SOLAIR

Increasing the Market Implementation of Solar Air-Conditioning Systems for Small and Medium Applications in Residential and Commercial Buildings

Hlajenje stavb s sončno energijo
Primeri dobre prakse



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Increasing the Market Implementation of Solar Air-Conditioning Systems for Small and Medium Applications in Residential and Commercial Buildings

Intelligent Energy Europe

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Delovni paket 2: Analiza trga in analiza majhnih in srednje velikih solarnih hladilnih sistemov (SHS)

Naloga 2.2: Izdelava spletne podatkovne baze najboljših primerov

Katalog primerov dobre prakse

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Verzija 1.0

1 Uvod 3
2 Tehnologije 4
2.1 Sistemi z ohlajeno vodo 6
2.2 Odprt zračni hladilni sistem 9
2.3 Sprejemniki sončne energije 11
3 SOLAIR-ova podatkovna baza sistemov solarnega hlajenja in klimatizacije 12
4 SOLAIR primeri dobre prakse 13
4.1 Primeri dobre prakse: AVSTRIJA 14
4.2 Primeri dobre prakse: FRANCIJA 21
4.3 Primeri dobre prakse: NEMČIJA 28
4.4 Primeri dobre prakse: GRČIJA 42
4.5 Primeri dobre prakse: ITALIJA 47
4.6 Primeri dobre prakse: PORTUGALSKA 53
4.7 Primeri dobre prakse: ŠPANIJA 57
5 Solarno hlajenje: primeri naprednega pristopa 62

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AEE – Institute for Sustainable Technologies, Avstrija
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1 Uvod

V večini Evropskih držav je opazen trend povečevanja rabe energije za hlajenje in klimatizacijo stavb, ki naj bi se nadaljeval tudi v prihodnjih desetletjih. Razlogov za to splošno povečanje je več, kot na primer, višji standard bivalnega ugodja, trenutno še vedno nizke cene energije, arhitekturni trendi v smislu velikih zastekljenih površin in nenazadnje spreminjanje klimatskih razmer. To povečanje potreb po hlajenju in klimatizaciji stavb posledično povzroča neugodno povečanje rabe fosilnih goriv ter v vedno večji meri probleme s stabilnostjo dobave električne energije v nekaterih mediteranskih državah. Slednje posledično zahteva drage nadgradnje obstoječih električnih omrežij, da te lahko prenesejo konične obremenitve v času največje rabe električne energije.

Zanimajo nas torej izboljšani koncepti gradnje, osredotočeni na zmanjšanje hladilnih obremenitev s pasivnimi in inovativnimi ukrepi ter uporaba alternativ za pokrivanje preostalih potreb po hlajenju. Hladilni sistemi z glavnim ali pomožnim virom toplote – sončno energijo so ena od možnosti zagotavljanja hladu.

V kontekstu projekta SOLAIR je solarno hlajenje oziroma solarna klimatizacija *toplotno* gnan proces. V tem smislu lahko solarno hlajenje prispeva k

- nadomeščanju fosilnih goriv z uporabo sončne energije in s tem Evropskim ciljem po povečanju uporabe obnovljivih virov energije;
- zmanjševanju emisij toplogrednih plinov, tako s prihrankom primarne energije, kot tudi z neuporabo okolju škodljivih hladiv;
- stabilnim električnim omrežjem z zmanjševanjem potreb po električni energiji ter koničnih moči;
- Optimizirana uporaba solarnih sistemov z uporabo proizvedene toplote za podporo ogrevanju stavbe, hlajenju stavbe ter pripravo tople sanitarne vode.

V okviru projekta SOLAIR je bilo izdano več gradiv o solarnem hlajenju, ki so namenjene različnim ciljnim skupinam. V tem katalogu so predstavljeni primeri dobre prakse iz SOLAIR-ove podatkovne baze. Veliko teh primerov je pričelo z obratovanjem leto ali dve pred sestavo tega kataloga, zato zaenkrat ne moramo prikazati dolgoletnih izkušenj z delovanjem teh sistemov. Izraz 'Dobra praksa' se torej v tem primeru nanaša na primerno zasnovo sistema in obetajoč pristop k solarnemu hlajenju. Namen kataloga je, da predstavi primernost solarnega hlajenja za različne tipe stavb, za različne lokacije in z različnimi tehnološkimi rešitvami. V začetku kataloga je kratek pregled tehnologij solarnega hlajenja.

Več informacij o SOLAIR–ovi bazi je dostopnih v brošuri - pregled razpoložljivih tehničnih rešitev in uspešno delujočih sistemov po državah (Cross-country report) na naslovu www.solair-project.eu.

2 Tehnologije

Projekt SOLAIR je osredotočen na solarne hladilne in klimatizacijske sisteme 'majhnih' in 'srednjih' moči. Ta umestitev v 'majhne' in 'srednje' se ujema z tržno dosegljivimi hladilnimi sistemi; v tem smislu so 'majhni' sistemi z nazivno hladilno močjo pod 20kW, srednje veliki sistemi pa nekje do 100kW.

Manjši sistemi ponavadi uporabljajo toplotno gnane hladilnike s hladno vodo, srednje veliki sistemi pa lahko uporabljajo tudi tako imenovano sušilno hlajenje (DEC). Če je v prvem primeru nosilec hladu, ki odvaja toploto iz stavbe voda v zaprtem krogu, je pri slednjem nosilec zrak, kateremu se pred vstopom v prostor neposredno uravnava temperatura in vlažnost. Na sliki 2.1 sta prikazana dva najpogostejša primera sistemov. Seveda so možne tudi kombinacije z istočasno uporabo obeh tehnologij. Pri sistemih z ohlajeno vodo lahko preko centralnega omrežja za razvod hladne vode dovajamo hlad decentraliziranim hladilnim enotam, kot so na primer konvektorji (večinoma z razvlaževanjem), hladilni stropovi, zidovi ali pod, lahko pa hladilno vodo uporabimo tudi za pripravo svežega zraka v centralni klimatizacijski napravi. Potrebna temperatura olajene vode je odvisna od izvedbe hlajenja in je pomembna pri zasnovi sistema. Ker se v projektu SOLAIR ne osredotočamo na končne naprave za distribucijo hladu te niso podrobneje predstavljene.

Iz slike 2.2 je razvidno da toplotno gnan proces deluje na treh temperaturnih nivojih : z grelno toploto Q_{heat} ,ki jo dovaja proces na temperaturnem nivoju T_H, odvajamo toploto Q_{cold} na hladni strani pri temperaturi T_C, medtem ko iz sistema odvajamo odvečno toploto Q_{reject} v okolico pri temperaturi T_M. Grelno toploto Q_{heat} lahko zagotovimo s primerno zasnovanim solarnim sistemom s sprejemniki sončne energije; ta lahko deluje samostojno ali pa s pomožnimi viri toplote.

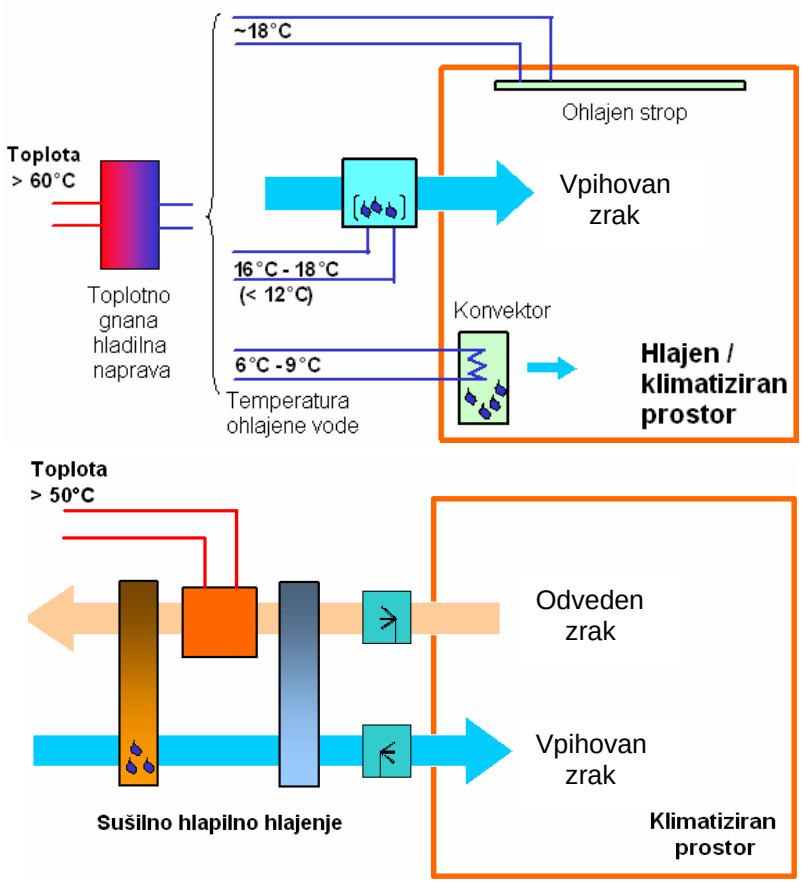
Med tem, ko je pri odprtih krožnih procesih ponor toplote vključen v sam proces znotraj zračnega toka, pri zaprtih procesih z ohlajeno vodo potrebujemo sistem za odvod toplote v okolico, kot na primer hladilni stolp. Trenutno je dan velik poudarek na izbor vrste sistema za ponor toplote, saj je ta komponenta običajno vzrok za velik del lastne rabe energije solarnega hladilnega sistema.

Osnovno število s katerim ovrednotimo hladilni proces je COP (coeficient of performance) ali hladilno število, definirano kot COP = Q_{cold} / Q_{heat}. Hladilno število nam pove koliko grelne toplote potrebujemo na enoto 'proizvedenega' hladu (bolj natančno: na enoto odvedene toplote). Hladilno število in hladilna moč sta močno odvisna od temperaturnih nivojev T_H, T_C in T_M. Ta odvisnost je podrobneje opisana v npr. [Henning, 2006].

Pri tržno dosegljivih solarno gnanih hladilnih napravah se hladilna števila pri nazivnih delovnih pogojih gibljejo od 0,5 do 0,8 za naprave z enojnim učinkom in do 1,2 pri napravah z dvojnim učinkom.

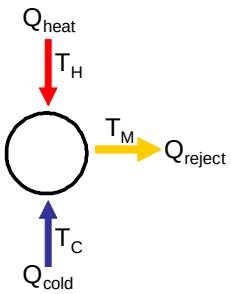
Pri odprtih sušilnih hladilnih sistemih je težje oceniti hladilno število, saj je to bolj odvisno od delovanja sistema. Hladilno število je koristno definirati le za sušilni način delovanja, saj je za ta način potrebna toplota. Izkušnje s sušilnimi

hladilnimi sistemi kažejo, da lahko dosežemo primerljiva hladilna števila kot pri absorpcijskih hladilnih napravah z enojnim učinkom.



Slika 2.1 Glavni vrsti toplotno gnanih hladilnih in klimatizacijskih tehnologij. Na zgornji sliki ohlajeno vodo proizvajamo v zaprtem krogu za različne decentralizirane aplikacije ali za hlajenje svežega zraka. Na spodnji sliki se vpihovan zrak neposredno hladi v odprtem procesu. Vir: Fraunhofer ISE.

Tehnologije so podrobneje opisane v nadaljevanju. Pri obeh tehnologijah je potrebna toplota, da zagotovimo kontinuirano delovanje sistema. Pri aplikacijah s katerimi se ukvarja SOLAIR je znatni del, oziroma vsa potrebna toplota zagotovljena s solarnim sistemom.



Slika 2.2 Osnovna shema toplotno gnanega hladilnega procesa.

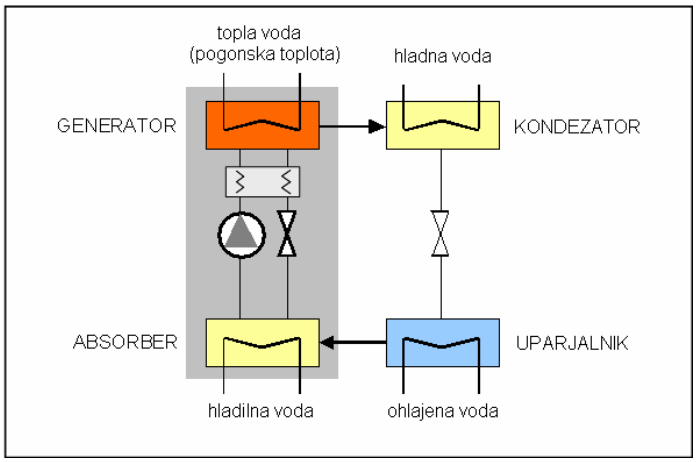
2.1 Sistemi z ohlajeno vodo

Absorpcijske hladilne naprave

Prevladujoča tehnologija toplotno gnanih hladilnih naprav je zasnovana na absorpciji. Osnovni fizikalni proces absorpcije poteka med najmanj dvema snovema, pri čemer ena nastopa kot hladivo, druga pa kot sorbent. Glavni sestavni deli absorpcijske hladilne naprave so prikazani na sliki 2.3. Proces absorpcijskega hlajenja je podrobno opisan v številnih virih npr. [ASHRAE, 1988], zato tu ne bo podrobneje predstavljen.

Večina absorpcijskih hladilnih naprav uporablja vodo kot hladivo in tekoči litijev bromid kot sorbent. Tipične hladilne zmogljivosti teh naprav so do nekaj sto kilovatov. Kot vir toplote večinoma uporabljajo odpadno toploto iz drugih procesov, toploto iz daljinskega omrežja ali toploto iz kogeneracije. Potrebna temperatura toplotnega vira je običajno nad 85°C, hladilno število (COP) pa je med 0,6 in 0,8. Do pred nekaj leti, je bila najmanjša naprava na trgu naprava z hladilno močjo 35 kW Japonskega proizvajalca.

Absorpcijske hladilne naprave z dvojnim učinkom (dvostopenjske), ki imajo dva generatorja, potrebujejo višje grelne temperature (>140°C), a imajo tudi višja hladilna števila (>1,0). Najmanjša naprava tega tipa na trgu ima zmogljivost približno 170 kW. Ker so pri tej tehnologiji potrebne višje temperature, je pri solarnem sistemu nujna uporaba sprejemnikov sončne energije s koncentratorji. Ta tehnologija je primerna za geografska področja z veliko direktnega sončnega obsevanja.



Slika 2.3 Shema toplotno gnane absorpcijske hladilne naprave. V primerjavi z običajno električno gnano kompresorsko hladilno napravo imamo pri absorpcijski hladilni napravi namesto mehanskega kompresorja toplotni kompresor z absorberjem in generatorjem. Hladilni učinek je posledica uparjanja hladiva (npr. vode) v uparjalniku pri nizkem tlaku. Lastnosti fazne spremembe nam omogočijo prenos velike količine energije. Pare hladiva se absorbirajo v absorber s čemer bogatijo raztopino hladiva in sorbenta. Da proces absorpcije nemoteno poteka, je potrebno hlajenje absorberja. Raztopina se iz absorberja neprestano črpa v generator, v katerem se raztopina regenerira za kar je potrebno dovesti toploto (npr. iz solarnega sistema). Hladivo gre iz generatorja v kondenzator, kjer zaradi ohlajanja kondenzira in se potem preko ekspanzijskega ventila vrne v uparjalnik. S tem je krog sklenjen.



Slika 2.4a Primeri majhnih absorpcijskih hladilnih naprav, ki uporabljajo vodo kot hladivo in litijev bromid kot sorpcijsko sredstvo. Levo: Naprava zmogljivosti 4,5 kW španskega proizvajalca Rotartica. V sredini: 10 kW hladilna naprava z visoko učinkovitostjo pri delni obremenitvi in visokim hladilnim številom nemškega proizvajaca Sonnenklima. Desno: Hladilna naprava zmogljivosti 15 kW, ki jo izdeluje nemški EAW; ta naprava je na voljo z različnimi močmi: 30 kW, 54 kW, 80 kW in več. Viri: Rotartica, Sonnenklima, EAW.

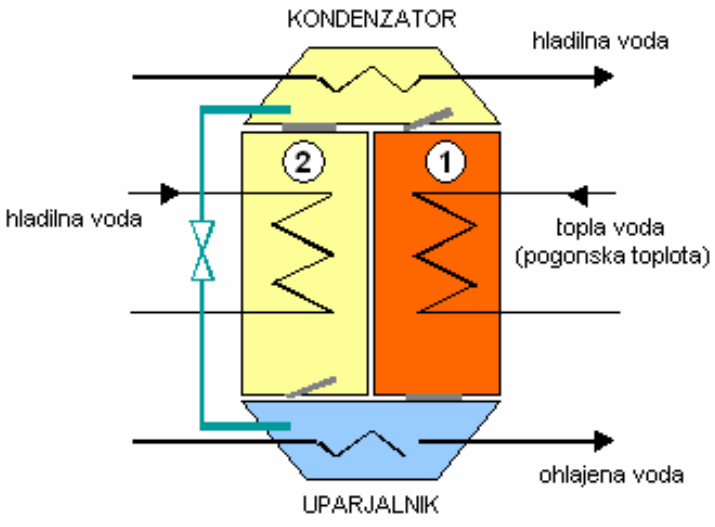


Slika 2.4b Nekateri primeri absorpcijskih hladilnih naprav. Levo: Hladilna naprava (par amoniak-voda) s hladilno močjo 12 kW avstrijskega proizvajalca Pink. V sredini: Naprava uporablja vodo kot hladivo in litijev klorid kot sorbent. Uporablja tudi kristalizacijsko fazo sorbenta, kar omogoča notranje shranjevanje energije. Zmogljivost naprave je približno 10 kW; napravo proizvaja ClimateWell, Švedska, in lahko deluje tudi kot toplotna črpalka. Desno: Absorpcijska hladilna naprava z delovnim parom H_2O/LiBr in zmogljivostjo 35 kW podjetja Yazaki, Japonska. To hladilno napravo velikokrat zasledimo v obstoječih sistemih solarnega hlajenja, saj je bila več let najmanjša naprava na evropskem trgu, primerna za solarno hlajenje. Sedaj je na voljo tudi manjša naprava istega proizvajalca s hladilno močjo 17,5 kW. Viri: Pink, ClimateWell, Yazaki.

V zadnjem času se stanje na trgu spreminja, saj se v segmentu majhnih in srednje velikih hladilnih naprav pojavlja veliko novih izdelkov. Večinoma so zasnovani tako, da za delovanje potrebujejo nižje temperature grelne toplote, ki jo lahko zagotovimo s stacionarnimi ravnimi ali vakuumskimi sprejemniki sončne energije. Hladilna naprava najmanjše moči, ki je trenutno tržno dosegljiva ima hladilno moč 4,5 kW. Na sliki 2.4 je prikazanih nekaj naprav majhnih in srednjih moči. Poleg običajnega delovnega para H_2O/LiBr se uporabljata tudi H_2O/LiCl in NH_3/H_2O. Uporaba slednjega z amoniakom kot hladivom v namene hlajenja stavb je relativno nova, saj je bila ta tehnologija večinoma v uporabi za hlajenje večjih moči v območju pod 0°C v industriji. Prednost te tehnologije je predvsem pri aplikacijah, kjer je potreben velik dvig temperature ($T_M - T_C$), na primer v področjih s pomanjkanjem vode, kjer je potrebno izvesti suho hlajenje pri visoki temperaturi okolice.

Adsorpcijske hladilne naprave

Poleg naprav, ki uporabljajo tekoči sorbent, obstajajo tudi naprave s trdno sorpcijsko snovjo. Ta material adsorbira hladivo, in ga nato odda, ko mu dovedemo toploto. Da dosežemo kontinuirano delovanje potrebujemo najmanj dve ločeni posodi s sorpcijsko snovjo. Na sliki 2.5 so prikazane komponente adsorpcijske hladilne naprave. Večina sistemov na trgu uporablja vodo kot hladivo in silica gel kot sorbent. Raziskave in razvoj gredo v nove sisteme, ki kot sorbent uporabljajo zeolite.



Slika 2.5 Shema adsorpcijske hladilne naprave. Osnovni sestavni deli so dve ločeni posodi 1 in 2, ter uparjalnik in kondenzator. Med tem, ko se sorbent v prvi posodi desorbira (odstranjevanje adsorbirane vode) z uporabo zunanjega toplotnega vira, npr. solarnega sistema, sorbent v drugi posodi adsorbira uparjeno hladivo, ki prihaja iz uparjalnika; če hočemo izboljšati učinkovitost procesa je potrebno drugo posodo hladiti. Hladivo, ki kondenzira v hlajenem kondenzatorju, gre v uparjalnik, kjer se zaradi nizkega tlaka ponovno upari. Pri tem se ustvari uporabna hladilna toplota. Procesa adsorpcije in desorpcije v obeh posodah se periodično izmenjujeta. To je običajno izvedeno s preklopnim ventilom.

Danes je na trgu le nekaj adsorpcijskih naprav proizvajalcev iz Japonske, Kitajske in Nemčije. Od leta 2007 je na trgu naprava nemškega podjetja z zmogljivostjo 5,5 kW, novejša verzija (model 2008) pa dosega že 7,5 kW. Tipične vrednosti hladilnega števila (COP) za adsorpcijske naprave so med 0,5 in 0,6. Njihova prednosti pred absorpcijskimi napravami so nižje potrebne temperature grelne toplote, ki se začnejo že pri približno 60°C, ni potrebna črpalka za raztopino hladiva in posledično so te naprave tudi manj hrupne.



Slika 2.6 Primeri adsorpcijskih hladilnih naprav. Levo: Hladilna naprava zmogljivosti 70 kW Japonskega proizvajalca Nishiyodo. Adsorpcijske hladilne naprave podobnih zmogljivosti proizvaja tudi Japonsko podjetje Mayekawa. Desno: Adsorpcijska hladilna naprava zmogljivosti 7,5 kW, nemškega proizvajalca SorTech.

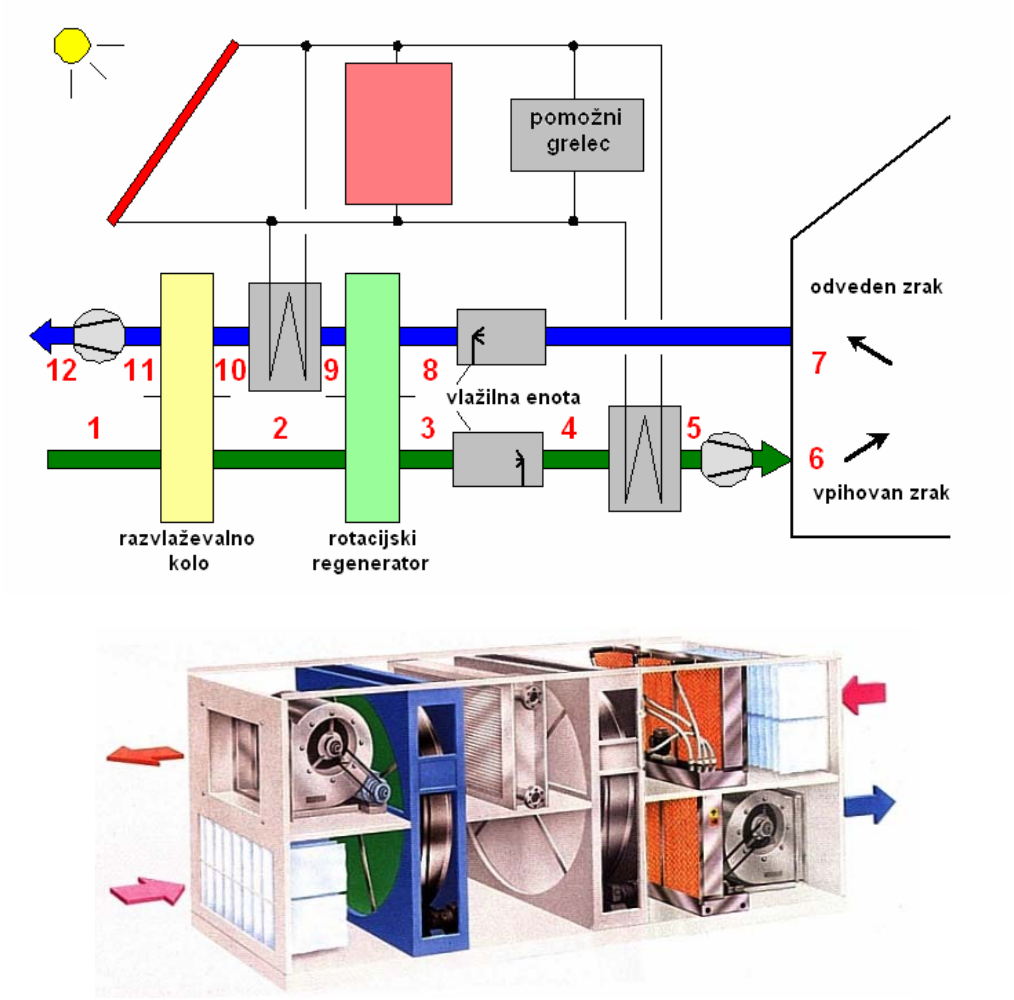
2.2 Odprt zračni hladilni sistem

Med tem ko toplotno gnane hladilne naprave, ki so bile predstavljene zagotavljajo ohlajeno vodo, ki jo pošiljamo v klimatizacijske naprave in sisteme, odprt zračni hladilni proces neposredno hladi zrak. Ne glede na vrsto toplotno gnane hladilne naprave z odprtim krožnim procesom ta deluje na principu hlapilnega hlajenja z razvlaževanjem s pomočjo higroskopične snovi v trdnem ali tekočem stanju. Najbolj je razširjena uporaba vrtečega sušilnega kolesa z nanosom silikagela ali litijevega klorida. Vse potrebne komponente so standardne in se uporabljajo v namene klimatizacije ter razvlaževanja zraka v stavbah in industrijskih objektih vrsto let.

Standardni sistem, ki uporablja sušilno kolo je prikazan na sliki 2.7. Ta sistem je primeren za geografska področja z zmernimi klimatskimi pogoji, saj je pri visoki vlažnosti okoliškega zraka tega težko razvlažiti do te mere, da ga lahko ohladimo s hlapilnim hlajenjem. Za klimatske pogoje, ki so značilni v mediteranskih državah, je potrebno uporabiti drugače zasnovane odprte zračne hladilne sisteme.

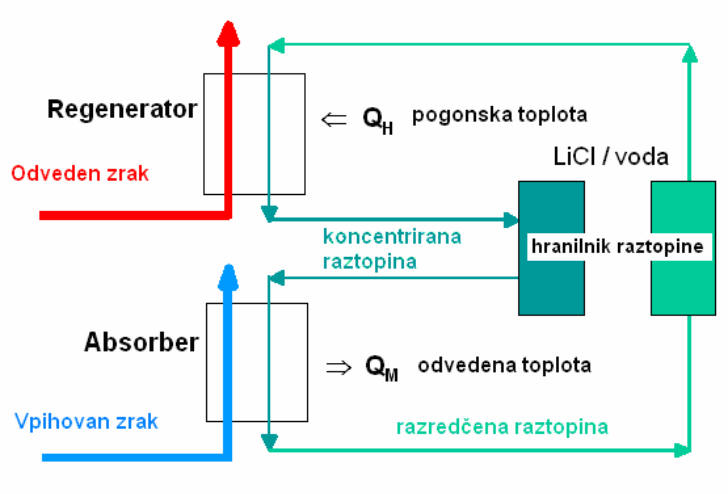
Sistemi s tekočimi sorpcijskimi sredstvi imajo nekaj prednosti v primerjavi s prej omenjenimi sistemi s sušilnimi kolesi. Z njimi dosegamo višje stopnje raz-vlaževanja pri isti temperaturi grelnega medija, omogočajo pa tudi možnost

shranjevanja energije s pomočjo koncentriranih higroskopičnih tekočin. Sicer še niso tržno dostopni, a so zelo blizu vstopa na trg; poteka že nekaj demonstracijskih projektov, kjer se testira uporabnost te tehnologije v namene solarno podprte klimatizacije.



Slika 2.7 Shema toplotno gnanega hlapilnega hladilnega sistema s sušilnim kolesom (DEC), (Vir: Fraunhofer ISE) in spodaj: Skica naprave (Vir: Munters). Procesi si sledijo takole:

1→2 sorpcijsko razvlaževanje zunanjega zraka
2→3 zrak ima po razvlaževanju visoko temperaturo in nizko vlažnost, zato ga s prenosnikom toplote (rotacijski regenerator ali rekuperator) predhodno ohladimo
3→4 zrak navlažimo in s tem ohladimo (hlapilno hlajenje) ter ga vpihujemo v prostor
4→5 grelnik se uporablja samo v ogrevalni sezoni za predgrevanje zraka
5→6 z ventilatorjem vpihujemo zrak v stavbo
6→7 svežemu zraku se zaradi notranjih hladilnih obremenitev poviša temperatura in vlažnost
7→8 odpadni zrak iz stavbe se ohladi s hlapilnim hlajenjem skoraj do nasičenja
8→9 ohlajen odpadni zrak vstopi v rotacijski regenerator s katerim predhladimo zrak, ki dokaj vroč zapušča razvlaževalno kolo.
9→10 regeneracijska toplota se zagotovi s solarnim sistemom
10→11 voda, vezana v porah sušilnega kolesa, se desorbira z vročim odpadnim zrakom
11→12 odpadni zrak z ventilatorjem potisnemo v okolico

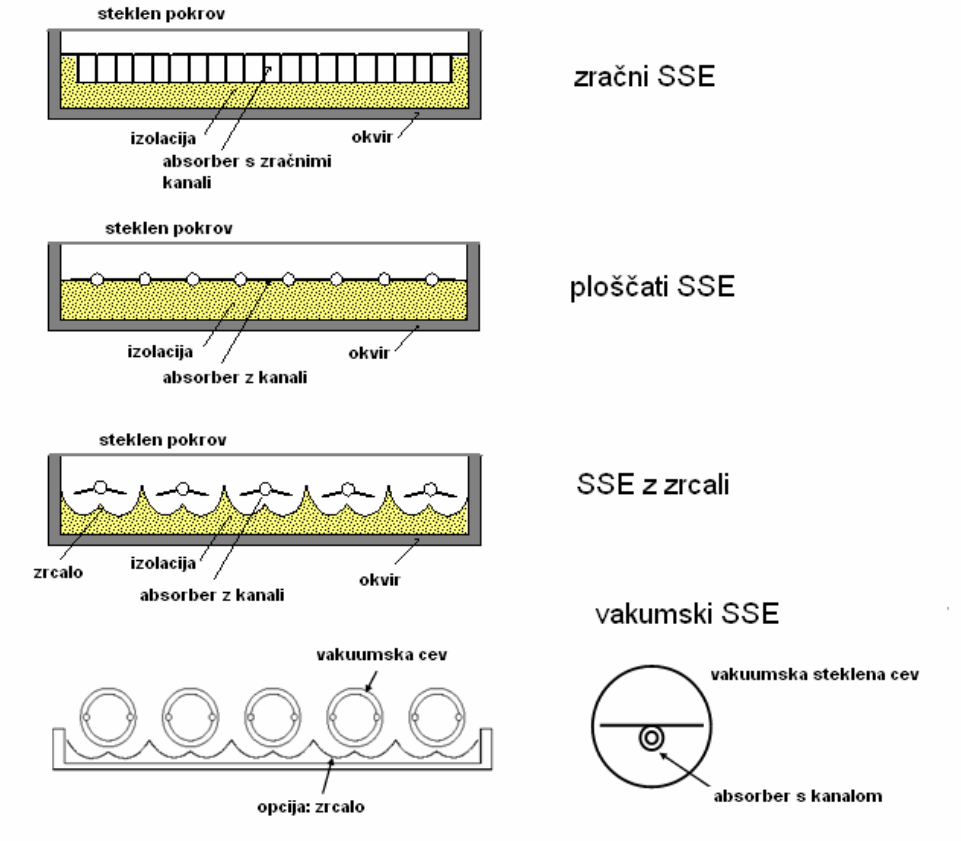


Slika 2.8 Osnovna shema sušilnega hlajenja s tekočim sorpcijskim sredstvom. Svež zrak se razvlaži v posebej oblikovani pršni coni absorberja, kjer se koncentrirana solna raztopina razredči z vlago, ki je v svežem zraku. Učinkovitost procesa se poveča z odvajanjem sorpcijske toplote, na primer s posrednim hlapilnim hlajenjem odpadnega zraka in rekuperacijo toplote. Če je potrebno, lahko dodamo še eno enoto s hlapilnim hlajenjem za hlajenje svežega zraka. (rekuperacija toplote in hlapilno hlajenje nista prikazana v tem diagramu). V regeneratorju se dovaja toplota (npr. iz solarnega sistema), da ponovno dobimo koncentrirano raztopino. Koncentrirana in razredčena raztopina sta lahko shranjeni v visoko energijskih hranilnikih, kar nam do neke mere omogoča časovni zamik v času med hlajenjem in regeneracijo. Vir: Fraunhofer ISE.

V splošnem so sušilni hladilni sistemi zanimiva možnost v primerih, ko imamo centralni klimatizacijski sistem. V stavbah kjer imamo visoke latentne in senzibilne hladilne obremenitve, lahko proces klimatizacije razdelimo na razvlaževanje s solarno gnanim odprtim sušilnim procesom in dodatnim hladilnim sistemom z ohlajeno vodo s katerim hladimo zrak (npr. s hladilnimi stropovi).
Odprti sušilni hladilni sistemi so podrobneje opisani v [Henning, 2004/2008] in [Beccali, 2008].

2.3 Sprejemniki sončne energije

Na voljo je veliko različnih tipov sprejemnikov sončne energije (SSE) in večina med njimi je primerna za solarno hlajenje. Pri tem pa je pomembno, da izberemo primeren SSE glede na izbrano tehnologijo solarnega hlajenja in klimatske pogoje kraja. Osnovni tipi sprejemnikov sončne energije so prikazani na sliki 2.9. Uporaba cenenih toplozračnih SSE je omejena na uporabo pri odprtih sušilnih hladilnih sistemih, saj ta tehnologija zagotavlja najnižji temperaturni njivo grelne toplote (nekje od 50°C naprej). Za solarne hladilne sisteme z ohlajeno vodo potrebujemo kvalitetne ravne SSE (selektivni nanos, kakovostna izolacija). Na sliki niso prikazani SSE s koncentratorji ter SSE s sledilnim mehanizmom, s katerimi lahko pridobimo toploto na temperaturnem nivoju med 100°C in 200°C, ki je potrebna za pogon absorpcijskih naprav z dvojnim učinkom ali pa hladilnih naprav z delovnim parom amoniak-voda, ki delujejo pri večjih temperaturnih razlikah.



Slika 2.9 Primeri SSE, ki so primerni za solarno hlajenje.
Vir: SOLAIR / Fraunhofer ISE.

3 SOLAIR-ova podatkovna baza sistemov solarnega hlajenja in klimatizacije

V okviru projekta SOLAIR je bila izdelana podatkovna baza uspešno delujočih solarnih hladilnih in klimatizacijskih sistemov malih in srednjih hladilnih moči. V tabeli 3.1 je kratek pregled te podatkovne baze. Bolj podrobno je ta predstavljena v SOLAIR [SOLAIR: Review technical solutions, 2008]. Iz te baze so vzeti 'primeri dobre prakse', ki so predstavljeni v nadaljevanju.

Vrsta stavbe	Število sistemov	Tehnologija	Hladilna moč [kW]	Država
Bolnišnica (& dom ostarelih)	1	Ab	10	FR
Laboratorij (za javno bolnišnico)	1	Ad	70	DE
Javna knjižnica	1	DEC	81	ES
Javne pisarne	3	DEC_{liq}, DEC	11-30	DE, AT, PT
Druge javne stavbe	2	Ad, DEC	5.5-6	DE, GR
Komercialne pisarne	11	Ab	9-70	AT, FR, DE, GR, IT, PT, ES
Konferenčna dvorana	1	DEC	60	DE
Vinska klet	1	Ab	52	FR
Stanovanjske zgradbe	3	Ab, Ad	4.5-10	AT, IT, ES
	skupaj: 24			

Table 3.1 Tip stavbe, tehnologija, hladilna zmogljivost ter porazdelitev držav in sistemov v SOLAIR-ovi podatkovni bazi.
Okrajšave: Ab = Absorpcija; Ad = Adsorpcija; DEC = Sušilno hlapilno hlajenje; DEC_{liq} = Sušilno hlapilno hlajenje s tekočim sorbentom.

4 SOLAIR primeri dobre prakse

Veliko primerov, ki so predstavljeni v nadaljevanju je pričelo z obratovanjem leto ali dve pred sestavo tega kataloga, zato zaenkrat ne moramo pričakovati dolgoletnih izkušenj z delovanjem teh sistemov. Izraz 'dobra praksa' se torej v tem primeru nanaša na primerno zasnovo sistema, učinkovito delovanje napreden pristop k zasnovi solarnega hlajenja. Namen kataloga je, da predstavi primernost solarnega hlajenja za različne vrste stavb, za različne lokacije in z različnimi tehnološkimi rešitvami.

Primeri v tem katalogu so povzeti z njihovih predstavitev na SOLAIR-ovi spletni strani. Za nekatere primere je na voljo več podatkov, kar je označeno na desni strani opisa posameznega sistema in si jih lahko naložimo na računalnik s spletne strani.

4.1 Primeri dobre prakse: AVSTRIJA

Primeri predstavljeni na naslednjih straneh:

1. Ökopark, Hartberg
2. Bachler, Gröbming
3. SOLution, Sattledt

Ökopark Hartberg, Austria

Description of the application

Office building cooling (+ heating and hot water)

General description of the system

The 30.4 kW DEC system has a heat energy input from 12m² flat plate collectors and a 30 kW biomass boiler as auxiliary heat source. The peak cooling load of the building is 20 kW and the peak heating load is 24 kW. The number of heating demand hours is 3560 per year. The heating and cooling supply is distributed through air ducts with heat recovery.

Central air-conditioning unit

Technology	open cycle (DEC)
Nominal air volume flow rate	6,000 m^3/h
Minimum air volume flow rate	- m^3/h
Desiccant cooling system type	solid desiccant
Desiccant type	Silica Gel
Cooling capacity	30.4 kW (max)
Brand of desiccant unit	-

Solar thermal

Collector type	flat-plate
Brand of collector	Vacuum-tube collector
Collector area	12 m^2 gross area
Tilt angle, orientation	70° south
Collector fluid	water-glycol
Typical operation temperature	-

Configuration

Heat storage	3 m^3 water
Cold storage	-
Auxiliary heating support	biomass
Use of auxiliary heating system	heating & cooling
Auxiliary chiller	no

System performance

Annual cooling load/annual regeneration heat = annual COP = 0.6
kWh primary energy/kWh cooling = solar fraction = 1.66
Daily solar gain = 60 kWh, gain on collector surface 430 kWh/m² collector area
Daily electricity demand =65 kWh for AHU, pumps, water treatment etc.
Average collector efficiency is 40%.
The adiabatic operation mode, which does not need the regeneration heat, is important for the enlargement of the COP to 0.6.

General information



Type of building Office building
Location Hartberg, Austria
Auxiliary heating support Biomass
In operation since 2000-09
System operated by Ökopark Hartberg
Air-conditioned area 280 m^2
- capacity 30.4 kW max

Specific information

Further specific information about the system are included in the filled in technical questionnaire.

AT02_Hartberg.pdf 250 K

Contact

For more information on the project please feel free to contact:

Charlotta Wikler
c.winkler(at)aee.at

Se nadaljuje na naslednji strani

System reliability and overall success of the installation

The users and owners of the buildings are satisfied.
The use of the DEC plant is normal satisfying. In case of disturbances there are not yet the suitable persons available to repair, due to the not well known technology. Main problem is the hygiene of the open water basins. Biological cleaning of the water by a biocide and UV-light (254 nm) together with water quality checks is a practical way.
The centralized cooling system needs a large amount of electricity for ventilation. If renewable heat is used fort the regenerator, the CO_2 emissions are significantly reduced.
The following items could be learned at the Hartberg DEC:

1. The control strategy for all year round operation is not fully developed.
2. Water treatment have to include also the biologic cleaning (biocide and UV-radiation) of the water. Time by time, especially after long periods without operation, the air humidification facilities have to be cleaned.
3. Service intervals should be fixed and a staff of educated people is necessary.
4. Especially protections against lightning damages in the control have to be executed specially in the country side.
5. The temperature for the regeneration has to be high enough to avoid to high indoor air humidity.



View at the Ökopark Hartberg, Austria

Bachler in Gröbming, Austria

Description of the application

The system is used for office cooling and heating and hot water preparation. The solar thermal system also heats up a swimming pool during summer time.

General description of the system

Closed cycle absorption with ammonia/water as working pair. The system has biomass as auxiliary heating for heating and for the absorption machine.
The building is an office building for a HVAC company with 700 m² cooled office area.
The peak cooling load of the building is 9 kW and the building is cooled via concrete core activation.
The building has mechanical building ventilation with heat recovery.
The heat rejection is wet, open EWK Axima refrigeratoin with 25 kW.

Central air-conditioning unit

Technology	closed cycle
Nominal capacity	9 kW_{cold}
Type of closed system	Absorption
Brand of chiller unit	PINK chillii PSC 9
Chilled water application	chilled ceilings
Dehumidification	no
Heat rejection system	wet open

Solar thermal

Collector type	flat-plate
Brand of collector	From the company "Neuma-Solar" in Kremsmünster, Austria
Collector area	46 m^2 aperture
Tilt angle, orientation	45°, south
Collector fluid	water-glycol
Typical operation temperature	80 °C (driving heat for cooling application)

The solar collectors are partly mounted on the ground, partly installed on the façade of the building. The system is operated with a variable flow control.

Configuration

Heat storage	3x4.5 m^3 water
Cold storage	none
Auxiliary heating support	biomass 150 kW
Use of auxiliary heating system	space heating in winter, heating & cooling
Auxiliary chiller	no

System performance

The absorption chiller has a COP of 0.64.

General information



Type of building Office building
Location Gröbming, Austria
In operation since 2007
System operated by Bachler HVAC company (own office building)
Air-conditioned area 700 m^2
Capacity 9 kWcold

Figures





Clicking an image opens the gallery view.

Specific information

Further specific information about the system are included in the filled in technical questionnaire.

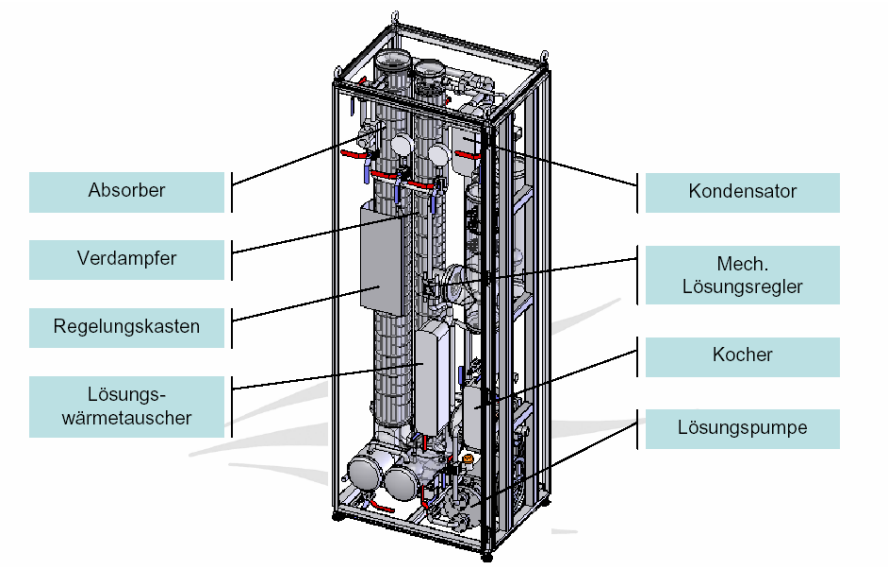
AT01_Bachler.pdf 391 K

Contact

For more information on the project please feel free to contact:

Charlotta Winkler
c.winkler@aee.at

Se nadaljuje na naslednji strani



Components of the Ammonia/Water chiller, installed at the Bachler system, Gröbming, Austria. Source: PINK Energie- und Speichertechnik.

Absorption chiller SOLution, Sattledt, Austria

Description of the application

Absorption chiller with open wet cooling tower to cool 350 m² office building with a peak cooling load of 8 kW.

General description of the system

Auxiliary heating only for heating system: gas boiler with 9 kW. Solar thermal system serves to heat the domestic hot water.

Central air-conditioning unit

Technology	closed cycle
Nominal capacity	15 kW_{cold}
Type of closed system	absorption
Brand of chiller unit	EAW WEGRACAL SE 15
Chilled water application	chilled ceiling
Dehumidification	no
Heat rejection system	wet open

Solar thermal

Collector type	flat-plate
Brand of collector	SOLution
Collector area	40 m^2 aperture
Tilt angle, orientation	35°
Collector fluid	water-glycol
Typical operation temperature	75 °C driving temperature for chiller operation

Configuration

Heat storage	2 m^3 water
Cold storage	water, 0.8 m³
Auxiliary heating support	gas boiler, 9 kW
Use of auxiliary heating system	space heating in winter
Auxiliary chiller	no

System performance

No data is available yet.

System reliability and overall success of the installation

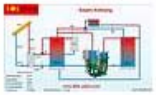
The system works to the satisfactory of the building users.

General information



Type of building office building
Location Sattledt, Austria
In operation since 2005
System operated by SOLution Solartechnik GmbH
Air-conditioned area 350 m^2
Capacity 15 kW

Figures

Clicking an image opens the gallery view.

Specific information

Further specific information about the system are included in the filled in technical questionnaire.

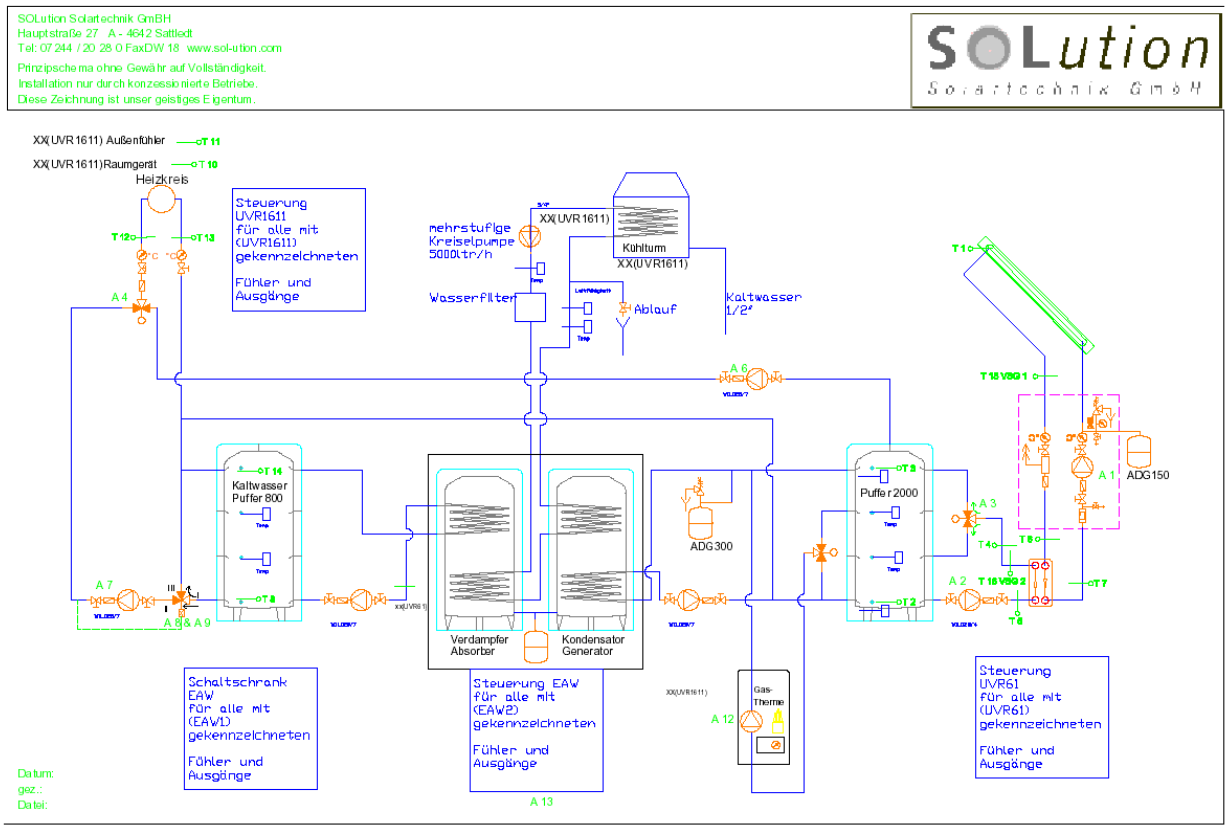
AT03_SOLution.pdf 300 K

Contact

For more information on the project please feel free to contact:

Charlotta Winkler
c.winkler@aee.at

Se nadaljuje na naslednji strani



Scheme of the solar cooling system at Sattledt, Austria

4.2 Primeri dobre prakse: FRANCIJA

Primeri predstavljeni na naslednji straneh:

1. Résidence du Lac, Maclas
2. GICB building, Banyuls sur Mer
3. Kristal building, Saint Denis de la Réunion

Résidence du Lac, Maclas, France

Description of the application

The targeted building welcoming the solar cooling application is the Résidence du Lac, a building dedicated to retired people. This building is sitted in the village of Maclas in the Rhône Alpes area, close to Lyon. The village is in altitude, nearly 450 m high.
The building was created in the seventies and is of an average quality level for the energy efficiency. Only one small part of the building is cooled, the leisure space/restaurant which is compulsory since summer 2003 in retired buildings. This area is of 210 m² and includes a veranda oriented in the Southern direction. Efforts were made to increase the solar protection level in the veranda by adding dark thin protection films. Till 2007, the building owner used electric compression chillers (3 monosplits). Two of them were out of order in 2007 and the management took the decision with the help of the SIEL (Syndicat Intercommunal d'Energie de la Loire) to go for a solar cooling system. The owner of the system is the SIEL itself.

General description of the system

The system is based on an absorption chiller of 10 kW coupled with evacuated tube collectors. The system is in configuration of a quasi solar autonomous cooling system because only a small electric compression chiller (splite type) is used in case of failure of the solar system. The load of a part of the entire building is based on the following scenario: cooling demand from June to mid September and heating demand from mid October to end of May. The solar system is using fan coils for the cooling and heating modes but thanks to a buffer storage, it can be valorized as well in the heating mode through the central heating network of the Résidence du Lac. The heat rejection system is done by a drycooler sitted in the Northern facade of the building.

Central air-conditioning unit

Technology	closed cycle
Nominal capacity	10 kW_{cold}
Type of closed system	Absorption
Brand of chiller unit	Sonnenklima
Chilled water application	fan coils
Dehumidification	no
Heat rejection system	dry

Solar thermal

Collector type	evacuated tube
Brand of collector	Thermomax Mazdon 20
Collector area	24 m^2 absorber area
Tilt angle, orientation	30 °, 15 ° west
Collector fluid	water-glycol
Typical operation temperature	75 °C driving temperature for chiller operation

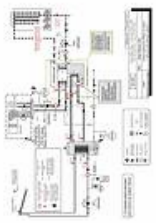
General information



Type of building Retired people residence
Location Maclas, France
Auxiliary heating support fuel (central heating system)
In operation since 2007
System operated by SIEL
Air-conditioned area 210 m^2

Figures






Clicking an image opens the gallery view.

Se nadaljuje na naslednji strani

Configuration

Heat storage	0.5 m^3 water
Cold storage	buffer water (80 litres)
Auxiliary heating support	none
Use of auxiliary heating system	-
Auxiliary chiller	yes
- type	el. compression chiller
- capacity	3 kW_{cold}

System performance

Energy production expectations:

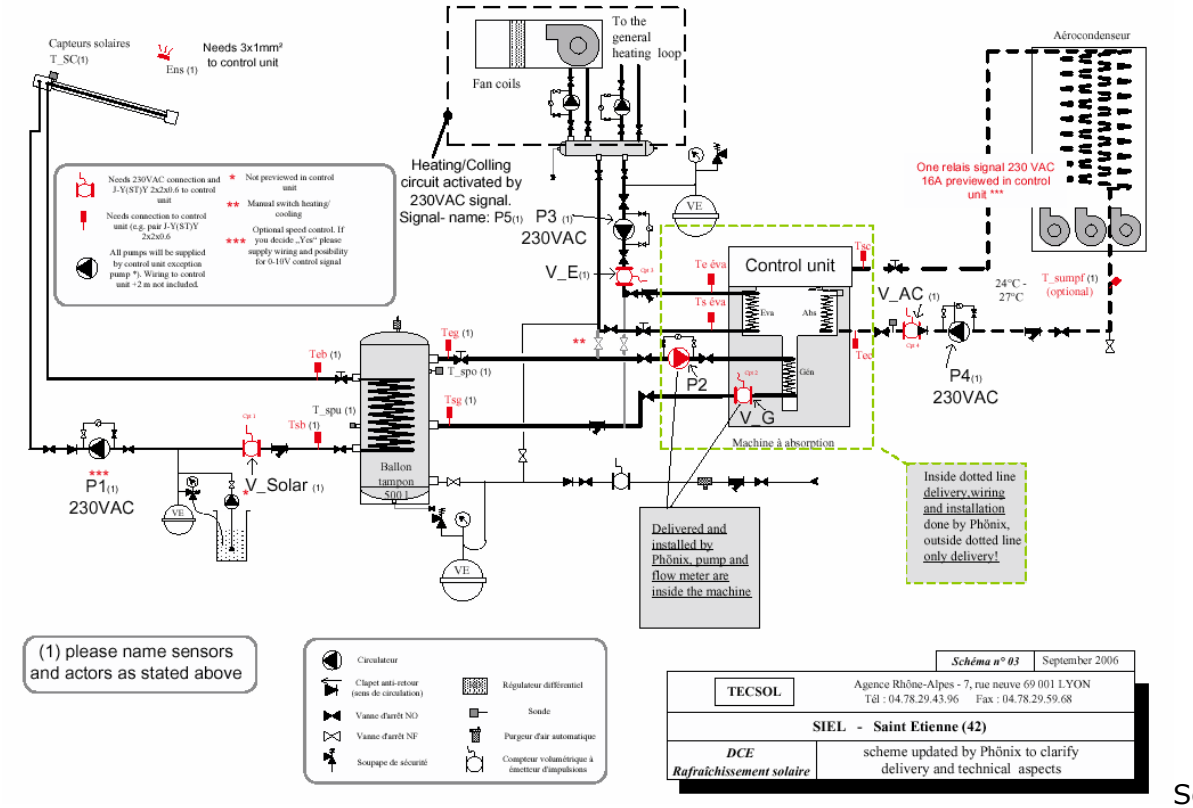
- Cooling : 4,300 kWh/year (4 months)
- Heating : 8,300 kWh/year (8 months)

TOTAL = 12 600 kWh/year

Energy savings:

- Cooling: 5 c€/kWh (EER = 2; bad quality split)
- Heating: 6 c€/kWh (fuel burner; 85 %)
- Electricity consumption : 845 kWh = 42 €/year

TOTAL = 1,150 €/year
(on the basis of an average increase of energy price of 5 %/year)



Sc

Scheme of the solar cooling system at Maclas, France

GICB building in Banyuls sur Mer, France

Description of the application

The targeted building welcoming the solar cooling application is the GICB building. This wine cellar is dedicated to wine conservation in the city of Banyuls sur Mer, in the seaside close to the Spanish border (Mediterranean sea). The ground floor is used for dispatching and the bottle storage is done in Level -1 and Level -2. Started in summer 1989 without cooling system, the wine cellar behaviour has been tested for two years. An ambient temperature continuous measurement in the three levels permitted to analyse their behaviour and to determine the best working conditions for cooling.
The important thermal inertia of Level -1 and Level -2 in comparison with the Ground Floor, which in addition the level where new bottles are transiting before being stored, has led to limit the Level-2 temperature to 17 °C, the Level -1 temperature to 19 °C, and, with the potential cooling energy excess the Ground Floor temperature to 22 °C. Thermal gains are quite weak. They are mainly sensible gains by conduction through the walls or by infiltration. Latent gains are considered as negligible in comparison.
The cooling demand is fitting the solar resource evolution during the year.
Solar energy is able to be used for an heating system for occupant comfort in winter at the Ground Floor (≈18 °C) and potentially the pre-heating of water used on a new bottling process.
All of these points are favourable criteria for using solar energy on this site.

General description of the system

The cooling system is made of 130 m² of evacuated tube collectors (useful area) Cortec Giordano on the roof, oriented in South/South-West and directly fixed on the roof at nearly 15°, a technical premises situated in Level -2 and owning a buffer storage tank of 1 000 litres, a single effect indirect absorption chiller YAZAKI type WFC 15, with a nominal cooling power of 52 kW, several circulating pumps for the different loops, a general electrical managing chest, a open loop cooling tower with a nominal power of 180 kW, installed in the Northern front, three air conditioning units (one per level) having a filter, a cold exchanger for chilled water (+ an heat exchanger for the Ground Floor one) and a centrifugal fan with a 25,000 m³/h flow. The distributed cooling power is between 25 and 35 kW, depending on the levels. The air conditioning units are working in full recycling (with exhausting through a ventilation shaft) the maximum difference between exhausting and re-using is nearly of 4 °C, avoiding thus any thermal shock risk. The primary loop (collector loop) is filled in with water, for a working temperature between 60 and 95 °C. All the other loops work as well with pure water. Balance valves 'TA Control' permit a precise flow adjustment in each loop and under-loop, which is essential for the good system management.

Central air-conditioning unit

Technology	closed cycle
Nominal capacity	52 kW_{cold}
Type of closed system	absorption
Brand of chiller unit	YAZAKI
Chilled water application	AHU
Dehumidification	no
Heat rejection system	wet cooling tower

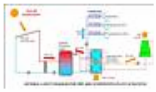
General information



Type of building Wine cellar
Location Banyuls sur Mer
In operation since 1991
System operated by Dalkia
Air-conditioned area 4,500 m^2
Capacity 52 kW

Figures




Clicking an image opens the gallery view.

Contact

For more information on the project please feel free to contact:

Daniel Mugnier
daniel(at)tecsol.fr

Se nadaljuje na naslednji strani

Solar thermal

Collector type	evacuated tube
Brand of collector	Giordano Cortec 2
Collector area	130 m^2 absorber area
Tilt angle, orientation	15°, 15° west
Collector fluid	water
Typical operation temperature	85 °C driving temperature for chiller operation

Configuration

Heat storage	1 m^3 water
Cold storage	none
Auxiliary heating support	none
Use of auxiliary heating system	-
Auxiliary chiller	no

System performance

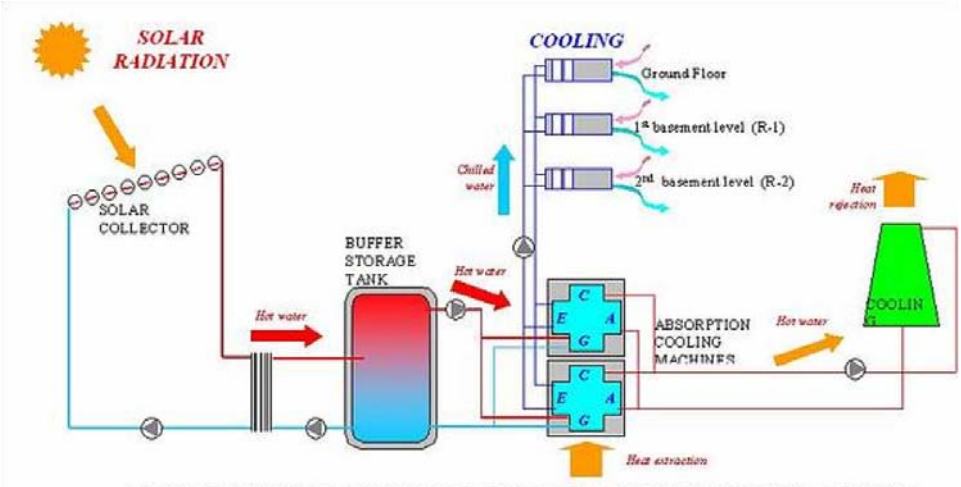
Energy production (2007)
Cooling only: 17,000 kWh/year (from May to end of September)

Energy savings
Cooling: 0.05 €/kWh (EER = 2)
Electricity consumption: 2,800 kWh = 280 €/year

TOTAL = 950 €/year
(on the basis of an average increase of energy price of 5 %/year)

System reliability and overall success of the installation

This installation is a very good success for the end user. The solar cold production is in adequation with the load of the building: decrease the temperature increase in the wine cellar. Adequation between solar production and cooling load of the 3 storage levels in the building. A lot of different articles, reports on TV, publications. The user is as well using the system as a marketing attraction for potential clients and visitors. The user is satisfied of the performances and do not need any back up. No major issues in the system since 1995. Change of the primary loop pump and of the crepuscular sensor by a irradiation sensor to decrease the electric COP of the system.



GENERAL LAYOUT DIAGRAM FOR THE AIR-CONDITIONING PLANT AT BANYULS

Kristal building in Saint Denis de la Réunion, France

Description of the application

The targeted building welcoming the solar cooling application is the Kristal office building. It is dedicated to offices and residential in the city center of Saint Denis in the Réunion island (Indian Ocean, southern hemisphere). This building is made of 5 levels and the solar cooling system is on the top floor. The general orientation of the building is North/South therefore the roof (45° tilt) is oriented East/Weast.
The building was created in 2006 and is of good quality level for the energy efficiency. All of the building is cooled, this means the cooled area is of 875 m². The owner of the building is the SCI Cristal company belonging to the DIII Espaces contemporain holding.

General description of the system

The system is based on an absorption chiller of 35 kW coupled with 92 m² evacuated tube collectors. The system is in configuration of a solar assisted cooling system because a 115 kW compression chiller is used as a back up to face the cooling load (no heating demand in this place) all year long. The distribution system is a chilled water net using fan coils working at 10/14 °C temperature level. The heat rejection system is done by a wet cooling tower on the top of the building.

Central air-conditioning unit

Technology	closed cycle
Nominal capacity	35 kW_{cold}
Type of closed system	absorption
Brand of chiller unit	YAZAKI
Chilled water application	fan coils
Dehumidification	no
Heat rejection system	wet cooling tower

Solar thermal

Collector type	evacuated tube
Brand of collector	Thermomax Mazdon 20+30
Collector area	92 m^2 absorber area
Tilt angle, orientation	45°, 90° west and 90 east
Collector fluid	water
Typical operation temperature	80 °C driving temperature for chiller operation

Configuration

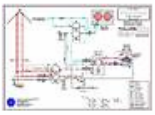
Heat storage	0.5 m^3 water
Cold storage	buffer water (80 litres)
Auxiliary heating support	none
Use of auxiliary heating system	-
Auxiliary chiller	yes
- type	el. compression chiller
- capacity	115 kW_{cold}

General information



Type of building Office building
Location Saint Denis de la Réunion
In operation since July 2006
System operated by Alisea
Air-conditioned area 825 m^2
Capacity 35 kW

Figures


Clicking an image opens the gallery view.

Se nadaljuje na naslednji strani

System performance

Energy production expectations
Cooling only: 46,000 kWh/year (10 months out of 12)

Energy savings
Cooling: 0.05 €/kWh (EER = 2; bad quality split)
Electricity consumption: 7,600 kWh = 760 €/year

TOTAL = 2,550 €/year
(on the basis of an average increase of energy price of 5 %/year)

System reliability and overall success of the installation

Problem with cooling tower noise and commisioning delay due to issues on monitoring quality. The compression chiller is compensating the performance lacks of the solar cooling system. The building owner could communicate on the first solar cooling plant in operation on a demo site in Réunion Island. Issues to make work the system because no reliable phone line available till now. Machine works without problems. Minor problems occur with external control and measuring technology. It will be assessed after sufficient monitoring period.



Collector array and heat rejection unit of the Saint Denis de la Réunion solar cooling system, France

4.3 Primeri dobre prakse: NEMČIJA

Primeri predstavljeni na naslednji straneh:

1. Fraunhofer ISE, Freiburg
2. University Hospital, Freiburg
3. Chamber of Commerce 'Südlicher Oberrhein' (IHK-SO), Freiburg
4. Office building of Ott Ingenieure, Langenau
5. Solar Info Center SIC, Freiburg
6. Office building of IBA AG, Fürth

Fraunhofer ISE, Freiburg, Germany

Solar air-conditioning with adsorption chiller of the canteen kitchen area at Fraunhofer ISE, Freiburg, Germany

Description of the application

The Fraunhofer Institute for Solar Energy Systems (ISE) institute building is an energy efficient building with passive cooling measures. An exception is the canteen kitchen area, where due to high internal loads active cooling of the supply air is appropriate. This is done by means of a small size thermally driven chiller.

General description of the system

The system technology is a closed cycle chilled water system with an adsorption chiller. Heat is provided by a solar thermal system and by the heat network of the institute. During summer, the system runs in cooling mode. The medium temperature heat of the chiller is rejected by three ground tubes of 80 m each. In winter, the heat pump function of the machine is activated and the ground tubes act as low-temperature energy source. The system thus cools and heats the supply air into the kitchen.

Central air-conditioning unit

Technology	closed cycle
Nominal capacity	5.5 kW_{cold}
Type of closed system	Adsorption
Brand of chiller unit	SorTech ACS 05
Chilled water application	supply air cooling
Dehumidification	occasionally
Heat rejection system	dry, ground tubes

Solar thermal

Collector type	flat-plate
Brand of collector	Solvis FF 35s 3/2 FKY
Collector area	22 m^2 aperture
Tilt angle, orientation	30°, south
Collector fluid	water-glycol
Typical operation temperature	75 °C driving temperature for chiller operation

Configuration

Heat storage	2 m^3 water
Cold storage	none
Auxiliary heating support	Institute heat network, operated by CHP and gas boiler
Use of auxiliary heating system	Auxiliary driving source for chiller, auxiliary driving source for heat pump operation in winter
Auxiliary chiller	no

System performance

The thermal coefficient of performance (COP) for a 14-days cooling operation in June 2007 was 0.57. The low heat rejection temperature levels due to the ground tube application are of advantage. The solar thermal coverage of the total heat input into the chiller for this operation period was 56%.

General information



Type of building kitchen area of Institute
Location Freiburg, Germany
In operation since 2007
System operated by Fraunhofer ISE
Air-conditioned area 42 m^2

Figures





Clicking an image opens the gallery view.

Specific information

Further specific information about the system are included in the filled in technical questionnaire.

DE04_FhG-ISE-Freiburg.pdf

Contact

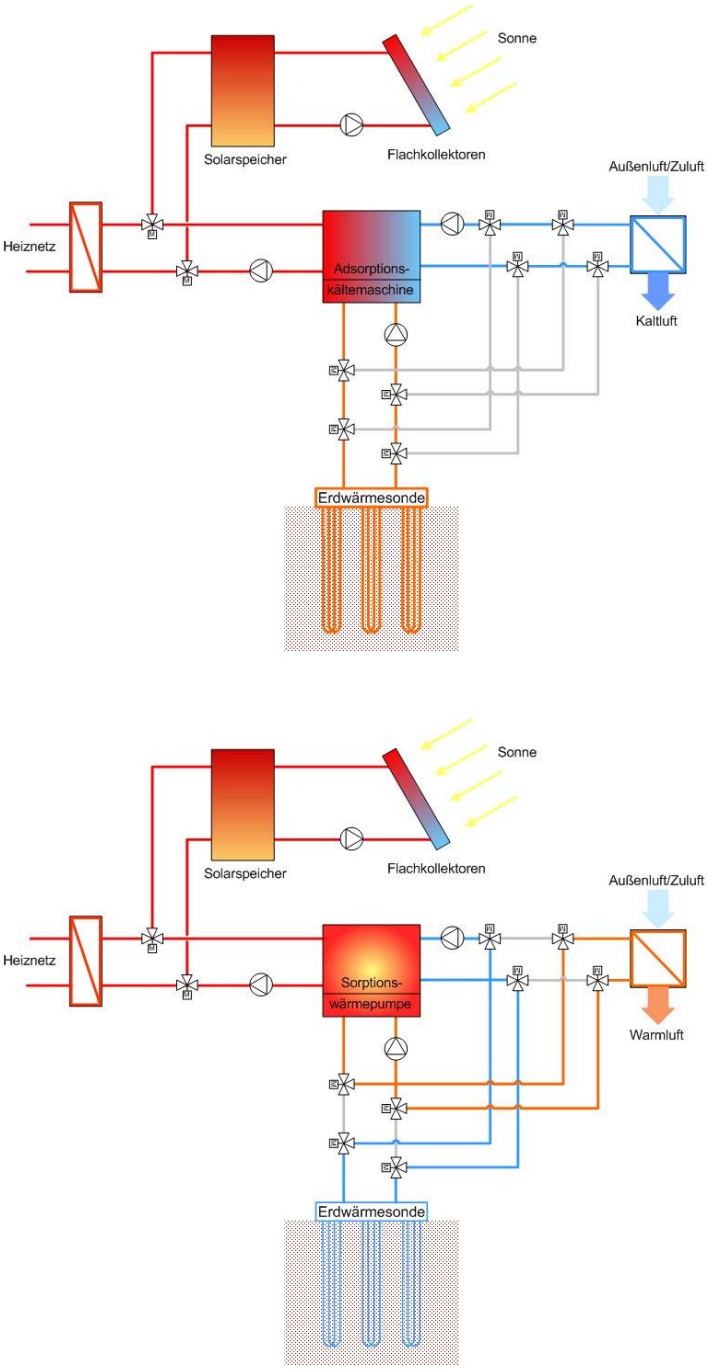
For more information on the project please feel free to contact:

Edo Wiemken
edo.wiemken(at)ise.fraunhofer.de

Se nadaljuje na naslednji strani

System reliability and overall success of the installation

The first weeks of operation have revealed a reliable system operation. No long-term monitoring data are available so far. The system concept is promising: no cooling tower is required and a fraction of the rejected heat in summer will be available as low-temperature heat source for heat pump operation in winter. Another advantage is the noiseless operation of the chiller.



Solar cooling system at Fraunhofer ISE in Freiburg, Germany. Top: cooling operation during summer. Bottom: heat pump operation during winter.

University Hospital in Freiburg, Germany

Description of the application

During summer months, the supply air of a separate laboratory building at the University Hospital is cooled by means of a solar thermally assisted chilled water production. The chilled water temperature level is approx. 9°C and is used for supply air cooling in two air handling unit of the laboratory building, equipped with heat recovery. Due to the requirements on the laboratory room air temperature, cooling demand may occur during summer also during night. Additional heat to guarantee the chiller operation is provided by the locally operated steam network of the Hospital. In winter, the solar thermal system assists the laboratory heating.

General description of the system

The system technology is a closed cycle chilled water system with an adsorption chiller. Two heat sources exist to operate the chiller:

1. A solar thermal system, consisting of vacuum tube collectors (direct-flow type)
2. Heat from the steam network of the Hospital is used via a condensate heat exchanger

A closed wet cooling tower is applied for heat rejection from the chiller. Additionally to the solar hot water storage of 6 m³ volume (consisting of three storages connected in series), a buffer of 2 m³ volume is used in the return flow of the driving heat in order to smooth the periodically temperature peaks in the hot water circuit, thus allowing a stable control of the collector system. During winter, the supply air heating is directly assisted by the solar collectors.

Central air-conditioning unit

Technology	closed cycle
Nominal capacity	70 kW_{cold}
Type of closed system	Adsorption
Brand of chiller unit	Nishiyodo NAK 20/70
Chilled water application	supply air cooling
Dehumidification	occasionally
Heat rejection system	closed wet cooling tower

Solar thermal

Collector type	vacuum tubes
Brand of collector	Seido 2-16
Collector area	167 m^2 aperture
Tilt angle, orientation	30° and 45°, south
Collector fluid	water-glycol
Typical operation temperature	75 °C driving temperature for chiller operation

Configuration

Heat storage	6 m^3 water
Cold storage	2 m^2 water
Auxiliary heating support	condensating steam heat exchanger, driven by the Hospital steam network
Use of auxiliary heating system	Auxiliary driving source for chiller, auxiliary driving source for supply air heating in winter
Auxiliary chiller	no

General information



Type of building Laboratory building of the University Hospital
Location Freiburg, Germany (48° North, 7°50' East)
In operation since 1999
System operated by Energy Management of the University Hospital
Air-conditioned area 360 m^2

Figures





Clicking an image opens the gallery view.

Specific information

Further specific information about the system are included in the filled in technical questionnaire.

DE01_Hospital-Freiburg.pdf

Contact

For more information on the project please feel free to contact:

Edo Wiemken
edo.wiemken(at)ise.fraunhofer.de

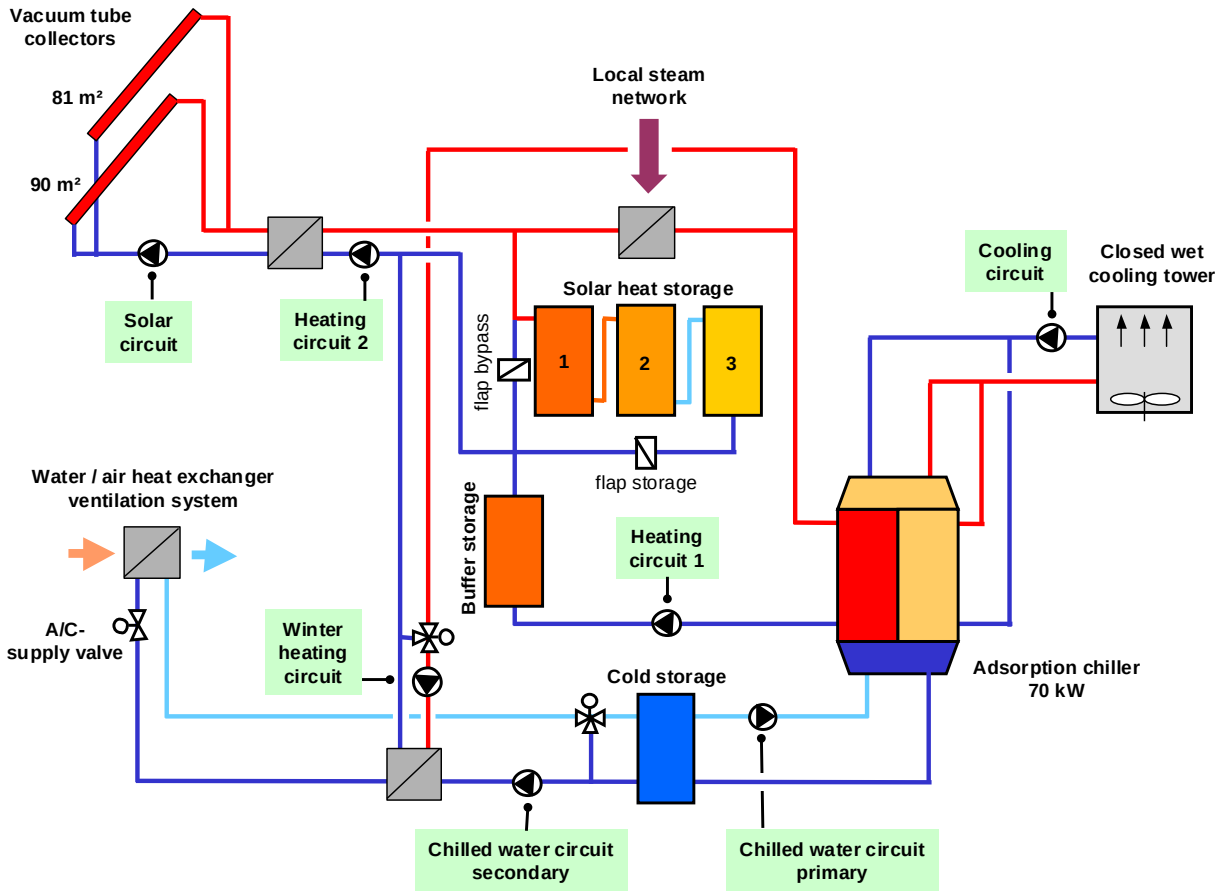
Se nadaljuje na naslednji strani

System performance

The energy balance of 2003 stated an average thermal coefficient of performance (COP) of 0.42; the solar coverage of the total heat input (cooling and heating) was 28 %. The average COP is decreased through periods of part-laod operation during summer nights with low cooling demand. At clear sky summer days, a solar coverage of the driving heat input into the chiller of approx. 90 % may be achieved. The annual specific collector yield was 365 kWh/m²a.

System reliability and overall success of the installation

Due to the complex hydraulic system, an optimised system control is difficult to achieve. Important improvements in the control strategy have been made by varying the cycle length (period between two adsorption cycles or regeneration cycles respectively) according to the part load status of the chiller. The overall reliability of the sytem is good, the laboratory users are satisfied with the system.



Scheme of the solar cooling system at the University hospital laboratory building, Freiburg, Germany

Chamber of Commerce 'Südlicher Oberrhein' (IHK-SO) in Freiburg, Germany

Description of the application

A seminar room and a cafeteria area of the building, often used as seminar room as well, are connected to a deseccant evaporative cooling system for air-conditioning of these areas. Although passive measures like external shading, high quality glazing etc. have been applied to prevent high solar gains, the large glazing fraction of the rooms requires for active cooling. During cooling and dehumidification use in summer, the system is solar thermally autonomous driven. Additional heat from a gas boiler is used in winter for supply air heating only.

General description of the system

The system technology is an open cycle desiccant evaporative cooling system, using solar thermal heat for regeneration of the desiccant wheel. The desiccant wheel contains silicagel as sorption material. The regeneration is driven solar autonomous by flat-plate air collectors, a heat storage is not applied. The air volume flow rate in the air handling unit varies in a broad range according to the requirements; the air volume flow rate through the air collectors is independent from the air-handling volume flow rate in order to allow an optimised operation of the desiccant wheel. During winter, the supply air is pre-heated by the collectors and heated according to the set values by a fossil back-up system.

Central air-conditioning unit

Technology	open cycle (DEC)
Nominal air volume flow rate	10,200 m^3/h
Minimum air volume flow rate	2,500 m^3/h
Desiccant cooling system type	solid desiccant
Desiccant type	Silica Gel
Cooling capacity	max. 60 kW
Brand of desiccant unit	DehuTech

Solar thermal

Collector type	air collector, flat-plate
Brand of collector	Grammer
Collector area	92 m^2 aperture
Tilt angle, orientation	0 °, south
Collector fluid	air
Typical operation temperature	70 °C regeneration temperature of sorption wheel

Configuration

Heat storage	none
Cold storage	none
Auxiliary heating support	gas boiler
Use of auxiliary heating system	supply air heating in winter
Auxiliary chiller	no

General information



Type of building Seminar and cafeteria room of the IHK-SO building
Location Freiburg, Germany (48° North, 7°50' East)
In operation since 2001
System operated by IHK-SO
Air-conditioned area 213 m^2

Figures




Clicking an image opens the gallery view.

Specific information

Further specific information about the system are included in the filled in technical questionnaire.

DE02_IHK-Freiburg_DEC.pdf

Contact

For more information on the project please feel free to contact:

Edo Wiemken
edo.wiemken(at)ise.fraunhofer.de

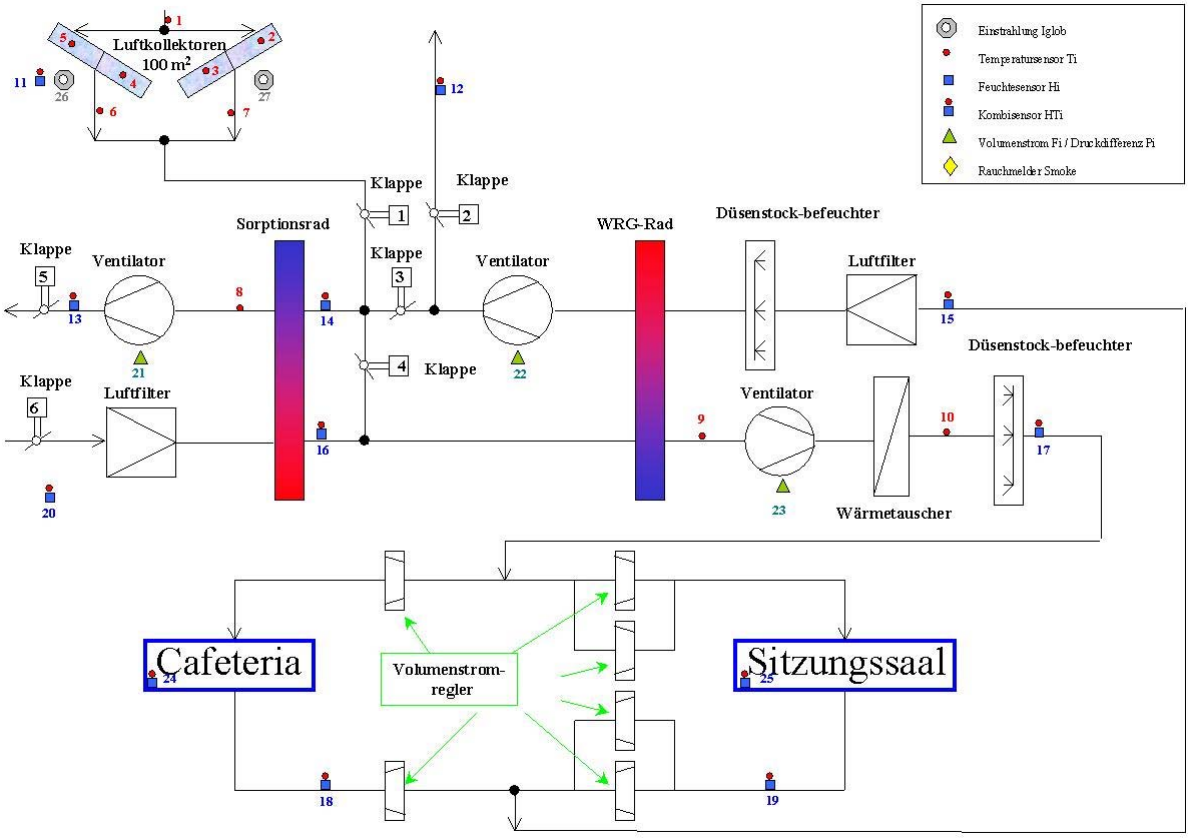
Se nadaljuje na naslednji strani

System performance

In the desiccant cooling mode, an annual coefficient of performance (COP) of 0.43 was obtained. The solar coverage of the overall heat input (supply air heating and regeneration heat) was on an annual average 50%. A specific annual collector yield of 111 kWh/m²a was achieved. The performance of the system is limited due to the limited use of the seminar rooms and subsequently limited activation of the air handling unit (in 2004: 1080 hours).

System reliability and overall success of the installation

After the start of the system, improvements in the system control were necessary to allow a sufficient system operation. From this experience, a carefull initialization period is unavoidable. The system concept of autonomous cooling operation is an appropriate solution in this application. In less than 5 % of operation hours, the room air states exceed the set values. The acceptance of the system by the users is very good. As a consequence of the installed solar air collector system, the collector system contributes to 10 % of the total system cost only.



Scheme of the Desiccant Evaporativ Cooling (DEC) system at IHK-SO, Freiburg, Germany

Office building of Ott Ingenieure in Langenau, Germany

Description of the application

The office building of Ott Ingenieure in Langenau is air-conditioned during summer with a solar thermally assisted chilled water system. The chilled water is provided at a temperature of approx. 13 °C. It is mainly used for the chilled ceilings at the offices, but additionally for supply air cooling of the central air handling unit. Since the business of Ott Ingenieure covers also heating systems and solar thermal systems, the application is a demonstration of solar applications as well.

General description of the system

The system technology is a closed cycle chilled water system with a medium-sized absorption chiller. Three heat sources are available, providing heat for chiller operation and for space heating: a solar thermal vacuum tube collector system, a CHP unit and a gas boiler. The CHP unit runs on heat demand. The chilled water serves for supply air cooling of a central air handling unit and is used to operate the chilled ceilings in the offices. Heat rejection is done using an open wet cooling tower. Additional back-up systems on the cold side (e.g., electrically driven compression chiller) are not applied.

Central air-conditioning unit

Technology	closed cycle
Nominal capacity	35 kW_{cold}
Type of closed system	Absorption
Brand of chiller unit	Yazaki WFC 10
Chilled water application	Chilled ceilings, supply air cooling
Dehumidification	no
Heat rejection system	open wet cooling tower

Solar thermal

Collector type	vacuum tubes
Brand of collector	Seido 2-6
Collector area	30 m^2 absorber
Tilt angle, orientation	25°, 45° south-west
Collector fluid	water-glycol
Typical operation temperature	85 °C driving temperature for chiller operation

Configuration

Heat storage	2 m^3 water
Cold storage	1 m^3 water
Auxiliary heating support	CHP with 19.5 kW heating capacity, gas boiler with 50 kW heating capacity
Use of auxiliary heating system	auxiliary driving source for chiller, auxiliary driving source for space heating in winter
Auxiliary chiller	no

General information



Type of building office building
Location Langenau, Germany (48°30' North, 10°07' East)
In operation since 1997
System operated by Ott Ingenieure
Air-conditioned area 415 m^2

Figures





Clicking an image opens the gallery view.

Specific information

Further specific information about the system are included in the filled in technical questionnaire.

DE03_Ott-Langenau.pdf

Contact

For more information on the project please feel free to contact:

Edo Wiemken
edo.wiemken(at)ise.fraunhofer.de

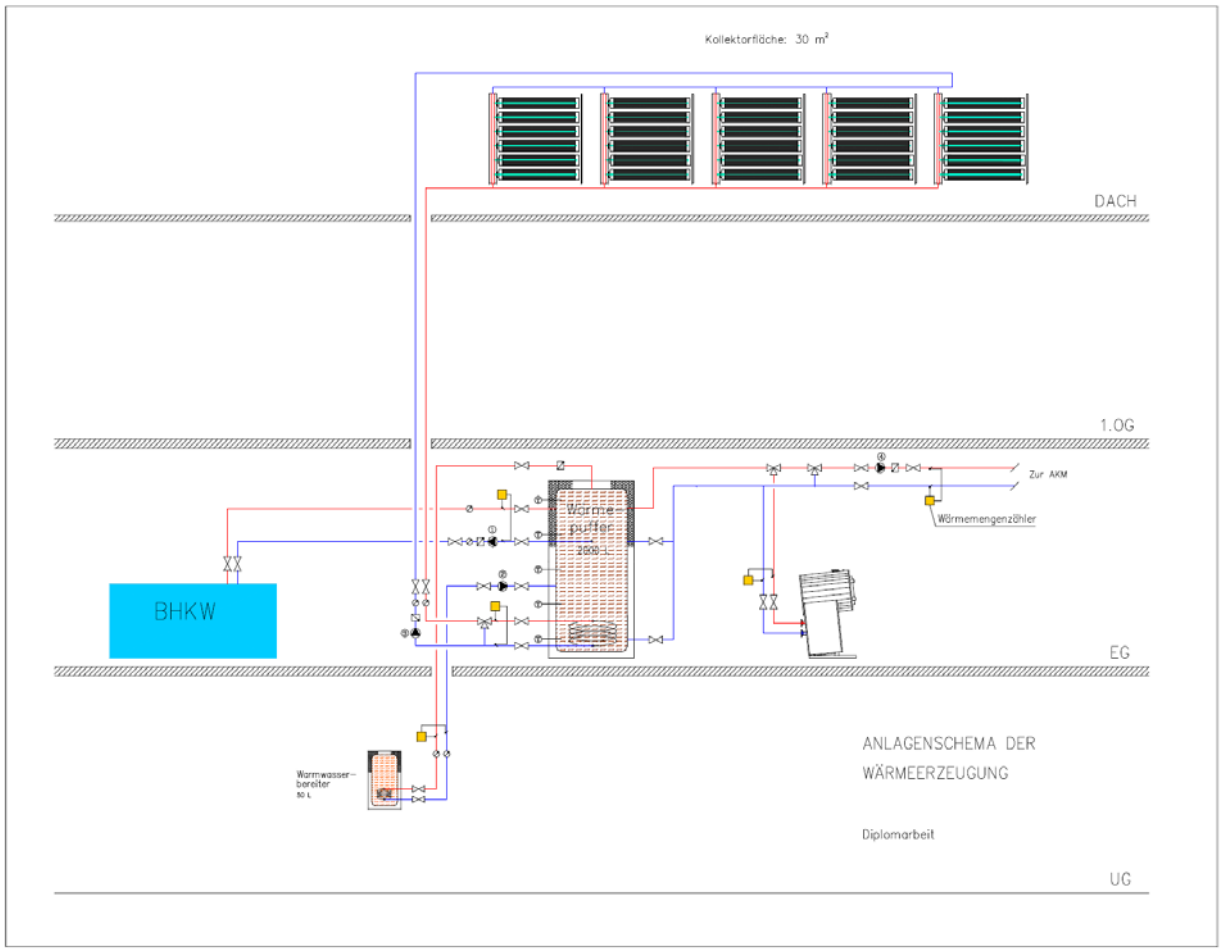
Se nadaljuje na naslednji strani

System performance

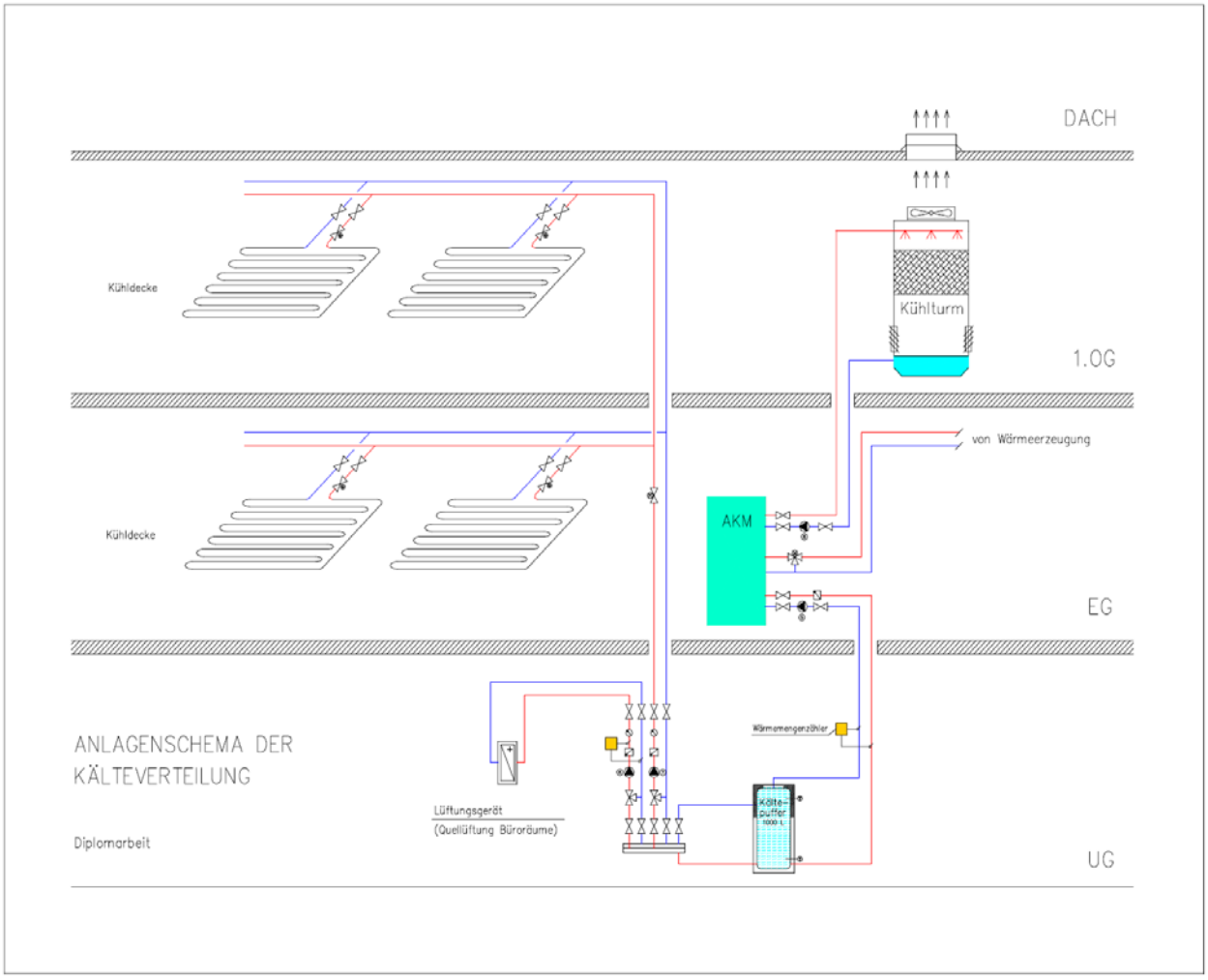
From a monitoring period in 1999, an annual coefficient of performance (COP) of 0.50 was obtained. The solar thermal coverage of the total heat input for heating and cooling was 12 %; the contribution of the gas boiler and of the CHP to the heat input was 44 % each. From the energy balance, a specific annual collector yield of 286 kWh/m²a was determined.

System reliability and overall success of the installation

The system showed less solar coverage than expected, of which one reason is connected with the limitation in size of the collector array. A revision of the collector system is planned. The sufficient cooperation of three heat generation units requires some effort in the design of the system control. Some reliability problems are connected with the CHP unit, but the overall reliability of the solar thermally driven cold production is good; the overall concept is correct and promising.



Heat production sub-system of the solar cooling system at Ott Ingenieure, Langenau, Germany



Cold production sub-system of the solar cooling system at Ott Ingenieure, Langenau, Germany

Solar Info Center SIC, Freiburg, Germany

Description of the application

The Solar Info Center at Freiburg hosts companies, active in solar energy business. A part of the building is rent to Fraunhofer ISE. Within this part, an area of offices and a seminar room is air-conditioned by a liquid dessicant cooling system, driven in a solar thermal autonomous cooling mode. It is a pilot system to demonstrate the applicability of this technology.

General description of the system

The system technology is an open cycle liquid desiccant evaporative cooling system, using solar thermal heat for regeneration of the diluted LiCl solution. Solar thermal heat is provided by a flat-plate collector. The sorption process is cooled, thus increasing the sorption efficiency. An advantage of the system is the storage of diluted and concentrated solution in separate storages, which allows a decoupling in time between the dehumidification and regeneration process to a certain degree. No back-up heating systems for the regeneration of the solution is applied. During winter, heat from the district heat network from the University hospital is applied for supply air heating.

Central air-conditioning unit

Technology	open cycle (DEC)
Nominal air volume flow rate	1,500 m^3/h
Minimum air volume flow rate	600 m^3/h
Desiccant cooling system type	liquid desiccant
Desiccant type	Lithium Chloride
Cooling capacity	10 kW
Brand of desiccant unit	Menerga

Solar thermal

Collector type	flat-plate
Brand of collector	Ufe Ecostar
Collector area	16.8 m^2 aperture
Tilt angle, orientation	30 °, south
Collector fluid	water
Typical operation temperature	55–70 °C regeneration temperature

Configuration

Heat storage	1.5 m^3
Cold storage	solution storages
Auxiliary heating support	district heating network
Use of auxiliary heating system	supply air heating in winter
Auxiliary chiller	no

System performance

Considering the overall cold production of the air handling unit (all operation modes: desiccant cooling, free cooling, adiabatic cooling) with relation to the total regeneration heat input, an average coefficient of performance (COP) of 1.0 was achieved. The specific annual collector yield was approx. 270 kWh/m²a.

General information



Type of building Seminar room and office area within the SIC
Location Freiburg, Germany (48° North, 7°50' East)
In operation since 2004
System operated by Fraunhofer ISE
Air-conditioned area 300 m^2

Figures



Clicking an image opens the gallery view.

Specific information

Further specific information about the system are included in the filled in technical questionnaire.

DE05_SIC-Freiburg_LDCS.pdf

Contact

For more information on the project please feel free to contact:

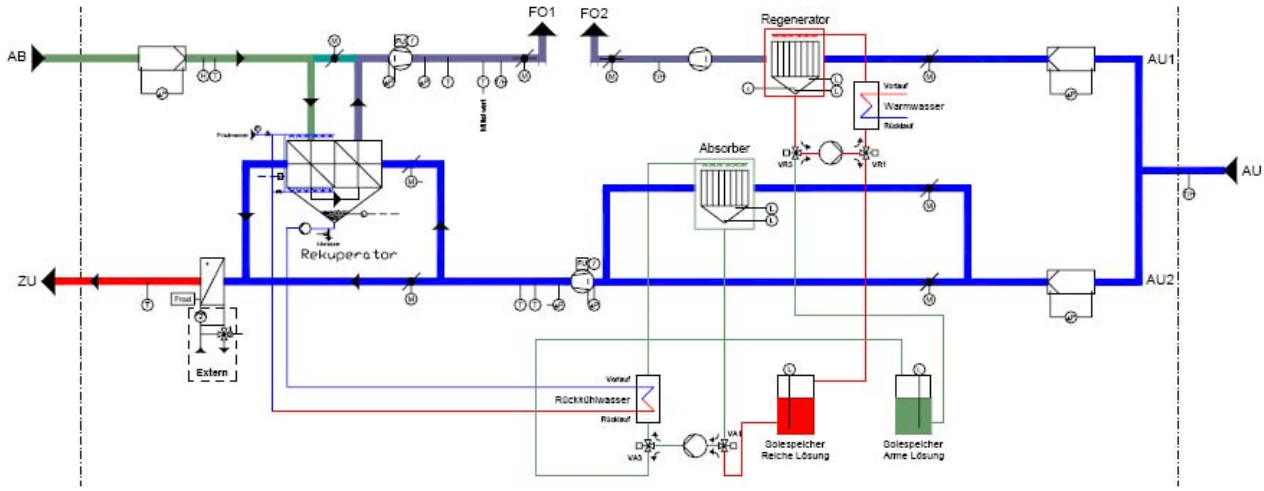
Edo Wiemken
edo.wiemken(at)ise.fraunhofer.de

Se nadaljuje na naslednji strani

System reliability and overall success of the installation

Many improvements in the system control were applied within the first year of operation, mainly adressing an optimised operation of pumps and fans. In between, the system operation is reliable and promising and the availability of the system is very high. A transfer of the solution into the supply air has never occurred.





Installed solar driven liquid desiccant evaporative cooling system and scheme of the system at the Solar Infor Center (SIC), Freiburg, Germany

Office building of IBA AG in Fürth, Germany

Description of the application

To increase the room air comfort in the offices, a solar autonomous thermally driven chiller is installed. The chiller provides chilled water at a temperature level of approx. 9 °C for the operation of fan coils and chilled ceilings in the offices. The system is designed for top cooling.

General description of the system

The system technology is a closed cycle chilled water system with a medium-sized absorption chiller. Heat is provided by a solar thermal system only, a gas boiler is installed, but used for space heating in winter. The heat rejection circuit of the chiller is connected to an open wet cooling tower. To avoid stagnation situations in the collector and to increase the collector efficiency, surplus heat of the collector is supplied to a nearby spa.

Central air-conditioning unit

Technology	closed cycle
Nominal capacity	30 kW_{cold}
Type of closed system	absorption
Brand of chiller unit	EAW Wegracal SE 30
Chilled water application	chilled ceilings, fan coils
Dehumidification	in fan coils
Heat rejection system	open wet cooling tower

Solar thermal

Collector type	flat-plate
Brand of collector	Solvis F-802-S, F-652-D
Collector area	87.7 m^2 aperture
Tilt angle, orientation	25 °, south
Collector fluid	water-glycol
Typical operation temperature	86 °C driving temperature for chiller operation

Configuration

Heat storage	3.7 m^3 water
Cold storage	1.4 m^3 water
Auxiliary heating support	gas boiler
Use of auxiliary heating system	for space heating; not used for chiller operation
Auxiliary chiller	no

System performance

The system went into operation in August 2007; no monitoring data are available at present. Due to the operation mode of solar autonomous cooling, high environmental benefits are expected compared to a conventional system solution with an electrically driven compression chiller.

System reliability and overall success of the installation

Due to the recent start of the system, no experience is available so far. The system is supported as a pilot installation in the frame of Solarthermie 2000plus, which is a federal funding scheme for large solar thermal applications. Monitoring of projects within this funding scheme is compulsory, thus, system experience will be made public available.

General information



Type of building Office building
Location Fürth, Germany (49°30' North, 11° East)
In operation since 2007
System operated by IBA AG
Air-conditioned area 920 m^2

Figures





Clicking an image opens the gallery view.

Specific information

Further specific information about the system are included in the filled in technical questionnaire.

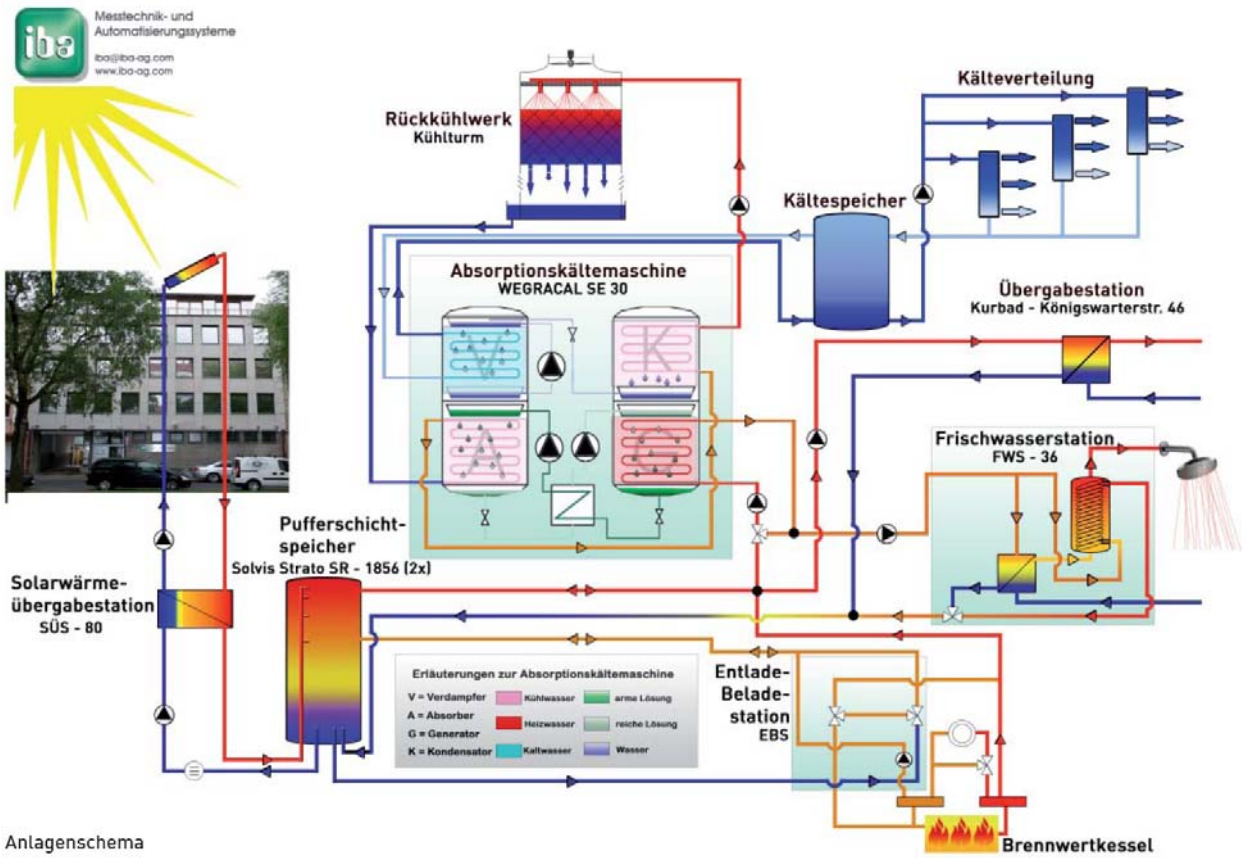
DE06_IBA-Fuerth.pdf

Contact

For more information on the project please feel free to contact:

Edo Wiemken
edo.wiemken(at)ise.fraunhofer.de

Se nadaljuje na naslednji strani



Scheme of the solar cooling system at IBA AG, Fürth, Germany

4.4 Primeri dobre prakse: GRČIJA

Primeri predstavljeni na naslednji straneh:

1. Center for Renewable Energy Sources, Koropi
2. Promitheus building – Sol Energy Offices, Palaio Faliro

Center for Renewable Energy Sources in Koropi, Greece

Description of the application

The open cycle desiccant evaporative cooling system is used for demonstration and research purposes. It is used to heat and cool the solar thermal building at the P.E.N.A. demonstration site of C.R.E.S.

General description of the system

The system technology is open cycle desiccant evaporative cooling system. Heat is provided by a solar thermal system and by a back-up electric heater installed directly inside the hot water storage tank. In winter the solar thermal system supplies a water-air heat exchanger installed in the DEC system in order to heat the room.

Central air-conditioning unit

Technology	open cycle (DEC)
Nominal air volume flow rate	1,100 m^3/h
Minimum air volume flow rate	373 m^3/h
Desiccant cooling system type	solid desiccant
Desiccant type	Lithium Chloride
Cooling capacity	- kW
Brand of desiccant unit	Klingenburg

Solar thermal

Collector type	flat-plate
Brand of collector	Calpak
Collector area	10 m^2 gross
Tilt angle, orientation	45°, 0° west/east
Collector fluid	water-glycol
Typical operation temperature	60 °C (driving heat for cooling application)

Configuration

Heat storage	0.5 m^3 water
Cold storage	none
Auxiliary heating support	electric heater
Use of auxiliary heating system	directly heats the hot water storage tank, used both for heating and cooling
Auxiliary chiller	no

System performance

This is a newly installed system, system performance has not been analyzed yet.

System reliability and overall success of the installation

The first weeks of operation have revealed a reliable system operation. No long-term monitoring data are available so far. The system is promishing, since no special and expensive components are used. The low driving temperatures allow the use of low cost flat-plate selective collectors.

General information



Type of building Technology demonstration
Location Koropi, Attiki
In operation since 2007
System operated by CRES
Air-conditioned area 84 m^2

Figures







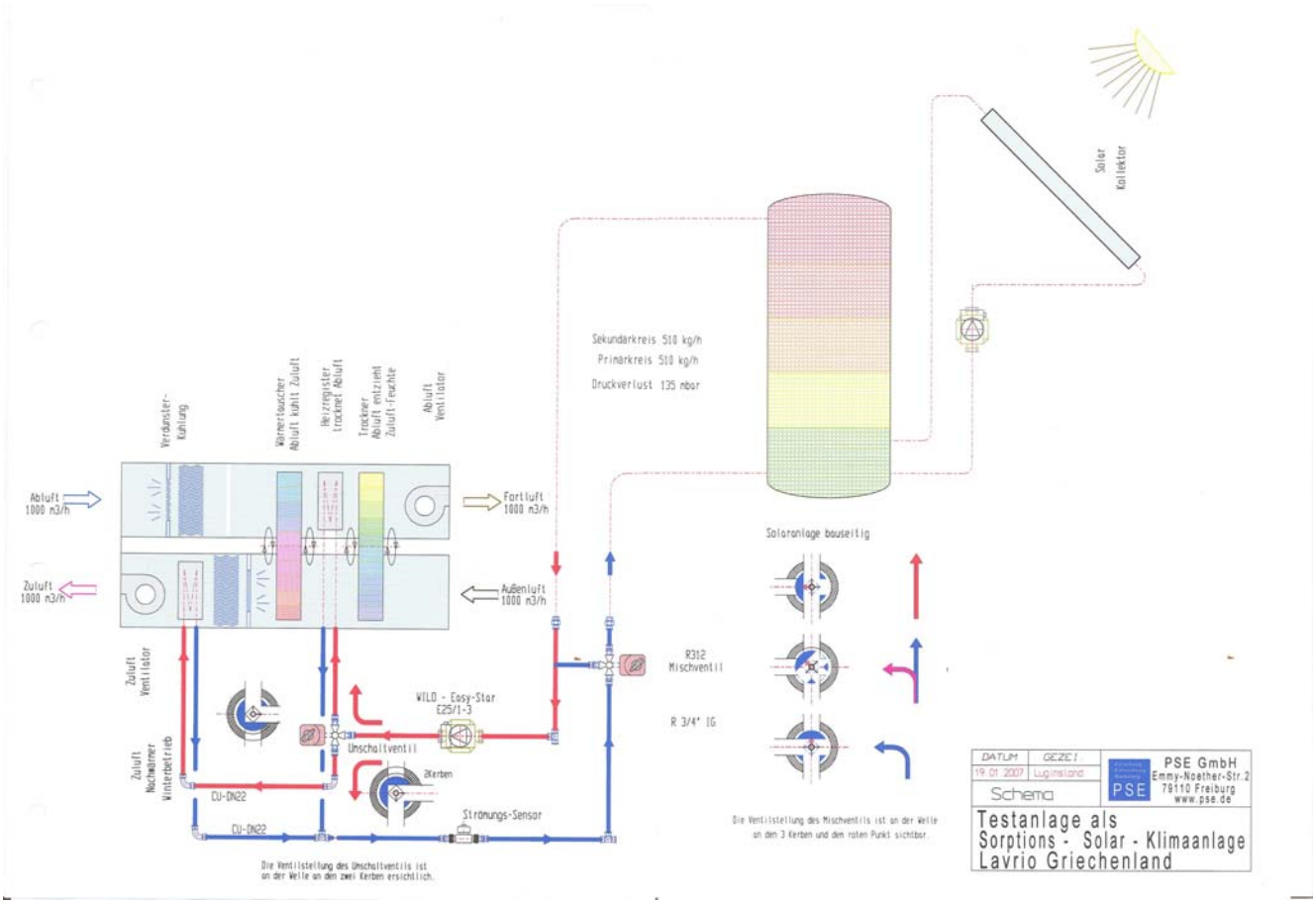

Clicking an image opens the gallery view.

Contact

For more information on the project please feel free to contact:

Vassiliki Drosou
drosou@cres.gr

Se nadaljuje na naslednji strani



Scheme of the solar driven desiccant evaporative cooling system at Lavrio/Koropi, Greece

Promitheus Building, Sol Energy Offices in Palaio Faliro, Greece

Description of the application

The closed cycle absorption cooling system is used to heat and cool the offices of the Sol Energy company.

General description of the system

The system technology is closed cycle absorption cooling system. Heat is provided by a solar thermal system and is backed-up by a ground source heat pump.

Central air-conditioning unit

Technology	closed cycle
Nominal capacity	35 kW_{cold}
Type of closed system	Absorption
Brand of chiller unit	Yazaki
Chilled water application	fan coils, chilled ceilings, supply air cooling, chilled floor
Dehumidification	yes
Heat rejection system	wet open

Solar thermal

Collector type	flat-plate
Brand of collector	Chromagen
Collector area	78.6 m^2 gross
Tilt angle, orientation	35°, 0° west/east
Collector fluid	water
Typical operation temperature	83 °C (driving heat for cooling application)

Configuration

Heat storage	2x180 m^3 water
Cold storage	1x180 m^3 water
Auxiliary heating support	ground souce heat pump
Use of auxiliary heating system	a geothermal heat exchanger is utilised for direct cooling of the building or as a heat rejection system for the cooling equipment
Auxiliary chiller	yes
- type	SCROLL
- capacity	61.5 kW_{cold}

System performance

This is a newly installed system, system performance has not been analyzed yet.

System reliability and overall success of the installation

The first weeks of operation have revealed a reliable system operation. No long-term monitoring data are available so far.

General information

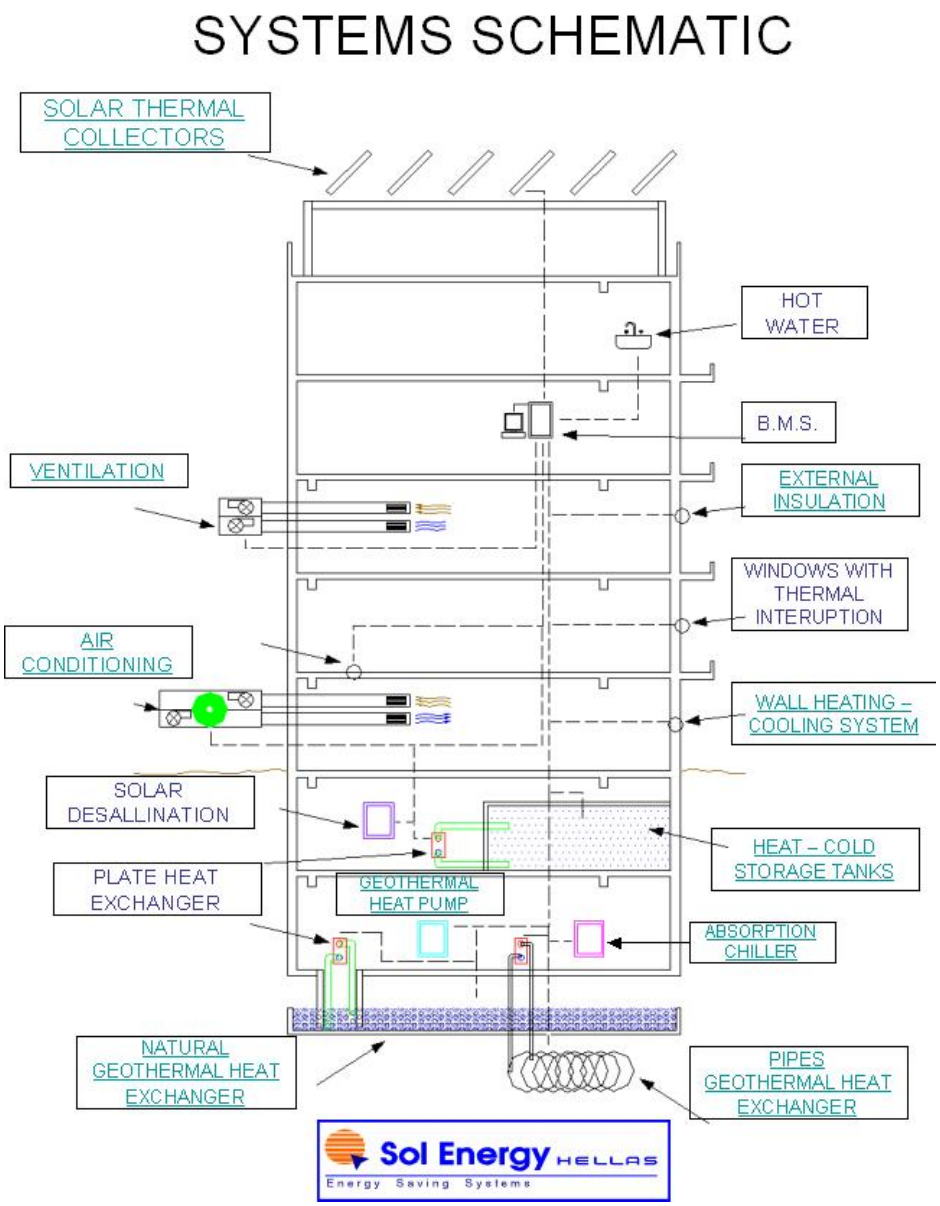
Type of building Offices, residential
Location Palaio Faliro, Attiki, Greece
In operation since 2007
System operated by Sol Energy Hellas
Air-conditioned area 360 m^2
Capacity 63 kW cooling, 14 kW heating

Contact

For more information on the project please feel free to contact:

Vassiliki Drosou
drosou(at)cres.gr

Se nadaljuje na naslednji strani



Scheme of installations of the solar energy building in Palaio Faliro, Greece

4.5 Primeri dobre prakse: ITALIJA

Primeri predstavljeni na naslednji straneh:

1. Manufacturing area, Bolzano
2. Residential building, Milan
3. ISI Pergine business center, Trento

Manufacturing area in Bolzano, Italy

Description of the application

In this manufacturing area in Bolzano, a need for cooling exists in the period from June till September.
The 400 m² building is naturally ventilated and heating and cooling is distributed through walls and floor.

General description of the system

150 square meters of flat plate collectors are connected with 15 kW absorption chiller, 3 tanks are installed in the system and they operate according to the season.
The system has two operation modes: winter and summer.

- In summertime only 9 m³ of storage buffers are available for cooling purposes and as auxiliary heater just the gas heater is used.
- In winter both 8 m³ storages work in series to satisfy the heating demand.

For both modes 0.6 m³ are used for DHW purposes, this can be heated by sun and oil heater.
The heat rejected from the system goes through a wet cooler.

Central air-conditioning unit

Technology	closed cycle
Nominal capacity	15 kW_{cold}
Type of closed system	absorption
Brand of chiller unit	EAW Energieanlagenbau GmbH
Chilled water application	wall and floor cooling
Dehumidification	no
Heat rejection system	wet open

Solar thermal

Collector type	flat-plate
Brand of collector	Ebner Solartechnik
Collector area	100 m^2 + 50 m² gross (two collector fields)
Tilt angle, orientation	60 °, south
Collector fluid	water-glycol
Typical operation temperature	90 °C (driving heat for cooling application)

Configuration

Heat storage	17.6 m^3 water (total volume of 4 tanks)
Cold storage	none
Auxiliary heating support	gas boiler
Use of auxiliary heating system	heating & cooling
Auxiliary chiller	no

General information



Type of building Industrial
Location Bolzano, Italy
In operation since 2005
System operated by EURAC research institute for renewable energy
Air-conditioned area 400 m^2
Capacity 15 kW

Figures






Clicking an image opens the gallery view.

Specific information

Further specific information about the system are included in the filled in technical questionnaire.

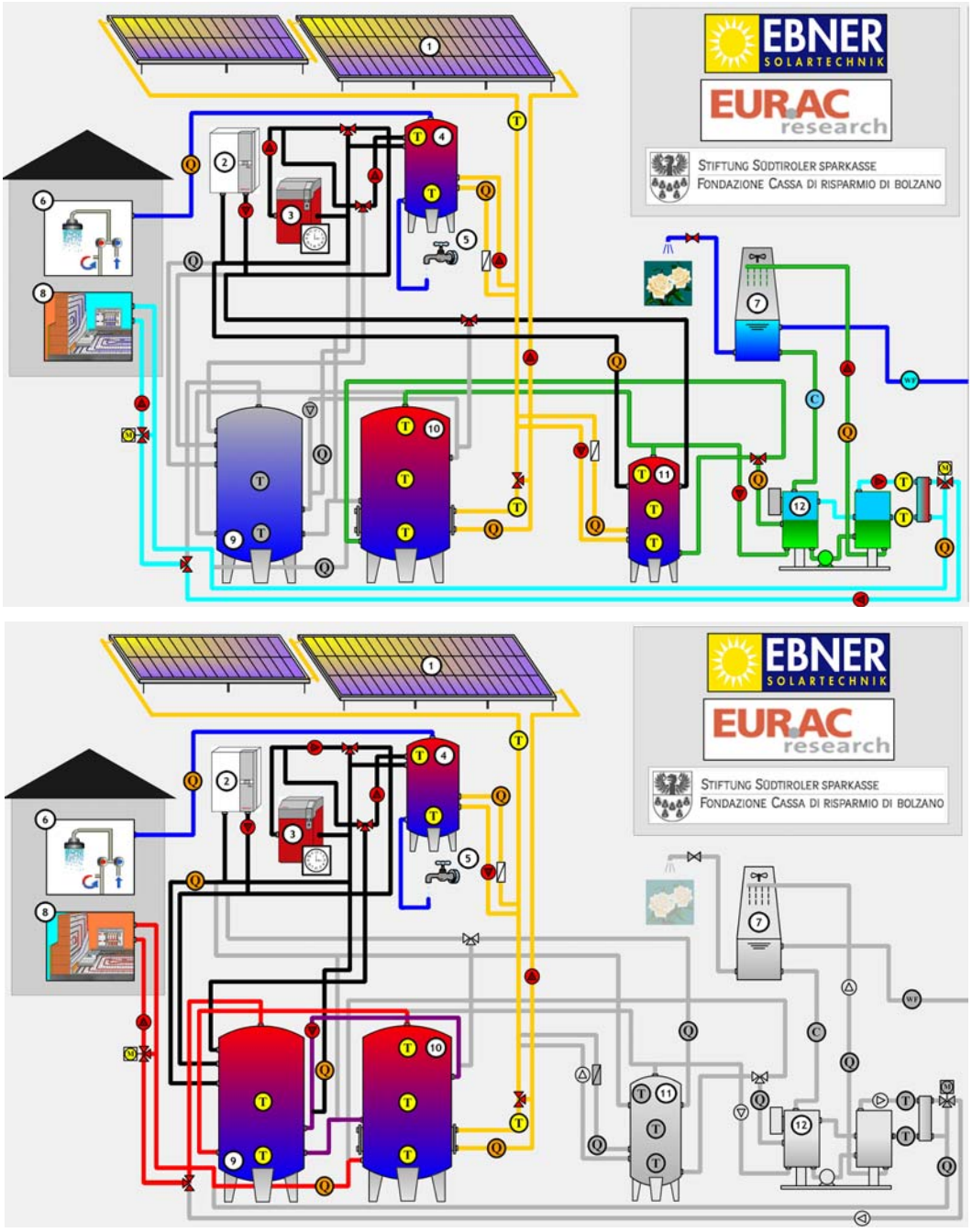
IT01_Bolzano.pdf

Contact

For more information on the project please feel free to contact:

Marcello Aprile
marcello.aprile(at)polimi.it

Se nadaljuje na naslednji strani



Scheme of the solar cooling system in Bolzano, Italy. Top: cooling operation mode in summer; bottom: heating mode in winter

Residential Building, Milan, Italy

Description of the application

The residential building, where the system is installed, is situated in a border of a municipal park in Milan (North of Italy). This is a two floor building. The building is quite well insulated, in fact it has a ventilated and insulated roof with a U-value of 0.68 W/(m²K). The external walls are made with an air space (5 cm), a layer of insulating material (8 cm) and light bricks (25 cm). At the first floor there are two test rooms and a bathroom. They are both facing south with a large window of 1.38 m x 2.05 m.

General description of the system

The solar cooling plant is fed by a 20 m² of CPC collectors which deliver thermal energy used for driving a 4.5 kW absorption machine in summer and four fan-coils for the heating in winter.
The system is solar alone, it means that there isn't a back-up system so the chilled water production and the heating function in winter are assigned only to the collector field.

Central air-conditioning unit

Technology	closed cycle
Nominal capacity	4.5 kW_{cold}
Type of closed system	absorption
Brand of chiller unit	Rotartica Solar 045v
Chilled water application	fan coils
Dehumidification	no
Heat rejection system	dry

Solar thermal

Collector type	CPC
Brand of collector	Kloben CPC
Collector area	20 m^2 aperture
Tilt angle, orientation	30°, 0°
Collector fluid	water-glycol
Typical operation temperature	90 °C driving temperature for chiller operation

Configuration

Heat storage	2 m^3 water, two tanks
Cold storage	none
Auxiliary heating support	none
Use of auxiliary heating system	none
Auxiliary chiller	no

System performance

The system thermal coefficient of performance (COP) for operation in summer 2007 was ranging between 0.6 and 0.7.

System reliability and overall success of the installation

The system has showed a reliable operation. Moreover, a development of the control system is foreseen in summer 2008.

General information

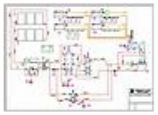


Type of building residential
Location Milan, Italy
In operation since 2007
System operated by Politecnico di Milano
Air-conditioned area 90 m^2
Capacity 4.5 kW

Figures







Clicking an image opens the gallery view.

Specific information

Further specific information about the system are included in the filled in technical questionnaire.

IT02_Milano.pdf

Contact

For more information on the project please feel free to contact:

Marcello Aprile
marcello.aprile(at)polimi.it

ISI Pergine, Business Centre, Trento, Italy

Description of the application

The business center in Trento is a newly constructed two-storey high building with an area of about 10,000 square meters.
The plant system has been selected with the intent of providing medium-high quality standards for the tertiary sector, including summer cooling and forced ventilation. For the ventilation, implying large quantities of air treatment, an efficient energy recovery system has been provided. The owner of the building is TECNOFIN TRENTINA S.P.A. The province of Trento co-financed 32 % of the overall costs of the plant.

General description of the system

The system is based on an absorption chiller of 108 kW coupled with 240 m² flat plate collectors. The system is connected via a heat exchanger to the district heating. The distribution system is chilled beams for cooling and heating with low temperature (50–40 °C winter; 14.5–17.5 °C summer). The heat rejection system is done by a 175 kW wet cooling tower. Secondary hot water storage allows to face variations in solar radiation intensity (autonomy of 20'), ensuring system stability.
The comfort objectives (winter and summer air-conditioning, air changes, silent operation, reduction of air currents, individual climate control) have oriented the choice towards a mixed system with primary air and terminals with a relevant radiant component, both for heating as for cooling: for this purpose ceiling linear ventilated terminals were selected (the so called "chilled beam").

Central air-conditioning unit

Technology	closed cycle
Nominal capacity	70 kW_{cold}
Type of closed system	absorption
Brand of chiller unit	LG
Chilled water application	chilled tubes
Dehumidification	no
Heat rejection system	wet open

Solar thermal

Collector type	flat-plate
Brand of collector	Solel
Collector area	240 m^2 aperture
Tilt angle, orientation	30°, 0° (south)
Collector fluid	water-glycol
Typical operation temperature	85 °C driving temperature for chiller operation

Configuration

Heat storage	2 m^3 water, other fluids,...
Cold storage	water
Auxiliary heating support	district heat
Use of auxiliary heating system	heating & cooling
Auxiliary chiller	yes
- type	el. compression chiller
- capacity	120 kW_{cold}

General information



Type of building office building
Location Trento, Italy
In operation since -
System operated by -
Air-conditioned area - m^2
Capacity 108 kW

Figures



Clicking an image opens the gallery view.

Specific information

Further specific information about the system are included in the filled in technical questionnaire.

IT03_Pergine.pdf

Contact

For more information on the project please feel free to contact:

Marcello Aprile
marcello.aprile(at)polimi.it

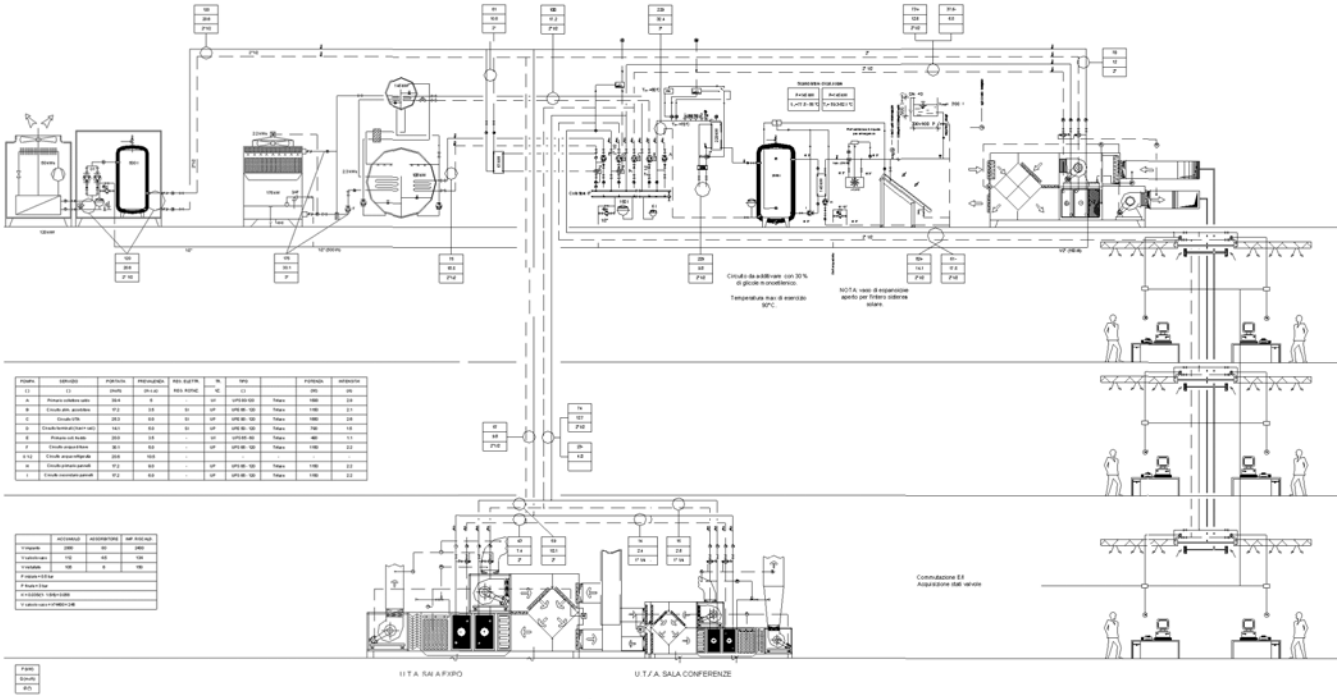
Se nadaljuje na naslednji strani

System performance

(Estimation performance data because the plant has to be yet operational)
Overall nominal thermal loads: The nominal winter thermal loads will be of the order of 229 kW and for this capacity has been sized the district heating system.
Whereas the winter situation the sum of the thermal loads of each single space corresponds to the overall building load, during the summer period, as well known, the global loads result inferior to the algebraic sum (each space is valued during its most critical hour according to its solar exposure, the overall building will have a unique critical hour which will not necessarily correspond to the maximum thermal load of all spaces).
Thus the sum of the summer loads (excluding thermal heat recovery) is of 188 kW, having a maximum contemporary load of 170 kW.
Under these conditions the solar collectors supply 145 kW. With this thermal power the absorber can produce 108 kW.
When under cloudy sky conditions the thermal load (in absence of solar radiation) drops from 170 kW to 120 kW.
The compression refrigeration machine is thus selected to cover this capacity.

System reliability and overall success of the installation

Estimation: Generation of the 70 % of the site cooling utilising solar energy with CO_2 emissions saving.



Scheme of the cold production and cold distribution system at Trento, Italy

4.6 Primeri dobre prakse: PORTUGALSKA

Primeri predstavljeni na naslednji straneh:

1. INETI building, Lisbon
2. Office building Vajra, Loulé

INETI building in Lisbon, Portugal

Description of the application

The objective is to have air conditioning of 12 office rooms, located in the first floor of Building G of INETI Campus and belonging to the Renewable Energy Department.
The design chosen for the system optimizes users comfort in office rooms whom are well satisfied with system operation along the years.

General description of the system

The air conditioning system is an air handling unit of DEC type incorporating a heat pump and assisted by 24 CPC type solar collectors located in the flat cover of the building. A gas boiler is used as backup for the solar thermal system in winter.
Cooling is provided in summer months (between April-May and September-October) and heating in winter months (between October and March).

Central air-conditioning unit

Technology	open cycle (DEC)
Nominal air volume flow rate	5,000 m^3/h
Minimum air volume flow rate	2,000 m^3/h
Desiccant cooling system type	solid desiccant
Desiccant type	lithium chloride,...
Cooling capacity	36 kW
Brand of desiccant unit	MODULAIR AG SACHSEN

Solar thermal

Collector type	CPC
Brand of collector	Ao Sol
Collector area	46.1 m^2 aperture
Tilt angle, orientation	30°, 0° west/east
Collector fluid	water
Typical operation temperature	45-60 °C driving temperature for chiller operation

Configuration

Heat storage	2 m^3 water
Cold storage	none
Auxiliary heating support	gas boiler
Use of auxiliary heating system	space heating in winter
Auxiliary chiller	yes
- type	heat pump
- capacity	16.4 kW_{cold}

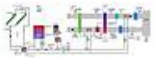
General information



Type of building office building
Location INETI Campus, Lisbon
In operation since 1999
System operated by -
Air-conditioned area 117 m^2
Capacity 597 m^3

Figures





Clicking an image opens the gallery view.

Specific information

Further specific information about the system are included in the filled in technical questionnaire.

PT01_INETI_DEC.pdf 848 K

Contact

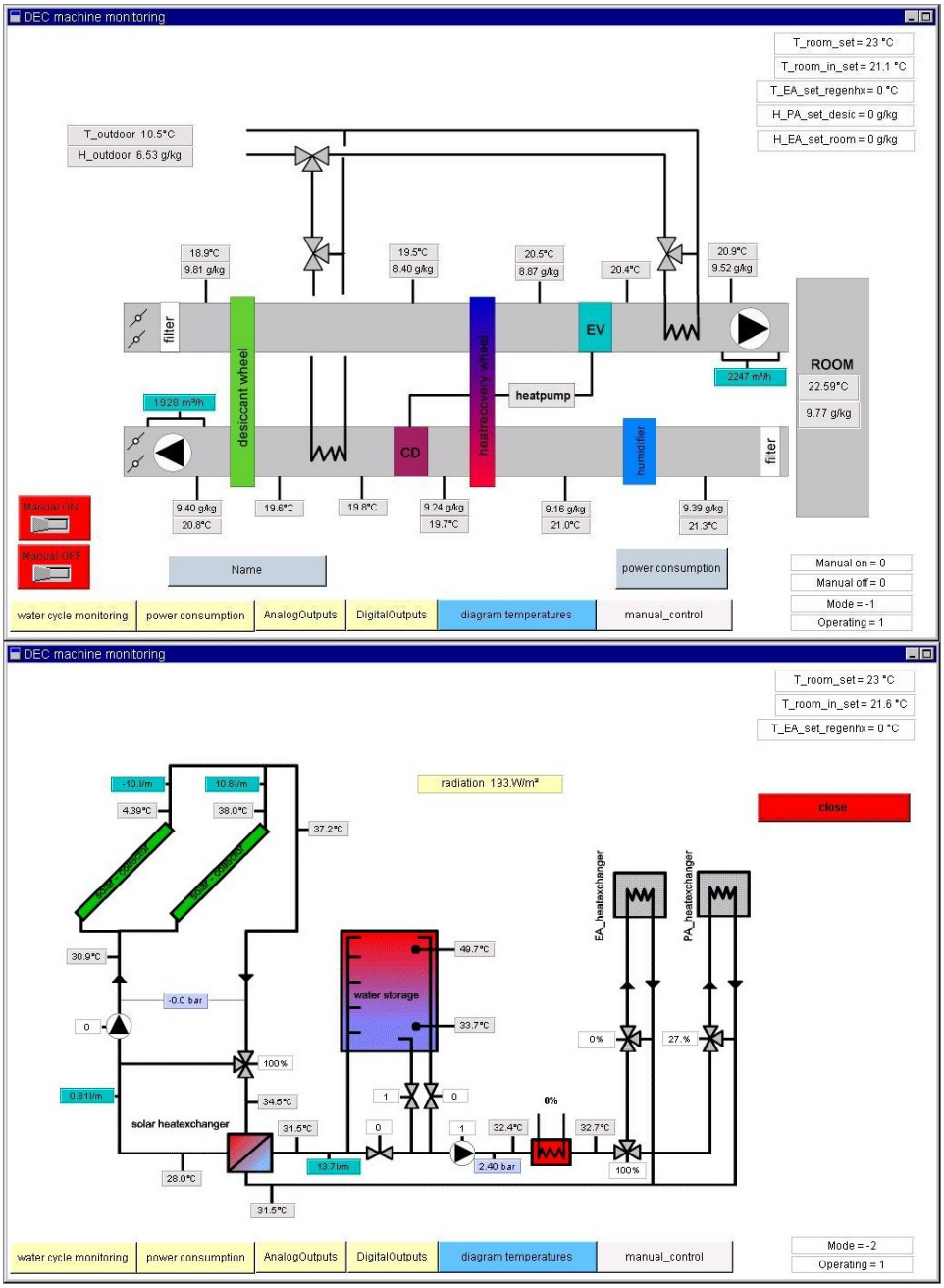
For more information on the project please feel free to contact:

Maria João Carvalho
mjoao.carvalho(at)ineti.pt

Se nadaljuje na naslednji strani

System performance

The standard design of the solar assisted desiccant evaporative technology incorporates two humidifiers: one for the process air, after heat recovery wheel, and another for the exhausted air, before heat recovery wheel.
The system that is installed at INETI was modified to incorporate a heat pump in the process air path (incoming new air path), substituting the humidifier in this path. The reason of this modification relies on the limited size of the air distribution system, which obliged to reduce the air flow rate in the design conditions and at the same time to introduce air in the rooms at lower temperature, to be able to cover the cooling load.
The analysis of system behaviour showed the need to introduce again a humidifier in the incoming air duct. This change was made (2007) but it is not yet operational and monitored.



Scheme of the desiccant evaporative cooling system (top) and of the solar / auxiliary heating sub-system (bottom) at the Ineti building, Lisbon, Portugal

Office Building Vajra in Loulé, Portugal

Description of the application

Solar Heating and Cooling of the Head Office Building of Vajra – Solar Thermal Design and Distribution Company located in the south of Portugal, Algarve.

General description of the system

The thermal cooling system installed is an absorption chiller (yazaki). The solar thermal system is composed by flat plate collector and a storage tank. Auxiliary heat is provided by a gas boiler.
Cooling is provided in summer months (between April and October) and heating in winter months (between November and March). The system also provides hot water preparation.

Central air-conditioning unit

Technology	closed cycle
Nominal capacity	35 kW_{cold}
Type of closed system	absorption
Brand of chiller unit	Yazaki
Chilled water application	fan coils
Dehumidification	no
Heat rejection system	wet open

Solar thermal

Collector type	flat-plate
Brand of collector	Sonnenkraft
Collector area	128.8 m^2 aperture
Tilt angle, orientation	30°, 15° west
Collector fluid	water-glycol
Typical operation temperature	88 °C driving temperature for chiller operation

Configuration

Heat storage	12 m^3 water
Cold storage	none
Auxiliary heating support	gas boiler
Use of auxiliary heating system	space heating in winter
Auxiliary chiller	no

System performance

No monitoring data is available.
The overall performance of the system, evaluated by the owner in terms of conventional energy reduction of consumption, is good.

System reliability and overall success of the installation

The user is a company working in solar thermal (design and commercialisation). The system is installed in its office and they are satisfied with it.

General information



Type of building office building
Location Loulé, Algarve, Portugal
In operation since September 2005
System operated by Vajra
Air-conditioned area 670 m^2

Figures





Clicking an image opens the gallery view.

Specific information

Further specific information about the system are included in the filled in technical questionnaire.

PT02_VAJRA_absorption.pdf 18

Contact

For more information on the project please feel free to contact:

Maria João Carvalho
mjoao.carvalho(at)ineti.pt

4.7 Primeri dobre prakse: ŠPANIJA

Primeri predstavljeni na naslednji straneh:

1. Pompeu Fabra Library, Mataró
2. Headquarter building of CARTIF, Valladolid

'Pompeu Fabra' Library in Mataró, Spain

Description of the application

The Pompeu Fabra Library of Mataró is a building that was designed to integrate a photovoltaic and a solar thermal system in the own structure in order to produce electricity and heating, keeping the requirements of a public library. The optimal equilibrium between energy, comfort, natural lighting, aesthetical appearance and economical resources was applied in the conception of that building.

General description of the system

Between 2000 and 2002 a new project in the framework of JOULE III, called AIRCOOL, was carried out to develop a desiccant cooling unit integrated with the photovoltaic modules and a new solar air collectors field, with air as the only heating and cooling fluid, to provide air-conditioning to the audiovisual-children area. The responsible ones of this project were HfT Stuttgart, TFM S.A., Grammer, Loughborough University, Siegle+Epple and Sauter Ibérica.
This new system was designed to improve the global energy efficiency of the building, as well as comfort in the west side area, taking profit of the existing solar equipment.
The capacity of the new cooling unit is 55 kW with a solar air collectors field of 105 m², south oriented and with a tilt angle of 20º. The total airflow rate is 12,000 m³/h. A compression cooling unit and a gas boiler are the back-up systems to support the solar cooling and heating production.

Central air-conditioning unit

Technology	open cycle (DEC)
Nominal air volume flow rate	12,000 m^3/h
Minimum air volume flow rate	6,000 m^3/h
Desiccant cooling system type	solid desiccant
Desiccant type	silica gel
Cooling capacity	81 kW
Brand of desiccant unit	Siegle+Epple (ATU), Seibu Giken (wheel)

Solar thermal

Collector type	air collector
Brand of collector	Grammer
Collector area	88 m^2 aperture
Tilt angle, orientation	20°, 5° west
Collector fluid	air
Typical operation temperature	65 °C driving temperature for chiller operation

Configuration

Heat storage	none
Cold storage	none
Auxiliary heating support	none
Use of auxiliary heating system	-
Auxiliary chiller	yes
- type	el. compression chiller
- capacity	246 kW_{cold}

General information



Type of building library
Location Mataró, Catalonia, Spain
In operation since July 2002
System operated by the owner
Air-conditioned area 471 m^2
Capacity 81 kW

Figures





Clicking an image opens the gallery view.

Contact

For more information on the project please feel free to contact:

Marie Proville
marie.proville(at)aiquasol.coop

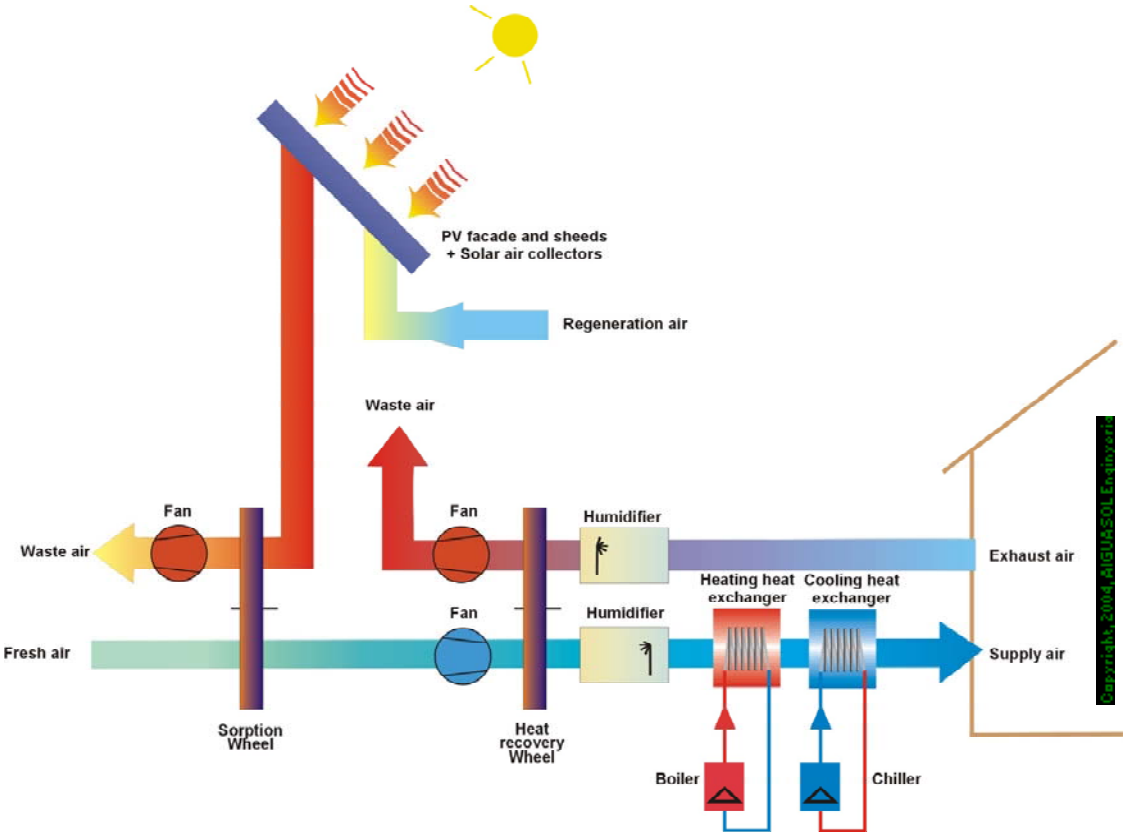
Se nadaljuje na naslednji strani

System performance

About environmental impact it can be noticed that noise problems detected in start-up period has been avoided. The technology guarantees a high primary energy savings using solar energy. The main environmental problem is the high water consumption. Humidifiers must be kept very clean to minimize this problem. Moreover, some proposals to recycle the water from humidifier should be considered by the owner. Water consumption is not registered by the system but a comparison in the bills before and after the installation of the system shows a increasing of 217 %.
Desiccant and evaporative cooling system with vapour compression back up for cooling is a technology that works properly in a humid and hot climate as the Mediterranean coast premises.

System reliability and overall success of the installation

The system is working properly, the indoor comfort conditions are better than the ones obtained with the previous installation, due to the fact that air cooling capacity has been increased and the load has been reduced using shading devices over west windows. The users are satisfied with the system. The users do not notice any incidence about uncomfortable air conditions during 2004 year operation.
Besides these improvements on the building air conditioning system, this installation consists on a demonstration of an environmentally friendly technology.



Scheme of the desiccant evaporative cooling system (DEC) in the public library at Mataró, Spain

Headquarter building of CARTIF in Valladolid, Spain

Description of the application

The solar installation is located in CARTIF Foundation Building 1, Boecillo, Valladolid, in the middle of Spain (Lat. 41º 32', Long -4º 45').
The weather of exposure is an extreme continental type, which characterises by its cold winters and warm summers and by the high temperature oscillations between day and night.
The building has a glass-front that foster heat gains by radiation mainly in those zones facing south.

General description of the system

Working hours in the building go from 7:00 to 15:00. This leads to a higher energy demand in the morning than in the evening. It must be taken into account that this regime penalizes this cooling application because when maximum temperatures are reached in the tanks, and best performances can be obtained, there is no cooling demand. This is precisely the reason that makes design be carried out with a high ratio of accumulation (50-75 l/m²). All the energy available that has not been used will be accumulated throughout all the afternoon to be used during the morning of the following day.
Regarding internal gains, it has been considered that there are 8 people seated typing (light working), with their own computers (400 W) and two copiers (2.5 kW). Artificial lighting is made with low consumption lamps (20 W/m²). The calculated daily energy consumption for each month is 199 kWh/day in June, 209 kWh/day in July, 199 kWh/day in August, and 169 kWh/day in September.
Thanks to an estimation of the hourly refrigeration loads, it can be seen that the highest cooling demand is 29 kW and takes place in August. The chosen machine has been a Yazaki WFC 10 (35 kW).
The solar system installed is an absorption one, working with two different solar fields.

Central air-conditioning unit

Technology	closed cycle
Nominal capacity	35.2 kW_{cold}
Type of closed system	absorption
Brand of chiller unit	YAZAKI
Chilled water application	fan coils
Dehumidification	no
Heat rejection system	wet closed cooling system

Solar thermal

Collector type	flat-plate
Brand of collector	Viessmann
Collector area	37.1 m^2 aperture
Tilt angle, orientation	40°, 0° west
Collector fluid	water-glycol
Typical operation temperature	-

Collector type	evacuated tube
Brand of collector	Viessmann
Collector area	41.2 m^2 aperture
Tilt angle, orientation	40°, tracking
Collector fluid	water-glycol
Typical operation temperature	-

General information



Type of building ×
Location ×
In operation since ×
System operated by ×
Air-conditioned area × m^2

Figures





Clicking an image opens the gallery view.

Contact

For more information on the project please feel free to contact:

Marie Proville
marie.proville(at)aiguasol.coop

Se nadaljuje na naslednji strani

System performance

No data available.

System reliability and overall success of the installation

After one year working, the conclusions were the following ones:
The absorption machine did not show any problem. The next step should be to make it work out of the nominal conditions.
The efficiency of the evacuated tubs collectors is higher than the flat plate ones, but its installation is much more fragile (tracking system), above all because of the starting and stop phases of the system.
No comfort problems were detected.

5 Solarno hlajenje: primeri naprednega pristopa

Večina solarnih hladilnih sistemov uporablja ravne ali vakuumske sprejemnike sončne energije prikazane v točki 2.3, ki pa so fiksno pritrjeni in ne sledijo soncu. Ti SSE so dovolj dobri za zagotavljanje potrebne toplote za pogon solarnih hladilnih sistemov, ki uporabljajo tehnologije predstavljene v primerih v točki 4.

Ne glede na to pa obstajajo razlogi za uvedbo naprednejših tehnologij, ki za delovanje potrebujejo temperaturni njivo grelne toplote nad 100 °C. Ti razlogi so:

- pogoji sončnega obsevanja na kraju postavitve sistema so ugodni in omogočajo delovanje visoko učinkovitega toplotno gnanega hladilnega procesa, npr. absorpcijske hladilne naprave z dvojnim učinkom. Višje hladilno število (COP) > 1,0 omogoča zmanjšanje velikosti solarnega sistema in sistema za odvod odpadne toplote v okolico. Zagotoviti pa moramo grelno toploto na temperaturnem nivoju > 150°C;
- sistem se uporablja za industrijsko ali komercialno aplikacijo, kjer je potrebno hlajenje procesov z nižjimi temperaturami hladilnega medija kot je to običajno za hlajenje in klimatizacijo stavb (npr. < 0°C). Takrat lahko uporabimo toplotno gnane absorpcijske hladilne naprave z delovnim parom amoniak/voda, ki pa zahtevajo višje temperature grelne toplote kot pri hlajenju stavb;
- v nekaterih geografskih področjih je lahko problematična poraba vode za odvod odpadne toplote v okolico, zato se tam lahko uporabi le suho (zračno) hlajenje, kar pomeni, da je temperaturni njivo odpadne toplote nad 40°C. Posledično je potrebno zagotavljati veliko temperaturno razliko med hladilno vodo ter temperaturo odpadne toplote. Kot primerna se spet pokaže absorpcijska tehnologija amoniak/voda s temperaturo grelnega medija > 100°C.

Zadnji primer velja za projekt MEDISCO [MEDISCO, 2006], ki je koordiniran s strani Politehnike iz Milana in ga izvajajo v povezavi z še nekaterimi partnerji iz Evropske unije Tunizije in Maroka. Projekt podpira tudi Evropska komisija. V okviru tega projekta sta zamišljena dva sistema, ki kombinirata tehnologiji SSE z linijskimi koncentratorji v kombinaciji z NH_3/H_20 absorpcijskimi hladilnimi napravami za procesno hlajenje v vinski kleti v Tuniziji in mlekarni v Maroku. Prvi sistem je pričel z delovanjem Aprila 2008.

Na Univerzi v Sevilji v Španiji so se pred kratkim odločili za naprednejši pristop k solarnemu hlajenju. Razlog za to pa so v tem primeru predvsem dobri pogoji sončnega obsevanja. Na strehi Escuela Superior de Ingenieros (ESI) so postavljeni SSE z linijskim Fresnel-ovim koncentratorjem. Svetla površina SSE je 352 m², nazivna toplotna moč 176 kW. Slika 5.1 prikazuje konstrukcijo polja SSE, ki ga je izdelalo Nemško podjetje PSE: Primarna zrcala medsebojno neodvisno enoosno sledijo soncu, tako da usmerjajo odbito sevanje v fiksni sprejemnik, ki je pritrjen na podpori nad zrcali. Sprejemnik je opremljen s sekundarnim zrcalom, ki zmanjšuje sevalne izgube. Prednosti te tehnologije SSE

sta odpornost na veter ter dober izkoristek razpoložljive površine. Oboje omogoča vgradnjo na ravne strehe industrijskih in poslovnih zgradb.

Solarni sistem zagotavlja toplo vodo pod visokim tlakom temperature okrog 170°C, ki jo uporablja absorpcijska hladilna naprava z dvojnim učinkom moči 174 kW . To je trenutno naprava z najnižjo nazivno močjo te vrste na trgu, ki jo proizvaja Kitajski proizvajalec Broad. Odvod odpadne toplote je izveden preko prenosnika toplote, ki je hlajen z vodo iz bližnje reke, tako da ni potreben hladilni stolp.

Več informacij o tej tehnologiji je podano v [Zahler, 2008].



Slika 5.1 SSE z Fresnel-ovim koncentratorjem zagotavljajo toplotoe za absorpcijsko hladilno napravo z dvojnim učinkom. Na vrhu: primarna zrcala so zamaknjena iz žarišča; to je preprosta metoda preprečevanja pregrevanja. Spodaj: pogled na primarna zrcala. Desno: absorpcijska hladilna naprava z dvojnim učinkom . Viri: AICIA, Sevilja (na vrhu in desno), PSE, Nemčija (Spodaj).

Viri

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