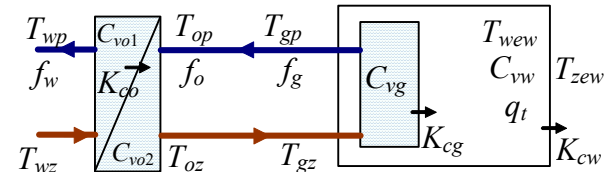
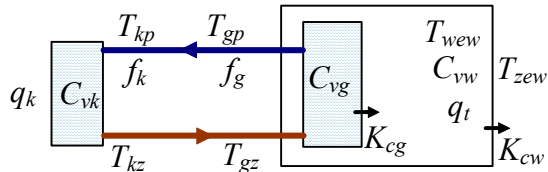
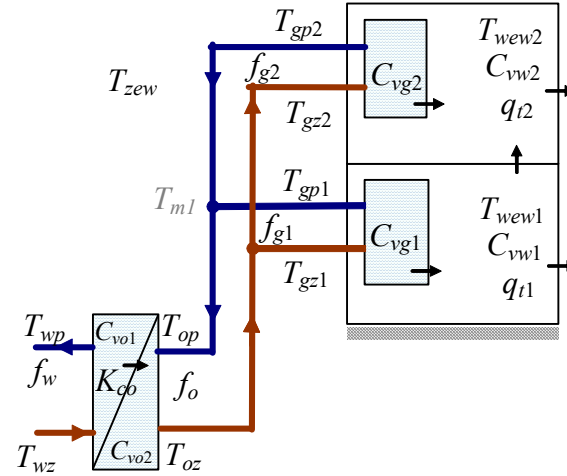
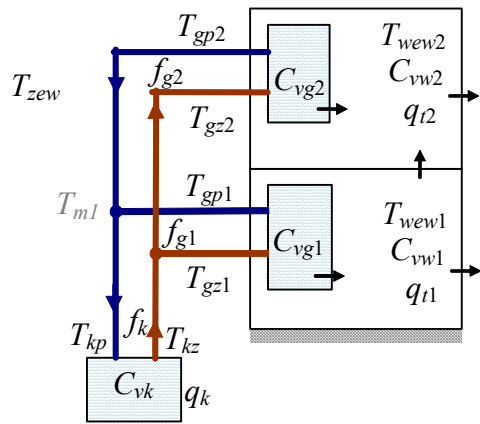


Ogrzewanie budynku – źródło i odbiorniki



$$\begin{cases} C_{vw} \dot{T}_{wew} = K_{cg} (T_{gp} - T_{wew}) - K_{cw} (T_{wew} - T_{zew}) + q_t \\ C_{vg} \dot{T}_{gp} = c_{pw} f_{mg} (T_{gz} - T_{gp}) - K_{cg} (T_{gp} - T_{wew}) \\ C_{vk} \dot{T}_{kz} = q_k - c_{pw} f_{mk} (T_{kz} - T_{kp}) \end{cases}$$

oraz $f_{mk} = f_{mg}$, $T_{gz}(t) = T_{kz}(t - T_o)$, $T_{kp}(t) = T_{gp}(t - T_o)$

$$\begin{cases} C_{vw} \dot{T}_{wew} = K_{cg} (T_{gp} - T_{wew}) - K_{cw} (T_{wew} - T_{zew}) + q_t \\ C_{vg} \dot{T}_{gp} = c_{pw} f_{mg} (T_{gz} - T_{gp}) - K_{cg} (T_{gp} - T_{wew}) \\ C_{vo2} \dot{T}_{oz} = K_{co} (T_{wp} - T_{oz}) - c_{pw} f_{mo} (T_{oz} - T_{op}) \\ C_{vo1} \dot{T}_{wp} = c_{pw} f_{mw} (T_{wz} - T_{wp}) - K_{co} (T_{wp} - T_{oz}) \end{cases}$$

oraz $f_{mo} = f_{mg}$, $T_{gz}(t) = T_{oz}(t - T_o)$, $T_{op}(t) = T_{gp}(t - T_o)$

$$\begin{cases} 0 = K_{cg} (T_{gp} - T_{wew}) - K_{cw} (T_{wew} - T_{zew}) + q_t \\ 0 = c_{pw} f_{mg} (T_{gz} - T_{gp}) - K_{cg} (T_{gp} - T_{wew}) \\ 0 = q_k - c_{pw} f_{mg} (T_{gz} - T_{gp}) \end{cases}$$

$$q_k = c_{pw} f_{mg} (T_{gz} - T_{gp}) = K_{cg} (T_{gp} - T_{wew}) = K_{cw} (T_{wew} - T_{zew})$$

$$c_{pw} f_{mk} (T_{kz} - T_{kp})$$

Opis odbiorników ciepła

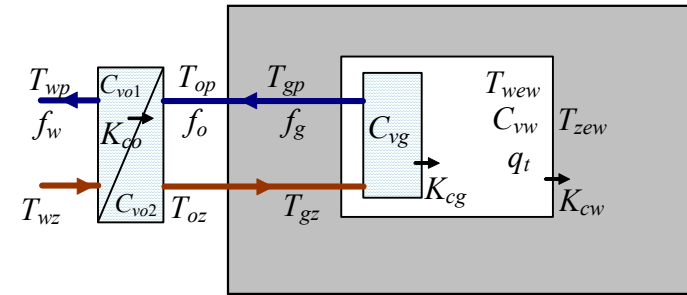
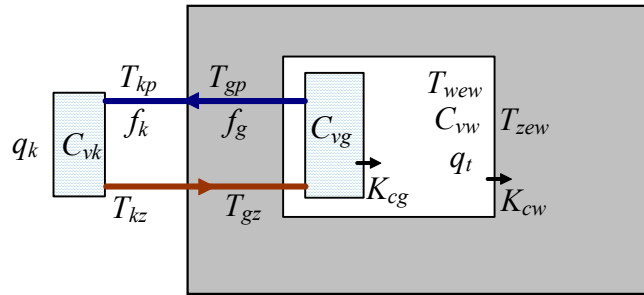


$$\begin{cases} C_{vw} \dot{T}_{wew} = K_{cg} (T_{gp} - T_{wew}) - K_{cw} (T_{wew} - T_{zew}) + q_t \\ C_{vg} \dot{T}_{gp} = c_{pw} f_{mg} (T_{gz} - T_{gp}) - K_{cg} (T_{gp} - T_{wew}) \end{cases}$$

$$\begin{cases} 0 = K_{cg} (T_{gp} - T_{wew}) - K_{cw} (T_{wew} - T_{zew}) + q_t \\ 0 = c_{pw} f_{mg} (T_{gz} - T_{gp}) - K_{cg} (T_{gp} - T_{wew}) \end{cases}$$

$$c_{pw} f_{mg} (T_{gz} - T_{gp}) = K_{cg} (T_{gp} - T_{wew}) = K_{cw} (T_{wew} - T_{zew})$$

Sterowanie pogodowe



Dowolny stan równowagi:

Stan równowagi w warunkach nominalnych:

$$c_{pw} f_{mg} (T_{gz} - T_{gp}) = K_{cg} (T_{gp} - T_{wew}) = K_{cw} (T_{wew} - T_{zew})$$

$$c_{pw} f_{mgN} (T_{gzN} - T_{gpN}) = K_{cg} (T_{gpN} - T_{wewN}) = K_{cw} (T_{wewN} - T_{zewN})$$

$$\frac{c_{pw} f_{mg} (T_{gz} - T_{gp})}{c_{pw} f_{mgN} (T_{gzN} - T_{gpN})} = \frac{K_{cg} (T_{gp} - T_{wew})}{K_{cg} (T_{gpN} - T_{wewN})} = \frac{K_{cw} (T_{wew} - T_{zew})}{K_{cw} (T_{wewN} - T_{zewN})}$$

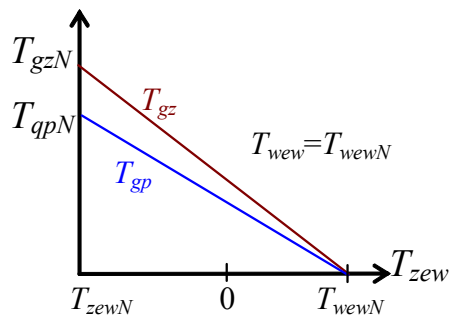
Zał.: przepływ jest nominalny ($f_{mg} = f_{mgN}$):

$$\frac{T_{gz} - T_{gp}}{T_{gzN} - T_{gpN}} = \frac{T_{gp} - T_{wew}}{T_{gpN} - T_{wewN}} = \frac{T_{wew} - T_{zew}}{T_{wewN} - T_{zewN}}$$

Zał.: zmienne wejściowe – T_{zew} (pomiar), T_{wew} (wartość zadana)

zmienne wyjściowe – T_{gz} , T_{gp}

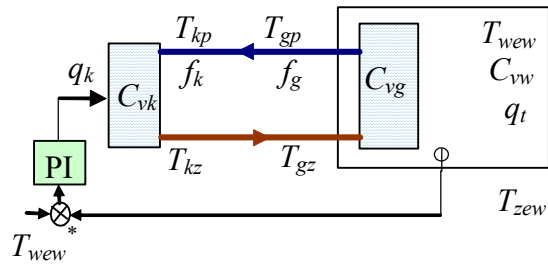
Krzywe pogodowe:



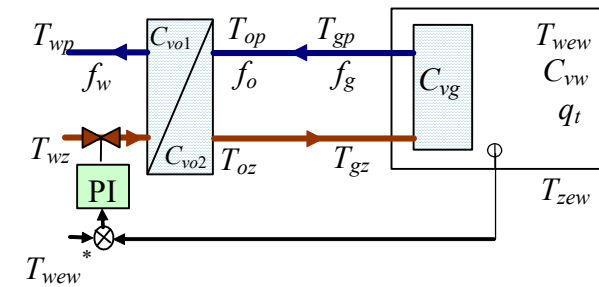
$$T_{gz} = a_z T_{wew} - b_z T_{zew}, \quad a_z = \frac{T_{gzN} - T_{zewN}}{T_{wewN} - T_{zewN}}, \quad b_z = \frac{T_{gzN} - T_{wewN}}{T_{wewN} - T_{zewN}}$$

$$T_{gp} = a_p T_{wew} - b_p T_{zew}, \quad a_p = \frac{T_{gpN} - T_{zewN}}{T_{wewN} - T_{zewN}}, \quad b_p = \frac{T_{gpN} - T_{wewN}}{T_{wewN} - T_{zewN}}$$

Regulacja ogrzewania budynku - regulacja centralna



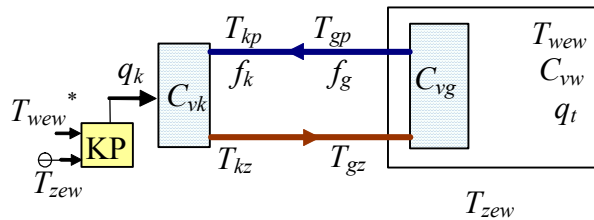
Regulacja bezpośrednia
(na podstawie bezpośredniego pomiaru reprezentatywnej T_{wew})



Sterowanie pogodowe
(na podstawie krzywych pogodowych)

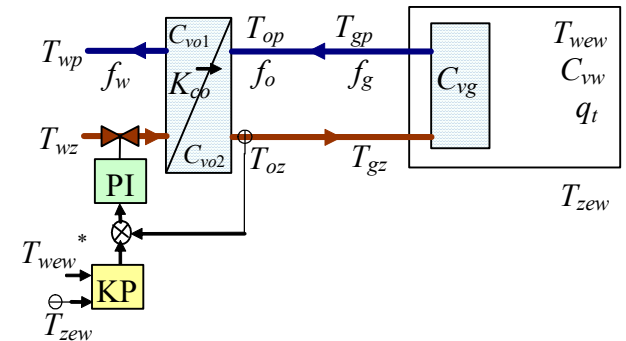
$$q_k = c_{pw} f_{mg} (T_{gz} - T_{gp})$$

$$T_{gz} = a_z T_{wew} - b_z T_{zew}, \quad T_{gp} = a_p T_{wew} - b_p T_{zew}$$



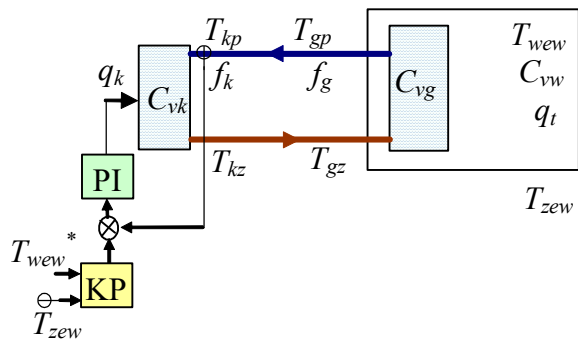
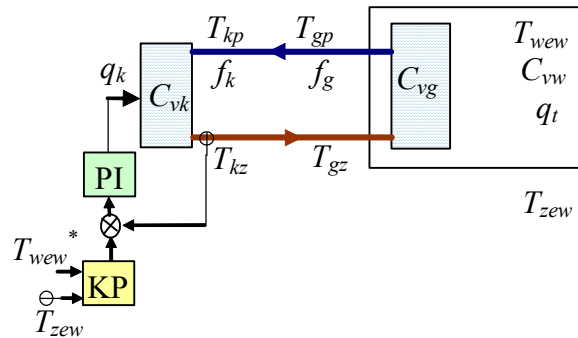
Regulacja pogodowa
(na podstawie krzywych pogodowych)

$$T_{gz} = a_z T_{wew} - b_z T_{zew}$$

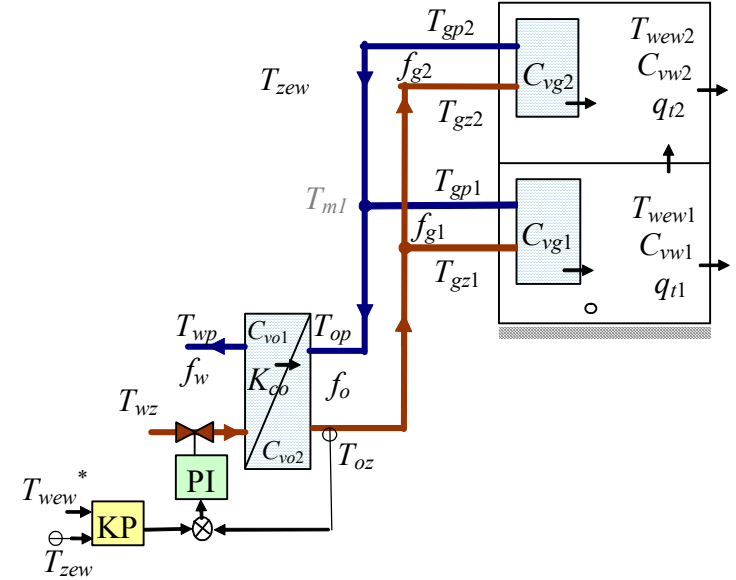
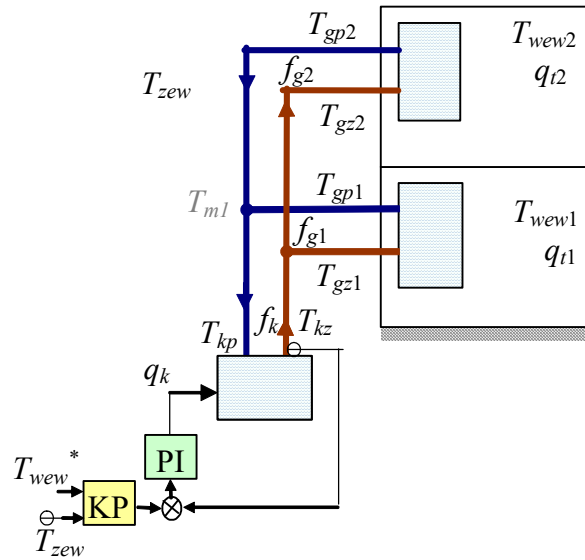
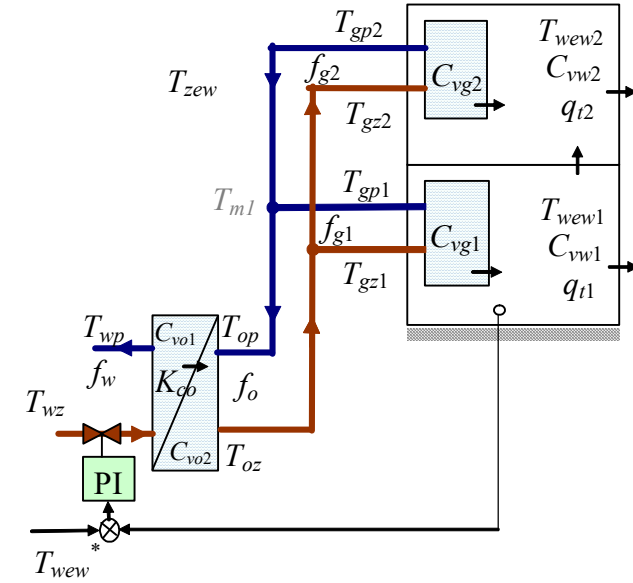
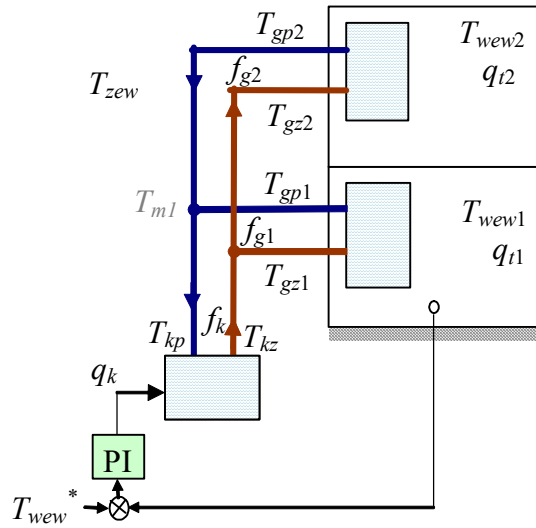


Regulacja pogodowa
(na podstawie krzywych pogodowych)

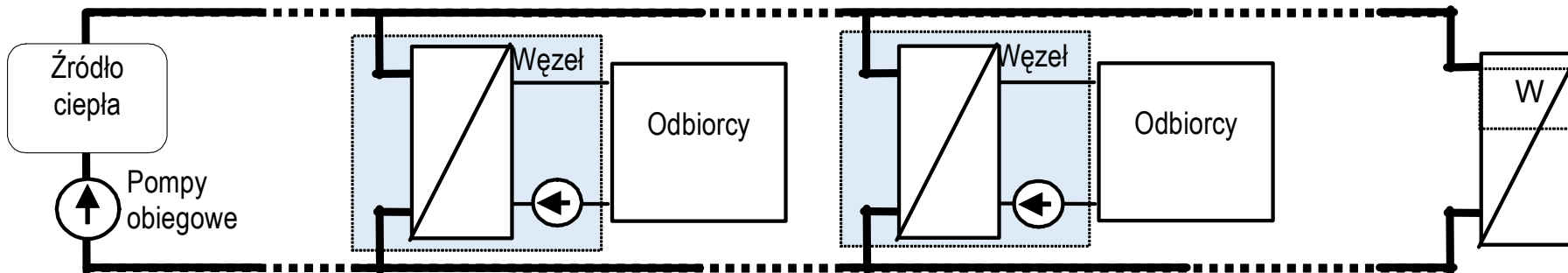
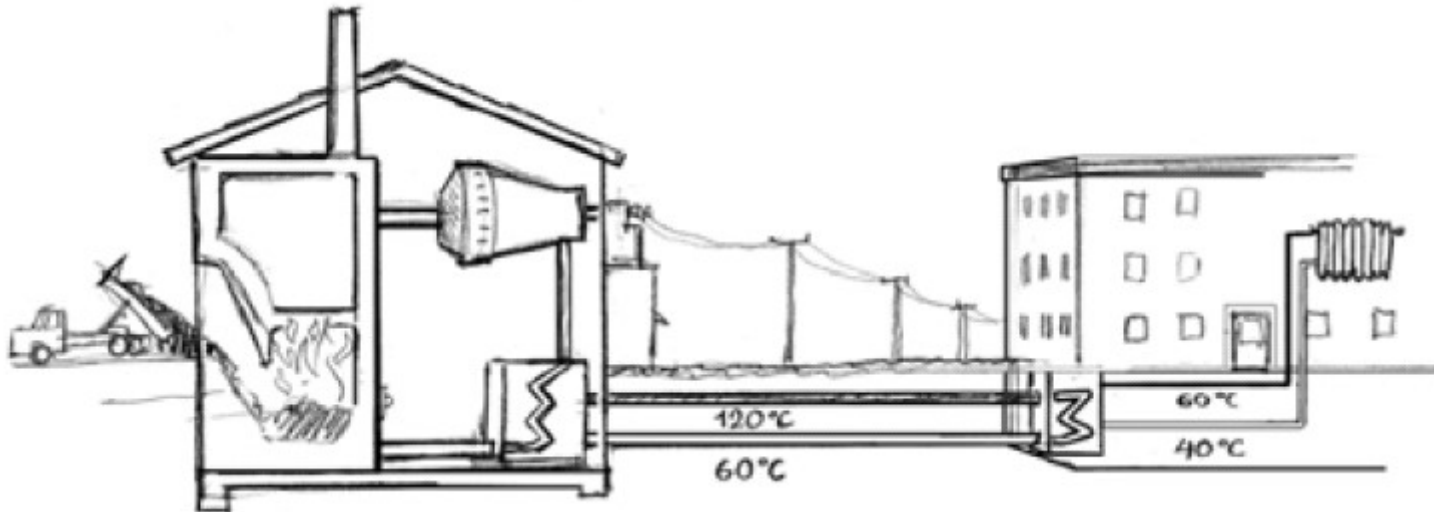
$$T_{gp} = a_p T_{wew} - b_p T_{zew}$$



Regulacja ogrzewania budynku - regulacja centralna



Sieć ciepłownicza



Ciepłownia

Węzeł
ciepłowniczy

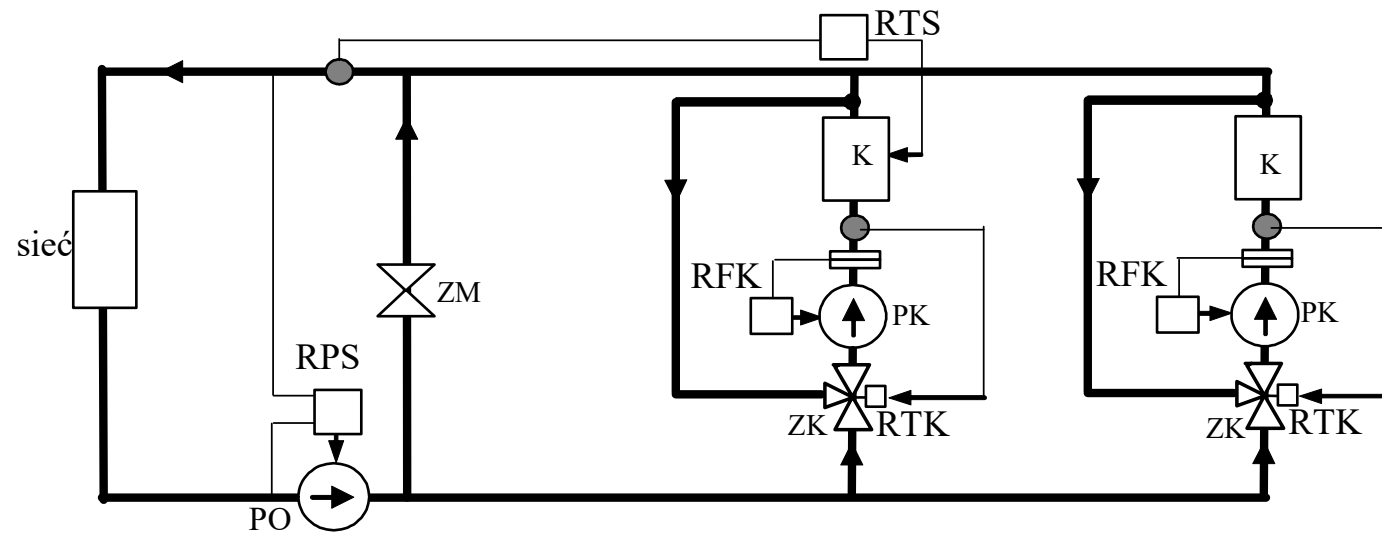
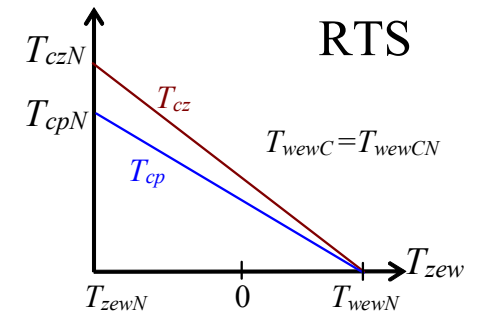
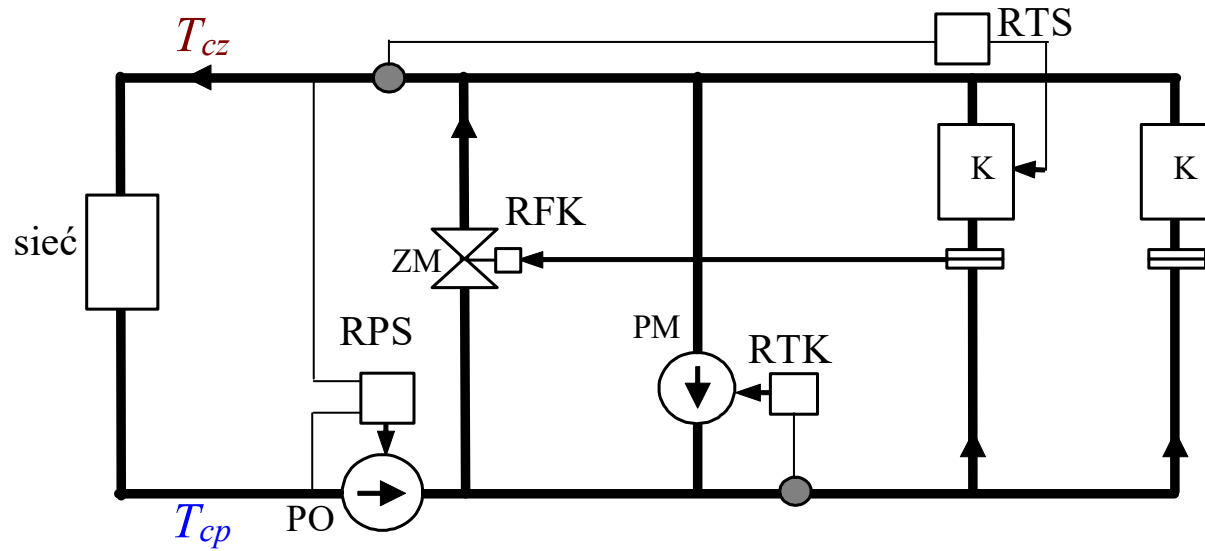
Instalacja
c.o.

Regulacja
centralna

Regulacja
węzłowa

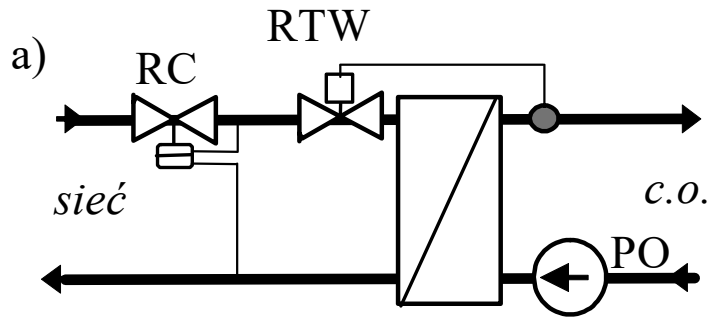
Regulacja
lokalna

Układy regulacji na ciepłowni

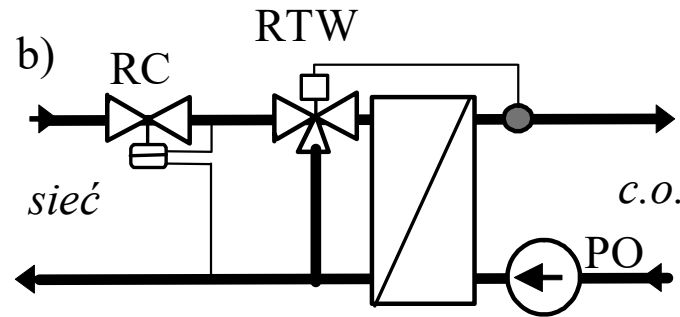


Układy regulacji na węzłach ciepłowniczych

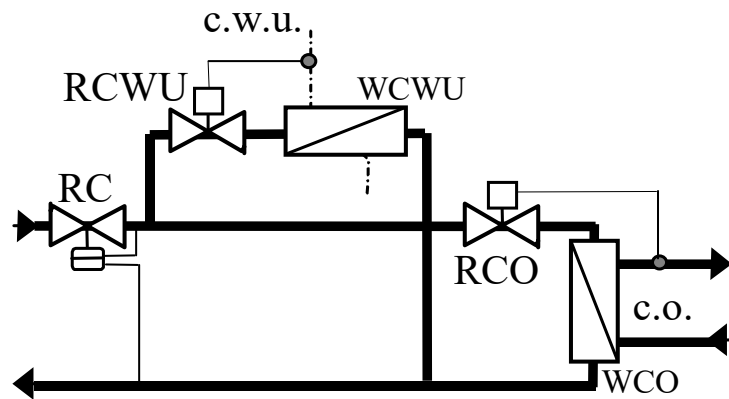
Węzły wymiennikowe



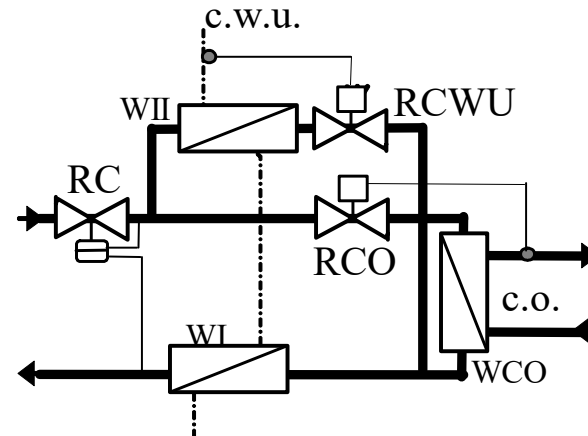
jednofunkcyjny



jednofunkcyjny



dwufunkcyjny
równoległy



dwufunkcyjny
szeregowo-równoległy

