plotG(vx,vy,char,size,color)..... plot(data,char,size,clr)..... UnestRow(data)

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

$data := augment(xL, xV)$ $appVersion(4) = "0.98.6179.21440"$

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

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

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

System data given by Valentino [20201119]

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

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

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

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

Cfr(K,X,x) Expansion

The McCabe-Thiele tray-stage system companion

list := 2 .. 19

pilot the length of the McCabe-Thiele tray-stage system

t0 := time(1)

The automated McCabe-Thiele tray-stage system companion

```
StageSystem= | [tray:= 0  u:= 0  v:= 0  O:= 0  C:= 0]
             | "initialize the loop starting @ xB"
             | | ω:= Cf(xB)
             | | ωop:= solve(operating_line(x) - ω , x , 0 , 1)
             | | stage_1 := [ω  ωop]
             | "collect/export the user-suite as per list"
             | "shrink/elongate the suite wrt project"
             | for i ∈ list
             |   | ω:= Cf(ωop)
             |   | ωop:= solve(operating_line(x) - ω , x , 0 , 1)
             |   | stage_i := [ω  ωop]
             | "Unest row wise [ω  ωop]"
             | tray:= stage_1
             | for j ∈ 2 .. rows(stage)
             |   tray:= stack(tray , stage_j)
             | tray
             | [u:= col(tray , 1)  v:= col(tray , 2)]
             | for i ∈ 1 .. rows(u)
             |   C_i := [u_i ; u_i]
             | for i ∈ 1 .. rows(v)
             |   O_i := [v_i ; v_i]
             | [C:= UnestRow(C)  O:= UnestRow(O)]
             | C:= C_(2 .. rows(C)) 1
             | O:= O_(1 .. (rows(O) - 1)) 1
             | StageSystem:= augment(O , C)
```

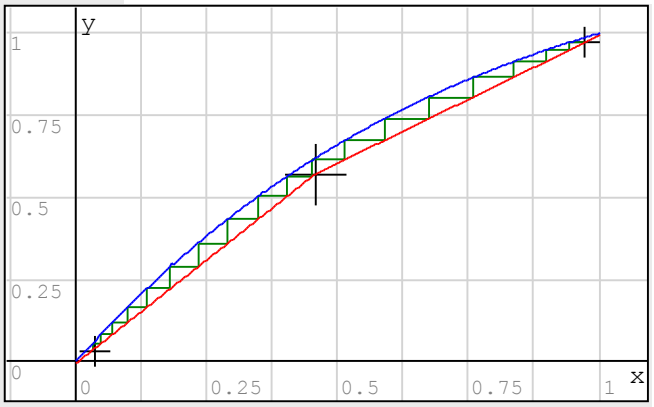
assign/isolate as needed.

StageSystem := StageSystem

time(1) - t0 = 5.6 s

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

```
plotStrip:= | Cf(x)·λ(x)
            | operating_line(x)·λ(x)
            | StageSystem
            | [jnct 0.571 "+" 40 "black"]
            | [0.0351 0.032 "+" 20 "black"]
            | [0.9714 0.972 "+" 20 "black"]
```



plotStrip

incorrect inequalities ... !

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

from incomplete equalities

operating_line(jnct) = ""

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

from complete equalities

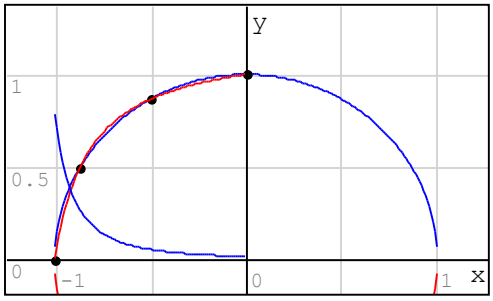
operating_line(jnct) = 0.571

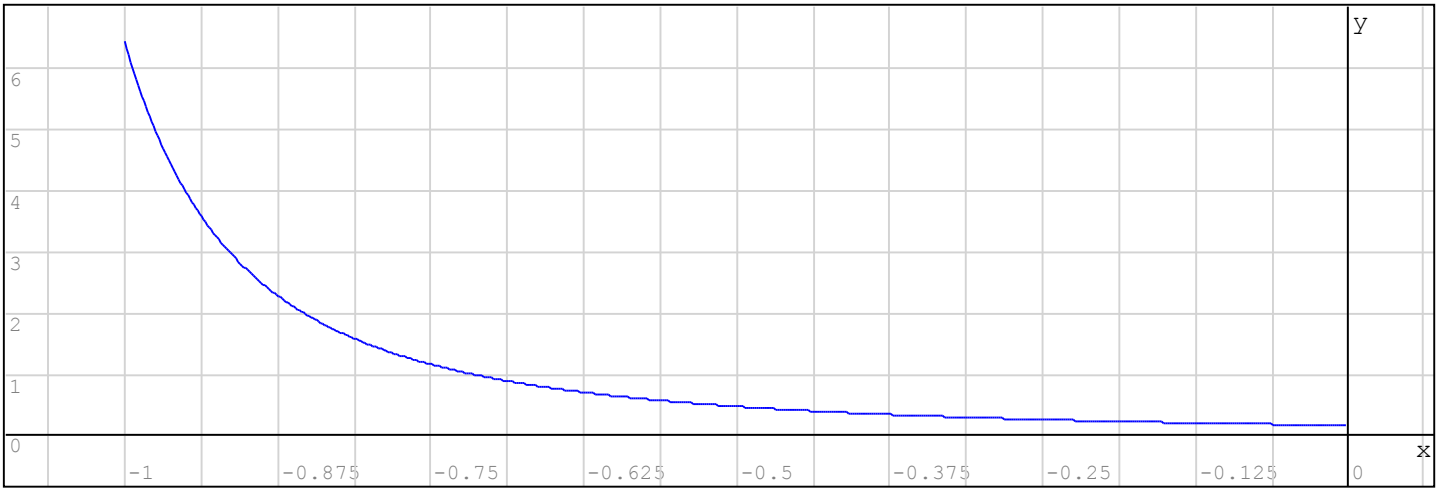
OBSERVE ...
Occasionally, Thiele will produce 1 or more glitch.
This project produces 3 glitches ... just ignore.
It indicates the support points are not true, QED below.
The 4 points circle produces no glitch 1rst derivative.

QED 4 points circle absent of glitches

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

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





$$\frac{d}{dx} f(x) \cdot c(x)$$