# EXERCISE 5

## 1 Problem table algorithm

We have the following streams:

| *stream #* | *type* | $cp \cdot \dot{m}$ *[kJ/K · s]* | $T_{start}$ [°C] | $T_{target}$ [°C] |
|---|---|---|---|---|
| 1 | hot | 3.5 | 180 | 60 |
| 2 | hot | 1.5 | 140 | 30 |
| 3 | cold | 2.0 | 45 | 115 |
| 4 | cold | 5.0 | 70 | 160 |

With a global $\Delta T_{min} = 10\ °C$.

### a)

Make a stream table where the temperatures have been adjusted for $\Delta T_{min}$.

### b)

Sort the temperatures and draw the streams in a diagram where the temperature intervals can be identified. Which intervals have heat surplus and which intervals have heat deficit?

### c)

Draw the heat-cascade and determine the minimum utility consumptions and the pinch temperature.

## 2 HINT software

### a)

Draw the grand composite curve of the stream data in exercise 1 using HINT. Check that the cascade you calculated earlier are in accordance with the grand composite curve drawn by HINT.

### b)

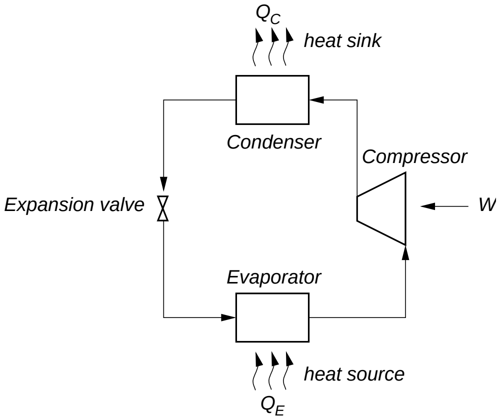
Steam is available at two levels:

- High pressure, $12.5\ bars$ and 190 $°C$
- Low pressure, $2.7\ bars$ and 130 $°C$

Choose the most efficient usage of the steam and draw it in the grand composite curve. How much low pressure and high pressure steam are we using?

# 3 Heat pump

We want to investigate if a heat pump can reduce the steam and cooling water needs. The available heat pump is an electric motor CCC (closed compression cycle) heat pump.




The heat pump characteristics are:

- Evaporation temperature $60\ °C$
- Sink temperature $125\ °C$
- Coefficient of performance, $COP = \frac{Q_C}{W} \approx \frac{Q_C}{Q_C - Q_E} = 3$

### a)

What is the approximate reduction in low pressure steam and cooling water consumption that we can expect?

### b)

Draw the heat pump in the grand composite curve.