ProEcoPolyNet
Best practice Sheet
”Absorption chiller driven by bio-heat”

RTD Project Identification

RTD Project Name: *Absorption chiller driven by bio-heat*

Description of technology

Biomass boiler and absorption chiller for small-scale heating/cooling applications

Ab- or adsorption chillers have just been available with rather large cooling capacities, most often beyond 100 kW, which made them unsuitable for smale scale applications such as airconditioning in office or residential buildings. Only recently smaller engines with a capacity of 10-20 kW have emerged and even smaller ones (2-5 kW) are under way.

The main benefit of a thermally-driven ab- or adsorption chiller is the lower electricity consumption compared to an electrical compression chiller. By using renewable heat (e.g. solar heat or heat produced by a biomass boiler) the whole process is nearly CO_2 neutral.

In Stigliano (Matera province, Basilicata Region, Italy) the installation of a joint heating and cooling biomass system will be completed by the end of 2007. The system is installed in the Centro Eccellenza Bioenergia (see Fig. 1), which is an office building with a size of 1.000 m^3 and acts as a regional “Formative Centre for Bioenergy Applications”. The production of "cold" is done by a single stage lithium bromide (LiBr) absorption chiller driven by hot water produced by a biomass boiler. The biomass boiler is used for hot water producrtion, for space heating in winter and for airconditioning in summer.

The Li-Br cycle was prefered to the ammonia cycle due to the possibility of using lower process temperatures (90 C°), which can also be achieved by commercial biomass water boilers. The ammonia cycle requires diathermic oil boilers or high pressure steam with temperatures up to 300 °C.

Fig. 1 ***The Centro*** **Eccellenza Bioenergia**

The performance of the plant will be compared to a reference system (electrical compression chiller) in respect of economical, environmental and social aspects. Process monitoring of energy balances and biofuel costs will be carried out to evaluate the installation.

Operating principle

The absorption cycle

The absorption cycle uses a heat-driven concentration difference to move refrigerant vapors (usually water) from the evaporator to the condenser.

As shown in Fig. 2 refrigerant (mostly water) is evaporating in the evaporator. Heat is consumed and this causes the chilling effect. The water vapor is absorbed by the absorber (concentrated LiBr solution) due to its hygroscopic characteristics. The more diluted solution is then pumped to the concentrator at a higher pressure where heat is applied (using steam or hot water) to drive off the water and thereby re-concentrate the lithium bromide. The water driven off by this heat input step is then condensed (using cooling tower water), collected and transported to the evaporator to complete the cycle. The absorption chiller must operate at very low pressures (about l/l00 th of normal atmospheric pressure) for the water to vaporize at a cold enough temperature.

The absorbent is the material that is used to maintain the concentration difference in the machine. Most commercial absorption chillers use LiBr. LiBr has a very high affinity for water, is relatively inexpensive and non-toxic. However, it can be highly corrosive and disposal is closely controlled. Water used as refrigerant is extremely low cost and safety simply isn't an issue.

Technical characteristics of installation

The proposed system will be constituted by three main components:

- biomass high efficiency water boiler (see Fig. 3) with a thermal output capacity of 55 kW (by Froeling)
- absorption chiller (see Fig. 4) with a cooling capacity of 35 kW (by Maya) and a COP (Coefficient of Performance) of 0,7.
- cooling tower

A simplified scheme of the installation is shown in Fig. 5.

The plant is supposed to operate for 2.000 hours/year during the winter season. During the summer and the intermediate seasons other 2.000 hours/year are foreseen (airconditioning and domestic hot water production).

It is estimated, that this biomass project contributes to climate protection with CO_2-savings of 110 t per year.

Location and use

This LiBr-absorption chiller in combination with a biomass boiler is intended to be used for airconditioning of residential and office buildings. In this case the chiller was installed in an office building with a size of 1000 m^3.

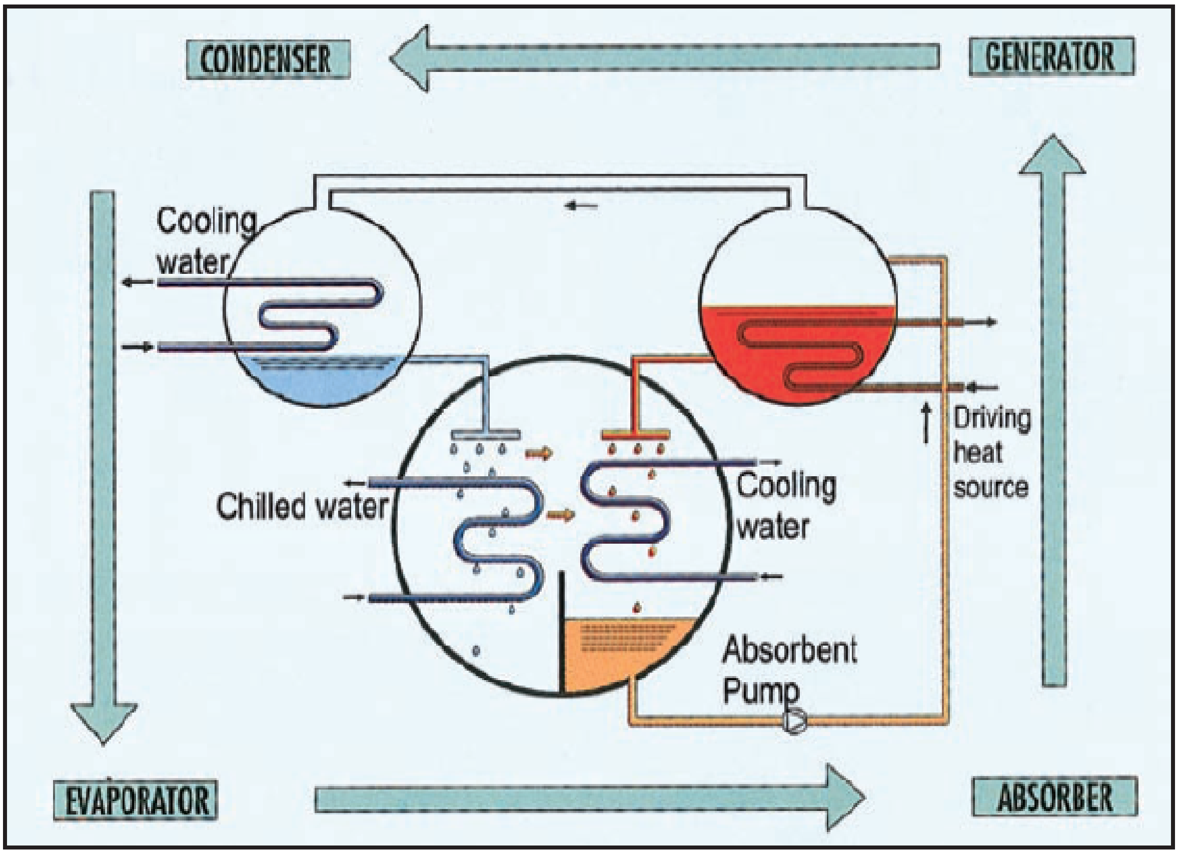

Fig. 2 ***The basic operation cycle of the single stage absorption chiller***

State of Development/Market implementation

Small scale absorption chillers driven by bio-heat, which can compete with modern electrical compression chillers, are still in the phase of field testing. Practical guidelines for the construction, design and dimensioning of such absorption chillers are still rare. A greater number of evaluated demonstration plants might help to overcome this lack of experience.

Benefits and obstacles

Benefits

- Absorption chillers provide the possibility to produce "cold" by the usage of renewable energy (biomass or solar energy).
- The electricity grids – especially in the warmer, southern parts of Europe – are not designed for peak loads nowadays encountered on hot summer days. This might results in a instable grid and even in electrical power outages. The replacement of electrically driven compression chillers by thermally driven absorption chillers could reduce the huge amount of electricity used for air-conditioning and help to reduce the risk of a national electric power breakdown.
- Absorption chillers do not use refrigerants with ozone-depleting potential or global warming potential.

Fig. 3 ***The biomass boiler***

Obstacles

- The upfront investment costs for absorption chillers are still higher than for conventional electrical compression chillers. Simulations for various office buildings have shown that the upfront investment costs for absorption systems are still about 2 up to 2,5 times higher than for conventional systems. Even assuming very low fuel prices absorption chillers are mostly not competitive if no subsidies are granted.

Fig. 4 ***The absorption chiller***

Capital investment and maintenance costs

► *Capital investment*

Capital costs are put at € 65.000. The additional charges compared to a conventional electrical compression chiller are around € 30.000. Subsidies of € 35.000 were granted.

► *Fuel costs*

Biofuel costs: 120 €/toe

(wood chips with a moisture content of 35%, complying with ÖNORM M 7133)

► *Fuel consumption (estimation)*

Overall fuel consumption: 60 toe/year

Fuel consumption for cooling: 20 toe/year

► <u>*Cost-Benefits features (estimation)*</u>

Operating costs of a conventional vapour compression chiller *(reference system)*

- kWh_{el} x working hours x working factor
- Electric energy fare: 0,14 €/ kWh_{el}
- Yearly energy cost: € 7.000

Operating costs of the absorption chiller driven by biomass

- kWh_{th} x working hours x working factor
- Biomass cost: 0,02 €/kWh_{th}
- Yearly energy cost: € 1.000

Additional charges PAY- BACK time

- 6 years

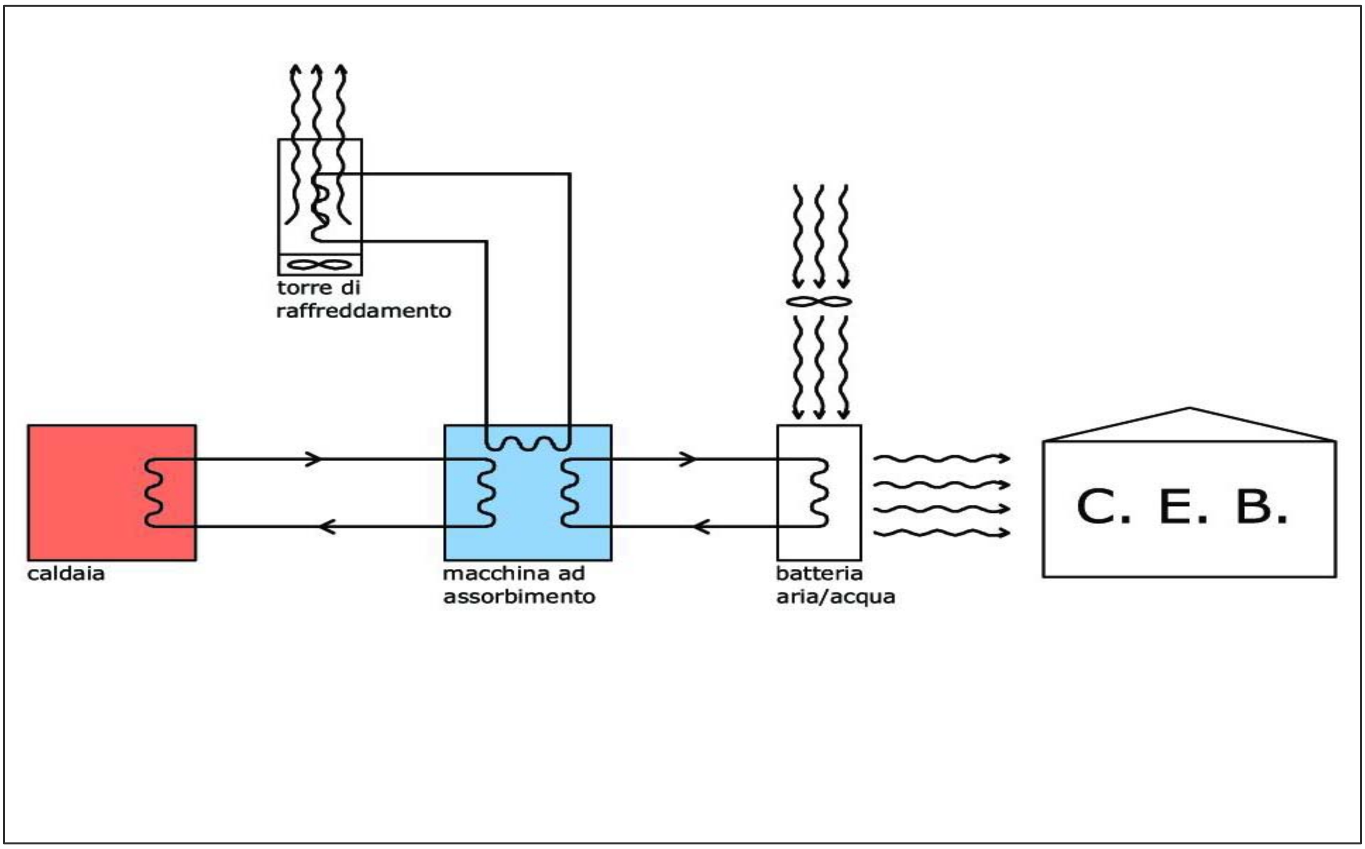

Fig. 5 ***Simplified scheme of the plant*** *(heat source (caldaia), absorption chiller (macchina ad assorbimento), cooling tower (torre di raffreddamento), storage (batteria)*

Contact and further information

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