plotG(vx,vy,char,size,color)

$$xL := \begin{bmatrix} 0 \\ 0.0917 \\ 0.1842 \\ 0.2779 \\ 0.3732 \\ 0.4703 \\ 0.5699 \\ 0.6721 \\ 0.7776 \\ 0.8867 \\ 1 \end{bmatrix} \qquad xV := \begin{bmatrix} 0 \\ 0.1543 \\ 0.2943 \\ 0.4188 \\ 0.5315 \\ 0.6327 \\ 0.7236 \\ 0.8049 \\ 0.8776 \\ 0.9424 \\ 1 \end{bmatrix}$$

$data := \mathrm{augment}(xL, xV)$ $\qquad$ $\mathrm{appVersion}(4) = \text{"0.98.6179.21440"}$

$$\begin{cases} xD := 97\ \% \\ xB := 2\ \% \\ xF := 40\ \% \\ q := 1.5 \\ R := 3.5 \end{cases}$$

```
Benzene purity in distillate
Benzene purity in bottom
Benzene fraction in feed
'q' value
Reflux ratio
```

$$\begin{cases} qline(x) := x \cdot \dfrac{q}{q-1} - \dfrac{xF}{q-1} \\ top\_op(x) := x \cdot \dfrac{R}{1+R} + \dfrac{xD}{1+R} \end{cases}$$

System data given by Valentino [20201119]

$$bottom\_op(x) := x \cdot \frac{R \cdot (xF - xB) + q \cdot (xD - xB)}{q \cdot (xD - xB) + R \cdot (xF - xB) - xD + xF} + \frac{xB \cdot (xF - xD)}{q \cdot (xD - xB) + R \cdot (xF - xB) - xD + xF}$$

incorrect

$$jnct := \frac{xD \cdot (q-1) + xF \cdot (R+1)}{q+R} = 0.457$$

$$operating\_line(x) := \begin{cases} bottom\_op(x) & \text{if } x \le jnct \\ top\_op(x) & \text{if } jnct \le x \\ \text{""} & \text{otherwise} \end{cases}$$

$x < jnct$

$jnct < x$

Thiele(X,Y,0) "K" .... Thiele(X,Y,1) "Table"

Cfr(K,X,x) Expansion

$$UnestRow(data) := \left| \begin{array}{l} v := data_1 \\ \text{for } j \in [2..\mathrm{rows}(data)] \\ \quad v := \mathrm{stack}(v, data_j) \\ v \end{array} \right.$$

$$Th(x) := \begin{cases} 1 & \text{if } (0 \le x) \wedge (x \le 1) \\ \text{""} & \text{otherwise} \end{cases}$$

$$Op(x) := \begin{cases} 1 & \text{if } (0 \le x) \wedge (x \le 1) \\ \text{""} & \text{otherwise} \end{cases}$$

TraySystem

$$\begin{cases} i := [1..19] \\ Tray := Tray_i \\ tray := UnestRow\left(Tray\right) \\ \left[\; u := \mathrm{col}\left(tray, 1\right) \;\; v := \mathrm{col}\left(tray, 2\right) \right] \end{cases}$$

$$\begin{cases} \left[\; C := UnestRow\left(C\right) \;\; O := UnestRow\left(O\right) \right] \\ C := C_{[2..\mathrm{rows}(C)]\,1} \\ O := O_{[1..(\mathrm{rows}(O)-1)]\,1} \\ strip := \mathrm{augment}\left(O, C\right) \end{cases}$$

$$\begin{bmatrix} bottom\_op\left(0.457\right) \\ operating\_line\left(0.457\right) \end{bmatrix} = \begin{bmatrix} 0.571 \\ 0.571 \end{bmatrix}$$

for $i \in \left[1..\mathrm{rows}\left(u\right)\right]$

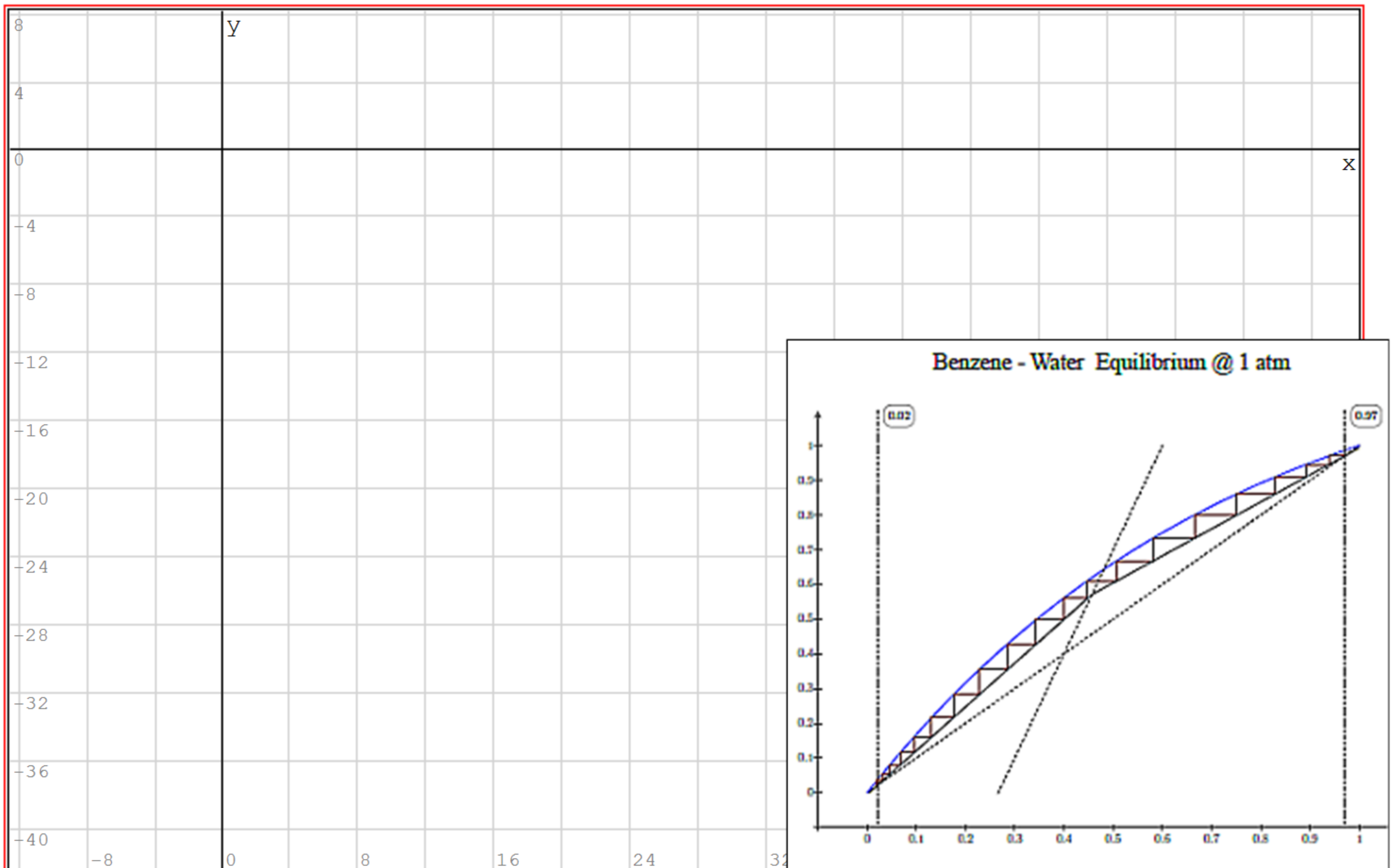
$$C_i := \begin{bmatrix} u_i \\ u_i \end{bmatrix}$$

for $i \in \left[1..\mathrm{rows}\left(v\right)\right]$

$$O_i := \begin{bmatrix} v_i \\ v_i \end{bmatrix}$$

$$plotStrip := \begin{cases} Cf\left(x\right) \cdot Th\left(x\right) \\ operating\_line\left(x\right) \cdot Op\left(x\right) \\ strip \\ \left[\; jnct \;\; 0.571 \;\; \text{"+"} \;\; 100 \;\; \text{"black"} \right] \\ \left[\; 0.0351 \;\; 0.032 \;\; \text{"+"} \;\; 40 \;\; \text{"black"} \right] \\ \left[\; 0.9714 \;\; 0.972 \;\; \text{"+"} \;\; 40 \;\; \text{"black"} \right] \end{cases}$$

$$\begin{bmatrix} Tray_1 \\ Tray_{19} \end{bmatrix} = \blacksquare$$



plotStrip

$$operating\_line\left(x\right) := \begin{cases} bottom\_op\left(x\right) & \text{if } x < jnct \\ top\_op\left(x\right) & \text{if } jnct < x \\ \text{""} & \text{otherwise} \end{cases}$$

from incomplete equalities

$operating\_line\left(jnct\right) = \text{""}$

Binary fractional distillation is a means of separating two liquid components via a distillation column (which contains a number of trays, or stages).
It's a concept encountered by virtually every Chemical & Process Engineering student.
This application calculates the required number of theoretical stages for a set of specified operating parameters via the McCabe-Thiele method. It plots the classic McCabe-Thiele diagram and evaluates the minimum and actual reflux ratio, and the thermodynamic state of the feed.

This disabled collapsed section exposes the possible glitches. Amongs all the projects I have done, very few glitches appeared, and only one in those cases. They appear in data sets that under the hood aren't true. In this demo Thiele-McCabe, we find 3 . We prove it otherwise applying Thiele on the 4 point circle.

About glitches

The 4 points Thiele circle ... no glithes

$$plot(data, char, size, clr) := \begin{array}{l} \text{for } k \in [1..\text{rows}(data)] \\ \quad [\, r3_k := char \;\; r4_k := size \;\; r5_k := clr \,] \\ \text{augment}(data, r3, r4, r5) \end{array}$$

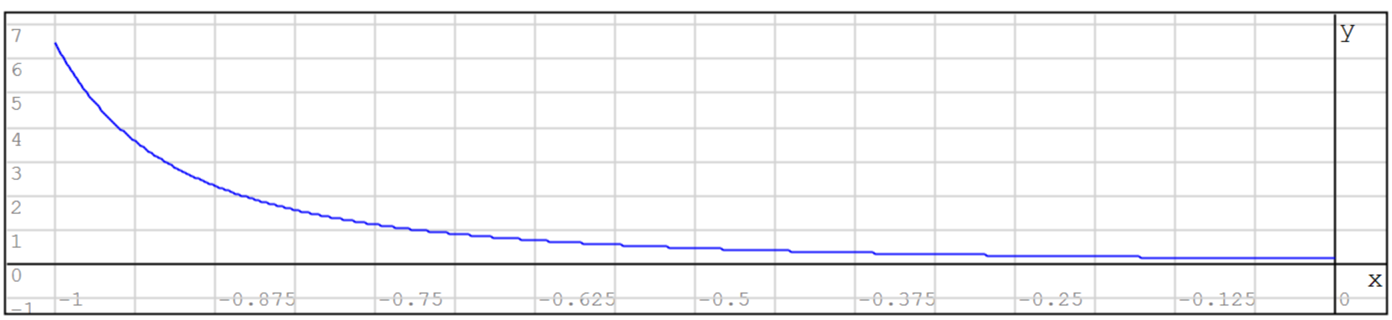
$$data := \begin{bmatrix} -1 & 0 \\ -0.86602540378444 & 0.5 \\ -0.5 & 0.86602540378444 \\ 0 & 1 \end{bmatrix}$$

$$Th(x) := \begin{cases} 1 & \text{if } (-1 \le x) \wedge (x \le 0) \\ \text{""} & \text{otherwise} \end{cases}$$

$$Circle := plot(data, ".", 14, \text{"black"})$$

$$K := \begin{bmatrix} 0 \\ 0.26794919243112 \\ 1.18301270189221 \\ 1.34969465094621 \cdot 10^{14} \end{bmatrix}$$

$$f(x) := K_1 + \cfrac{x-(-1)}{K_2 + \cfrac{x - \left(-\frac{21650635094611}{25000000000000}\right)}{K_3 + \cfrac{x - \left(-\frac{1}{2}\right)}{K_4}}}$$



$$1 \cdot \left(\frac{d}{d\,x} f(x) \cdot Th(x)\right)$$

accuracy of 4 points fit is not the question. Rather derivative glitches ... none to be seen.