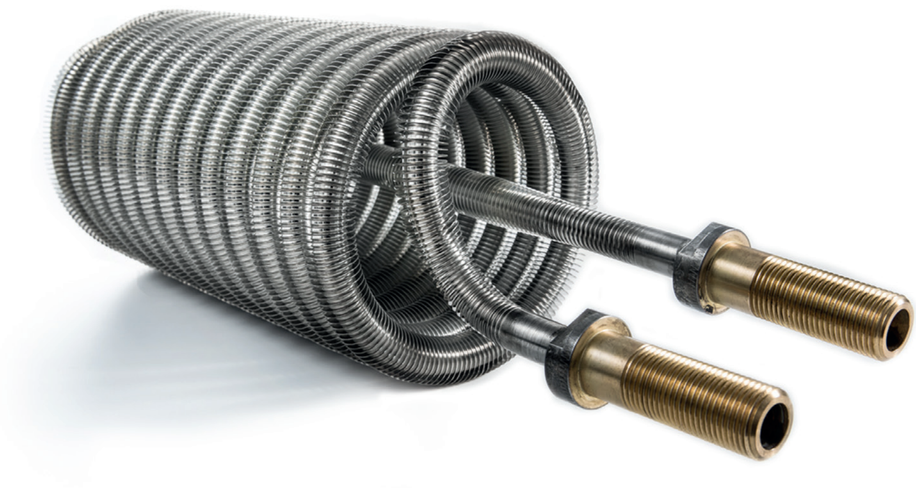


Finned Tube Heat Exchanger

WRW

Diagrams with performance and pressure drop

The diagrams on the following pages will be helpful when choosing a heat exchanger to heat up a water tank by using water of a heating circuit.

The diagrams are based on our own tests with heating water and unforced convection in the tank.

With water as heating fluid, the capacity to be transferred is:

$\dot{Q} = \dot{q}\ (t_1 - t_s)$

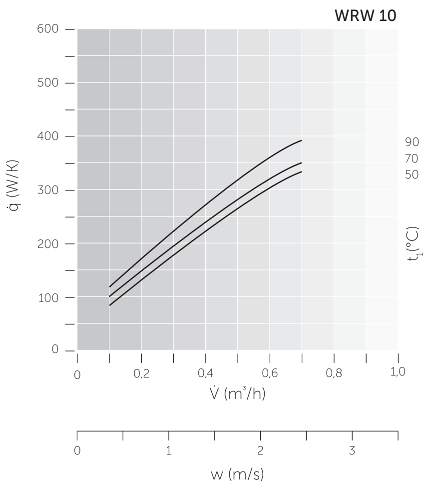
The pressure drop in the heat exchanger is given in the diagram on.
With heating fluids (mixture) as used in solar power units, the capacity drops by the factor f_1 and the pressure drop rises by the factor f_2:

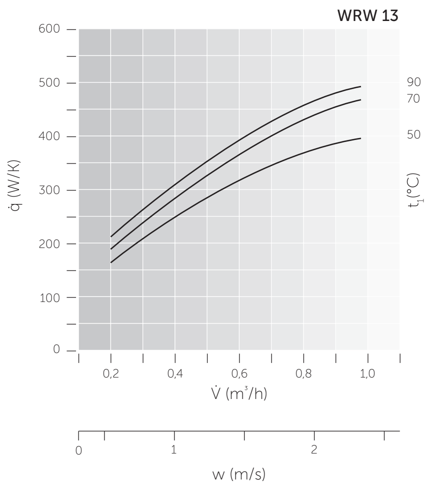
$\dot{Q}_G = f_1 \cdot \dot{q}\ (t_1 - t_s)$
$\Delta p_G = f_2 \cdot \Delta p$

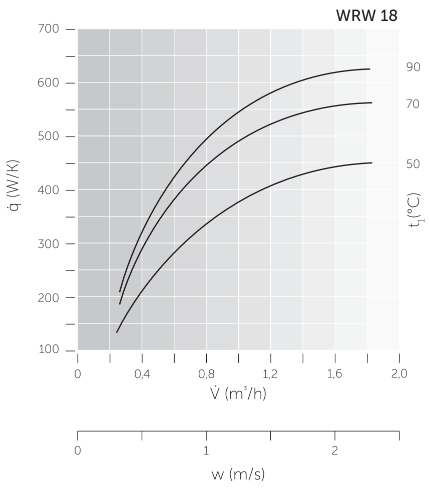
Legend	
$\dot{Q}$ (W)	Capacity to be transferred
$\dot{q}$ (W/K)	Capacity per K of temperature difference $(t_1 - t_s)$
t_1 (°C)	Heating water temperature at inlet
t_2 (°C)	Heating water temperature at outlet
t_s (°C)	Mean temperature of tankwater surrounding the heat exchanger
$\dot{V}$ (m³/h)	Heating water volume flow
w (m/s)	Heating water velocity (limit 2.5 m/s)
Δp (bar)	Pressure drop on heating water side
f_1 (–)	Correction factor for lower capacity when using other heating fluids
f_2 (–)	Correction factor for pressure drop increase when using other heating fluids
Index G	Other heating fluid (mixture)

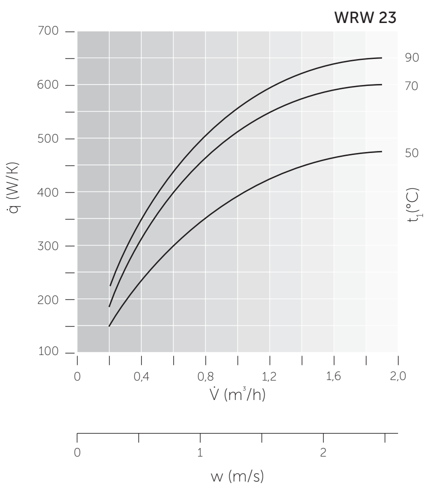
Factors of a few commercial heating fluids (mixtures):

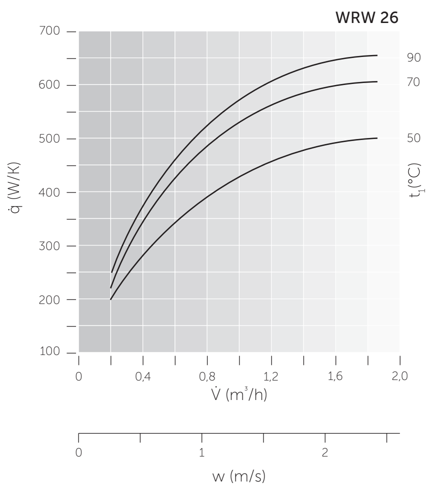
Mixture	f_1	f_2
Antifrogen N (concentration 20%)	0,95	1,15
Antifrogen N (concentration 40%)	0,85	1,35
PKL 90 (concentration 100%)	0,55	1,45

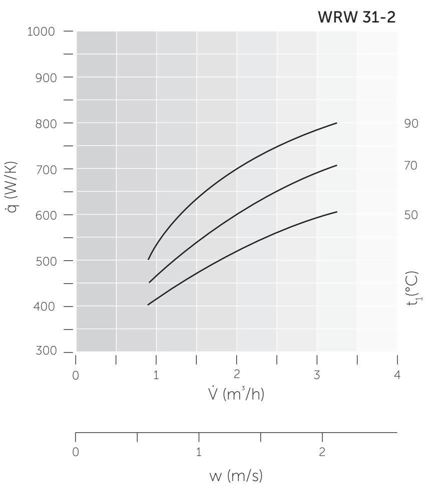

WRW 10
q̇ (W/K)
V̇ (m³/h)
w (m/s)
t₁(°C)
90
70
50

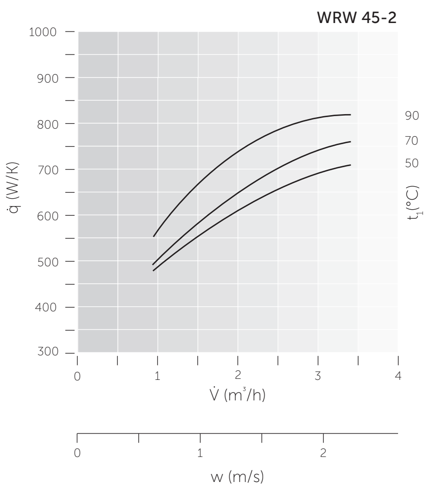

WRW 13
q̇ (W/K)
V̇ (m³/h)
w (m/s)
t₁(°C)
90
70
50

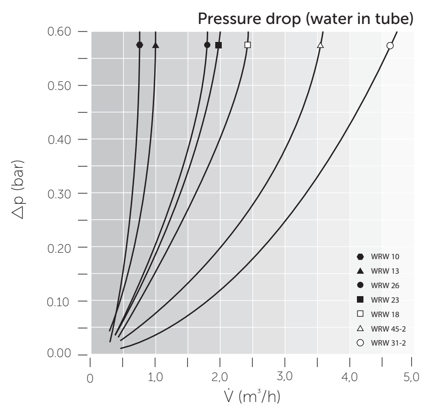

WRW 18
q̇ (W/K)
V̇ (m³/h)
w (m/s)
t₁(°C)
90
70
50


WRW 23
q̇ (W/K)
V̇ (m³/h)
w (m/s)
t₁(°C)
90
70
50


WRW 26
q̇ (W/K)
V̇ (m³/h)
w (m/s)
t₁(°C)
90
70
50


WRW 31-2
q̇ (W/K)
V̇ (m³/h)
w (m/s)
t₁(°C)
90
70
50


WRW 45-2
q̇ (W/K)
V̇ (m³/h)
w (m/s)
t₁(°C)
90
70
50


Pressure drop (water in tube)
Δp (bar)
V̇ (m³/h)
WRW 10
WRW 13
WRW 26
WRW 23
WRW 18
WRW 45-2
WRW 31-2

Example

A 300 l water tank is to be reheated through a solar power system filled with a 40 % Antifrogen N water mixture. The heating fluid enters the tank at 50 °C to reheat the 15 °C tank water. The volume flow is 1.0 m^3/h and the maximum pressure drop in the heat exchanger is 0.3 bar.

a)

What is the capacity a specific heat exchanger can transfer to the tank water?

Solution to a)

Maximum pressure drop for a 40% Antifrogen N solution: 0.3 bar. Maximum pressure drop for water:

$$\Delta p = \frac{\max. \Delta p_G}{f_2} = \frac{0{,}3}{1{,}35} = 0{,}22 \text{ bar}$$

Refer to pressure drop diagram:
Δp max. 0.22 bar and V=1.0m^3/h, hence WRW 23 or WRW 26:
Refer to diagrams WRW 23 and WRW 26:
V=1,0m^3/h, and t_1=50 °C, hence
WRW 23: $\dot{q}$ = 410 W/K
WRW 26: $\dot{q}$ = 440 W/K
Capacity: $\dot{Q}_G = f_1 \cdot q\,(t_1 - t_s)$:
WRW 23: $\dot{Q}_G$ = 0.85 • 410 (50 – 15) = approx. 12 kW
WRW 26: $\dot{Q}_G$ = 0.85 • 440 (50 – 15) = approx. 13 kW

b)

What is the pressure drop to be kept in mind when selecting the circulation pump?

Solution to b)

$\Delta p_G = f_2 \cdot \Delta p$; (see Δp diagram)
WRW 23: Δp_G = 1.35 • 0.16 = 0.22 bar
WRW 26: Δp_G = 1.35 • 0.19 = 0.26 bar

c)

What is the return temperature of the heating fluid?

Solution to c)

the heat exchanger, the heating fluid cools off by

$$\Delta t = \frac{\dot{Q}_G}{\dot{V} \cdot p \cdot C_p}$$

Physical properties for the 40% Antifrogen N heating fluid:
σ = 1.055 kg/m^3; Cp = 0,986 Wh/kgK

$$\text{WRW 23: } \Delta t = \frac{12{,}000}{1.0 \cdot 1{,}055 \cdot 0.986} = 11{,}5 \text{ K}$$

Return temperature t_2 = 50 – 11,5 = 38,5°C

$$\text{WRW 26: } \Delta t = \frac{13{,}000}{1.0 \cdot 1{,}055 \cdot 0.986} = 12{,}5 \text{ K}$$

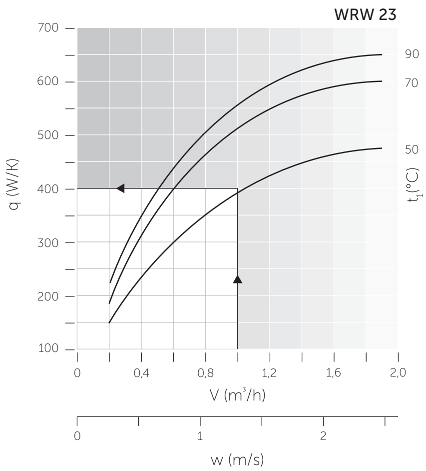
Return temperature t_2 = 50 – 12.5 = 37.5°C

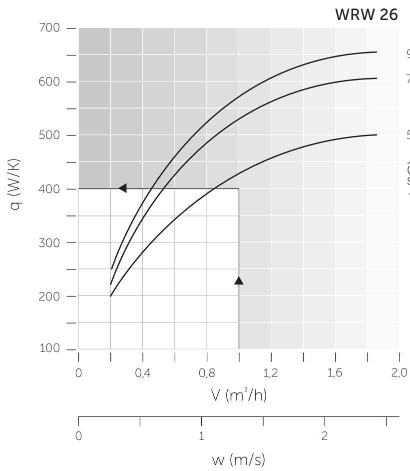
d)

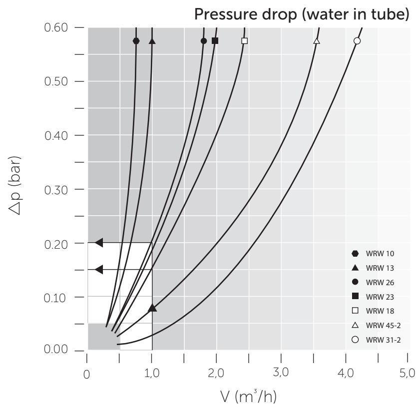
What capacity can be transferred when the temperature of the water surrounding the heat exchanger is 45 °C?

Solution to d)

The water temperature around the heat exchanger is 45 °C, the capacity is only $\dot{Q}_G = f_1 \cdot \dot{q}\,(t_1 - t_s)$
WRW 23: $\dot{Q}_G$ = 0.85 • 410 (50 – 45) = approx. 1.75 kW
WRW 26: $\dot{Q}_G$ = 0.85 • 440 (50 – 45) = approx. 1.9 kW







wieland

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