. A general

rule is that the air in a residential property shall be exchanged at least 12 times in 24 hours. In a conventional system in a residential building that was built in the 60´s and 70´s the warm air is evacuated by a fan out of the building.

Function

The technology for installing an Exhaust Air Heating Pump on the extract pipe makes it possible to reuse the energy that the exhaust-air contains.

The principle of an Exhaust Air Heating Pump is based upon the fact that energy is released when a fluid goes from gas to liquid in the condensation phase. The process starts with that the warm air, which is the exhaust air, meets the refrigerant. The refrigerant then goes from liquid form to gas form. The gas is transported through the pipe to the Exhaust Air Heating Pump. In the compressor the refrigerant is compressed and the temperature of the gas increases to 100 degrees Celcius due to the compression. The hot gas goes thereafter into the condenser where the hot gas meets the colder water in the radiator- or tap water-system.

When the hot gas is cooled down by the cold water, the refrigerant goes from gas to liquid. Energy is then released and transported over to the radiator or tap water system.

The energy is then stored in two different accumulation-tanks, one connected to the radiator-system and one connected to the tap water-system. In winter time the Air Heating Pump supports both accumulation-tanks with energy and in summer only the accumulation tank for the tap water.

Installation

The Exhaust Air Heating Pump is normally installed in the basement near the boiler. The pipes that transport the refrigerant from the Exhaust Air Heating Pump to the roof normally goes through the refuse chute that is often no longer in use in Sweden nowadays. Up on the roof the pipes are connected to the exhaust airflow. Normally the accumulation-tanks are also located in the main heating unit .

Economy

Calculations show that an Exhaust Air Heating Pump will reduce the consumption of energy in a residential property by around 30-40 %. The payback-period has shown to be between 3-7 years in monitoring studies that have been done. The economical risk with the installation is that the price for electricity will increase more over time compared with the price for heating. Since the Exhaust Air Heating Pump is driven by electricity the calculation will be affected if the cost for electricity increases more than projected, compared with the cost for normal heating. Nevertheless, historically development has shown that costs for different types of energy follow each other in a similar way.

The Waste-Water Heat Exchanger.

Background

The other system that will be presented is the Waste-Water Heat Exchanger. The waste-water that a residential building produces comes from the tap-water system and goes through toilets, dishwashers, showers, faucets and back into the waste-water system.

An apartment that is inhabited by two adults and two children consumes around 75 m3 water every year that has a temperature of 50 degree Celcius. Studies show that the temperature is around 25 degree Celcius when the waste water passes the main waste-water pipe at ground level.

In a normal property this energy is not re-used. By installing a Waste-Water Heat Exchanger it is possible to extract the energy from the waste water.

Function

The function of the Waste-Water Heat Exchanger is quite simple and based on a normal pipe that the waste water passes through on its way to the treatment-plant. The pipe is surrounded by a heat carrying layer. On the other side of the heat carrying layer is copper pipe twisted around the wastewater-pipe. The incoming water flows through the copper-pipe on its way to the main Heat Exchanger for tap-water. When the incoming water hits the Waste-Water Heat Exchanger it has a temperature of 8 degrees Celcius and when it leaves the Waste-Water Heat Exchanger it has a temperature of 18 degrees Celcius. This means that main heat exchanger only has to heat the water from 18 degrees Celcius to 55 degrees Celcius instead of 8 degrees Celcius to 55 degrees Celcius.

Installation

The installation of the Waste-Water Heat Exchanger is quite simple. Just take away 7.0 m of the ordinary waste-water-pipe and replace it with the Waste-Water Heat Exchanger unit.

The technology is especially suited in large buildings with many apartments where the waste water from a lot of apartments goes through one big waste-water pipe.

Enonomy

In the studies that have been done, it shows that the payback-period for installing a Waste-Water Heat Exchanger in a residential building is somewhere between 3 to 6 years. Naturally, in properties where the consumption of heated water is big the payback-period is shorter. Especially in properties with a high proportion of families with children, this installation is suitable due to the high consumption of heated tap water.

The life expectancy of the Waste-Water Heat Exchanger is estimated to be 20-30 years.
The Waste-Water heat Exchanger will work without any extra input of energy. The reason for this is that the incoming water is pressed through the Waste-Water Heat Exchanger by the pressure that comes from the water-tower.

Sensor Controlled Lighting

Background
One of the costs that a property owner has to deal with is electricity. The area where most savings can be done is lighting inside residential buildings. Often lighting is switched on much more than is required in areas like stairwells, laundry rooms and basements. By installing occupancy sensors that switch off the lighting when no one is present, it is possible to save energy. For instance in a stairwell there should be a low basic lighting and when people go into the stairwell a stronger lighting is activated. But the question is, how much will the installation of sensor controlled lighting save?
In order to answer that question special measurement equipment has been developed for this purpose.

Function
The measurement equipment is able to measure things such as:
- How long daylight was sufficient for the required lighting level?
- In what way people used the area?
- How long artificial light was switched on unnecessarily?

The sensor makes a couple of thousand measurements every week and after 2-4 weeks it is possible to use the data to predict the potential saving that will be made by installing sensor controlled lighting.
The sensor is then connected to a computer and the calculation is made.

Installation
The sensor is positioned easily below the ceiling at various points in the actual building. The sensor is driven by a battery.

Economy
The product has just been developed so the price for it is not determined. The advantage of the sensor is that only a couple are required and these ones can be used at several different places a lot of times.

Groupwork.

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Installation of an Exhaust Air Heating Pump in Navigatören 5 in Eskilstuna, Sweden.

Background:
Navigatören 5 is a residential building, built 1964. The property contains 80 apartments.
The ventilation-system is a mechanical exhaust system and works as described in the presentation.
The property's power-demand for heating is 922 Mwh per year.

The total cost for heating will be 69.000 Euro for 2011.

The calculation says that with the Exhaust Air Heating Pump installed, it will reduce the amount of energy that is bought from the heat supplier from 922 Mvh to 367 Mwh per year.

The cost for heat-energy in residential building in Eskilstuna is 74.8 euro/Mwh.

The electricity that the Exhaust Air Heating Pump requires to function is 166 Mwh electricity per year.

The cost for electricity is 110 euro/Mwh.

The repair and maintenance for the pump will be 2,000 euro every year.

The life expectancy of the pump is 20 years.

The total investment for purchase and installation of the Exhaust Air Heating Pump will be 161,300 euro.
The interest rate is 7 %.
Assume that the relation in price between heating and electricity will be constant during the next 20 years.

Questions:
1. What is the pay back period for the investment?
2. What is the net present value for installing the Exhaust Air Heating Pump?

Groupwork.

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Answer:

The saving

Cost for heat-energy today: 922*74.8	68,966 Euro.
Cost for heat-energy after inst.: 367*74.8	27,452 Euro.
Savings:	41,514 Euro.
Electricity for the pump: 166*110	18,260 Euro
Repair and maintenance	2,000 Euro
Total saving per year:	21,254 Euro
Payback period: 161,300/21,254	7.6 year.

NPV:
Use the annuity-formula:

$$NPV = -161300 + 21254\left[\frac{1}{0{,}07} - \frac{1}{0{,}07(1{,}07)^{20}}\right] = 63780$$

The net present value for the investment is 63,780 euro.