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Deliverable 8

Measurements on Thermal Energy Flow at ITT Flygt Foundry, Emmaboda, Sweden

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1 Site Description

1.1 Climatic conditions

The industrial site of ITT Flygt Emmaboda is located in the south-eastern part of Sweden, as presented in figure 1.1.

Figure 1.1: Location of ITT Flygt Emmaboda as presented by www.hitta.se, copyright by Lantmäteriet.

Being located a fair distance from the sea in inland Sweden, Emmaboda is a smaller town in an area characterised by relatively flat but broken terrain with poor soils and many lakes. The landscape is generally dominated by spruce and pine forests.

Due to the nature of the landscape, wind is not a major issue when calculating building heat load demands. Neither is air humidity or solar radiation. Primarily, the key factors controlling building heat demand in Emmaboda are out door temperatures together with how the building is used and constructed.

The outdoor temperature at ITT Flygt Emmaboda has been monitored during 2007. Results are shown in figure 1.2.

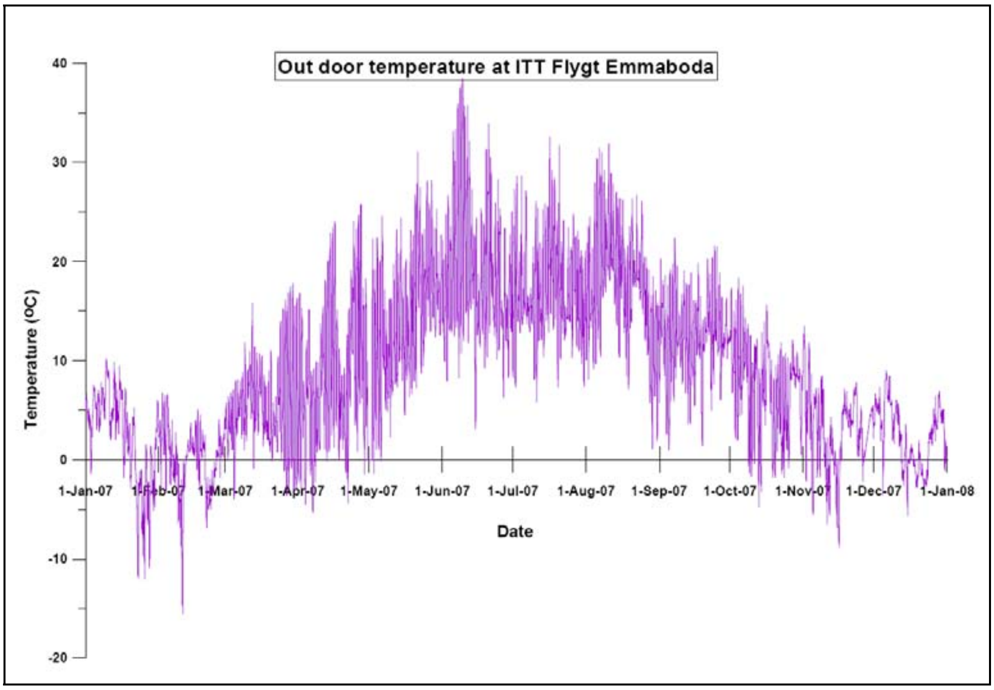

Figure 1.2: Out door temperature at ITT Flygt Emmaboda during 2007.

1.2 Energy price

For 2008, the relevant energy prices for ITT Flygt in Emmaboda were:

- District heating: 470 SEK/MWh
- Electricity: 450 SEK/MWh

1.3 Site maps

ITT Flygt Emmaboda is the worlds leading manufacturer of submersible pumps and mixers. The plant handles the whole production flow, from molten metal to finished products. As such it contains a foundry, an electric motor workshop and several product workshops, see figure 1.3. (www.flygt.se)

Figure 1.3. The ITT Flygt Emmaboda industrial area

The production is organised into one foundry and six product workshops. In the Electric Motor Workshop more than 100 different motor types for the pumps are produced. In the workshop PVB drainage pumps are manufactured, while the PVC, PVS and PVT workshops are mainly producing sewage pumps. The PVX workshop is manufacturing mixers and shafts. All together some 1 200 people is working at the plant. (www.flygt.se)

The surface area is approx. 330 000 m^2 while the buildings occupy some 100 000 m^2.

2 Energy use

2.1 Financial conditions

The ITT Flygt industrial site in Emmaboda has a large and expensive heating demand wintertime with an annual purchase of some 5 200 MWh regional district heating. At the price of 470 SEK/MWh, this costs the company approximately 2,4 million SEK each year.

2.2 Technical conditions

2.2.1 System description

The main target for a demonstration project with seasonal storage is to improve the utilisation of waste heat from the foundry. ITT Flygt has two new large ovens powered by electricity. The ovens are primarily cooled by a water cooling system in the oven mantle, see figure 2.1.

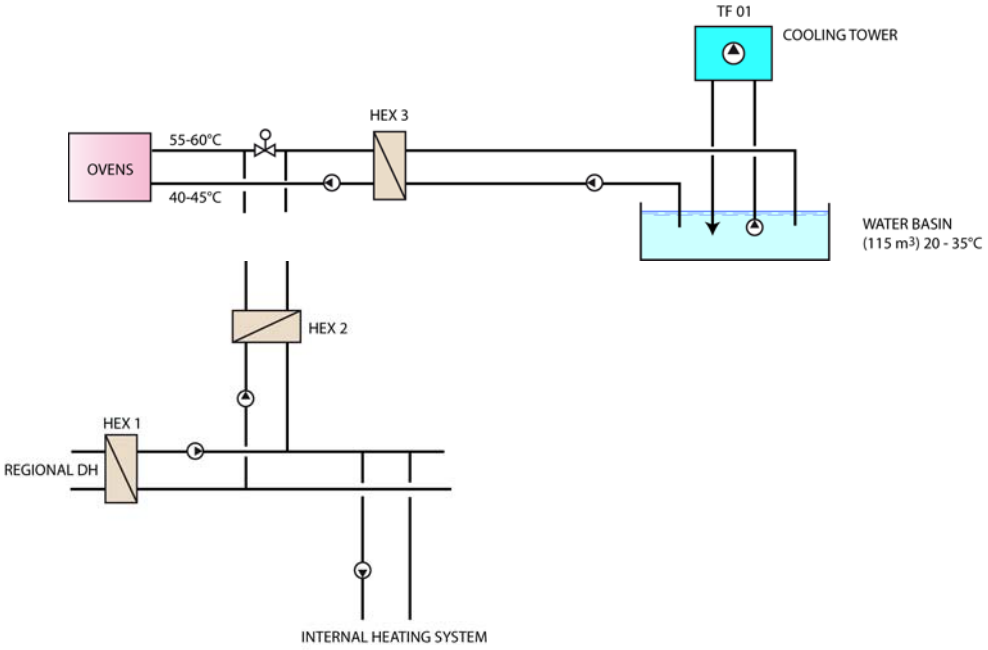

Figure 2.1 – Schematic description of the foundry energy system connected to the internal and regional district heating.

2.2.2 System temperatures

System temperatures have been measured all over the year 2007. These data show a temperature level of 40-45/55-60°C for the cooling loop to and from the ovens. The cooling water is a separate loop and is connected to three second loops by heat exchangers. One of these loops is ending into a water reservoir functioning as a temperature buffer. The reservoir is in turn cooled by an evaporative cooling tower and refilled with cold tap water. Reservoir temperatures normally range between 20-35°C.

The other two loops are connected to an internal district heating system used for heating parts of the foundry and the workshops on site. The temperatures in these loops are a few degrees lower than the mantle cooling loop.

Not shown in the figure is a cooling tunnel, the heat gained from this is directly ventilated away at a temperature level of 30-35°C. The thermal power of the exhaust air is around 360 kW (if used at a temperature drop to +15^{o}C)

Since the internal district heating system will be the link between a seasonal storage and the heat sources used for storage it is of great interest to know the current temperatures in the system as well as how they change in shorter time intervals.

As shown I figure 2.2. a clear weekly trend is visible that reflects the energy use of the industry. It also depicts the vacation period in July when the ovens are shut down. Distribution and return temperatures are mainly separated from October to March, indicating that this is when the DH delivers heat to the site buildings. General distribution temperatures during this period is 40-50°C (mainly around 43°C) with return temperatures ranging between 35-45°C (mainly around 38°C).

However, not weighted the distribution temperature varies much over short periods of time as shown in figure 2.3. This is related to the large cooling demand of the ovens. Summertime, when cooling towards the outside air temperature is less efficient and the internal DH system has no heating demand, this frequently results into temperature peaks around 70°C.

Wintertime, when cooling is more efficient and the DH system has a large heating demand, spikes of this kind rarely occurs.

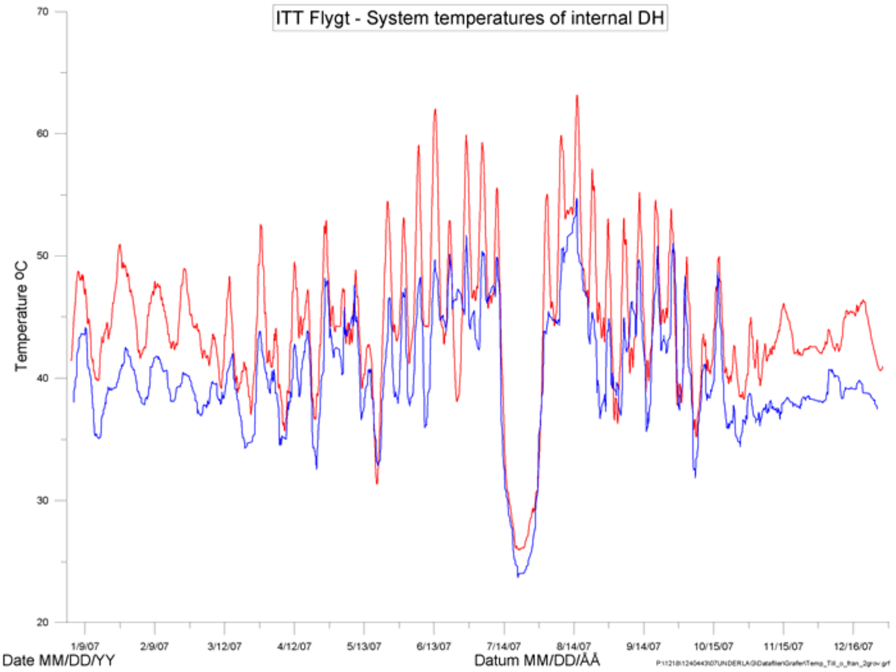

Figure 2.2. Weighted average distribution (red) and return (blue) temperatures in the internal DH system.

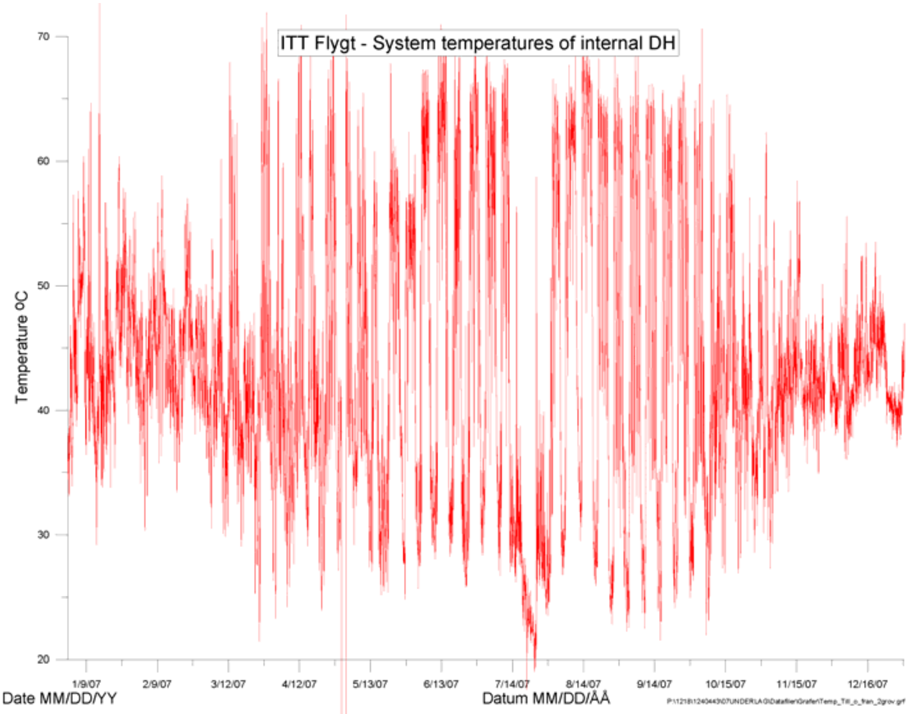

Figure 2.3 – Distribution temperatures of internal DH system (not weighted).

2.2.3 Thermal energy flow

The amount of energy transferred from the ovens to the internal DH systems is about 3 650 MWh annually. Also in summertime some heat from the ovens is dumped into the internal DH, but then mainly disappeared as losses. The amount of lost heat has been estimated to some 1 200 MWh/year.

The cooling tunnel with a flow of air around 65 000 m3/h has been calculated to represent 360-380 kW. This assumes a temperature drop from 33 down to 15^{o}C. Taken into account that that the foundry is running 4 400 hours a year, the waste heat from this system represents some 1 500 MWh/year.

Except for the connection to the cooling tower, the reservoir is used for some minor heat recoveries as well as for cooling of a compressor for compressed air. Unfortunately there are no reliable measurements on the heat that is chilled away by the cooling tower. However, a rough estimate based on older data indicates a waste heat amount of 2 500 MWh annually.

During the cold season the waste heat from the factory ovens is often not enough too heat all the site buildings. Hence, when the heating demand on the internal DH system is larger than the cooling demand of the ovens, ITT Flygt buys heat from the regional DH network. The year 2007, the heat bought was approximately 5 250 MWh.

2.2.4 Sources of waste heat available for storage

The energy situation described above clearly indicates that there are three heat sources available for seasonal storage, mainly from summer to be utilised in winter. These sources are

1. Direct heat exchanging from the ovens (as currently)

2. Heat from the cooling tunnel (by usage of a heat pump)

3. Heat from the reservoir (by using a heat pump)

A seasonal storage would indeed even out the peaky temperature situation in the internal DH net observed in figure 2.3.

2.3 CO_2 figures

Currently, ITT Flygt buys some 5 200 MWh of energy off the regional district heating network each winter. This is energy that could be used elsewhere within Emmaboda. It could for instance be used for replacing conventional oil burners in residential and commercial buildings.

Conventional oil burners exhume approximately 350 kg CO_2/MWh produced heat. If 5 200 MWh of already present district heating replaced 5 200 MWh of heating produced by several conventional oil burners, the release of circa 1 800 000 kg of CO_2 would be prohibited.

Viewed from this marginal perspective, the fact that ITT Flygt annually consumes 5 200 MWh of district heating indirectly contributes to a release of approximately 1 800 tons of CO_2 to the atmosphere each year.

3 Main conclusions

The ITT Flygt industrial site in Emmaboda has a large and expensive heating demand wintertime with an annual purchase of some 5 200 MWh regional district heating. This costs the company circa 2,4 MSEK each year. Also, due to the fact that the energy now used by ITT Flygt could be used to replace conventional oil burners in residential and commercial buildings within Emmaboda, these 5 200 MWh cause the release of approximately 1 800 tonnes of CO_2 annually.

Currently, approximately 3 600 MWh of heat is recovered from the ovens within the local DH. There is a large potential within the site to increase this amount by constructing a seasonal thermal energy storage system operating together with heat pumps.

This is due to the present amount of available waste heat during the summer season which has been estimated to be in the order of 3 800 MWh. This is regarded to be a large potential for further energy savings. Considering the amount of energy available for storage and the temperature levels of the heating/cooling systems, a high temperature borehole thermal energy storage system is recommended as a subject for further studies.

4 References

References found in this report are:

- www.flygt.se (2008-11-27)
- www.hitta.se (2008-11-27)