

Introduction to Annex 43:

Fuel driven sorption heat pumps

For residential and small scale commercial heating applications

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IEA National Teams Meeting for the UK Heat Pump Industry, DECC, 18th August 2014

Contents:

- Background to Annex 43 - Fuel (Gas) Driven Sorption Heat Pumps
- State of the art and new developments

Reasons for gas driven heat pumps

- Buildings with radiators which might need higher temperatures
- Replacement of existing boilers, minimal change of existing system
- Grid balancing – inability of electricity grid to cope with an all-electric future

Reasons for a new annex “Fuel driven heat pumps”

- Market for fuel driven heat pumps is rising (7000 in EU so far)
- Emerging technology just starting to enter market
- Big need for quality assurance measures
- Big need to optimize best system configurations for different applications
- Need for standards on test procedures
- Need for common understanding of field tests.

Focus:

- Fuel driven heat pumps for residential and light commercial (e.g. < 50 kW)
- Focus on heating mode, reversible allowed

Goals:

- Easy and sustainable market entrance and deployment
- Identify market barriers and opportunities
- Identify the potential markets and importance in future energy systems
- Identify market supporting measures

Participants:

Austria	AIT, University of Graz
France	GDF, GrDF, boostHEAT
Germany	Viessmann, Vaillant, Sortech, <u>Fraunhofer ISE</u> , Univ. of Berlin (ZAE), Stiebel Eltron
Italy	Robur, CNR-ITAE, Politecnico di Milano
USA	ORNL
UK	University of Warwick, Delta-EE

Work structure

A: Generic systems and system classification (ISE)

- WP1: Collection of technology and market relevant data
- WP2: Development
- WP3: System classification
- WP4: Development of generic systems and system boundaries

Work structure

B: Technology transfer (Warwick)

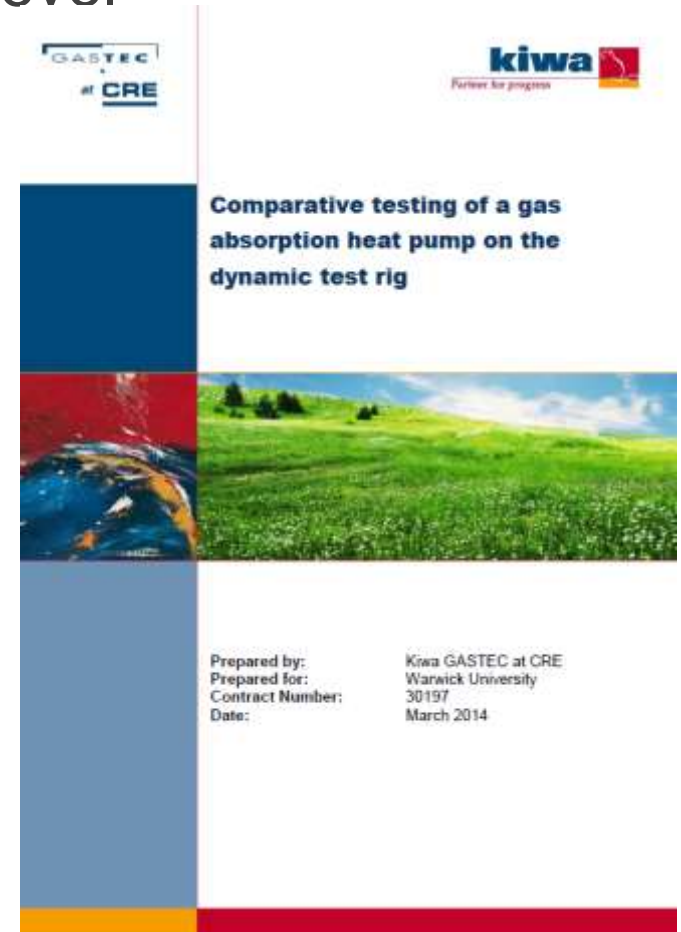
- WP 1: link research and industry (workshops) (Warwick)
- WP 2: New materials (database) (ISE)
- WP 3: New components/systems (CNR-ITAE)

Under WP1 i-STUTE, EHPA and Annex 43 hope to organise a gas fired heat pump workshop for industry in 2015.

Work structure

C: Field test and performance evaluation (Polimi)

- WP 1: Standardized Monitoring & Measurement Procedure
- WP 2: Test procedures on system level
- WP 3: Laboratory Tests
(Warwick/Kiwa)



Dynamic Heat Load Test Rig

- Runs for 24hours.

Table 4: Test results for GAHP in large house (700W/K)

Test number	Outside T (°C)	Humidity (%)	Regime	Flow (m ³ /h)	Flow T (°C)	Gas in (kWh)	Electric in (kWh)	Heat out from app (kWh)	24h Efficiency of appliance ^{*1}	Heat out from radi (kWh)	24h Efficiency of system ^{*2}	Mean Int T (°C)
178	7	57	Bi	1.5	60	156	16	185	108%	185	108%	18.2
134	0	64	Bi	1.15	60	185	17	214	106%	211	104%	14.9
136	0	52	Uni	1.15	60	268	22	302	104%	296	102%	18.4
184 ^{*3}	0	74	Uni	1.5	60	274	22	300	102%	300	102%	18.7
170	7	55	Uni	1.5	45	165	19	214	116%	212	115%	19.7
162	0	77	Cont	1.5	45	269	26	342	116%	338	114%	20.8

^{*1} Equivalent to the instantaneous coefficient of the performance (COP) averaged over 24 hours.

^{*2} Equivalent to SPF_H, assuming there are no buffer tanks or domestic hot water (DHW) use.

^{*3} In addition to the original test regime, an extra test was undertaken with a different flow rate.

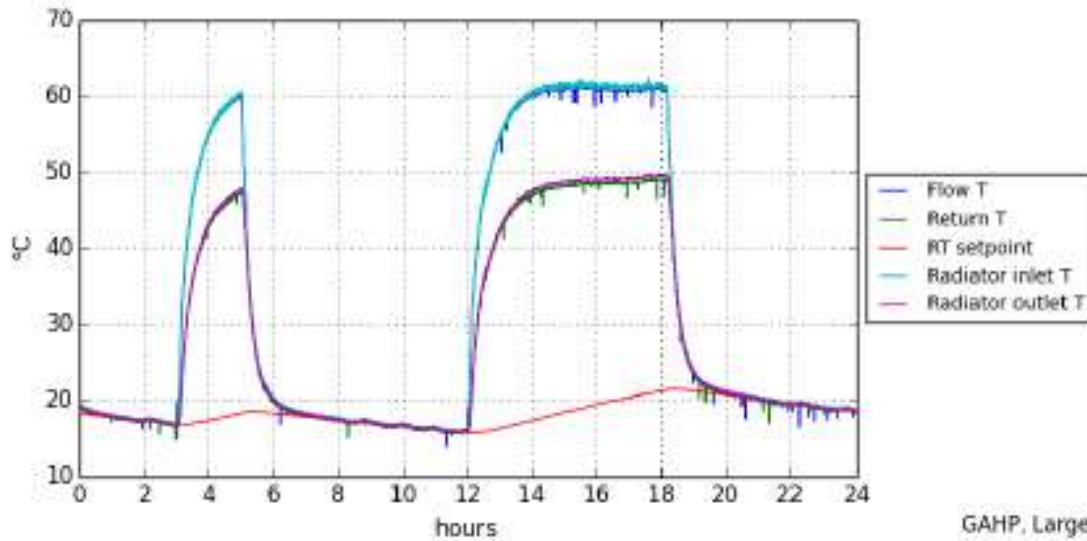
^{*4} Test 134 was an extra test with the GAHP, this was undertaken bimodally to check the safety and running of the appliance, so therefore if the tests at 0°C under-heated the property, then the tests were repeated unimodally as per the test programme.



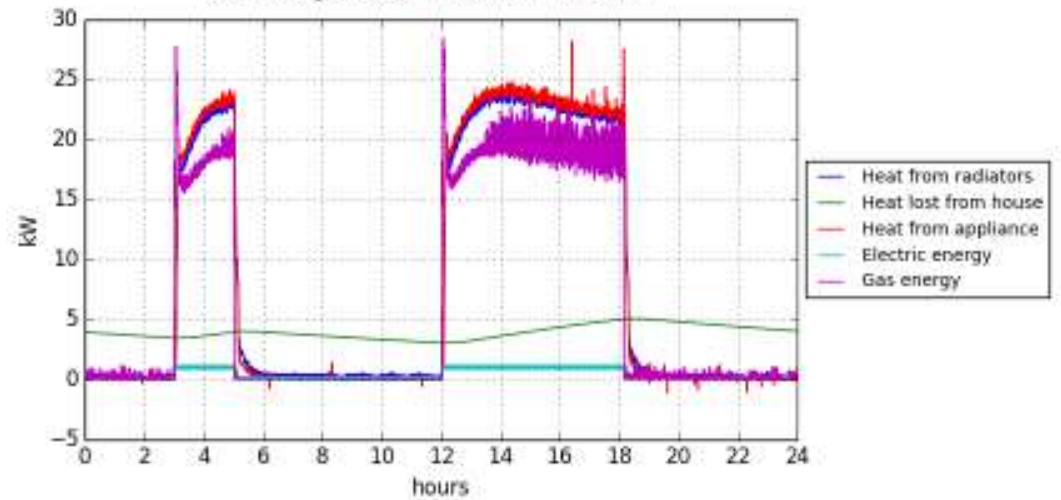
Test number 178

Temperatures

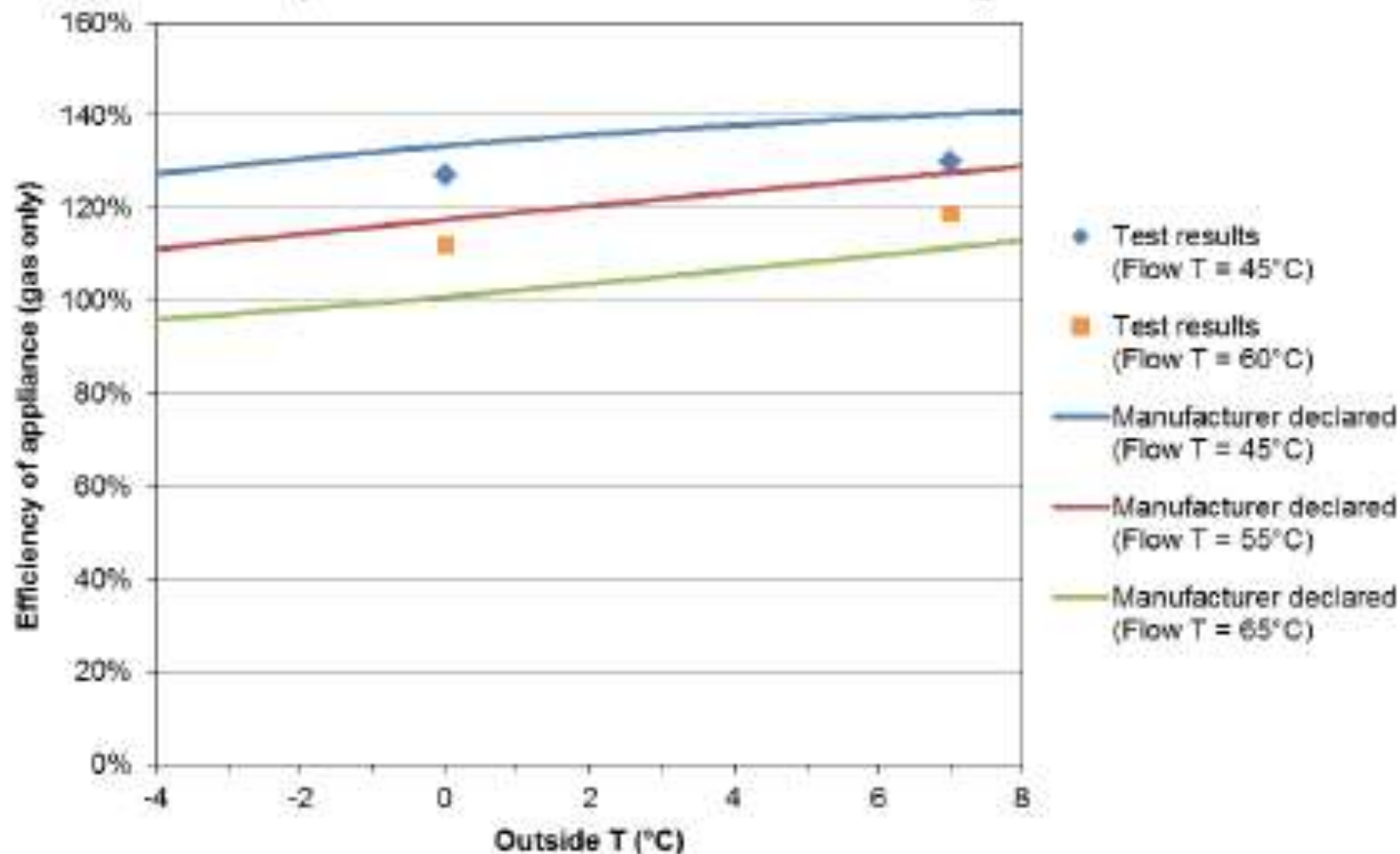
GAHP, Large house, 7°C, 60°C, Bi, 1.5m³/h



GAHP, Large house, 7°C, 60°C, Bi, 1.5m³/h



Comparison of manufacturer declared efficiency and experimental efficiencies observed at different flow temperatures
Efficiency calculated based on gas input (gross basis), neglecting electricity input
Where multiple results exist at different flow rates these have been averaged



Work structure

D: Market potential study and technology roadmap (CNR-ITAE)

- Simulation study to evaluate different technologies in different climate zones, different building types and building standards
- Combine with market data and actual building stock for technology roadmap (**Warwick/Delta-EE input for UK**)

E: Policy measures and recommendations, information

- Dissemination
- Workshops for planners, installers and decision makers
- Develop recommendations for policies e.g. building codes and funding schemes

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Technologies:

- Engines
- Sorption
 - Absorption
 - Adsorption



i-STUTE 



- Absorption
- Adsorption

Performance similar in principle
Refrigerants similar:

- Water
- Ammonia
- Alcohols

Existing and near market products:

Vaillant

Technical data of zeoTHERM VAS 106/4

Rated heat output range Heating 1,5-10 kW

Rated heat output range d.h.w. 4,2-12,5 kW

Adjustable flow temperature 20-75 °C

Recommended max. flow temperature HC < 40 °C

El. power consumption max. 100 W

Appliance width 772 mm

Appliance height incl. flue outlet 1.700 mm

Appliance depth 718 mm

Transport weight (without casing) 160 kg

Operating weight 175 kg

Integrated controller

zeolite module > no moving parts / no maintenance



Existing and near market products:

Vaillant system:

- Water refrigerant, zeolite adsorbent
- heat pump ,solar collector, water storage tank
- Only intended for use with underfloor heating systems with Maximum output temperature of 40°C
- Claimed reduction of annual energy use of 18% compared with a condensing boiler.
- Initial system sale price was around €16,000.
- On market for two years

Existing and near market products:

Robur

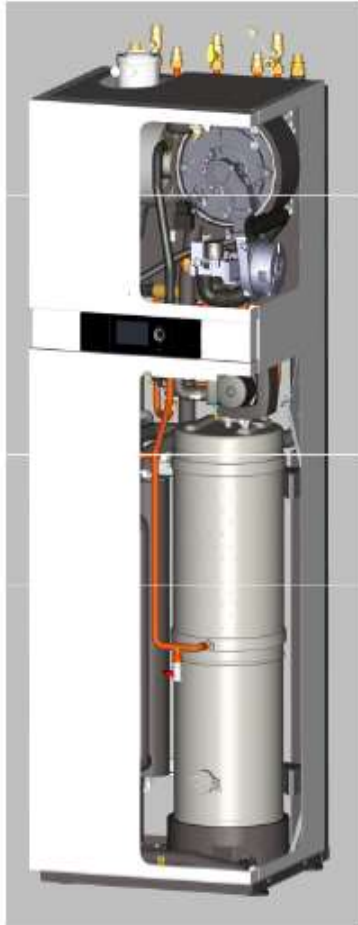
- Ammonia water absorption
- Air, water and ground source options
- DHW at 65°C (gross COP 1.24)
- 38 kW to radiators (supply temperature 50°C) COP of 1.52 (gross), 1.38 (net).
- Saving of about 40% in gas consumption compared to a condensing boiler.
- Single module 854(w) x 1256(d) x 1281(h).
- 18kW unit, is under development.
- The product is 'badged' by BDR Thermea and Bosch
- 40kW unit is c. £12,000.



Existing and near market products:

Viessmann Gas-Fired Zeolite Compact Heating Appliance

Features at a glance



Launched 2014

- Hybrid Heating Appliance:
Heating Power Modulation: 1,6 to 10 kW (1 to 7)
Booster capacity for DHW: 15 kW
- SGUE Heating (VDI 4650-2): 135 % (Hi 35/28 °C)
SGUE Heating (VDI 4650-2): 125 % (Hi 55/45 °C)
- Ambient Heat Source: 2013 GHS
From 2014 also Solar
- Working pair completely environment friendly
- Installation, maintenance and service analog to condensing boiler compact units
- Gas-Fired Adsorption Heat Pump in the dimensions of Viessmann compact heating appliances
- Dimensions: BxHxT: 600x595x1875 mm
- Weight : <170 kg (separable in two parts)

Existing and near market products:

Stiebel Eltron are developing a zeolite – water machine with help from Sortech and similar principal to Vaillant and Viessmann products

Existing and near market products:

Viessmann Gas-Fired Absorption Heat Pump

Features at a glance

- Wall mounted hybrid appliance:
 - Gas-fired absorption heat pump and a condensing boiler
- Seasonal heating GUE > 1.4 (55/45 °C)
- Seasonal heating GUE > 1.3 (65/50 °C)
- High modulation range (1.6 to 14 kW)
- Dimensions: BxHxT: 600x595x900 mm
- Weight : <90 kg
- Low noise
- Installation & Maintenance comparable to condensing boilers



Existing and near market products:

Sorption Energy

Change in product concept over time of project:



Where has the rest of the hardware gone?

Existing and near market products:

Sorption Energy

Fits into standard wall-mounted casing



Adsorbent Beds
(Generators)

Box-for-box exchange for
old boiler

Key competitive
advantage

- other gas-fired heat pumps too large for wall mount

Retrofit market >90% of
annual sales

Existing and near market products:

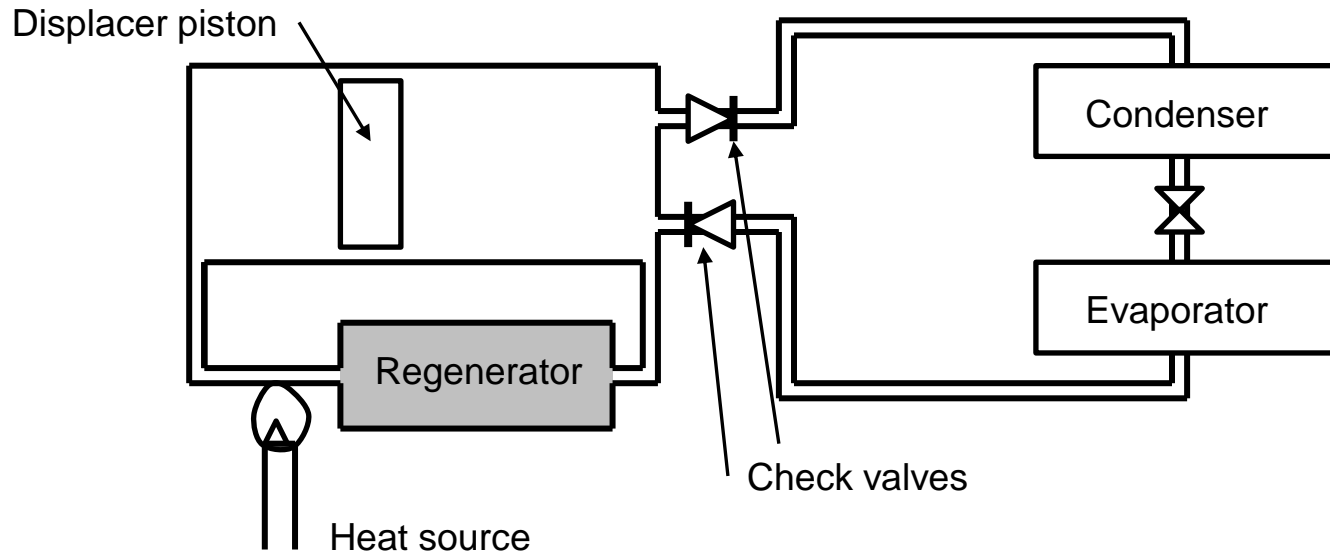
Cool BV (Netherlands)

Carbon – Ammonia thermal wave adsorption, similar to Sorption Energy. No details available.

Existing and near market products:

boostHEAT (France)

“As compared to the latest generation of condensation boilers, the consumption should be reduced by 45 to 60% in low temperature mode (35°C) and by 25 to 40% in medium and high temperature mode (55 to 65°C)”



Thermally driven compressor using CO₂ refrigerant.

Thank you!

Questions?