IEA Task 48

Design and performance calculation tools for Solar Cooling systems

TECSOL

IEA Task 48 Meeting n ° 1 – plenary cession
26th and 27th March 2012 In Milano (Italy)

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Bibliography

[1] IEA Task 38 « *Description of simulation tools used is solar cooling* », technical report of subtask C, Deliverable C2-A, P. Bourdoukan (LOCIE-CNRS) et Al., nov. 2009, 95p.

[2] IEA Task 38 « *Benchmarks for comparison of system simulation tools – absorption chiller simulation comparison* », technical report of subtask C, Deliverable C2-B, C. Bongs (Frauhofer ISE) et Al, nov. 2009, 39p.

[3] MeGaPICS « *Etat de l'art des outils de calcul existants* », deliverable L11, A. Le denn (TECSOL) & Al. , may 2011, 98p.

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Generic simulation tools

	Building	Systems (incl. Solar cooling)	Comments
EES		*X*	Numerical solution of algebraic equations [1]
Matlab + Simulink		*X*	[MeGaPICS project]
SPARK	*X*	*X*	General simulation environment, Equation based object [1] - PhD library for DEC and Abso + coll.
INSEL	*X*	*X*	Graphical programing language [1]
TRNSYS	*X*	*X*	Transient simulation of thermal systems and multizone buildings [1] – existing models of systems and custom models of chillers
EnergyPlus	*X*	*X*	Energy and load simulation pgm, simultaneous solution [1]

➔ some available models, to be « dll »

Specific simulation tools

	Building	Systems (incl. Solar cooling)	Comments
TRANSOL		*X*	Use TNRSYS kernell – see Aiguasol (Sp) or CSTB (Fr)
POLYSUN		*X*	See University of Rapperswil (HSR, Sw)
COLSIM	*X*	*X (no SAC)*	See Fraunhofer ISE

➔ to be validated

R&D project developed tools

Project	Language / Pgm	System	Comments	Source
MEDISCO	TRNSYS +Excel	Abso + collectors	excel input based + TRNSed App.	Fraunhofer ISE + Cimne
SolCoolSys	TRNSED +Excel	Adso + collectors	Couple building + SHC system	Fraunhofer ISE
SOLARCOMBI+	TRNSYS	Abso + collectors	Sensibility and comparison	Fraunhofer ISE
SOLERA	TRNSED +Excel	Abso + collectors	3 systems	Fraunhofer ISE
ODIRSOL	TRNSYS	Abso + FCP/ETC collectors	Some bugs remaining, no further development	TECSOL - CSTB
NEGST	?	Abso + FCP/ETC/PTC collectors	Compare different technology and caracteristic	Stuttgart University + ENEA
PolySmart	Java	Abso + FCP/ETC	Only energy balance - $ evaluation	Fraunhofer ISE
SACE	Java	Abso + collectors	Indicators calculations	Franhofer ISE

Other (components)

* load calcultor (Tomas N.) : java based, creates hourly values fo heating and cooling demand, based on annual demand as inputs

* solar cooling f-chart method : coeff. To be corrected – tested with real installation and not working (CEA)

* B4-Task 38 Pre-design tool

Future work

MeGaPICS	Excel	Ab/ad + FCP/ETC collectors (system)	Simplified component models	TECSOL - CEA
Heat4You project KollSorp project	TRNSys + interface	Ab + collector (system) Ad	Not decided (simulation or design)	Fraunhofer ISE
MeGaPICS	Matlab	Ab/ad + FCP/ETC collectors (system)	Only energy balance	PIMENT -

Name : OPDS (simplified presizing tool)

Area of use : ab/adsorption solar cooling, heating, DHW systems

To be used by : Designer and planners

Input : hourly meteo + load file / Parameters : automatic pre-sizing

Database: solar collectors, chillers

Output : monthly energy balance

Models : physical equations,

COPth = f (COPc)

empirical models for heat rejection and electrical conso

8760 calculations

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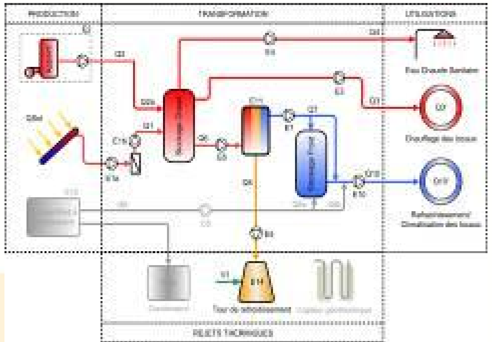
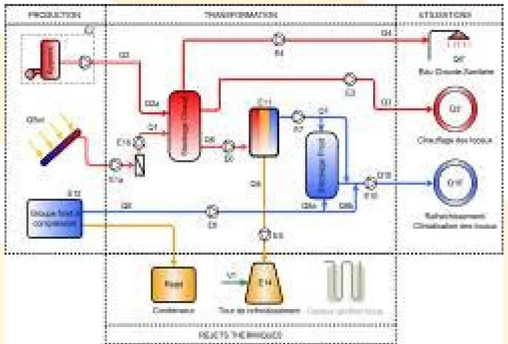
Configurations :

SSC+ systems

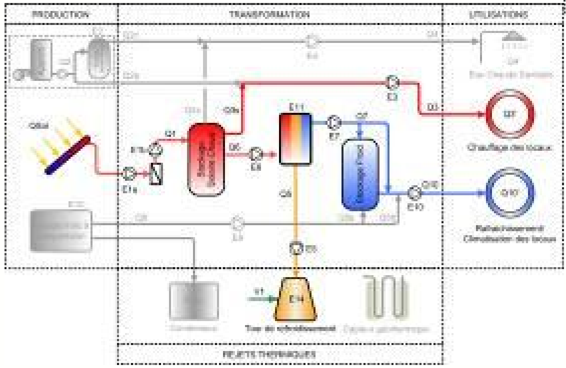
4 configurations

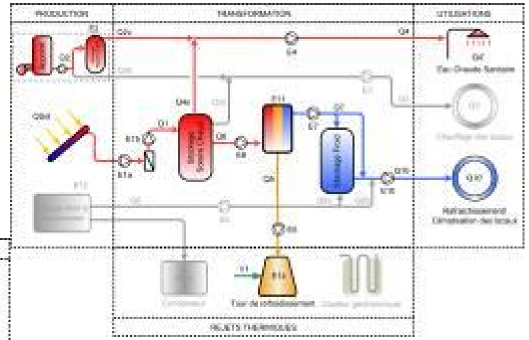


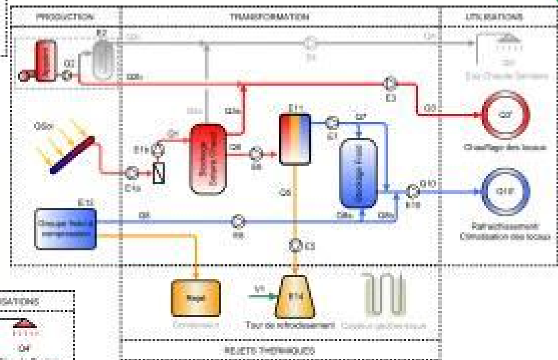


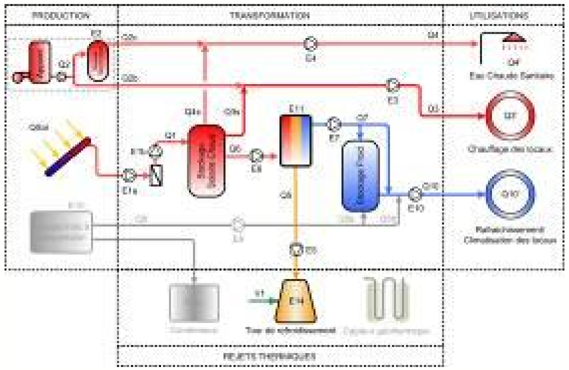
Collective systems

20 configurations









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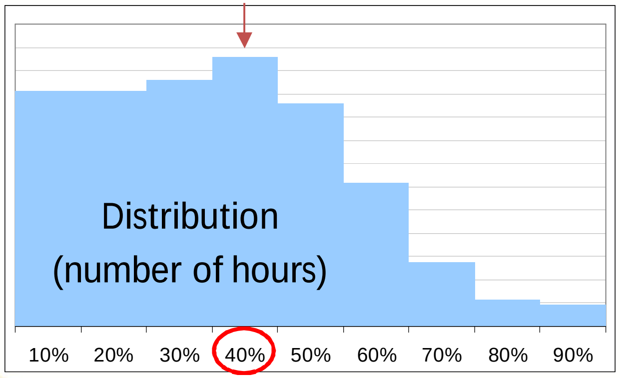
Automatic pre-sizing (1)

Propose a cooling capacity according the cooling loads : **Pcool = k * Bclim_max**

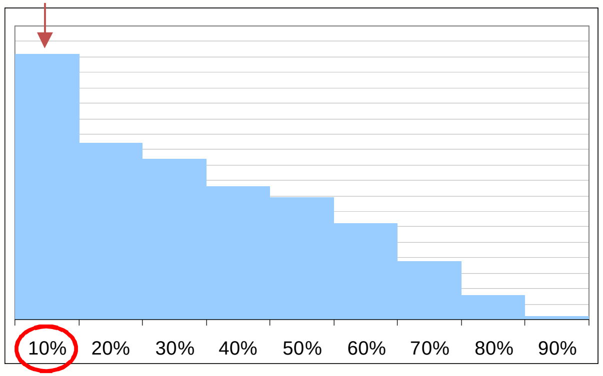
K = 0,4



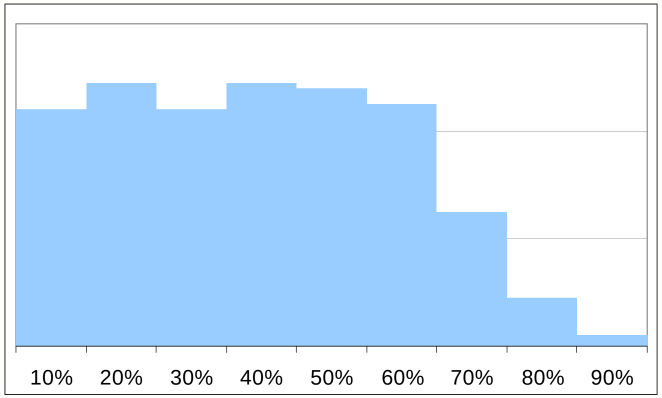
Percentage of Bclim_max

Example 1 : Office building (Case study)

K = 0,1



Example 2 : Multifamily houses (Case study)



Example 3 : Classroom (Monitoring data RAFSOL)

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Automatic pre-sizing (2)

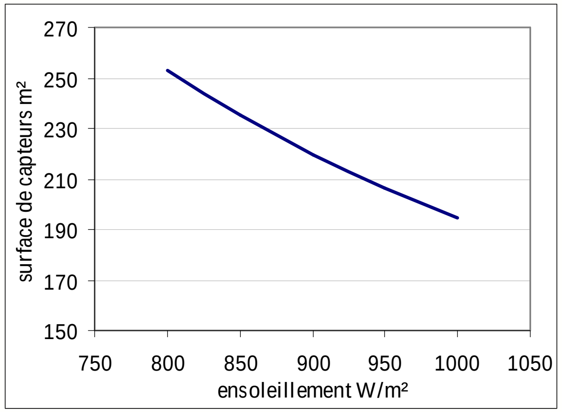
Pcool ➔ collector area (m²)

$$\begin{cases} \eta_{capt} = \eta_0 - a_1 \times \dfrac{(T_m - T_{ext})}{G} - a_2 \times \dfrac{(T_m - T_{ext})^2}{G} \\[2ex] S_{totale} = \dfrac{Pn_{totale} \times 1000}{G \times COP_n \times \eta_{capt} \times \eta_{ech} \times \eta_{bc}} \end{cases}$$

To fix the hypothesis :

Text	Ambiant temperature	° C	25	25	25
Tm	Collector average temperature	° C	85	85	85
G	Irradiation on collectors	W/m²	800	900	1000
n_bc	Hot storage efficiency	-	0.9	0.9	0.9
n_ech	Solar heat exchanger	-	0.9	0.9	0.9

→ A lot of influence



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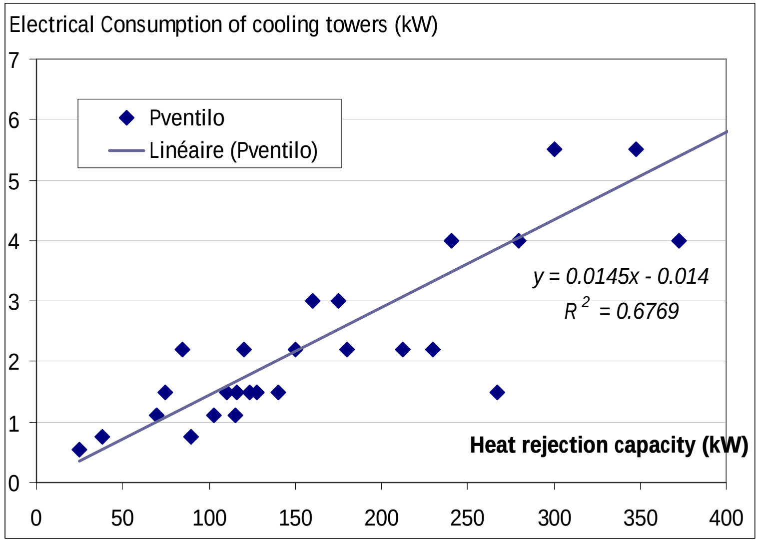
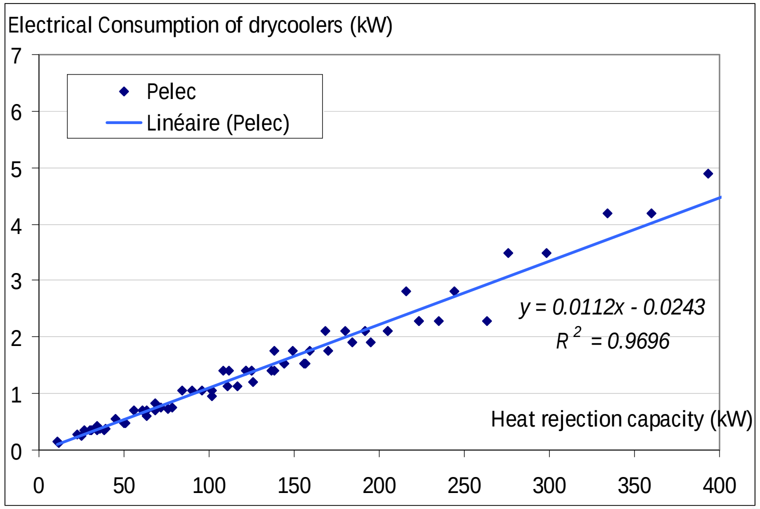
Electrical consumption calculations :

* Pn * kW	qair m3/s	qeau m3/hr	Pventilo kW	pdc mCE	Fabricant -	Modèle -
38	0.36	6.53	0.75	0.2	Baltimore Aircoil	VXT010 centrifuge
103	1.94	17.71	1.1	0.2	Baltimore Aircoil	VXT015 centrifuge
128	2.19	22.03	1.5	0.2	Baltimore Aircoil	VXT020 centrifuge
180	2.5	30.96	2.2	0.2	Baltimore Aircoil	VXT025 centrifuge
372.2	5.7	55.08	4	1.86	EVAPCO	LSTA 4-63
408	10.5	55.08	4	0.48	EVAPCO	AT 19-56
347.9	9	55.08	5.5	0.48	EVAPCO	AT 19-76
267.6	4.3	36.72	1.5	1.79	EVAPCO	ICT 4-54
212.4	4.3	36.72	2.2	1.79	EVAPCO	ICT 4-94
240.9	4.5	36.72	4	0.41	EVAPCO	AT 19-56
123.6	2.3	18.36	1.5	0.41	EVAPCO	ICT 4-54
116.1	2.2	18.36	1.5	0.41	EVAPCO	ICT 4-84
110	2.3	18.36	1.5	0.5	EVAPCO	LSTA 4-61
120	2.9	18.36	2.2	0.5	EVAPCO	LSTA 4-62
70	1.62	12	1.1	0.2	Air Traitement	5S6 centrifuge
75	1.75	12.9	1.5	0.4	Air Traitement	5S7 centrifuge
85	2 025	14.6	2.2	0.6	Air Traitement	5S7 centrifuge
115	2.7	19.76	1.1	0.2	Air Traitement	10S4 centrifuge
140	3.24	24.057	1.5	0.4	Air Traitement	10S6 centrifuge
150	3.51	25.776	2.2	0.6	Air Traitement	10S7 centrifuge
160	3.78	27.494	3	0.6	Air Traitement	10S8 centrifuge
175	4.05	30.071	3	0.6	Air Traitement	10S9 centrifuge
230	5.4	39.523	2.2	0.6	Air Traitement	20S4 centrifuge
280	6.48	48.115	4	0.6	Air Traitement	20S6 centrifuge
300	7.02	51.551	5.5	0.6	Air Traitement	20S7 centrifuge
325	7.56	55.847	7.5	0.6	Air Traitement	20S8 centrifuge
350	8.1	60.143	7.5	0.6	Air Traitement	20S9 centrifuge
25	0.63	2.6	0.55	0.013	Mita	PMS 4/65 axiale
90	2.19	4.29	0.75	0.2	DECSA	TMR 09 centrifuge



> To update with efficient products

Only 1 manufacturer
High efficiency fans
> to be completed



>>A3 : do you have input ?

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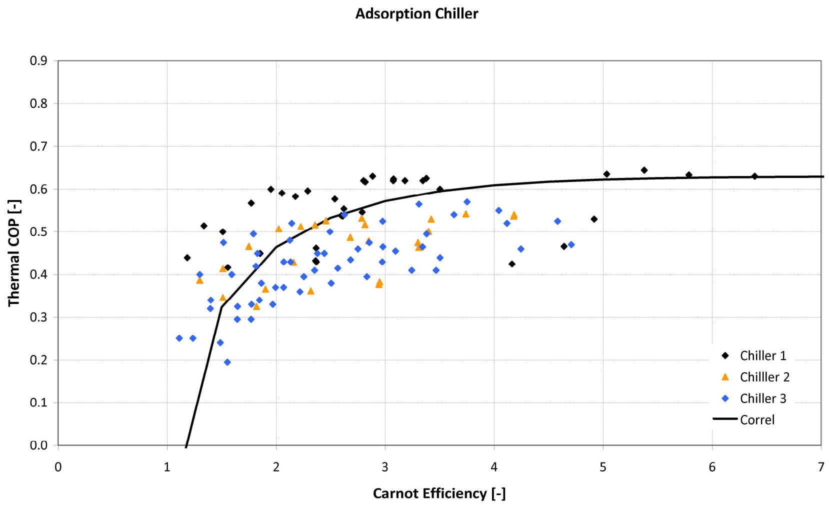
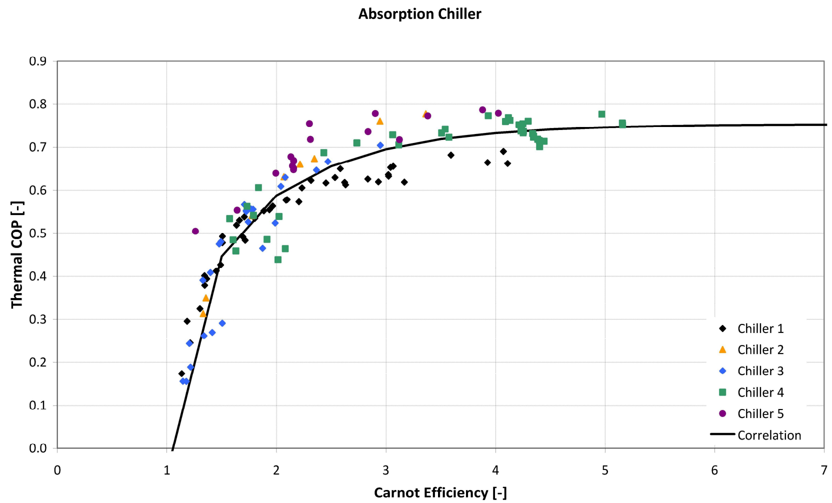
Chiller cold production :





>> need results of static test (about 20 points) with T ° C, flow rates, electrical consumption and cold production

$$COP_c = \frac{(Tc-(Tref+7{,}5))\times(Tf+273{,}15)}{((Tref+7{,}5)-Tf)\times(Tc+273{,}15)}$$

To be adjusted

$$COP_{ab} = a_1 \times \exp(-COP_c/b_1) + a_2 \times \exp(-COP_c/b_2) + COP_0$$

COP_0 = 0.75 for absorption chillers
COP_0 = 0.63 for adsorption chillers

>>A1 input ?

Validation:

- solar cooling production : comparison with TRNSYS models and RAFSOL installation (config. A1)
- DHW solar production : comparison with SOLO and monitored installation
- solar cooling and heating production: comparison with existing installation (SOLACLIM : case A2 - SONNENKRAFT)
- SSC+ installation : SOLERA INES installation (config C1)

... we need more !

>> hourly meteo data and loads and monthly results

Thank you for your attention