Solid sorption System for cooling in Tri - generation

- European RTD project "SOCOOL"

EU RTD sheet

Innovative Technology
- Small scale CHP
- Waste heat recovery
- Tri-generation

General information

- **Name of technology:** Solid sorption System for cooling in Tri-generation
- **Technology developer:**
  - Centro Ricerche FIAT (Italy)
  - Energy research Centre of the Nederlands (the Netherlands)
  - Consiglio Nazionale delle Ricerch (Italy)
  - Institute of Fundamental Technological Research, Polish Academy of Sciences (Poland)
  - University of Warwick (United Kingdom)
- **Date of issue:** 2007

Aims and Objectives

The project aimed at developing a small-scale combined cold, heat and power (tri-generation) system, which uses waste heat of the engine for producing cold. The development of this tri-generation system should permit to improve the efficiency of CHP systems, by reducing primary energy usage and by avoiding the utilisation of CFC/HCFC/HFC for cooling purposes. Consequently, this could give a contribution to achieve the Kyoto targets, develop more sustainable energy systems and to reduce the environmental impact for cooling, heating and power generation.

As the major issue a small solid sorption system with high power density was developed, which applies new working pairs as well as innovative system designs in order to achieve high rates of heat and mass transfer.

Figure 1 The SOCOOL Tri - generation system under construction

Description of the Technology

The Tri-generation systems proposed by the project utilise the waste heat of a CHP system for the production of cold, by means of solid sorption cooling Technology.

The solid sorption system consists of two reactor vessels (figure 2) containing heat exchangers filled with silica gel. An evaporator and a condenser are needed inside these two reactors. Heat losses from the exchanger to the environment are minimised by applying vacuum inside the vessel. The heat exchanger is connected with a heat transfer fluid (H_2O) that can be switched rapidly between two different supply temperatures. One sub-system is driven by the exhaust heat recovered from the CHP system and another is driven by the cooling jacket water.

Moreover, the new cooling machine developed within this project is low in cost, has a high efficiency, and operates with a high reliability.

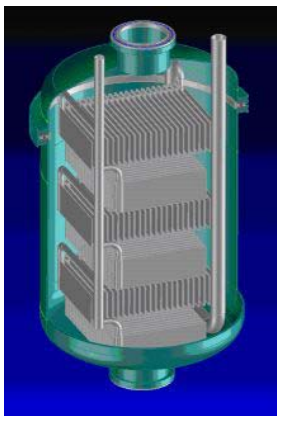

Figure 2 One of the two reactor vessels, filled with heat exchangers

Below are listed the main technical characteristics of installation in the Eco-canteen (CRF).

Type: Tri-generation systems, solid sorption system with two reactor vessels, heat exchangers filled with silica gel	
Electrical output capacity CHP unit	20 kW
Thermal output capacity CHP unit	44 kW
Thermal Output capacity (for air conditioning, hot water) from solid sorption machines	2 x 16 kW
Cooling Output from solid sorption machines	2 x 12 kW
Temperature ratio exhaust gas heat exchanger/1st solid sorption machine	210/190 °C
Temperature ratio CHP unit/2nd solid sorption machine	95/85°C

Table 1 Design data

European Project "Eco-Building International Club for advanced European sustainable energy technology dissemination in Europe and China"

Project partners:

ENEA (IT), ISNOVA (IT), FINCO (IT), ADEME (FR), AIMCC (FR), DTI (DK), DI (DK), CRES (GR), EBHE(GR), GPREC (GR), SEC(B), ZERI (CN), CBEEA (CN)

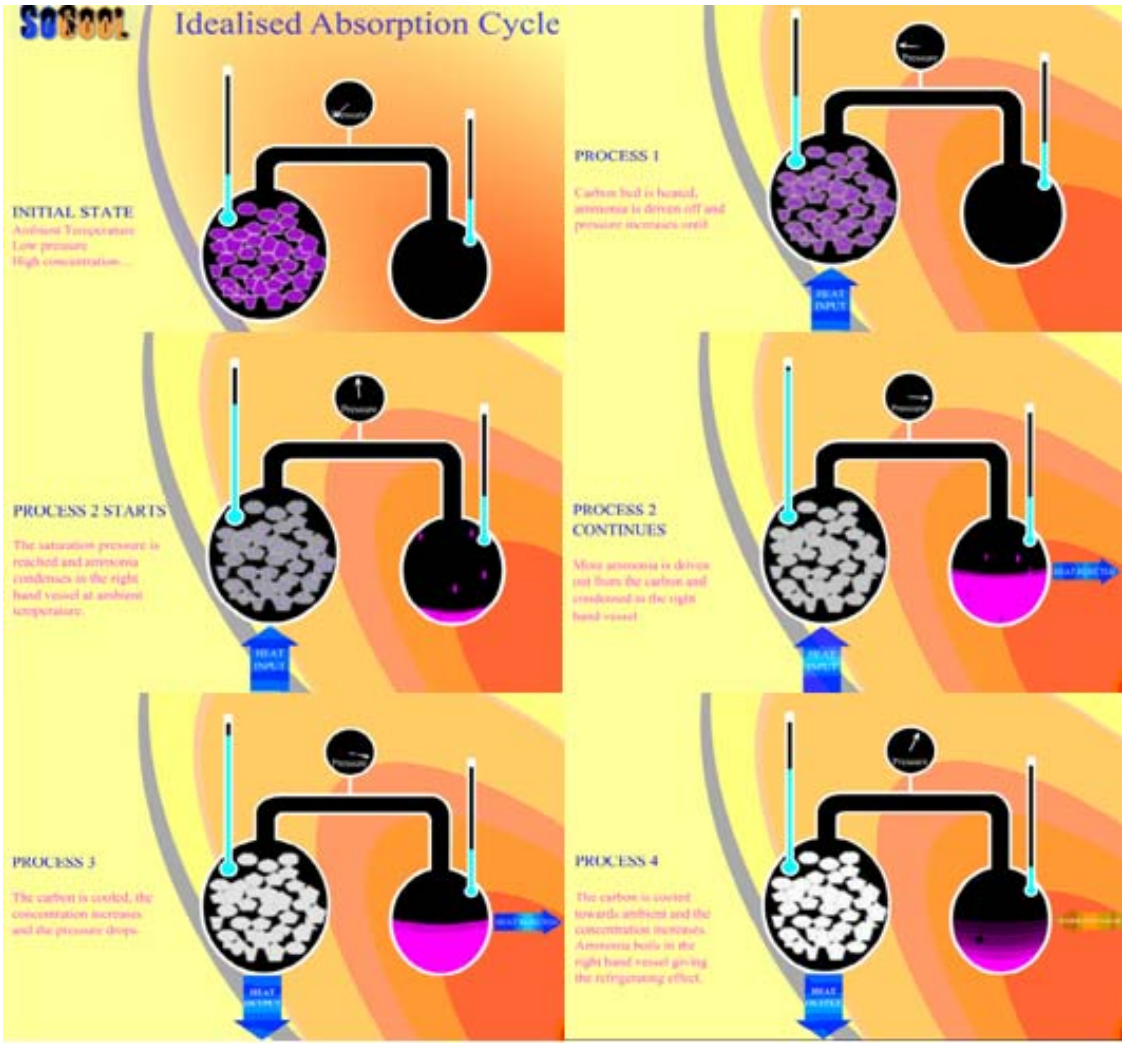

Figure 3 The principal of solid sorption cooling system

Below are shown the energy flow in tri-generation (left) and the generic SOCOOL operating scheme.

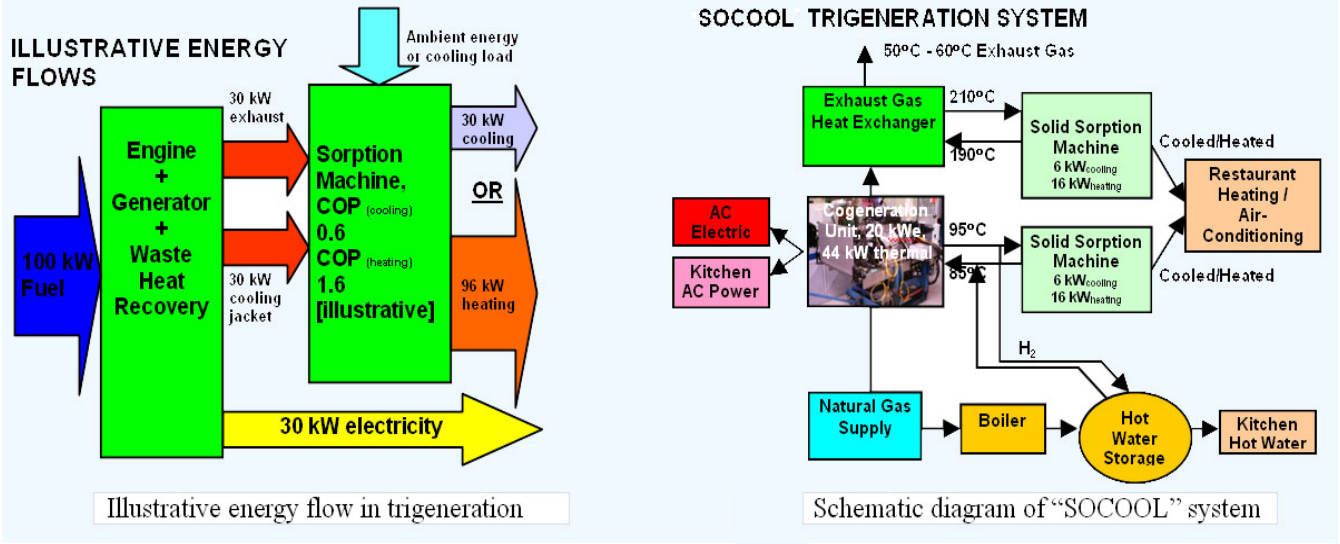

Figure 4 Energy flow in tri-generation (left) and the generic SOCOOL operating scheme

The project aims at promoting and widespread disseminating EU innovative Research and Technology Development and Demonstration results, as well as eco-sustainability criteria in building sector, which include:

- energy efficient building materials, components and systems not yet introduced into the building market or in their first market phase;
- innovative applications of heating/cooling and power supply technologies, combined with the use of renewable energy sources, in building sector;
- best EU demonstration eco-building projects.

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Results and Achievements:

The key issue of the project was to develop a solid sorption cooling system that can be driven by low-grade heat from the jacket cooling water of an internal combustion engine.

The targets for the cooling system were to reach a cooling power of 5 kW with a cooling power density > 20 kW/m^3. An increase in the overall energy efficiency of tri-generation systems of 15-20% has been realised by utilisation of the waste heat of a CHP system. In addition, the cold is produced by means of solid sorption cooling technology, and the peak of electricity demands for cooling purposes is reduced.

The heat transfer coefficient for the compact plate-fin type heat exchanger proposed by the project is 1800 W/m^{2}K, at a flow rate of 4 dm^3/min. When using the same heat exchanger filled with silicagel on the fin-side, the rate of heat transfer depends on the amount of sorbent that is heated or cooled. While, when using the test-rig equipped with a condenser/evaporator, an overall cooling power of 1 kW was measured using the silicagel filled heat exchanger. Based on these results a theoretical cooling power density of 80 kW/m^3 can be reached by using standard microporous silicagel as solid sorbent.

The cost of the new cooling machine developed through this project is low. Important objectives for further development are to produce a more compact system with an even higher volume-to-power ratio and to reduce the cost. Through further research, it is expected that the heat and mass transfer in the silica gel will be improved and standard components can be used as far as possible.

Possible application area

The cooling system, which has been developed, built and tested at project partner ECN, comes up to expectation, generating 5-6 kW of cooling from 8 kW of heat. Following durability tests at ECN it was moved to the Centro Ricerche Fiat (CRF) in Italy. The technology is now being demonstrated in their Eco-Canteen system: residual heat from a new micro CHP unit (a gas engine) is used to generate cooling for the company canteen. The system could be located and used in commercial or public buildings e.g. supermarkets, health centres and old people's homes.

Reference:

- RTD Project Name: Solid Sorption System for Cooling in Tri-generation (SOCOOL)
- RTD Contract No.: ENK5-CT-2002-00632
- Programme: FP 5

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Eco-Building Club: an innovative RTD&D results' promotion approach

Different from common market promotion approaches, where market operators are only simple message receivers, the project proposes an innovative approach: Eco-Building Club is a virtual round table, around which building market operators will be main actors for market penetration of research and demonstration results, through the following actions:

- determining what are more appropriated innovative RTD&D results for local market transferring;
- demonstrating the feasibilities of the research and demonstration results on real cases.