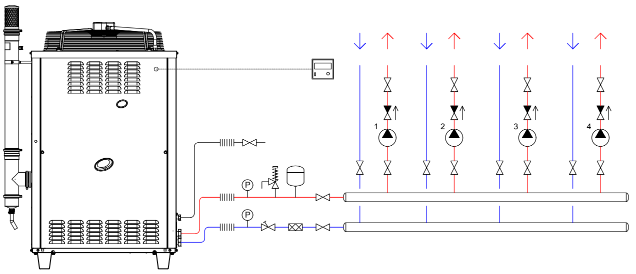
1 FLOW BALANCING

After the sizing of the generating system and the choice of distribution terminals has been completed, it is advisable to carefully consider that the system currently in the design does not present any interference between the hydraulic circuits such as to alter the setpoint in comparison with the regulation systems, resulting in reduced comfort, efficiency and even the life of the components of the system.
Referring to the system shown in Figure 1.1 *p. 1* the following occurs:

- at the system off, the output and return manifold pressures will be identical, so the Δp between the manifolds will be zero;
- When the first delivery is activated, a pressure differential will be created, equal to the pressure drop through the generator. Check valves are essential to prevent the risk of reverse flow on inactive delivery;
- The activation of subsequent delivery entails an increase in the water flow rate on the generator and as a consequence of the pressure drops, with the risk that they become so high that it will not allow the delivery pumps to function properly.

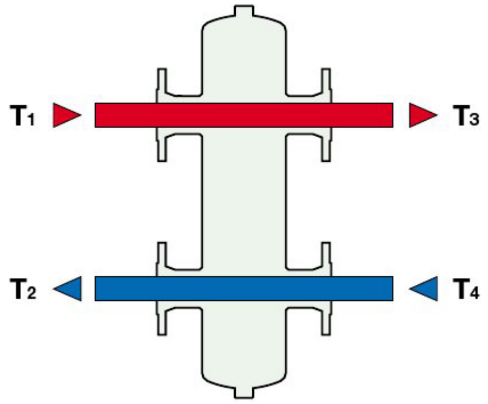
Figure 1.1 *System without hydraulic separator*



In general these systems characterized by strong imbalances in the flow rates are unlikely to work under the design conditions and therefore to ensure efficiency and comfort.
The hydraulic separator, referred to in Section C1.08, is the component commonly used to avoid interference between the hydraulic circuits, precisely because it allows constant working with null Δp between the manifolds.
However, careful balancing of the water flow between the primary and the secondary must be carefully considered, as inadequate balancing can trigger flow mixing phenomena, resulting in temperature changes.
In the optimal case the flow rates are perfectly balanced (see Figure 1.2 *p. 1*) and the primary and secondary temperatures are identical (T1 = T3 and T2 = T4).
Mixing becomes influential when the difference between primary and secondary flow exceeds 10%.
In this case two scenarios may occur:

- Primary flow rate lower than secondary flow rate (secondary recirculation)
- Primary flow rate higher than secondary flow rate (primary recirculation)

Figure 1.2 *Balanced separator*

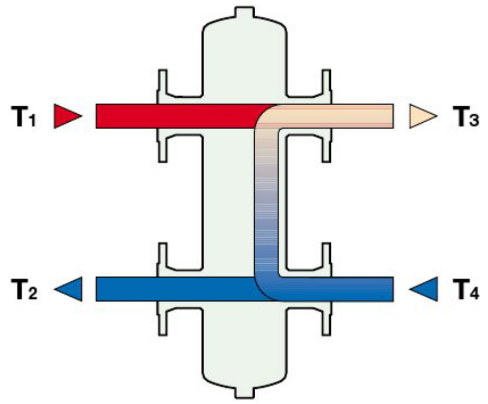


T1 Primary delivery temperature
T2 Primary return temperature
T3 Secondary delivery temperature
T3 Secondary return temperature

1.1 PRIMARY FLOW RATE LOWER THAN SECONDARY FLOW RATE

In this case, as shown in Figure 1.3 *p. 1*, the primary flow rate is lower than that of the secondary and there is partial recirculation of the secondary return flow, with consequent lowering of the delivery temperature T3 to the secondary as a result of mixing.

Figure 1.3 *Primary flow rate lower than secondary flow rate*



T1 Primary delivery temperature
T2 Primary return temperature
T3 Secondary delivery temperature
T3 Secondary return temperature

In this scenario, therefore:

- The delivery temperature T3 at the secondary is lower than the primary delivery temperature T1;
- The return temperature T2 of the primary and T4 of the secondary coincides.

These are the possible consequences:

- Reduction in the efficiency of the generating system due to the power generation at higher temperature needed to compensate for mixing;
- Potential reduction in comfort for utilities, due to the lower supply temperature of the emission devices, which therefore also significantly reduce heat exchange.

This case typically occurs when the secondary circuit works with

a thermal leap lower than the primary circuit.
In the worst case scenario, GAHP units can work at maximum temperature, but the serviced users still experience the cold feeling due to inefficient heat exchange due to temperature drop.
Reduced thermal exchange could easily also lead to a reduction in the thermal leap on the secondary, hence a return temperature increase and, ultimately, to the shutdown of the units for limit thermostating for return temperature too high.
The Table 1.1 *p. 2* shows the maximum temperatures that can be reached by the Robur units.

Table 1.1 *GAHP heating temperature limits*

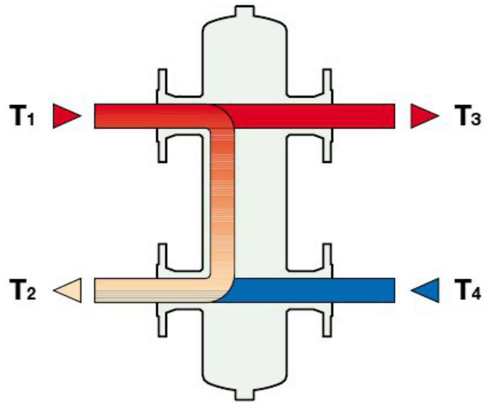
			GAHP A	GAHP-AR	GAHP GS/WS	AY00-120
Heating mode						
Hot water delivery temperature	maximum for heating	°C	65	-	65	-
	maximum	°C	-	60	-	80
Hot water return temperature	maximum for heating	°C	55	-	55	-
	maximum	°C	-	50	-	70

To calculate the amount of lowering of the delivery temperature to the secondary, it is sufficient to determine the thermal leap Δt on the secondary, based on the flow rate and the power generated by the primary, according to the relationship:
$Q = m \cdot cp \cdot \Delta t$
Where Q is the power generated in the primary expressed in [kW], m is the secondary water flow rate expressed in [kg/s], cp is the specific water heat in [kJ/kg ·°C] and Δt is the secondary thermal leap in [°C].
This thermal leap is added to the return temperature T4 of the secondary to determine the delivery temperature T3 of the secondary.

1.2 PRIMARY FLOW RATE HIGHER THAN SECONDARY FLOW RATE

In this case, as shown in Figure 1.4 *p. 2*, the primary flow rate is higher than that of the secondary and there is partial recirculation of the primary return flow, with a consequent increase in the return temperature T2 of primary due to mixing.

Figure 1.4 *Primary flow rate higher than secondary flow rate*



T1 Primary delivery temperature
T2 Primary return temperature
T3 Secondary delivery temperature
T3 Secondary return temperature

In this scenario, therefore:
- The delivery temperature T3 to the secondary is equal to the primary supply temperature T1;
- The return temperature T2 of the primary is higher than T4 of the secondary return.

These are the possible consequences:
- Significant reduction in the efficiency of the generation system due to the rise in the return temperature of the primary;
- Potential blocking of the Robur units for return thermostating;
- Heavy repercussions on comfort if the units reach the limit thermostating condition.

This case typically occurs when the secondary circuit works with a thermal leap higher than the primary circuit.
This involves the risk of rapidly reaching the thermostating condition on return temperature (see the Table 1.1 *p. 2*) and then switches off the units, even though there is a demand for service from the system, with heavy repercussions on the comfort of the users.
To calculate the magnitude of the rise in the primary return temperature, it is sufficient to determine the thermal leap Δt on the primary, based on its flow rate and the power absorbed by the secondary, according to the relationship:
$Q = m \cdot cp \cdot \Delta t$
Where Q is the power absorbed by the secondary expressed in [kW], m is the water flow rate of the primary expressed in [kg/s], cp is the specific heat of water in [kJ/kg ·°C] and Δt is the primary thermal leap in [°C].
This thermal leap is subtracted from the primary delivery temperature T1 to determine the primary return temperature T2.

2 HOW TO MAKE BALANCING

The guidelines to ensure that the system is properly balanced can be summarized as follows:
- Check the water flow of the Robur units on the technical data tables (see Section B);
- Pay attention to the fact that water flow rates for heating and conditioning are usually very similar;
- Pay attention to the fact that the thermal leap for the heating service is 10 °C, while the one for the cooling service is 5 °C