First year of operation of the world's largest solar heating plant and the world's largest seasonal storage.

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Abstract – This paper describes the first year experiences of the project in Vojens. The total collector field is 70.042 m2. Consisting of 17.500 m2, build in 2011 and 52.542 m2, added in 2015. In 2015 the 205.000 m3 pit heat storage was also set in operation.
The first year of operation has overall been satisfying. Collectors performing as expected, storage works as expected. In addition it was relatively easy to set in proper operation.
Nevertheless a few lessons is learned. All related to practical issues and to some extend the very large dimensions and volumes.
To deaerate the water in the pit, is a challenge. According to Henry´s law, water at low temperatures can contain a lot more air than water at higher temperatures. For this reason and in order to protect the construction against corrosion, as much air as possible has to be released early in the process. This was not 100% efficient, and caused problems with released air under the floating cover.
Due to the air issue, the removal of rain water has caused problems. Because of the air lifting the cover, the rain water did not move to the expected places at the cover. The water ponds was not always at the same place every time it was raining.

1. INTRODUCTION

The district heating plant in Vojens is owned by the consumers. Build in the early 1960-es, like a very large number of district heating plants in Denmark.

Over the years different fuels have been used. Starting with heavy fuel oil, via coal, to natural gas.

The natural gas is heavily taxed, coursing a comprehensive interest to change fuel to a fuel with lower or no taxes. Biomass is of interest.

Due to loss of revenue to the state, it is not allowed for plants, like Vojens, to change to a non-taxed fuel.

It is however allowed to change to a heating, where no fuel is needed at the site. Amongst these solar, heatpumps and surplus heat from industry etc.

2. Lessons learned.

2.1 Release of air

The water in the storage was drawn from two boreholes at the location. This is because the utility was not able to deliver the amount in a reasonable short time. The request was 60 m3/ hour, in 5 months. Before filling the water was filtered and softened. Natrium hydroxide is added to increase the pH-value to 9,5. The increased pH-value is needed to avoid biological activity in the water. (And corrosion).

The air from the water was released in a full flow microbubble deaerater.

The deaerater is not 100% efficient, demanding for treatment a couple of times, before no more air is released.

In Vojens the deareater was not placed at the optimum, because some of the water, heated in the solar fields, was led directly to the storage, and not via the microbubble deareater.

In coming projects this is changed to include all the heated water to the storage. It is also in use, when offloading the storage, giving a second treatment.

We still do expect some challenges, caused by release of air from the water. But in reduced amounts, reducing the practical problems it causes.

2.2 Removal of rain water from the cover.

The concept for removing rain water, can be summarised:

- By having slight slopes on the roof, it can be foreseen, where the rain will be collected. The slopes were made by varying the thickness of the insulation. (expanded clay)
- A pipe installation was made from the lowest points at the cover, fitted with inlet valves. The valves are to close, when no more water at the spot.
- Outside the storage a pump is to start the flow, and to be in operation as long as there is more water to remove.
- Finally the rain water is led to seepage on the location.

The lessons learned in this aspect are:

- Due to the air above the water, and below the cover, water was not collected at the planned spots. Due to the reduced insulation at some places, the air, tend to collect at these places, lifting the cover, and not allowing rain water to collect.

- Due to a number of very heavy rain falls the first year, it is decided to increase capacity of the rain water removal. To fulfil this, larger pipes and a different type and increased capacity of the pumps, are installed.

2.3 Scaling

After a couple of months, scaling in the heat exchangers was discovered.

It appeared to be the water from the storage, that coursed the scaling.

After cleaning (CIP) the problem seems to be solved, meaning that it probably only was a first year occurrence.

The water was analysed, not giving any problematic results.

Therefore it is not exactly known why it happened.

The water in Vojens was drawn from new boreholes at the location, filtered, softened and added NaOH to increase pH-value to 9,5

2.4 Other findings

The performance of the collectors and the storage is as predicted.

The weather conditions the summer 2016 was not ideal for solar energy. More sun than normal in April and May, and less the rest of the summer, gave a significant higher heat loss than calculated.

In addition the first years of operation always show a higher heat loss. (Heating of the surroundings)

5. CONCLUSIONS

First of all the performance of the plant, and the capacities do meet requirements.

Challenges with release of ait and the removal of rain water are solved, and gave god experiences for the next storages.

The scaling also seems to be solved.

In worst case an annual cleaning might be necessary.