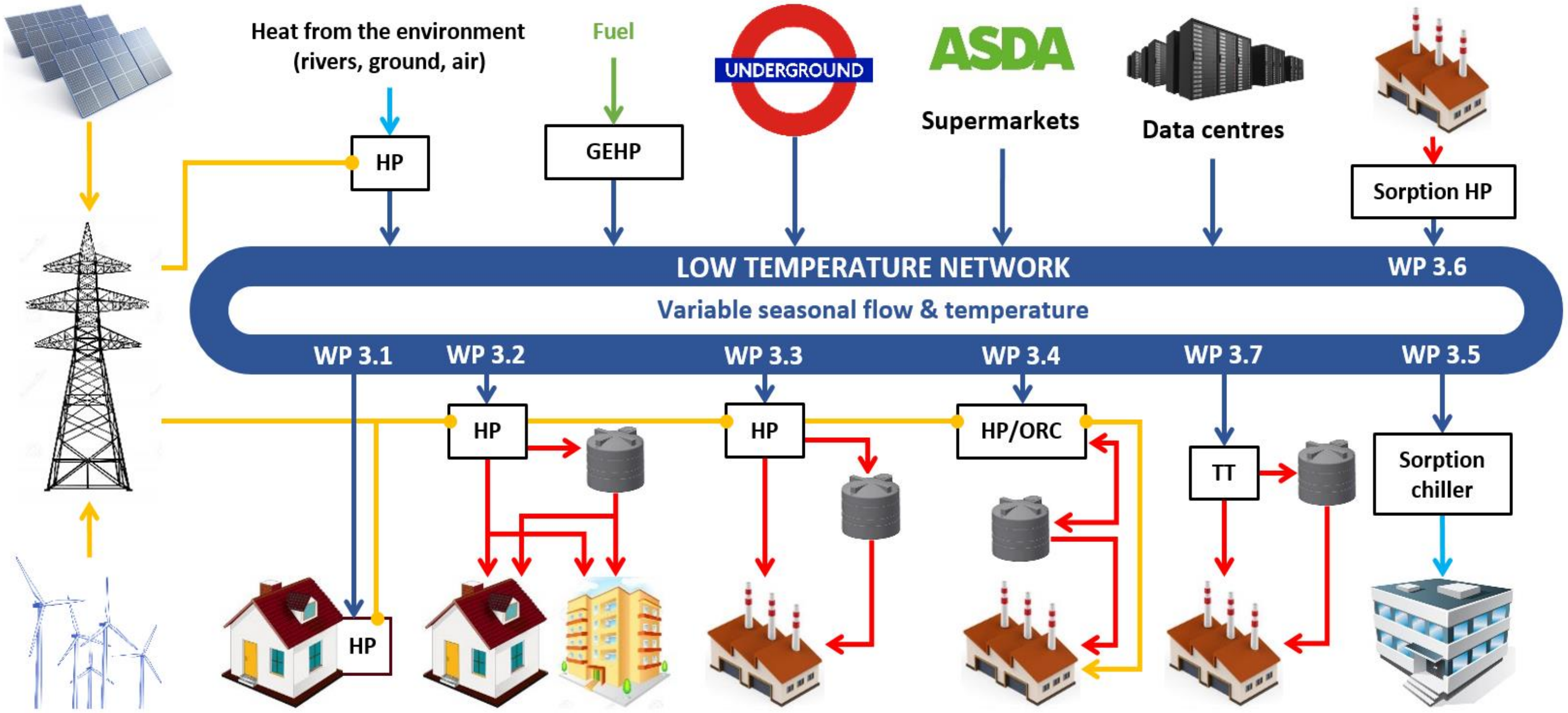
LoT-NET research focuses on the integration of low temperature (LT) networks with heat pumps and thermal storage technologies to maximise waste and ambient heat utilisation in low or zero-carbon heating and cooling solutions.

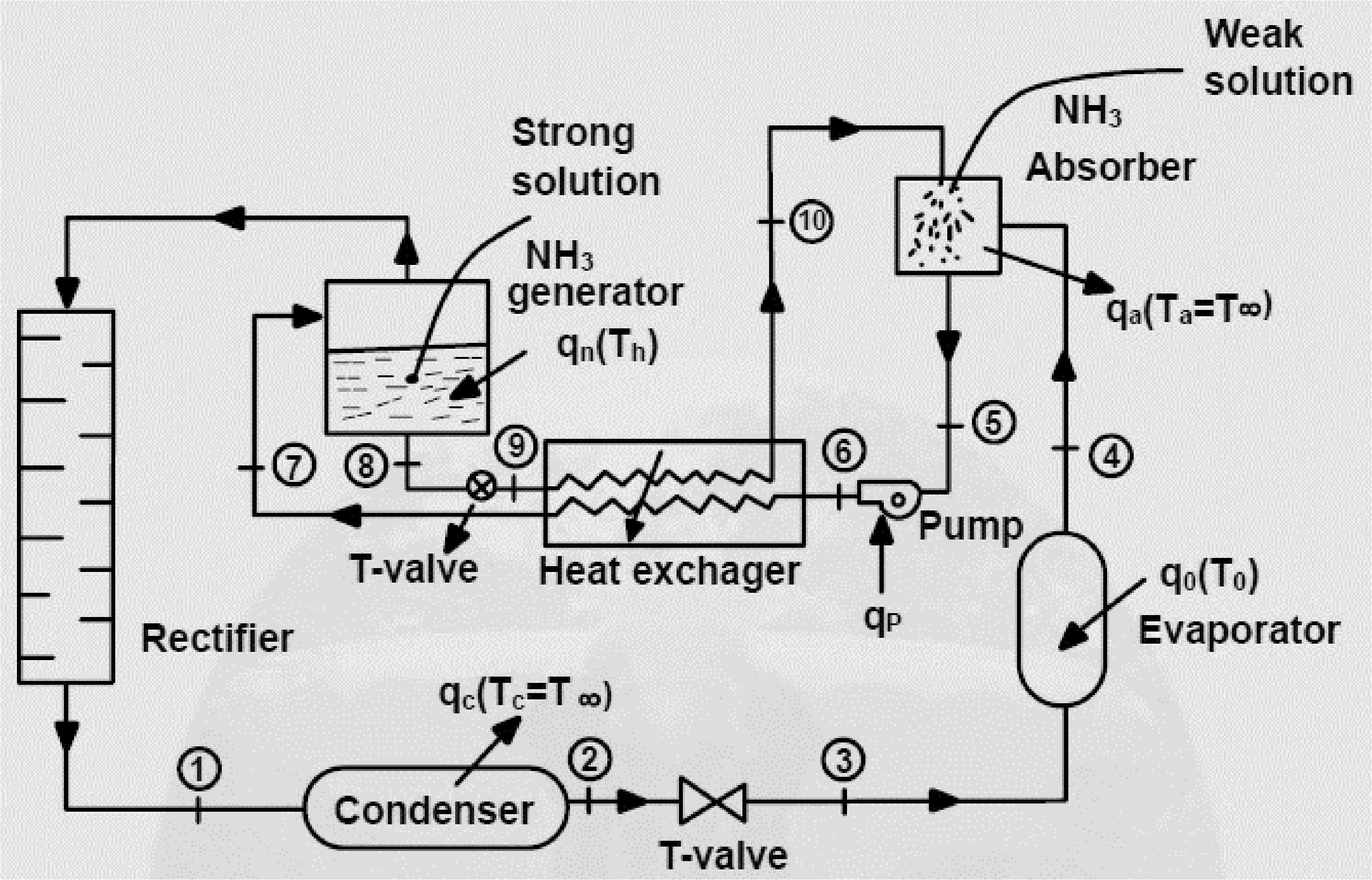


LoT-NET

Low Temperature Heat Recovery and Distribution Network Technologies

WP2.1 – Distribution medium, method

Absorption machines: example H_2O/ NH_3



Thermochemical district networks:

Thermochemical district networks are a new technology for district networks that can provide heating and cooling in one **heat loss-free** multiservice network.

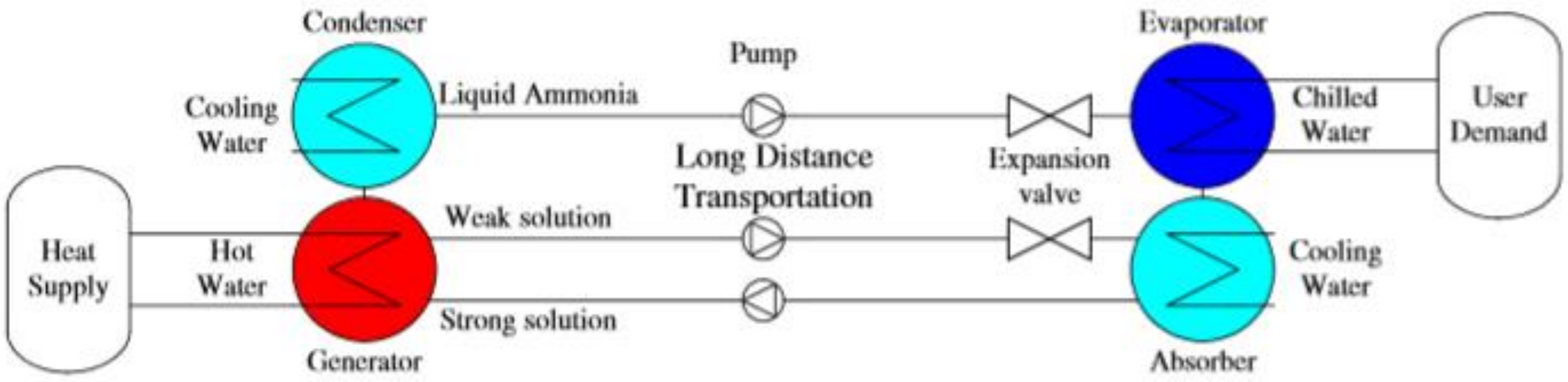
The innovation is the use of thermochemical fluids as transport medium (concentrated salt solutions).

The chemical potential is used to generate useful heat or cold from ambient heat at the place and time of demand.

Advantages: heat loss free

- Less investment (no insulation, smaller pipe diameters)
- Longer distances

Thermochemical district networks: Example schematics



Requirements for residential space heating:

- Evaporating with air as heat source preferably until -15°C
- Condensation below 30°C
- Fluid vapour pressures between 0.1 and 10 bar

Thermochemical fluids (water based)

Different groups of substances such as salts, alkalis, acids, organic compounds and ionic liquids can be used as absorbents.

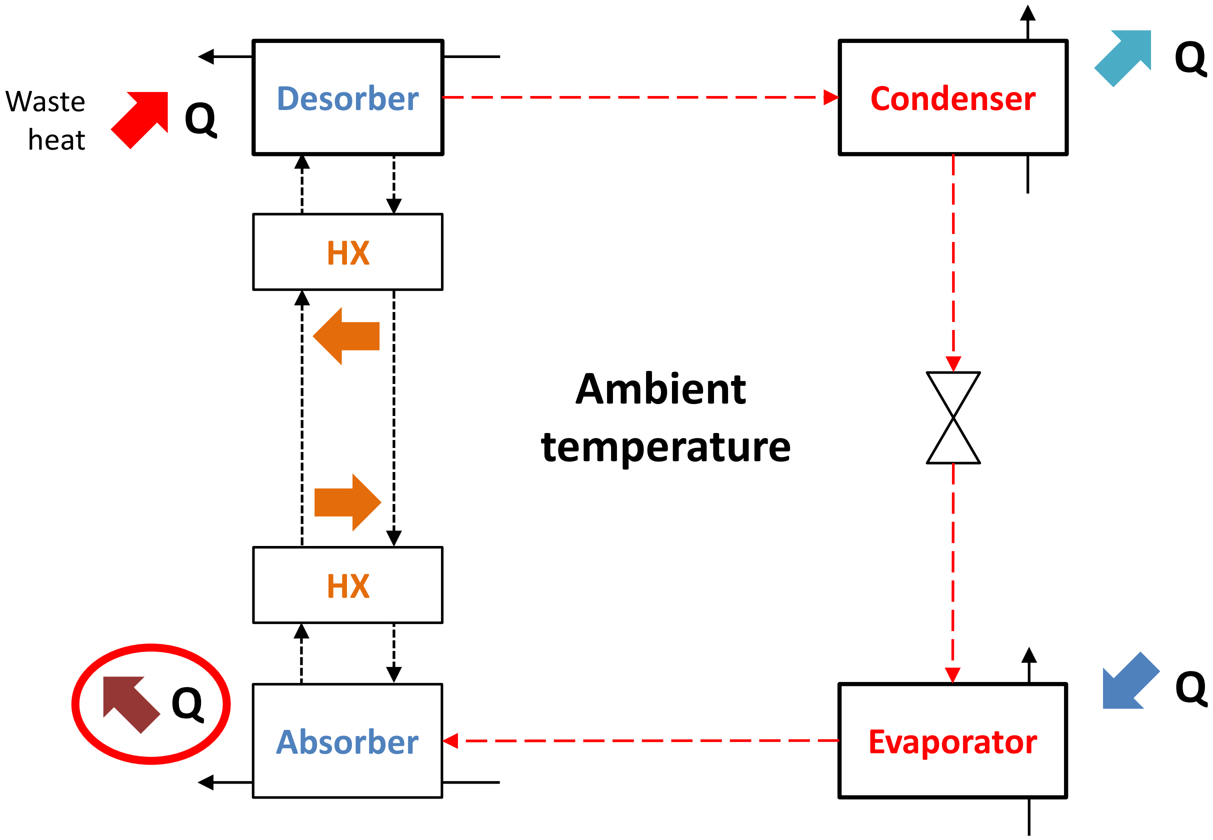
In addition to thermodynamic properties, the following criteria must be considered for the selection of the thermochemical fluid:

- Availability
- Price
- Environmental compatibility
- Recyclability
- Toxicity
- Chemical stability

Thermochemical fluids (water based)

Desiccant	Comments
Lithium bromide (LiBr)	Common in absorption plants (chillers), but not suitable in thermochemical network due to the high price.
Lithium chloride (LiCl)	common in dehumidification systems, but not suitable in thermochemical network due to the high price.
Calcium chloride ($CaCl_2$)	High efficiency.
Magnesium chloride ($MgCl_2$)	High efficiency.
Calcium nitrate $Ca(NO_3)_2$	Not corrosive. Low efficiency at low temperatures and high efficiency at high temperatures.
Sodium hydroxide (NaOH)	Very high efficiency. Not suitable in open processes.

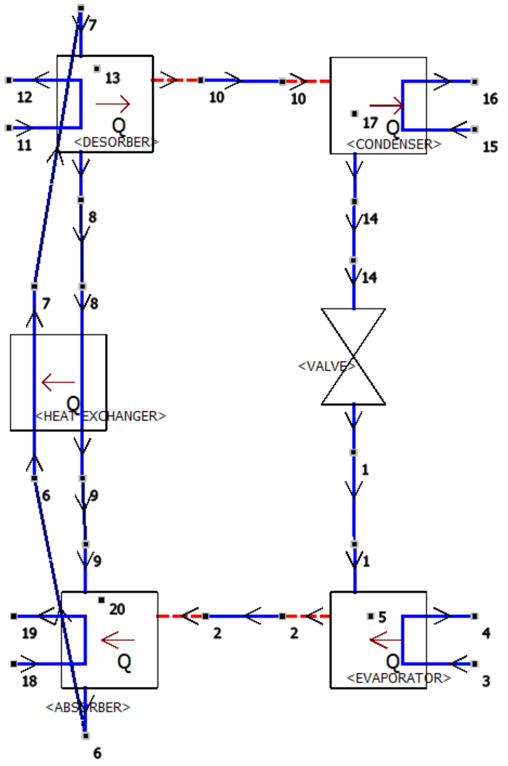
Example schematics



SorpSim – Sorption System simulation program (Oak Ridge National Laboratory)

Sorption system simulation tool to evaluate different thermally activated cooling and heating technologies.

Single-effect LiBr-water chiller



SorpLib – Dynamic library (Oak Ridge National Laboratory)

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A dynamic library for isotherm correlation of sorption working pairs.

Available equation of state of pure components (1) include: Water

Available pairs (32) data include:

- Water (14)
  - LiBr
  - LiBr:CH3COOK
  - LiBr:CH3CH(OH)COONa
  - LiBr:H2N(CH2)2OH
  - LiBr:HO(CH2)3OH
  - LiBr:LiNO3-LiI-LiCl
  - LiBr:LiI-OH(CH2)3OH
  - LiBr:LiNO3-LiI-LiCl
  - LiCl
  - CaCl2
  - Zeolite:5A
  - Zeolite:13X
  - SilicaGel
  - NaOH:KOH-CsOH
- CO2 (5)
  - Zeolite:5A
  - Zeolite:13X
  - Carbon:ACF(A-20)
  - Carbon:AC-MaxsorbIII
  - SilicaGel
- Propylene (5)
  - Zeolite:4A
  - Zeolite:13X
  - Zeolite:5A-crystal
  - Zeolite:5A-pellets
  - Carbon:MolecularSieve
- Propane (5)
  - Zeolite:4A
  - Zeolite:13X
  - Zeolite:5A-crystal
  - Zeolite:5A-pellets
  - Carbon:MolecularSieve
- Butene (1)
  - Zeolite:13X
- HFO1234ze (1)
  - Carbon:AC-MaxsorbIII
- HFC134a (1)
  - Carbon:AC-MaxsorbIII

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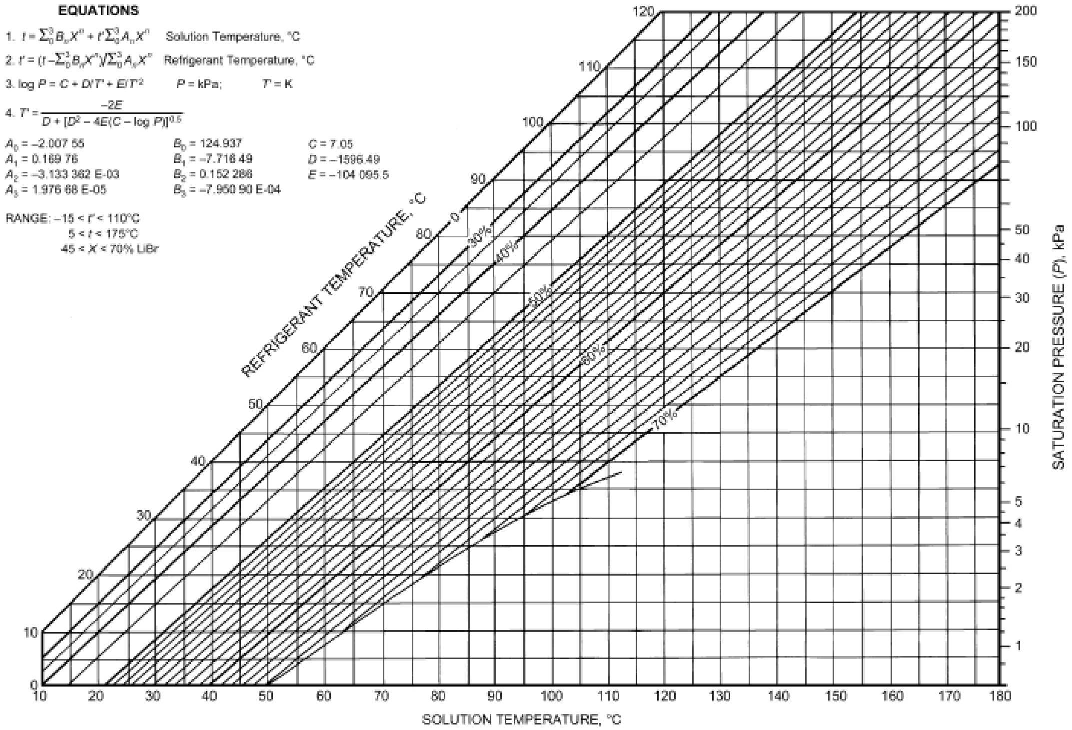
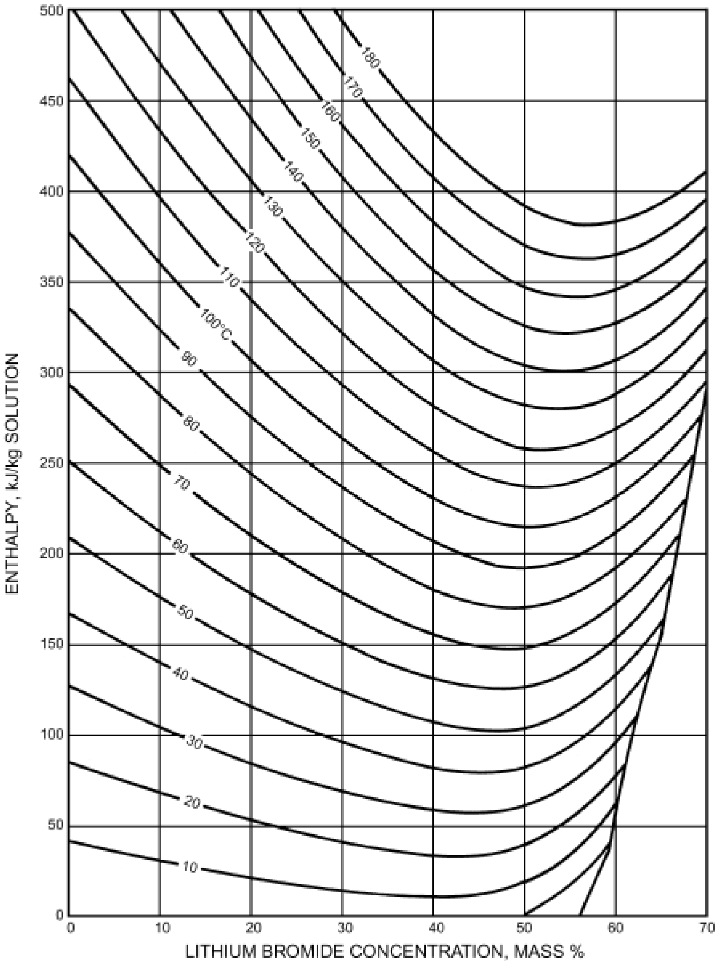
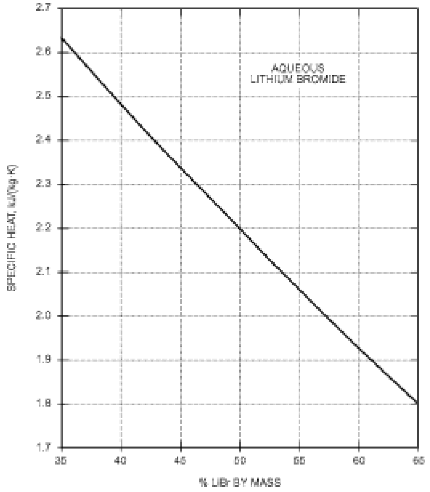
LiBr – H_2O properties (ASHRAE)

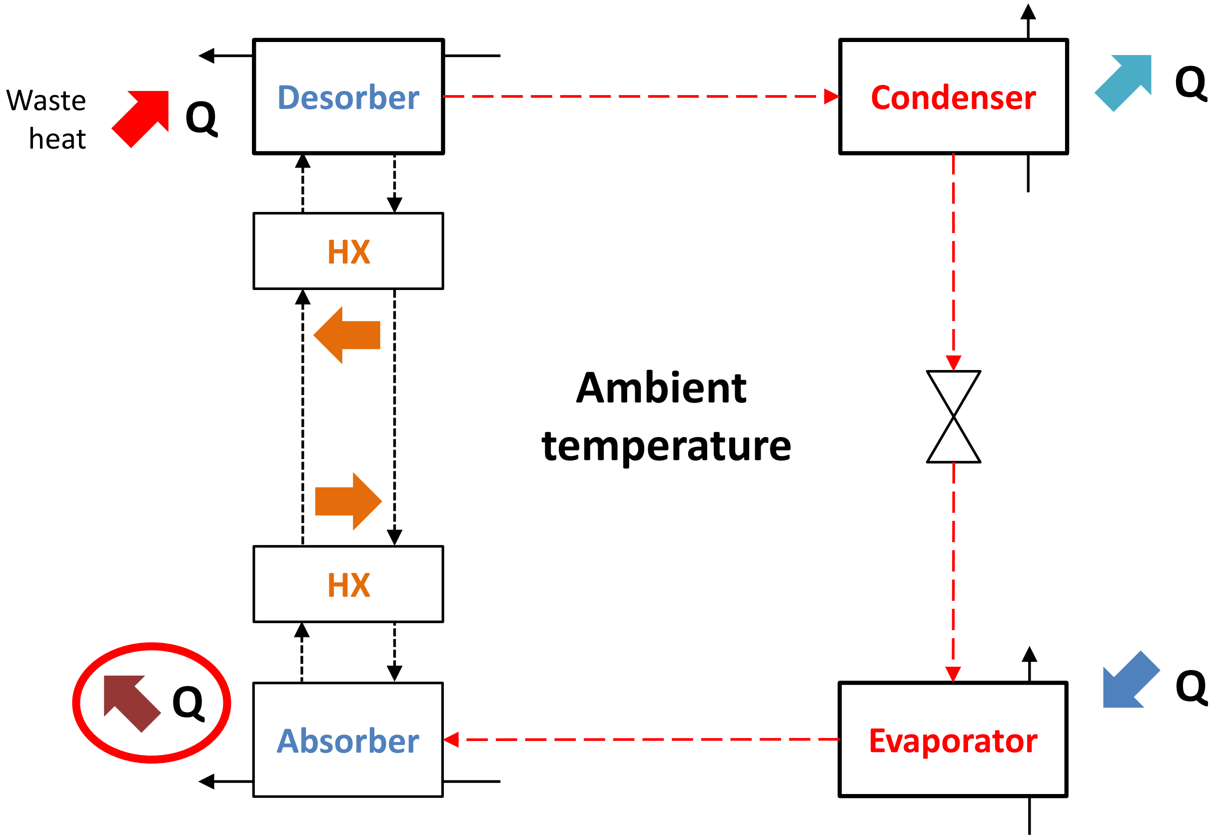






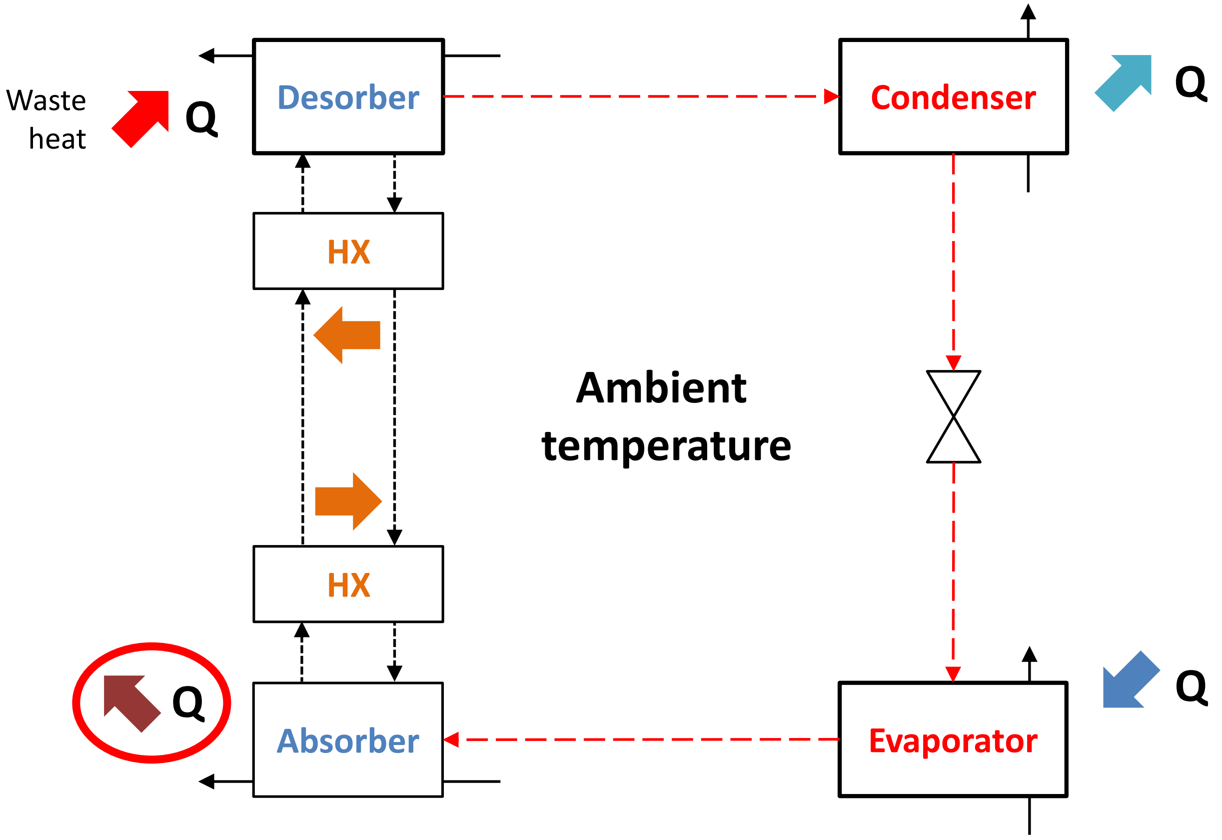
Example: LiBr – H_2O
Matlab simulation

Tamb (C)	Tabs (C)	Tdes (C)	Qa	Abs/Des	ΔTeq H_2O
5	30	35	2320.23	0.82	53.53
5	30	40	2424.35	0.87	102.59
5	30	45	2476.95	0.89	145.02
5	40	45	2295.23	0.75	45.66
5	40	50	2460.69	0.82	90.62
5	40	55	2533.41	0.85	130.07
5	50	55	2249.75	0.67	38.52
5	50	60			
5	50	65			
10	30	35	2361.48	0.85	54.48
10	30	40	2449.61	0.89	103.66
10	30	45	2496.87	0.91	146.19
10	40	45	2343.00	0.78	46.61
10	40	50	2489.21	0.84	91.67
10	40	55	2555.51	0.87	131.21
10	50	55	2304.48	0.70	39.46
10	50	60	2510.10	0.79	80.02
10	50	65			
15	30	35	2402.74	0.88	55.43
15	30	40	2474.87	0.91	104.72
15	30	45	2516.80	0.92	147.36
15	40	45	2390.77	0.81	47.56
15	40	50	2517.73	0.87	92.72
15	40	55	2577.61	0.88	132.34
15	50	55	2359.22	0.73	40.39
15	50	60	2542.19	0.81	81.04
15	50	65	2614.03	0.84	116.70
15	60	65	2251.92	0.64	32.90
15	60	70	2502.09	0.75	68.26
15	60	75			



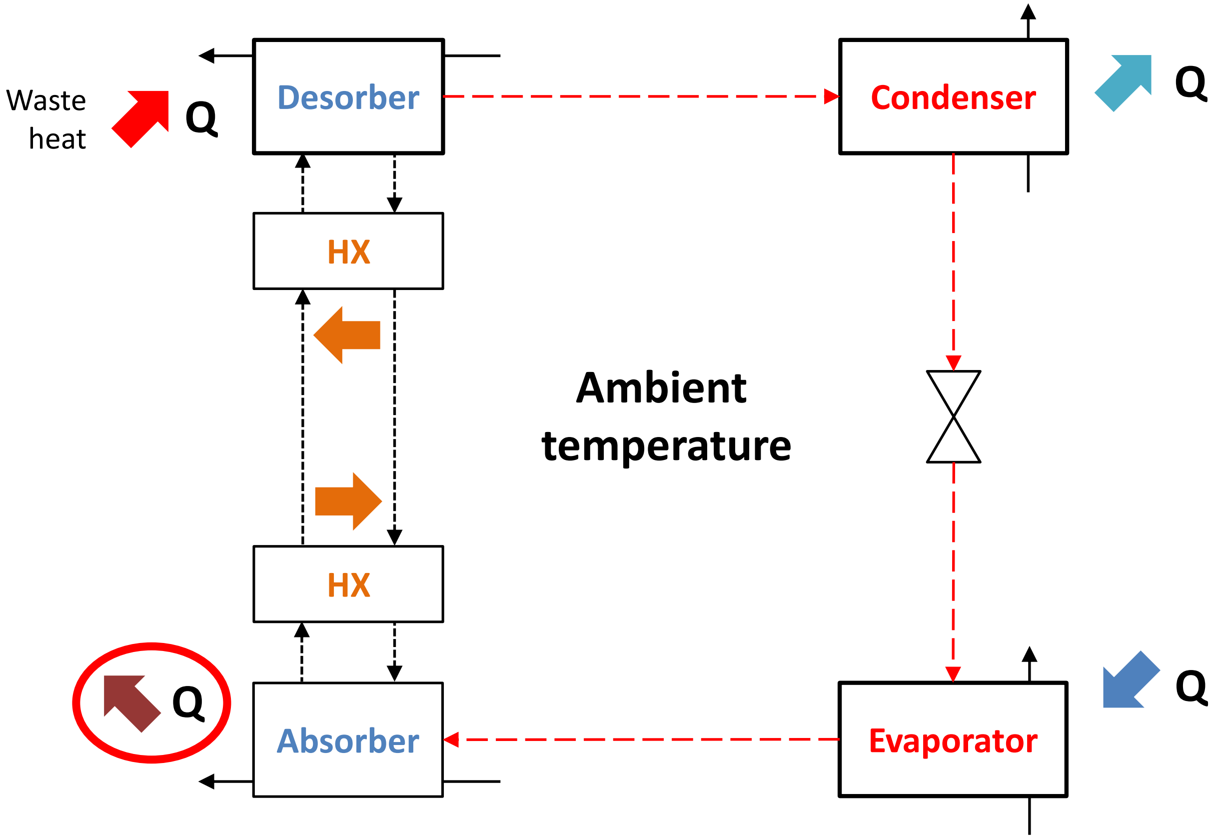
Example: LiI – H_2O Matlab simulation

Tamb (C)	Tabs (C)	Tdes (C)	Qa	Abs/Des	ΔTeq H_2O
5	30	35	2374.86	0.76	36.26
5	30	40			
5	30	45			
5	40	45			
5	40	50			
5	40	55			
5	50	55			
10	30	35	2371.01	0.81	42.34
10	30	40	2496.37	0.87	80.45
10	30	45	2561.14	0.88	111.94
10	40	45	2316.39	0.69	30.40
10	40	50			
10	40	55			
10	50	55			
10	50	60			
15	30	35	2365.35	0.87	50.32
15	30	40	2452.31	0.90	93.86
15	30	45	2502.99	0.91	129.75
15	40	45	2345.09	0.76	37.47
15	40	50	2506.35	0.83	71.72
15	40	55	2581.61	0.85	99.20
15	50	55	2221.56	0.62	24.49
15	50	60			
15	50	65			
15	60	65			
15	60	70			

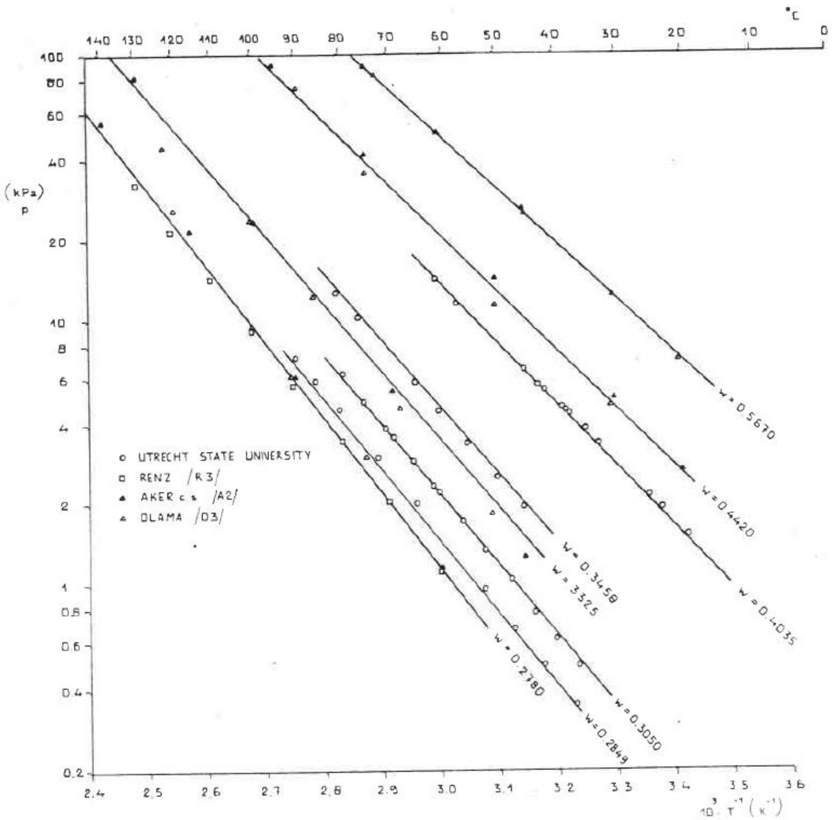


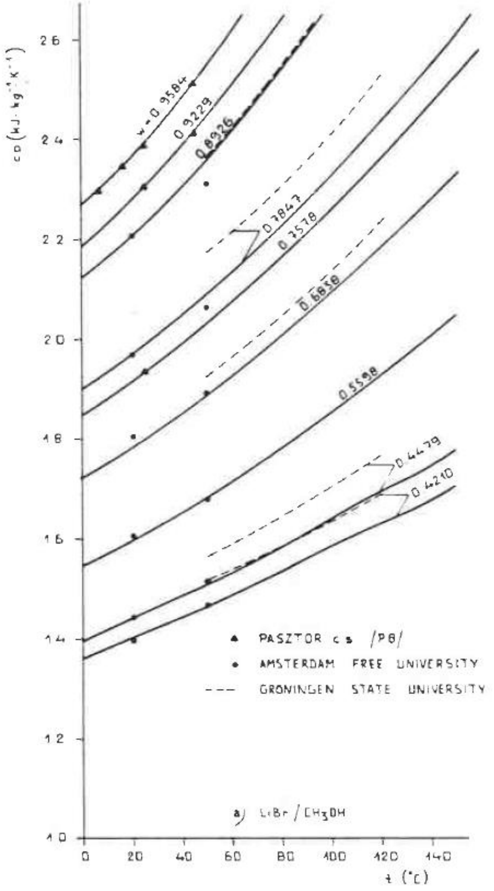
Example: LiCl – H_2O Matlab simulation

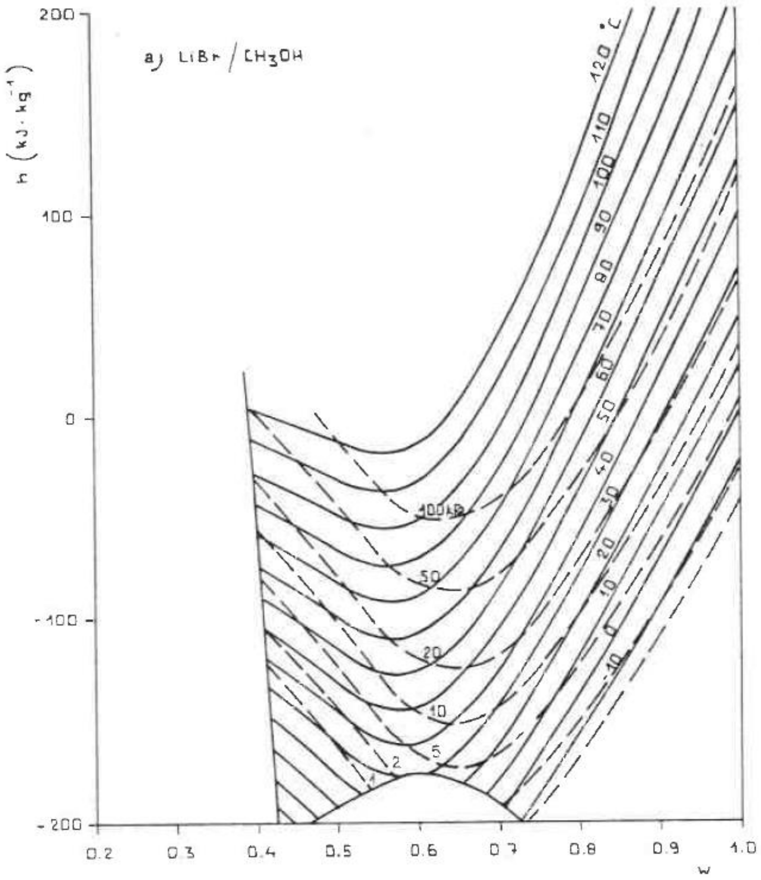
Tamb (C)	Tabs (C)	Tdes (C)	Qa	Abs/Des	ΔTeq H_2O
5	30	35	2478.59	0.86	73.28
5	30	40			
5	30	45			
5	40	45			
5	40	50			
5	40	55			
5	50	55			
10	30	35	2469.72	0.89	79.20
10	30	40	2530.91	0.92	145.97
10	30	45			
10	40	45			
10	40	50			
10	40	55			
10	50	55			
10	50	60			
15	30	35	2465.44	0.91	87.46
15	30	40	2510.53	0.93	157.89
15	30	45	2535.55	0.94	214.80
15	40	45	2446.72	0.86	73.35
15	40	50	2523.65	0.90	137.31
15	40	55			
15	50	55			
15	50	60			
15	50	65			
15	60	65			
15	60	70			



LiBr – CH_3OH properties (Iedema thesis 1984)







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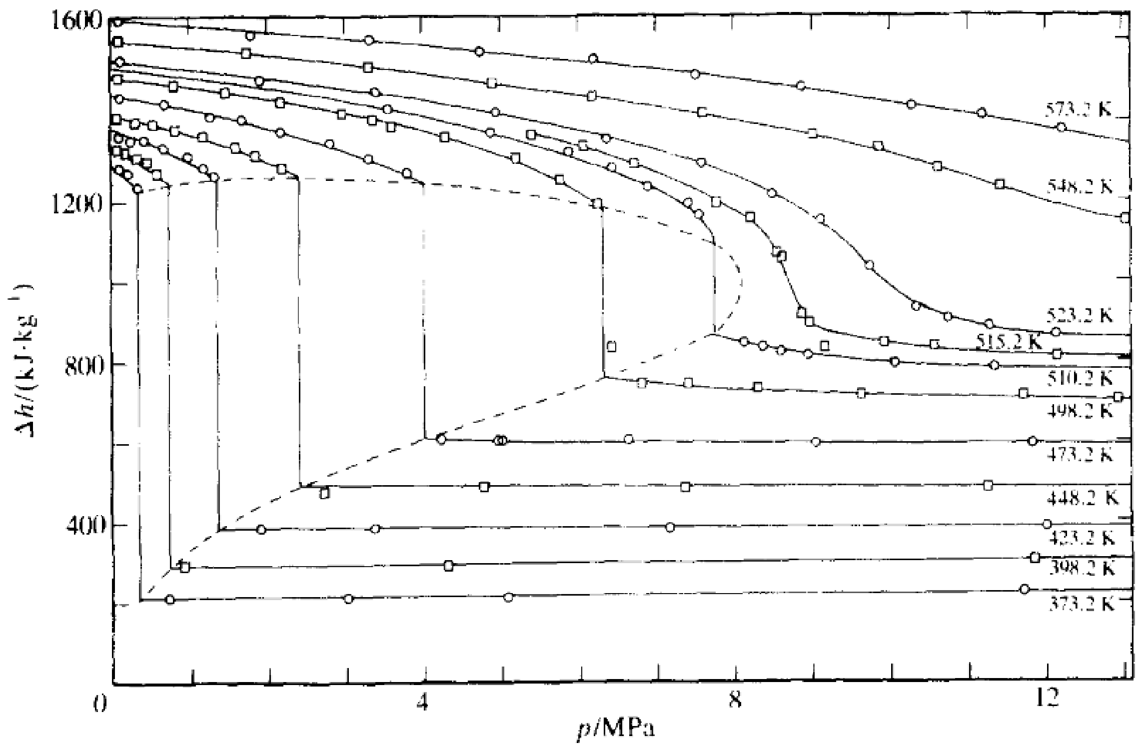
CH_3OH properties (The enthalpy of methanol, Yerlett)

TABLE 1. Measurements of the specific enthalpy of methanol. The enthalpy increment Δh was calculated using equation (2) as described in the text. $\Delta h = 0$ for liquid methanol at 298.15 K and the saturation pressure

T/K	p/MPa	Δh/kJ·kg^{-1}	p/MPa	Δh/kJ·kg^{-1}	p/MPa	Δh/kJ·kg^{-1}	p/MPa	Δh/kJ·kg^{-1}	p/MPa	Δh/kJ·kg^{-1}
373.2	0.10	1284.6	0.34	1237.9	3.02	214.5	11.72	222.5		
	0.21	1273.9	0.74	212.1	5.07	213.2				
398.2	0.10	1334.2	0.34	1311.6	0.59	1273.0	4.30	292.1		
	0.18	1326.9	0.46	1302.2	0.90	295.7	11.84	301.3		
423.2	0.10	1367.8	0.68	1336.5	1.20	1282.2	1.89	389.4	7.16	388.3
	0.27	1356.1	0.99	1314.7	1.32	1265.1	3.36	389.7	12.00	389.5
	0.44	1358.3								
448.2	0.10	1412.5	0.82	1381.7	1.85	1317.5	2.73	479.3	7.36	488.3
	0.33	1400.2	1.20	1364.8	2.19	1288.4	4.78	490.1	11.25	484.8
	0.56	1399.1	1.58	1337.8						
473.2	0.10	1464.4	1.68	1402.0	3.30	1309.3	4.94	602.5	9.04	596.2
	0.68	1447.9	2.20	1377.6	3.78	1272.4	4.98	605.7	11.83	591.9
	1.27	1414.4	2.82	1342.1	4.23	606.9	6.63	602.8		
498.2	0.10	1513.1	2.98	1422.0	5.20	1304.2	6.80	743.8	9.64	717.7
	0.83	1495.5	3.38	1403.9	5.75	1254.0	7.39	741.2	11.70	711.2
	1.47	1477.5	3.60	1389.4	6.25	1191.0	8.30	732.0	12.92	702.4
	2.18	1449.9	4.30	1360.6	6.42	836.5				
510.2	3.56	1433.4	6.45	1282.0	7.55	1163.1	8.60	825.2	10.05	793.6
	4.86	1371.0	6.90	1236.4	8.12	847.9	8.95	815.8	11.35	781.3
	5.88	1320.9	7.40	1192.7	8.37	838.2				
515.2	5.42	1363.4	7.77	1201.8	8.58	1057.1	9.16	835.3	10.55	828.1
	6.08	1336.2	8.22	1151.5	8.87	909.0	9.92	831.3	12.13	809.7
	6.72	1294.2	8.54	1066.8	8.95	892.0				
523.2	0.10	1554.8	4.94	1422.9	8.50	1218.3	10.33	931.4	11.29	883.6
	1.91	1504.9	6.36	1355.7	9.12	1152.7	10.74	904.7	12.14	868.3
	3.40	1473.3	7.58	1293.9	9.74	1036.6				
548.2	0.10	1603.7	4.91	1498.9	7.60	1420.7	9.86	1331.5	11.42	1238.0
	1.74	1572.9	6.18	1462.8	9.02	1365.6	10.64	1280.4	13.04	1150.4
	3.30	1534.8								
573.2	0.10	1653.0	4.74	1573.6	7.52	1512.2	10.28	1438.5	12.23	1375.3
	1.80	1620.2	6.20	1550.6	8.90	1481.0	11.18	1413.0	13.64	1326.5
	3.33	1604.4								

THE ENTHALPY OF METHANOL



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Example: LiBr – CH_3OH
Matlab simulation

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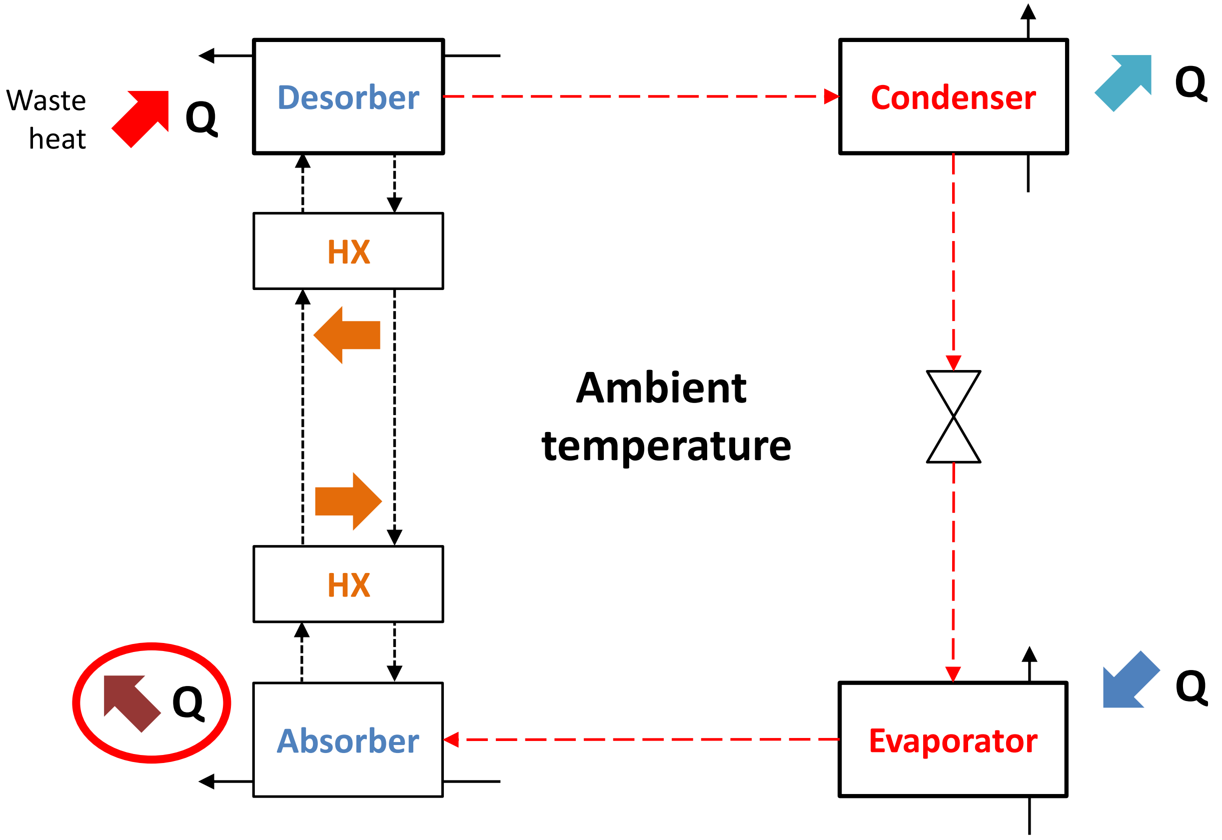
Tamb (C)	Tabs (C)	Tdes (C)	Qa	Abs/Des	ΔTeq H_2O
5	30	35	1404.05	0.80	30.82
5	30	40	1480.14	0.86	56.58
5	30	45	1515.96	0.87	75.94
5	40	45	1352.37	0.68	19.37
5	40	50			
5	40	55			
5	50	55			
10	30	35	1397.47	0.83	32.50
10	30	40	1463.28	0.88	60.44
10	30	45	1497.18	0.89	82.15
10	40	45	1386.81	0.73	22.97
10	40	50			
10	40	55			
10	50	55			
10	50	60			
15	30	35	1384.81	0.86	32.56
15	30	40	1441.57	0.90	62.02
15	30	45	1473.73	0.91	85.93
15	40	45	1399.94	0.78	26.24
15	40	50	1482.88	0.84	48.84
15	40	55			
15	50	55			
15	50	60			
15	50	65			
15	60	65			
15	60	70			



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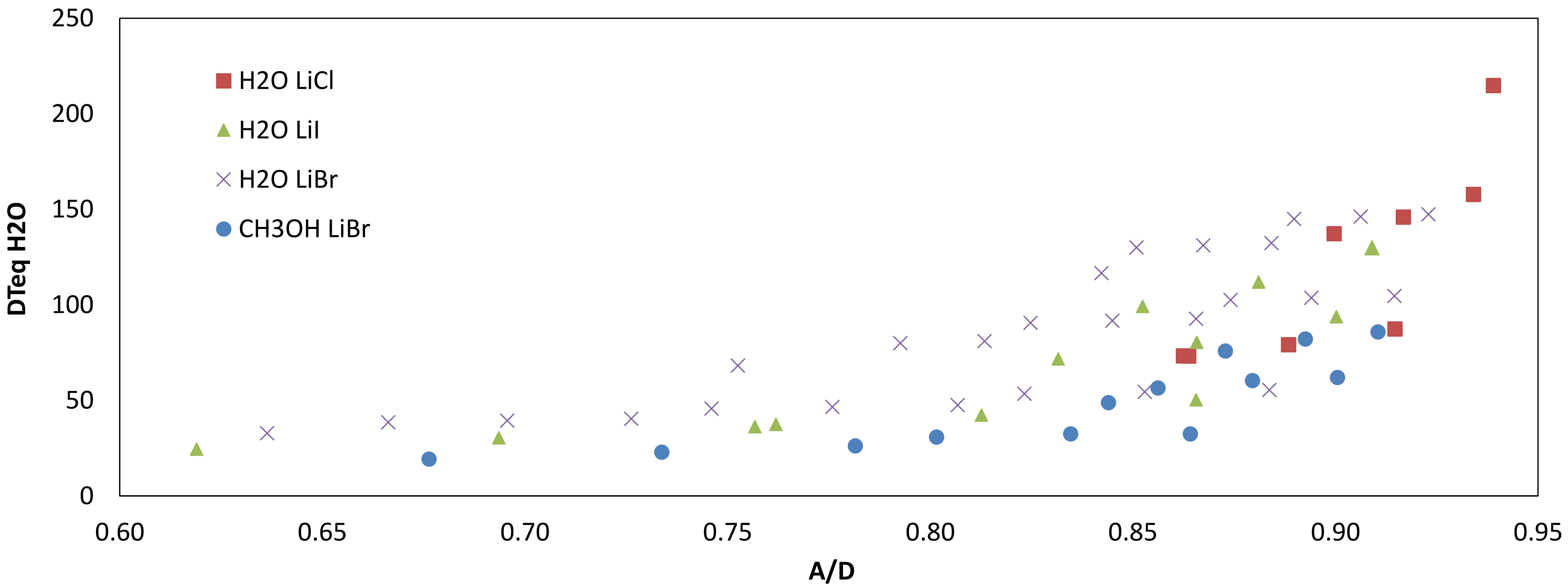
Pairs comparison



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Thank you

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Pairs comparison