Flue gas condenser reduce CO_2

The International Distric Energy Climate Awards

Submission

Name: Flue gas condenser reduce CO_2

Address: Klaipėdos 63, LT-00148, Palanga, Lithuania

Name of the owner: UAB Litesko, Jočionių 13, LT-02300, Vilnius Lithuania

Person submitting the application data:

Name: Aleksas Jazdauskas
Address: Jočionių 13, LT-02300, Vilnius Lithuania
Phone: +370 640 26179
E-mail: ajazdauskas@dalkia.lt

2011

The Dalkia group and it daughter company UAB Litesko is a biggest district heating companies in Lithuania. UAB Litesto supplies heat over than 60'000 flats in Lithuania. The company supply heat at nine cities of the Lithuania. Heat is supply not only for Lithuanian cities and towns, but also thousands of private enterprises, organizations and industries. It is natural that Litesko seek to be socially responsible, and minimize the urban heat polluting the surrounding environment.

The Lithuanian city Palanga, where is installed flue gas condenser is situated near the Baltic Sea. It is the main Lithuania resort. The district heat is supplied over the 6000 of users. The distance of the district heating network is over than 32 kilometres. Therefore the reducing of the pollution is very important. The made modernization is a good solution, to get free energy from flue gas and reduce the green house effect.

As the additional equipment was installed to generate and supply heat to existing district system better award category is **the modernization of existing scheme**.

The main reason to install some flue gas cleaning equipment was that the pollutions of the solid particles from wood chips boiler depended on quality of fuel, and varied from 400 to 800 mg/m^3. According Lithuanian environmental protection agency requirements, this pollution is allowed no more than 400 mg/nm^3. The decision to install flue gas recovering system comes from possibility to generate addition energy, solve the solid particle emissions problem and additionally reduce CO_2, CO and NOx pollutions too. After finishing the project at 2007, the reduction of solid particles in flue gas was over 50%, the CO- over 24%, the NOx – 27%.

Summary

In the small district heating networks the wood chips boilers are used. Supplied fuel can be from 30% and over 60% wet. Usually, to install good flue gas cleaning system is very expensive for such networks. Often only multicyclone is installed for cleaning solid particles. As the quantity of the water in the fuel varies in the wide range, the particle mate pollution can be over the norms. Possibility to reduce solid particles emissions and reduce the greenhouse effect is to install flue gas condenser to the wood chips boilers. The described system allows reduce solid particles from 800 mg/m^3 to 80 mg/m^3, to increase wood chips boiler efficiency in 25%, to reduce CO_2 pollution over 800 tonnes per year. The CO and NOx pollutions were reduced as well as. The wood chip boiler has an output of 6 MW and the flue gas condenser will add a further up to 1.9 MW. The flue gas recovery system includes condenser, water treatment system and a scrubber.

System history

According to rental contract with city municipal government Dalkia group daughter company Litesko took over operation of the heat sector in Palanga at 27/12/2000. The district heating network is with a single heat source (boiler district) and branch structure. This structure is the most unreliable structure.

Since 2000 new requirements for the reliability of district heating systems was applied, therefore new investments was required to fulfill this requirements. The additional heat sources should be installed at the boiler houses.

Since the contract was signed Litesko invests into increasing of the efficiency to produce heat, to increase reliability of district heating, and to save environment.

At the first year Litesko have made the reconstruction of the main boiler house and 4 small (without personnel) heating houses

At the second year, there was reconstructed boiler house and installed wood chips boiler **WEISS DHF-11.** This investment reduced CO_2 and save money as cheaper fuel was used. 2 flue gas recovering equipments for the natural gas boilers were installed

All years the mostly bad district network pipes were changed into new. As the stem was used only for the own purposes, there was refused to use old Russian steam boilers (2x 7Mw) and was installed small 1, 5 Mw.

The age of district heating system varies from 1 to 44 years old. The distance of the district heating system is 32566 meters.

There are 6133 users which are connected to Palanga district heating network. The heating square is 437779, 66 m^2

There are the boilers installed at the main boiler house now:

Boiler No.	Boiler type	Output	Efficiency	Fuel
1	Viessmann Vitomax 200	7,8MW		Natural gas
2	Steam boiler DKVR-10/13	6,3 MW (10 t/h garo)	87,0	Heavy oil and natural gas
3	Water heating boiler PTVM-30	34,9 MW	91,0	Heavy oil and natural gas
4	Water heating boiler PTVM-30	34,9 MW	91,0	Heavy oil and natural gas
5	Water heating boiler „WEISS DHF-11“	6 MW	82,5	Wood chips
6	Steam boiler VITAMAX200	1,0 MW (1,5 t/h garo)	91,0	Natural gas

The maximum fuel requirement for the network is for the network is 32, 7 Mw. It means that there is full reserve in power installed at main boiler house.

Basic heat generation and district network data:

- Installed power MW – 90,84
- Wood chips boiler power MW – 6
- Maximum requirement of power MW – 32,7
- Average requirements of power MW - 17
- Heat production MW/year – 65 000
- Supplied heat to district heating network MW/year – 85 000
- Production heat with wood chips MW/year – 35 400
- Heat produced with flue gas condenser MW/year – 6 300
- Average percentage produced energy with flue gas condenser from wood chips boiler % - 18
- Efficiency of wood chips boiler without flue gas condenser – 78
- Efficiency of the boiler house – 92
- Electricity consumption to produce heat kw/Mw – 18,3
- Water consumption in the district heating network m^3/year – 5600
- Heat losses in the district heat network % - 22

Assumptions

In the UAB „Litesko“ branch „Palangos šiluma“ wood chip boiler **WEISS DHF-11** has an output of 6 MWth and particulate mate (PM) emissions was up to 800 mg/nm^3. According Lithuanian environmental protection agency requirements, this pollution is allowed no more than 400 mg/nm^3.

There where several possibilities to reduce the PM pollutions:

- Install electrostatic precipitator (ESP)
- Install Bag filters
- Install Flue gas condenser

The budget investments were estimated for the all cases,

- Bag filters 120’000 Euro,

- ESP- 300’000 Euro,
- Flue gas condenser 600’000 Euro.

ESP and Bag filters do not produce the heat and investments were quite big. Therefore were refused to install its. With flue condenser it is possible to take heat up to 25% from boiler output.

Due to recovering heat from flue gas in the flue gas condenser, the pollution of CO, NOx, and CO_2 can be reduced too. After calculation business plan, the payback time of 3 years were obtained.

Technical description

The condenser’s function is based on spherical particles creating a very large absorbing surface. Through specially designed nozzles, small water droplets (spherical particles) are created that combined comprise the total absorption surface.

The flue gas is sprayed intensively with a large number of nozzles, and the water droplets’ absorbing surface constitutes the mechanical heat exchanger. The heat from the gas is absorbed by the liquid and transferred via the plate heat exchanger to the process in question, such as a district heating system. The heat producing curve described in the 1.Picture.

When the moist gas is cooled quickly, it can no longer carry moisture in its gaseous state, but instead condenses, meaning that it precipitates as a liquid. The more the gas is cooled, the greater the amount of condensate generated.

The condensate can be regarded as a measure of heat recovery. By measuring the volume of condensate, the volume of energy transferred can be easily calculated. The condensate is used as process water that cools the gas in a closed system. Excess condensate is discharged from the system to the recipient through the water treatment system.

The particle concentration in the process water consists is determined by the relation between the input dust volume and the volume of condensate formed during the same period. This means that if the flue gas is cooled less, because the district heat return increases, for example, the concentration will increase. This is offset by the fact that there is always a flow to the water treatment system that is much greater than the estimated maximum condensate flow. From the water treatment system, the surplus is always fed back to the process water, thus ensuring that a pre-determined particle concentration in the process water can be guaranteed.

When condensation ceases, fresh water would need to be added, since the condenser consumes water when the gas becomes saturated..

The gas is sprayed in a gently sloping tube (2. Picture, position 1) that is equipped with a large number of nozzles. The water runs along the bottom of the tube to a collection vessel where the pH value may be adjusted. From this vessel, the water is pumped into a plate heat exchanger that transfers the absorbed energy. The water is then fed once again to the nozzles to be finally collected in the tank. The entire process thus takes place in a closed system in which only the volume of condensate generated is discharged for water treatment.

Through the intensive water sprinkling of the gas, the condenser also functions as an efficient scrubber. The coarse dust particles are cleaned from the gas and fed to the water treatment unit (2. Picture, position 2) according to the above description. This scrubbing effect is important for the ability of the electrostatic precipitator to separate the finer dust particles from the gas.

There is no clogging and no enrichment of flue dust, with the resulting problematic depositions, since all condenser surfaces are always wet.

Thermal and chemical loads are minimized, and the equipment handles the most aggressive gases without incurring damage.

All replaceable components, such as pumps and valves, are of standard design and readily available.

The simple design and function means fewer repairs that can easily be performed by a local contractor.

The detail flow diagram of the flue gas condenser is given on 3. Picture

Scope of the project

The installation of the flue gas condenser in the Planaga city was carried out by official tender in “turn key” term. There was build new building (4 Picture), chimney, flue gas condenser set (4. Picture):

- Flue gas scrubber
- Condenser sloping tubes (5 Picture)
- Condenser tank
- Condenser pumps
- District heat network water pump
- District heat network heat exchanger

- Flue gas fun
- Droplet precipitator
- Control cabinet
- Condensate neutralisation system
- Water treatment system (6 Picture)

Emissions

Flue gas condenser produce approximately 4061 Mw/per six heating month. To produce such amount of energy with natural gas it is necessary to burn out 471'076 m^3 (boiler efficiency is evaluated). 1000 m^3 natural gas produce 1,84 tonnes of CO_2. Therefore the flue gas condenser reduce 867 tones CO_2 /per year.

Particulate matter before installing flue gas condenser, were polluted 4, 7 t/per year. After due the cleaning in the flue gas condenser were reduced up to 2, 3 t/year. It means were reduced over 50%

CO pollution before the project was 177, 4 t/per year, and after-134, 9. It contains about of 24%.

NO_x pollution before the project was 18.9 t/ year, and after - 13. 8. It contains about 27%

The details emission data is given at below table.

Name	Units.	before	design	actual	Remarks
PM	t/year	4,655	1.77	2.31	At the design ash content in fuel was calculated 0, 6%. Actual was 1,5%
CO	t/year	177,425	141,25	134,86	
NOx	t/year	18,858	18,02	13,76	

The innovation of the project

Usual flue gas condensers are installed where amount of solid particles is no more than 200mg/m^3. At the represented project particulate mate is four times higher (800 mg/m^3), than usual situation. In means, it was necessary to have additional solutions that the condenser can

operate. For this reason, before the condenser there was installed wet scrubber, to remove particles. To save heat at the scrubber, the temperature is controlled to be over dew point at gases. The dirty condensate from scrubber is collected at separate tank to precipitate solid particles on the bottom. From the bottom, sludge is pumped back to fuel storage. As the condensate from scrubber is alkaline, the particles in flue gases from wood chips is very small and there is some sand if the wood chips are prepared at forest, after some time, the sludge at the bottom of tank became hard. The process like cement carbonization takes place. Therefore, it is no possibilities to pump out this sludge.

To solve this problem, the water recirculation was added to system. Mechanical mixer was installed too. A acid soak is dossing to the condensate.

This project shows the way, how to solve the pollution of solid particles problems in small wood chips boilers, where installation of other cleaning systems is quite expensive and prolongs pay back time.

Installing flue gas condenser like flue gas cleaning system a lot problems can be solved. The pollution of solid particles can be reduced up to 80mg/m^3, the boiler efficiency can be increased up to 25%. As the heat is produced without any additional fuel, the CO_2 , CO and NOx emissions can be reduced.

Before the project, at winter time there was seems particles on the snow around the chimney. After the project was finished, the pollutions of solid particles is four times less than environmental agency requirements and community of the Palanga city was satisfied.

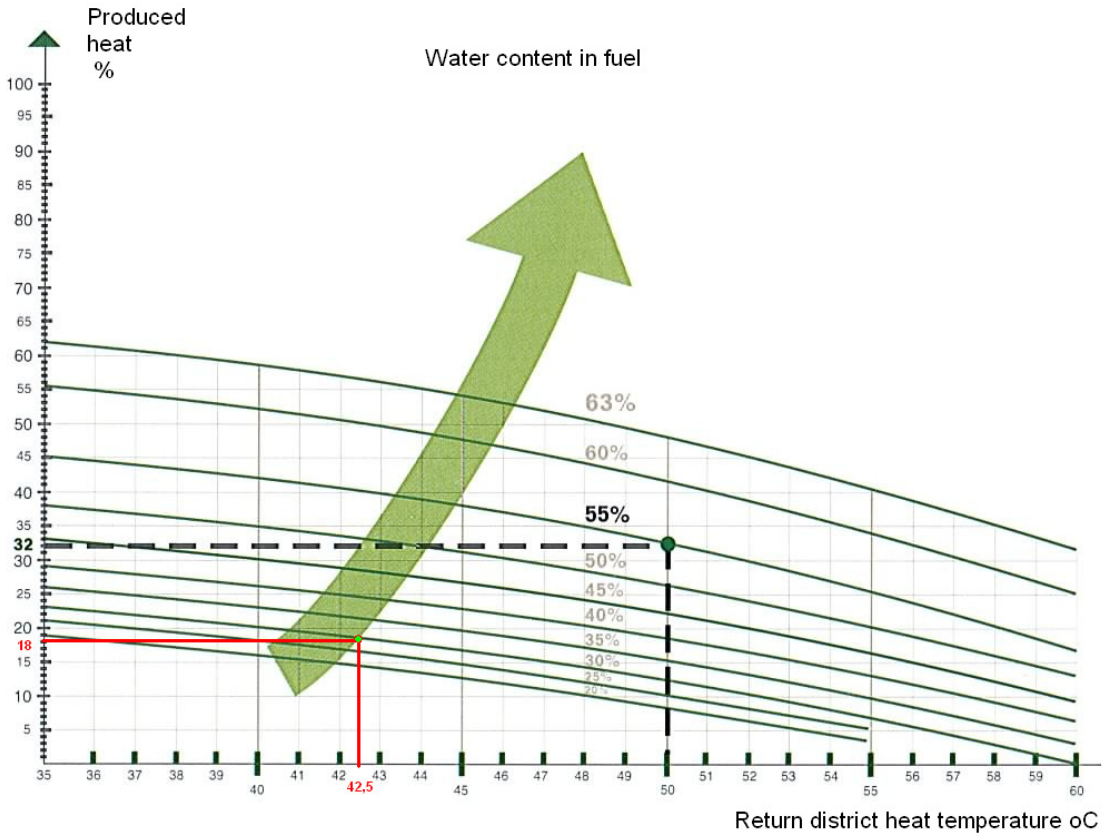
Financing of the project

The financing of this project was from two sources. Main part of budget was supplied by company Litesko investments 82,5%, another part 17.5% was supported by LAAIF (Lithuanian environmental protection investment fund).

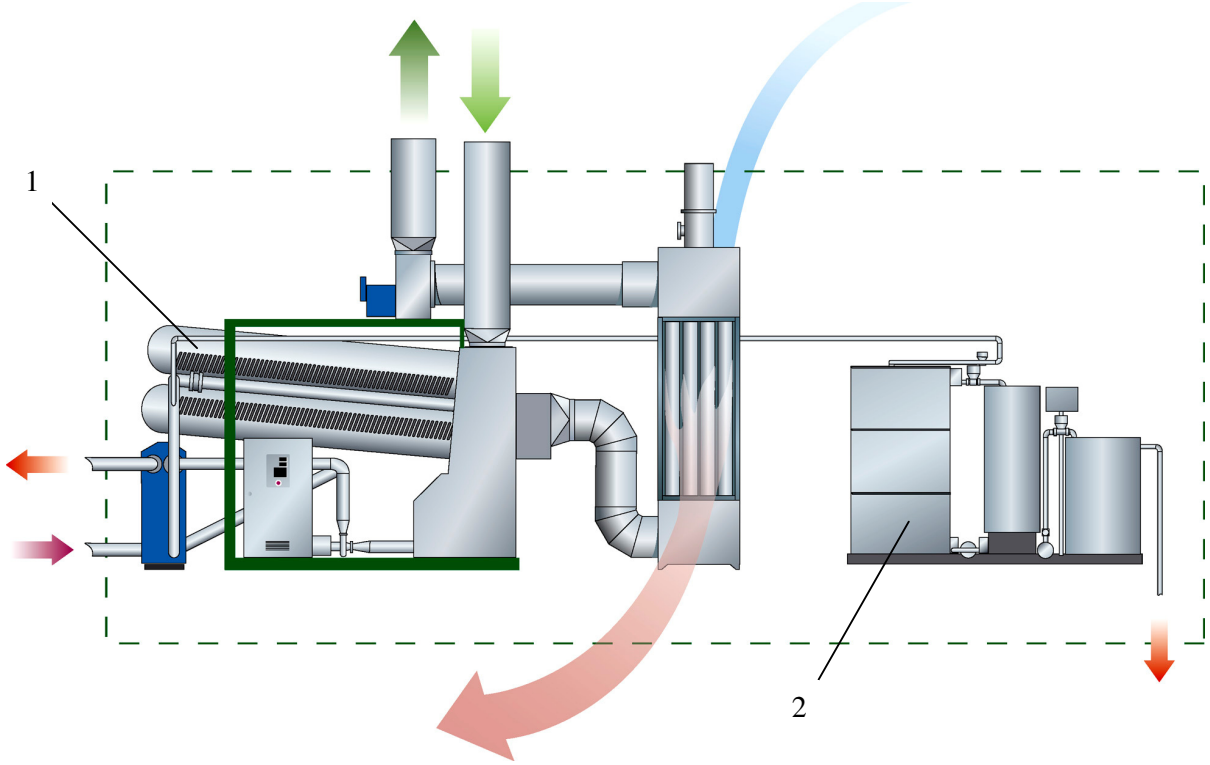
The confirmation of LAAIF fund financing is given in 7 Picture

Litesko

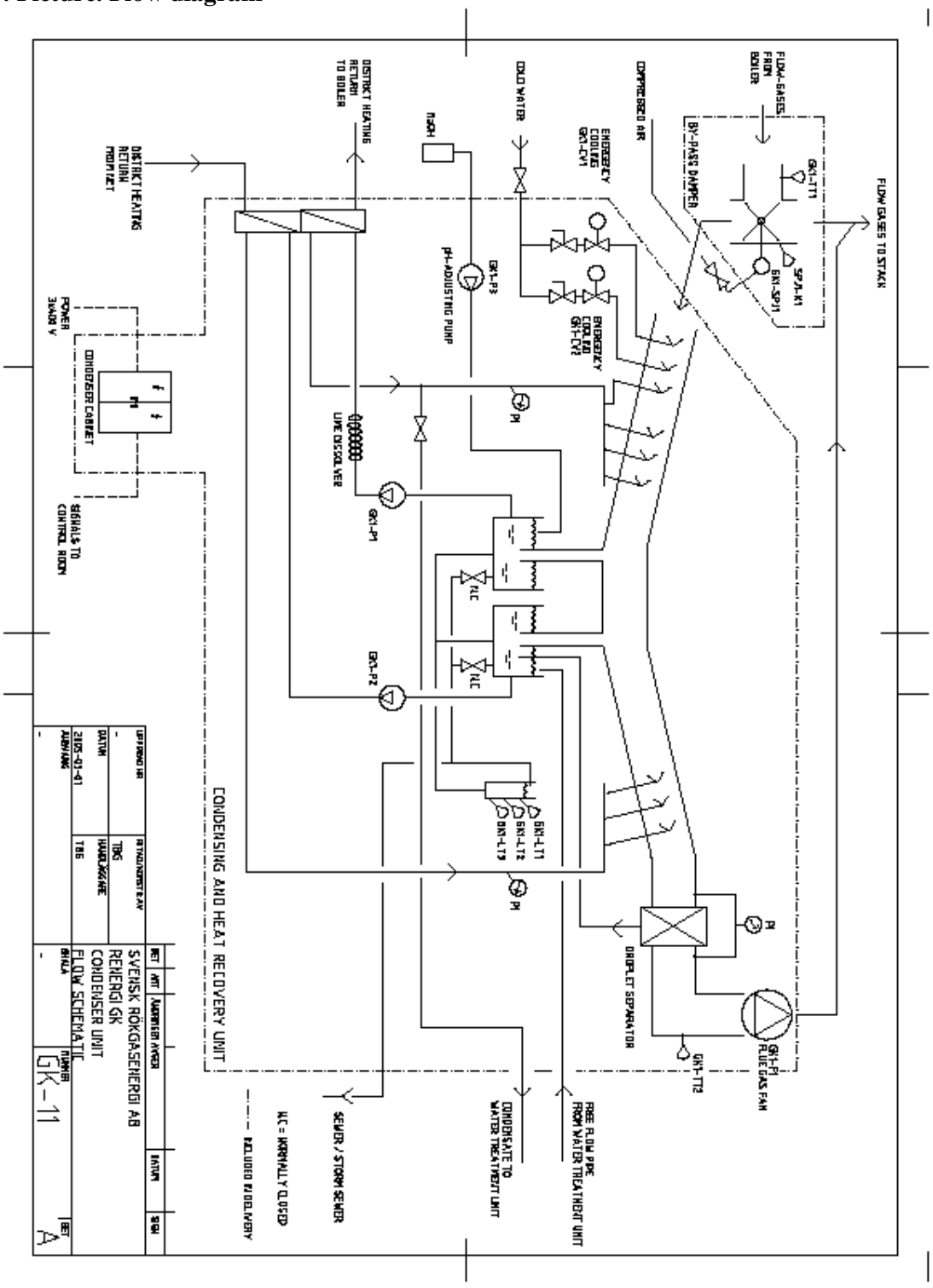
1. Picture. Heat recovery



2. Picture. Flue gas condenser schematic



3. Picture. Flow diagram



4. Picture. Flue gas condenser building

5. Picture Flue gas condenser

6. Picture. Water treatment system

7. Picture. LAAIF financing.