1 DEFINITIONS

Appliance / GAHP Unit / GA Unit terms used to refer to the GAHP (Gas Absorption Heat Pump) heat pump or the GA (Gas Absorption) chiller.
BMS (Building Management System) any non Robur supervisor controller.
TAC Robur authorised Technical Assistance Centre.
Common circulating pump circulating pump supplying a set of generators.
Independent circulating pump circulating pump supplying one generator only.
Primary circuit section of the air conditioning system starting from the generators to the hydraulic separator or heat exchanger (if installed).
Secondary circuit section of the air conditioning system downstream of the hydraulic separator or heat exchanger (if installed).
Parallel plumbing configuration set-up where the water inlet to each generator is in common.
Serial plumbing configuration set-up where all or part of the water flow into a generator is from another generator.
External request generic control device (e.g. thermostat, timer or any other system) equipped with a voltage-free NO contact and used as control to start/stop the GAHP/GA unit.
CCI Controller (Comfort Controller Interface) optional Robur control device which lets you manage up to three consistent modulating GAHP units (GAHP A, GAHP GS/WS) only for heating.
CCP Controller (Comfort Control Panel) = Robur control device which lets you manage in modulation mode up to 3 consistent GAHP units (GAHP A, GAHP GS/WS) and all system components (probes, diverter/mixing valves, circulating pumps), including any integration boiler.
DDC Control (Direct Digital Controller) optional Robur control device to control one or more Robur appliances (GAHP heat pumps, GA ACF chillers and AY00-120 boilers) in ON/OFF mode.
RB100/RB200 devices (Robur Box) optional interface devices complementary to DDC, which may be used to extend its functions (heating/cooling/DHW production requests, and control of system components such as third party generators, diverter valves, circulating pumps, probes).
Third Party Generator non Robur boiler or chiller, which cannot be directly managed from the DDC Panel and thus requires an additional interface device (RB200).
Robur generator Robur heat pump, boiler or chiller, that may be controlled directly via the DDC Panel.
Heat generator equipment (e.g. boiler, heat pump, etc.) for heat production for space heating and DHW.
Base group set of generators of the base system.
Separable/separate group set of generators of the separable/separate DHW system.
GUE (Gas Utilization Efficiency) efficiency index of gas heat pumps, equal to the ratio between the thermal energy produced and the energy of the fuel used (relative to NCV, net calorific value).
2 pipe system a system the primary and/or secondary circuit of which has one pair of pipes only (delivery/inlet), therefore unable to supply simultaneous hot and cold water services.
4 pipe system a system fitted with two pairs of pipes on both the primary and secondary circuit, therefore able to supply simultaneously two separate services.
Separable DHW system part of a primary circuit that is able to have two states by means of diverter valves:

- water plumbing connected to the base system ("included" state); in included state this part of the system integrates the space heating service;
- disconnected from the base system ("separate" state); in the separate state this part of the system is designated for DHW production, regardless of the service supplied by the base system.

Separate DHW system part of the primary circuit exclusively for DHW production, the plumbing of which is permanently disconnected from the base system.
DHW system a system only intended for domestic hot water production.
Base system part of the primary circuit on which generator's plumbing is permanently connected.
Heat system a system intended for production of hot water for heating and/or domestic hot water.
Cold system a system intended for production of cold water.
Integration coordinated control of various types of generators with the aim of maximizing the system's overall efficiency.
Power integration an integration mode where all generators produce power at the same temperature.
Temperature integration an integration mode where different types of generators may produce power at different temperatures.
"Integration and progressive replacement" operating mode operating mode possible for a serial plumbing configuration where the delivery temperature request is not compatible in certain operative conditions with the operating temperatures of certain generators (in particular GAHP).
"Integration and replacement" operating mode operating mode where the temperature request in certain operative conditions may not be compatible with the operating temperatures of certain generators (in particular GAHP).
"Integration" operating mode operating mode where the temperature request in all operative conditions is compatible with the operating temperatures of all generators.
Heat module for one Robur generator, it is the logic control unit that manages hot water production functions.
Cold module for one Robur generator, it is the logic control unit that manages cold water production functions.
First Start-up appliance commissioning operation which may only and exclusively be carried out by a TAC.
Service request it is the signal that turns on a certain service. Please note that certain service requests may be relayed to the Robur control system in different modes (directly to the DDC or through RB100/RB200).
S61/Mod10/W10/AY10 boards electronic boards on the GA/GAHP unit, to control all functions and to provide interfacing with other devices and with the user.
Service for Robur control systems, it is the term used to identify a specific functionality of the resources managed by the controllers (heating service, DHW service, conditioning service, valve service, circulating pump service, probe service...).
Hybrid system a system consisting of Robur heat pumps and boilers (Robur or third party units).
Mixed system a system consisting of Robur units and third party units.

2 ABSORPTION ADVANTAGES

- Extremely high winter energy efficiency
- High savings on management costs (up to 40%)

- Extremely high reliability thanks to the almost complete absence of moving parts
- Prevents installed electric power increase
- Option of combinations with boilers or chillers
- Stable and efficient operation even at very low outdoor temperatures (air versions)
- No efficiency decay over time
- Uninterrupted power delivery during defrosting (air versions)
- Thermodynamic circuit free from any scheduled maintenance (maintenance is comparable to that required for a condensing boiler)
- Service continuity thanks to modular regulation
- In geothermal space heating application, it halves the required probes
- No toxic refrigerants are used, harmful for the environment or the ozone layer
- Sealed circuit that does not require any refrigerant topping up
- No water consumption in conditioning (there is no evaporative cooling tower)
- Increase in the building's energy rating

3 ABSORPTION CYCLE

In the conventional cooling cycle (with vapour compression) the process by which the gaseous refrigerant goes from low pressure/low temperature on evaporator outlet to high pressure/high temperature conditions on the condenser inlet is performed by a mechanical compressor (usually electrical).
The substantial difference with the absorption cycle is that the same process is performed via "thermo-physical compression", divided into three main stages:

1. through a spontaneous refrigerant/absorbent reaction, the gaseous refrigerant is absorbed in low pressure liquid phase;
2. the pressure of the liquid solution is raised thanks to a pump;
3. the high pressure solution is heated to the point of releasing the refrigerant in gaseous phase again, at high temperature.

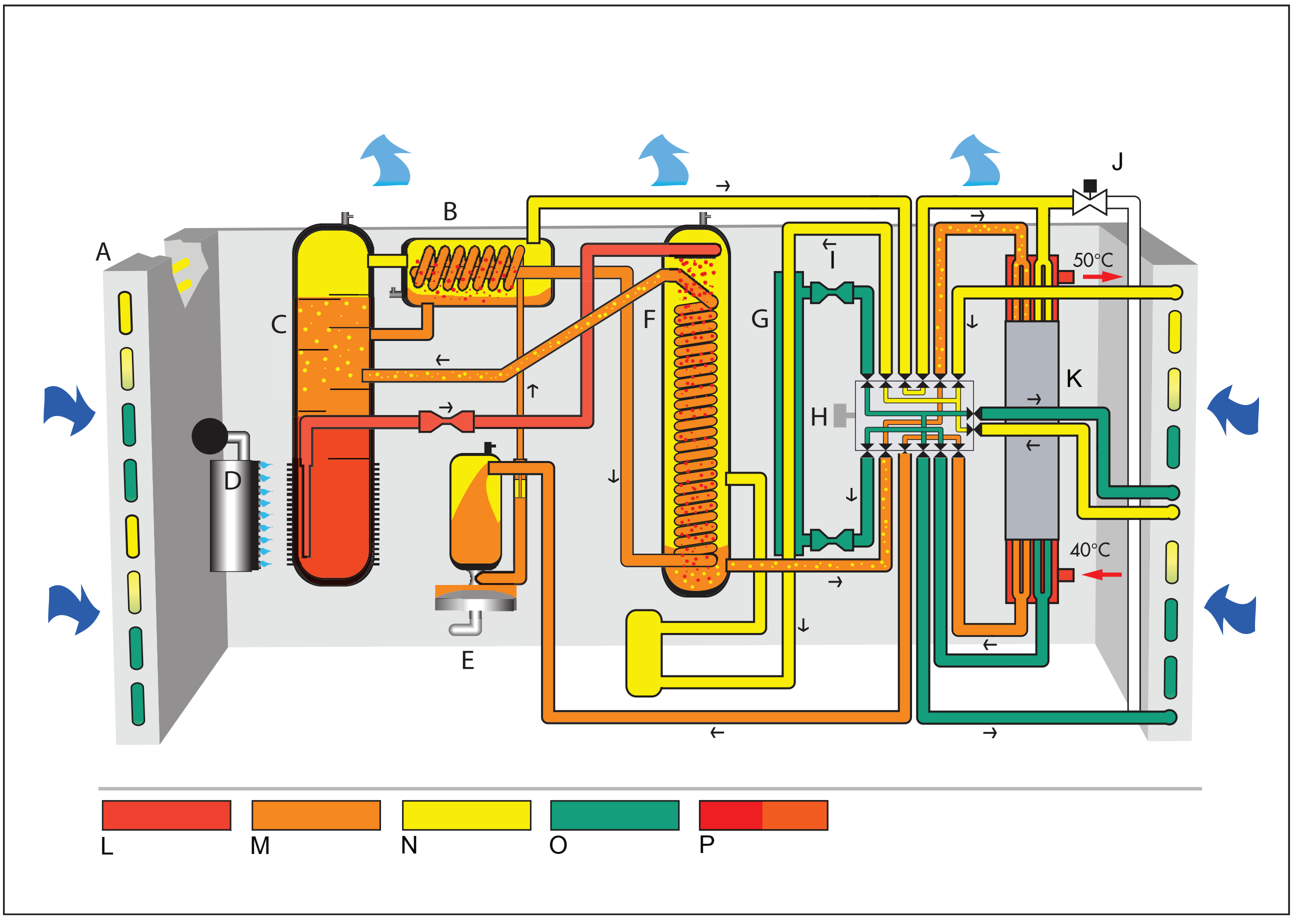
The advantages of this thermo-physical process compared to conventional mechanical compression are essentially as follows:

1. raising the pressure of a liquid requires far less energy (electricity) than compressing a gas;
2. the absorption reaction is highly exothermic and the released heat may be usefully exploited;
3. the "motive" energy of the process is primary energy (natural gas).

3.1 DETAILED DESCRIPTION

For a detailed description of a GAHP heat pump's thermodynamic cycle you should refer to Picture 3.1 *p. 3*, which shows the GAHP-AR cooling circuit in heating mode.
The multi gas burner (D) is used to heat the absorbent-refrigerant solution causing separation of the two components by evaporation of the refrigerant in the distillation column (C).
The burner-distillation column complex (C+D) is defined as generator and in absorption machines it replaces the typical compressor of electric heat pumps.
The refrigerant steam of the outlet of the generator goes through the rectifier (B) and separates from any residual water and goes into the shell and tube heat exchanger (M), which takes on the role of the machine's condenser-absorber in the winter season.
In this part of the cycle the heat exchanger acts as refrigerant condenser, which transfers the latent condensation heat to the water of the heating system.
This refrigerant state change therefore represents the machine's first useful effect.
The refrigerant on outlet of the condensation section goes through a first lamination section (I), a tube in tube heat exchanger (G) and a second lamination section where progressively, through subsequent decreases in pressure and temperature, it is taken to the ideal conditions to change state again into the gaseous phase.
In fact, in the finned coil (A) the refrigerant absorbs heat from the outdoor air and thus evaporates.
In this part of the circuit the heat pump imports into the cycle a portion of aerothermal renewable energy.
The refrigerant used by GAHP heat pumps in the finned coil (ammonia) may evaporate even at very low temperatures.
This thermodynamic feature of the refrigerant allows renewable energy to be taken from the air even when its temperature reaches highly negative figures, thus dispensing with the need to have backup boilers.
The ammonia evaporated in the finned coil (A), after overheating in the tube in tube heat exchanger (G) enters the pre-absorber (F) where it meets the atomized absorbent (water) thus giving rise to the actual absorption reaction.
Absorption is an exothermic chemical reaction whereby the emitted thermal energy needs to be removed.
In the pre-absorber (F) this energy is partially used to preheat the water-ammonia solution that is about to go back into the generator.
To complete the absorption reaction, the solution is sent into the shell and tube heat exchanger again (M).
In this stage of the cycle, the heat exchanger acts as absorber and allows a considerable amount of thermal energy, which represents the second useful effect of the machine, to be transferred to the heat transfer fluid of the heating system.
The water ammonia solution of the outlet of the heat exchanger (M) is conveyed by the solution pump (E) into the generator again, going through the pre-absorber (F) and the rectifier (B) again, where it is pre-heated, recovering heat from the cycle itself.
The thermodynamic cycle described above therefore restarts in the generator.
The inversion valve of the heat pump cycle (H), only provided for GAHP-AR units, consists of a mechanical component through which the refrigerant flow is diverted into the circuit.
This operation makes it possible to seasonally invert the operating mode and produce hot water in winter and chilled water in summer.
If required, the defrosting valve (L), only intended for GAHP A and GAHP-AR aerothermal heat pumps, allows the finned coil to defrost quickly, with no need to invert the cycle or switch on electrical auxiliary heaters.
This is because, as shown in Picture 3.1 *p. 3*, only one of the two evaporator energy intakes is diverted to the coil, namely hot ammonia vapour.
This makes it possible to assure quick ice removal while assuring 50% power to the heating circuit, without markedly altering the machine's efficiency.

Figure 3.1 *GAHP-AR absorption cycle (heating mode)*



A	Finned coil	G	Tube in tube heat exchanger	M	Ammonia-poor solution
B	Rectifier	H	Cycle inversion valve	N	Ammonia in vapour state
C	Distillation column	I	Lamination valve	O	Ammonia in liquid state
D	Burner	J	Defrosting valve	P	Heating system water
E	Solution pump	K	Shell and tube heat exchanger		
F	Pre-absorber	L	Ammonia-rich solution		