

# What's New in ChemSep 6.3

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*ChemSep* 6.3 has many new features and very many more minor upgrades and small improvements that, by and large, are invisible to most users. In this document we identify and describe the most important new features in *ChemSep*<sup>™</sup>

- 1. New: Equilibrium Stage Model and Efficiency Calculation and internals design
- 2. New: CAPE-OPEN Interface
- 3. New: Models for the System factor
- 4. New: Billet and Schultes (1999) models for packed column performance
- 5. New: Proprietary model for packed column performance developed by Raschig Gmbh.
- 6. New: Packed Column Design methods
- 7. New: Efficiency Derating
- 8. Improved: Packings Database
- 9. Improved: Operation limits plot
- 10. Improved: Output tables

The new models for the System Factor are described in a separate tutorial.

#### New: Equilibrium Stage Mass Transfer Model with Internals Design!

ChemSep now includes no less than 3 ways to model columns using the classical equilibrium stage model.

The first and most obvious way to choose the equilibrium stage model is on the *Operation* panel as shown below.



It may come as something of a surprise to many *ChemSep* users that the equilibrium stage model also is available after selecting the *Nonequilibrium* model on the above panel. In fact, the second method of selecting the equilibrium stage model, via the *Design* panel as shown below has always been part of *ChemSep*.



Here we see that an equilibrium stage can be selected as a possible **Column internal** in the same way that sieve trays, structured packing and so on can be selected. In fact, it is possible to model a column with a mixture of equilibrium stages together with sieve trays, valve trays, and packed sections should that be desired. The bottom part of the design panel lists the design parameters that may be specified for the equilibrium stage internal. **Note that none of these design parameters are calculated by the program**. The default value of the stage efficiency is 1; the default value of the other three parameters is 0.

The third (and the only new) way of selecting the equilibrium stage model is as a mass transfer coefficient model for any of the column internals (EXCEPT the equilibrium stage model)! The screen shot below shows the equilibrium stage mass transfer model selected for a column fitted with sieve trays.

👖 ChemSep (TM) - n-depre	op_EQ.sep		
File Edit Solve Analysis [	Databanks Tools Help		
🗋 🚅 🖬 🕨 🍣 🍝			
Components Operation Properties Thermodynamic:	Analysis V Pressures	Heaters/Coolers     Copy	Design Column specifications
Physical properti	Section	1 (design)	2 (design)
	Column internals	Sieve tray	Sieve tray
	First stage	15	20
Analysis	Section	15	23
V Pressures	Mass transfer coefficient	Equilibrium Stage	Equilibrium Stage
	Liquiu press resistance	Included	
🛛 🗸 Design	Vapour flow model	Mixed flow	Chan Fair
🚽 🗸 Column specifica	Liquid flow model	Mixed flow	Zuiderweg
🖻 🗸 Results	Pressure drop	Fixed	Harris Bubblestet model
- Tables	Entrainment	None	Chen-Chuang
Graphs	Holdup		Equilibrium Stage
McLabe-Thiele	Design method	Fraction of flood	Fraction of hood
FUG	Section 2: Mass transfer co	efficience	
Units	🕞 Load	Efficiency	×
Solve options		Murphree Efficiency	×
Paths	Save	Light Key	*
		Неауу Кеу	×
	Reset		
	Internale Assistant:		
	Distillation general		
Saved Converged 7 iter	ations C:\ChemSep\r	h-deprop_EQ.sep	11.

There is a very important difference between the equilibrium stage model as a column internal and as a mass transfer coefficient model. If selected as a mass transfer model it is necessary first to select the type of internal and, as noted above, that internal cannot be the equilibrium stage model.

Note the parameters section in the bottom part of the panel shown above (and it compare to the corresponding section shown above for the equilibrium stage internal. There are some similarities, but the equilibrium stage mass transfer model parameters do not include the diameter and stage height, although it does appear that both options have the efficiency in common.

Click in the white space to right of *Efficiency* and you will see a drop down list appear:

Section 2: Mass	transfer coefficient	Specified
🕞 Load	Efficiency	Specified
	Murphree Efficiency	0'Connell Distillation
Save	Light Key	O'Connell Absorption
	Неауу Кеу	×
Reset		

We see that for the equilibrium stage mass transfer model we may specify the efficiency (as also was the case for the equilibrium stage internal). We may also choose to calculate the efficiency using one of two O'Connell correlations: that for distillation or the one for absorption! These options are not available for either of the other two methods of selecting the equilibrium stage model.

If we elect to specify the tray efficiency then its value must be entered on line 2 of this section.

If we select either of the O'Connell methods then we need not enter anything on line 2 (it will be ignored if we do). In this case, however, we must select the light and heavy key components. Click in the white cell to the right of **Light Key** to see a list of compounds:

Section 2: Mas	s transfer coefficient	
🕞 Load	Efficiency	O'Connell Distillation
	Murphree Efficiency	-C2H6
Save	Light Key	C2H6
	Неауу Кеу	C3H8
Reset		C4H10
	l	C5H12

Select the light key from the list that appears. Repeat this action to select the heavy key in the white cell below. For the example shown here this part of the design panel now looks like this:

Section 2: Mass transfer coefficient			
🗁 Load	Efficiency	O'Connell Distillation	
	Murphree Efficiency	×	
Save	Light Key	C3H8	
	Неауу Кеу	C4H10	
Reset			

If the key compounds are not specified then *ChemSep* will estimate the O'Connell efficiency for all possible binary pairs in the mixture and then compute the average value of all of these efficiencies to use in the simulation!

Click on the column internal to see the equipment design section at the bottom of the panel:

🕂 ChemSep (TM) - n-dej	prop_EQ.sep				
File Edit Solve Analysis	File Edit Solve Analysis Databanks Tools Help				
🕒 🖻 🖬 🕨 💐 🦣 🛛	IX II E 🖉				
Title	🗸 Analysis 🖌 Pressures	🖌 Heaters/Coolers 🔻	🖊 Design 🖌 Column specifications		
Components	Internals Design		i		
Uperation					
	Insert Ren	nove Copy	System factor 1.00000 Import Settings		
Physical properti	Contion	1 (design)	2 (design)		
Reactions	Column internals	Sieve trau	Sieve trau		
	First stane	2	16		
🖻 🗸 Specifications	Last stage	15	29		
	Section height (m)				
Pressures	Mass transfer coefficient	Equilibrium Stage	Equilibrium Stage		
Heaters/Coolers	Liquid phase resistance	Included	Included		
- ✓ Design	Vapour flow model	Mixed flow	Mixed flow		
Column specifica	Liquid flow model	Mixed flow	Mixed flow		
	Pressure drop	Fixed	Fixed		
- Graphs	Entrainment	None	None		
- McCabe-Thiele	Holdup Design method	Fraction of flood			
Rating	Design method	_ riaction of hood	- rection or need		
FUG	Section 2: Column internal	s			
Units	🕞 Load	Column diameter (m)	×		
- Solve options		Tray spacing (mm)	×		
Paths	Save	Number of flow passes	8		
		Liquid flow path length (m	<u>1m) *</u> *		
	Reset	Active area (m2)	*		
	Internals Assistant	I otal hole area [m2]			
	Distillation general	Downcomer area (m2)	x		
Changed   Converged 7 i	iterations   C:\ChemSep\	n-deprop_EQ.sep	li.		

If we leave this section empty (as is the case here) then *ChemSep* will carry out tray (or packed column) sizing calculations. These equipment sizing calculations are not done for the equilibrium stage internal (because *ChemSep* does not then know what kind of column section – tray or packing – to design).

The internals design is available following a successful simulation in the Tables.

🕂 ChemSep (TM) - n-de	op_EQ.sep		
File Edit Solve Analysis	Databanks Tools Help		
Title	ables Graphs McCabe-Thiele Rating FUG		
Components	Tables		
	Select table: Internals design	Copy Font Print	
√ Reactions			<b>-</b>
Feeds	Column design:		
🖹 🚽 Specifications	Number of sections 2		
Analysis	System factor (-) 1.00000		
Pressures	Section 1	2	
	Column internals Sieve	Sieve	
Column specifica	Last stage 2	16 29	
B → Results	Section height (m)		
- Tables	Column diameter (m) 3.72600 Total trav area (m2) 10.9037	3.97129 12.3866	
Graphs	Column diameter (m) 3.726	3.97129	
- McCabe-Thiele	Tray spacing (mm) 610 Number of flow passes 4	610	
- Rating	Liquid flow path length (mm) 757.524	606.422	
FUG	Active area (m2) 8.70742	8.44022	
Units	Downcomer area (m2) 1.09816	1.9732	
Delha	Hole diameter (mm) 12.7	12.7	
····· Fauris	Weir length (m) 58.4225	16.6055	
	Weir height (mm) 54.08	54.08	
	Notch depth/Weir diameter (mm *	segmental *	
	Serration angle (o) *	*	21
		•	
• •			
Changed Converged 7	rations C:\ChemSep\n-deprop_EQ.sep		

The estimated efficiencies are also available either in a table or as shown below:



The Baur efficiency shown here is the same as the Murphree stage efficiency in this case (the reasons for this are discussed in our tutorial on efficiencies).

Note: the design options do not have to be the same in all column sections.

#### **New: CAPE-OPEN Interface**

*ChemSep* 6.3 has been CAPE-OPEN compliant for a log time. What is new with version 6.3 is the interface between the external program (this would be a flowsheet simulation program such as COCO – see <u>www.cocosimulator.org</u>) and *ChemSep*. The CAPE-OPEN interface now is part of the *ChemSep* interface itself.

If ChemSep has been called from a CAPE-OPEN simulator the CAPE-OPEN panel in ChemSep is visible:



The lower half of this panel usually is hidden from view, becoming visible when the *Show all options* is checked (highlighted in the rightmost of the red ovals above).

#### New: Correlations for Packed Column Performance

*ChemSep* 6.3 includes two new models for estimating mass transfer coefficients and pressure drop in packed columns. These are the model of Billet and Schultes (1999) and a proprietary model developed at Raschig Gmbh and included in ChemSep with their permission.

To select either of these models click on the mass transfer coefficient model selection for a packed column section:



The Billet and Schultes (1999) model requires a number of parameters to be entered in the lower part of the Design panel (visible after selecting the Billet and Schultes model or by clicking again in the mass transfer coefficient cell). Parameters for some packings are available in the original paper by Billet and Schultes as well as in some standard textbooks (e...g Separation Process Principles by J.D. Seader and E.J. Henley, Wiley New York 2002).

Important notes:

- 1. The parameters for the Billet and Schultes model must be entered separately for each column section for which the model is selected.
- 2. *ChemSep* does not require the Billet and Schultes model to be selected for both mass transfer and pressure drop (although one may certainly do so). The model parameters must be entered separately for the pressure drop model.

*ChemSep* 6.3 also includes proprietary models for mass transfer and pressure drop developed by Raschig Gmbh. Parameters for this model are loaded automatically at run-time if they are available. It is important to note that parameters for the Raschig correlations are available primarily for packings manufactured by Raschig Gmbh.

#### New: Packed Column Design Methods

*ChemSep* has always included two different methods for sizing packed columns. These are described in *The ChemSep Book* (see <u>www.chemsep.com</u>book) and in the technical section of the *ChemSep* help system. Version 6.3 introduces two new packed column sizing method. Click on the *Design Method* to see a list of possible design methods:

🕂 ChemSep (TM) - BSDe	esign_Test_RSR02b.sep	
File Edit Solve Analysis	Databanks Tools Help	
🗋 🚅 🖬 🕨 🍣 🍊 🤊		
Title     Components     Operation     Properties     Thermodynamic:     Physical properti     Reactions     Feeds     Specifications	✓ Analysis       ✓ Pressures       ✓ Heaters/Coolers       ✓ Design       ✓ Column specifications         Internals Design       Insert       Remove       Copy       System factor       1.00000       Import       Settings         Section       1 (design)       Column internals       Dumped Packing       First stage       2       1	
Specifications     Analysis     Pressures     Heaters/Coolers     Design     Column specifica     Results     Tables     Graphs     MoCaba Tkiala	Last stage     151       Section height (m)     15,0000       Mass transfer coefficient     Raschig (2009)       Liquid phase resistance     Included       Vapour flow model     Plug flow       Liquid flow model     Plug flow       Pressure drop     Raschig 2009       Entrainment     Holdup       Holdup     Default	
McLabe-I hiele Rating 	Design method       Fraction of flood (Leva)         Section 1: Design method       Pressure drop Fraction of flood (BS99/R)         Image: Constraint of flood (Leva)       *         Save       Efficiency derating factor         Reset       Internals Assistant:         Distillation general       Image: Constraint of C	
Changed Converged 5 i	iterations C:\ChemSep_\PackingVendors\Raschig\BSDesign_Test_RSR02b.sep	- //.

The new methods are:

- Fraction of Flood (BS99/R)
- Fraction of Flood (Leva)

In the first of these two methods the diameter is calculated using the flooding velocity calculated from either the method of Billet and Schultes (1999) or from the Raschig model. Note that if this option is selected then the BS99 method will be used if the Billet and Schultes method was chosen as the pressure drop model; the Raschig method will be used to calculate the flooding velocity if that method is selected to calculate the pressure drop. The Raschig model can also be used to calculate the flooding velocity if some method other than either of these two models was selected for the pressure drop!

The Leva design method uses the well-known Leva version of the GPDC to estimate the flooding velocity. Note that the original design by fraction of flooding method in *ChemSep* may also employ the Leva method if that model was selected as the pressure drop model. However, the way in which the calculations are done differs from the new (in *ChemSep*) method discussed here.

#### Improved: Packing Database

The files containing packing parameters have been revised as part of our ongoing work towards developing a validated set of design methods and correlations.

f ChemSep (TM) - BSDes	sign_Test_RSR02b.sep			_ 🗆 🗙	
File Edit Solve Analysis	Databanks Tools Help				
🗅 🗃 🖬 🕨 🍣 🍋 🗉	XIIIE				
Title Components Operation Properties Thermodynamic: Physical properti Reactions Feeds Specifications Analysis Pressures Heaters/Coolers Design Column specificat Results Tables Graphs McCabe-Thiele Rating	Analysis Pressures Internals Design Insert Rem Section Column internals First stage Last stage Section height (m) Mass transfer coefficient Liquid phase resistance Vapour flow model Liquid flow model Pressure drop Entrainment Holdup Design method	✓ Heaters/Coolers     ✓ Design       ove     Copy     System       1 (design)     ✓       Dumped Packing     ✓       2     151       151     15.0000       Raschig (2009)     Included       Plug flow     Plug flow       Plug flow     Plug flow       Default     Fraction of flood (Leva)	n Column specifications	ort Settings	
FUG	Section 1: Lolumn internals			_	
Solve options	_ Coad	Column diameter [m]	100.000	▲	
Paths	Save	DumpedType	R SR2	-	
		Specific surface area (m21m2)	97.0000		
	Reset	Dumped void fraction (m3/m3)	0.985000		
	Internale Assistanti	Nominal size (mm)	50.8000		
	Internais Assistant.	Critical surface tension (dyn/cm)	75.0000		
	Distillation general	Dumped pack factor [1/m]	1"	<u> </u>	
Changed Converged 5 it	terations C:\ChemSep_Y	PackingVendors\Raschig\BSDesi	ign_Test_RSR02b.sep	11.	

We now use a short name to identify the packing as shown inside the red oval in the image above. A few examples are:

Vendor Name	ChemSep Name
Raschig SuperRings No. 2	R SR2
Sulzer Mellapak 250.X	S M250X
Koch-Glitcsh IMTP 40	KG IMTP40
Montz B1-200	M B1-200

These short names are used by some of the new correlations and design methods. For this reason, **if you use** *ChemSep* to model packed columns it is essential that you reload the packing parameters so that the correct short name will be written to the simulation case file.

#### **New: Efficiency Derating**

*ChemSep* 6.3 includes for the first time the ability to apply safety factors to stage efficiencies and mass transfer coefficients.

To enter a derating factor click in a cell for the internals design method as shown in the two views of part of the design panel that appear below.

Design method	Fraction of flood	on of flood
Section 1: Design method		
🗁 Load	Fraction of flooding	×
	Fraction of weeping	×
Save	System factor model	×
	System factor	×
Reset	Efficiency derating factor	×
Design method	Fraction of flood (Leva)	
Section 1: Design method		
🕞 Load	Fraction of flooding	×
	System factor	×
Save	Efficiency derating factor	×
Reset		

Efficiency derating works by multiplying the efficiency or mass transfer coefficient by a "safety factor". For example, if an efficiency model is used (as discussed above) the value of efficiency used in the simulation is

 $E_{used} = E_{estimated} \times DeratingFactor$ 

If a mass transfer coefficient model is selected then

 $[ka]_{used} = [ka]_{estimated} \times DeratingFactor$ 

where  $\lfloor ka \rfloor$  is the product of the mass transfer coefficient and interfacial area.

The default value of the Derating Factor is 1.

It is possible to specify values of the *Derating Factor* that exceed 1; caution must be exercised in interpreting the results from such a simulation (assuming that the calculation works – something that becomes increasingly less likely as the *Derating Factor* increases in value).

#### Improved: Plot (and Table) of Operation Limits

The Operation Limits plot provided by *ChemSep* 6.3 provides much more information than it did in earlier versions of the program. The example below is for a column with 54 valve trays (FF stands for fraction of flooding).



The many different lines on this diagram are described briefly below:

The **Max FF** is the largest of the various flooding factors and is shown in red. Often, as is the case here, it is not visible in the above plot; being entirely hidden behind one of the other flood factors.

**System Factor** – also known as the foaming or derating factor. This parameter was either specified or calculated from a model as discussed in a separate tutorial.

The **System Limit**, or Ultimate Capacity is given by the smaller of  $C_1$  and  $C_2$  where

$$C_1 = 0.445 (1-F) (\sigma I (\rho_L - \rho_V))^{0.25} - 1.45 u_L$$

$$C_2 = 0.356(1-F)(\sigma/(\rho_L - \rho_V))^{0.25}$$

where  $u_L$  is the superficial liquid velocity in m/s and where

$$F = \frac{1}{\left(1 + 1.4 \left(\rho_L - \frac{\rho_V}{\rho_V}\right)^{0.25}\right)}$$

The surface tension should be in dyne/cm and the density in kg/m<sup>3</sup> when using the above equations. For considerable discussion of this concept see Stupin and Kister (*Trans. IChemE.*, **81A**, 136-146, 2003). For a brief introduction see *Separation Process Principles* (2<sup>nd</sup> Ed.) by J.D. Seader and E.J. Henley (Wiley, 2006 p218).

The Jet Flood Fraction of Flooding (Jet FF) - also known as Entrainment Flooding. - is calculated from

$$FF_{Jet} = u_V / u_F$$

where  $u_V$  is the superficial vapor velocity and  $u_F$  is the (estimated) flooding velocity.

The Downcomer Residence Time Flood Factor (DC res time FF) is calculated from:

$$Time_{DC} = \frac{Minimum Residence Time}{Downcomer Residence time}$$

The *Minimum Residence Time* is specified in *ChemSep* and can be changed by the user. First locate the *Settings* button on the *Design* panel:

🕂 ChemSep (TM) - n-deprop	o_EQ.sep			
File Edit Solve Analysis Da	atabanks Tools Help			
╚╔╏┝╡╡┥	XITEP			
Title Components Operation Properties Thermodynamic:	<sup>®</sup> Analysis	V Heaters/Coolers V	Design 🖌 Column specificati	Import Settings
	Section	1 (design)	2 (design)	
Reactions	Column internals	Sieve tray	Sieve tray	
Feeds	First stage	2	16	
E V Specifications	Last stage	15	29	
Analysis	Section height (m)			
Pressures	Mass transfer coefficient	Equilibrium Stage	Equilibrium Stage	
Heaters/Loolers	Liquid phase resistance	Included	Included	
	Vapour flow model	Mixed flow	Mixed flow	
Column specifica	Liquid flow model	Mixed flow	Mixed flow	
	Pressure drop	Fixed	Fixed	
L adies	Entrainment	None	None	
MaCaba Thiala	Holdup			
Bating	Design method	Fraction of flood	Fraction of flood	
FUG	Section 2: Column internals			
- Units	🗁 Load	Column diameter (m)	×	▲
- Solve options		Tray spacing (mm)	22	
- Paths	Save	Number of flow passes	×	
		Liquid flow path length (mr	n) ×	
	Reset	Active area (m2)	*	
		Total hole area (m2)	×	
	Internals Assistant:	Downcomer area (m2)	×	
	Distillation general	Hole diameter (mm)	×	<b>▼</b>
Changed Converged 7 iteral	tions C:\ChemSep\r	n-deprop_EQ.sep		

Click on this button to bring up the *Design Settings* in a separate window:

Design Mode Models and Settings - c:\bp\bin\\tdesign.def					
General Sieve trays Bubble-Cap trays Valve trays Weirs Downcomers Founding					
Description of design file	TDESIGN.DEF: saved by	H:\temp\cs\windows\WinCS\wincs.exe	;		
Change factors (-) Large/Medium/Small step	0.05	0.02	0.01		
Allowed deviation (-) for area for specified FF(DP)	0.05	Maximum allowed:			
Column diameter (m) where switch Small/Large column	1.3716	Liquid fractional entrainment (-)	0.05		
Convergence criterium on free area ratio (-)	Convergence criterium on free area ratio (-) 0.01 Vapour fractional entrainment (-) 0.35				
Maximum number of iterations	30	Froth height (fraction of tray spacing)	0.75		
Generate tray parameter output	Yes 💌	Pressure drop (Pa)	11000		
Generate messages	No				
Design method Continuous redesign					
Load Save Cancel					

Click on the *Downcomers* tab (circled in red in the image above). The Minimum residence time can be set in the cell shown circled in the image below. The default value shown above is based on guidelines in *Distillation Design* by H.Z. Kister (McGraw-Hill, 1992, p291) noting further that the figure shown here is for clear liquid (as distinct from the lower density froth). For trays with very low flows the default value is probably too high.

Design Mode Models and Settings - c:\bp\bin\\tdesign.c	lef	×
General   Sieve trays   Bubble-Cap trays   Valve trays   Weirs	Downcomers Rounding	
Duran and a start of		
D woncomer area method		
Downcomer velocity method	Glitsch	
Average liquid fraction (-)	0.5	
Seal (m), applied when your clearance	0.0127	
Minimum residence time downcomer (s)	1.5	
Clearance (m) Lower/Dofault/Upp tr	0.01 0.0381 0.1	
		_
Load	Save Cancel	

Downcomer backup flooding occurs when the height of aerated liquid in the downcomer exceeds the tray spacing. The **Backup FF** in the above plot is the ratio of the actual height to the calculated backup. The calculation of this height is described in *Distillation Design* by H.Z. Kister (McGraw-Hill, New York, 1992, p 283).

The Downcomer Velocity Flood Factor (**DC Vel FF**) is calculated from one of two ways. If the Downcomer Area method (see image below) is *Glitsch* then

$$FF_{DC backup} = \frac{Q_L}{A_d u_{L, DC, Glitsch}}$$

where  $u_{L,DC,Glitsch}$  is the downcomer velocity calculated from the Glitsch method.

Design Mode Models and Settings - c:\bp\bin\\tdesign.o	def	X
General Sieve trays Bubble-Cap trays Valve trays Weirs	Downcomers Rounding	
Dwoncomer area method Downcomer velocity method Average liquid fraction (-) Seal (m), applied when weir <clearance< th=""><th>Glitsch</th><th></th></clearance<>	Glitsch	
Minimum residence time downcomer (s) Clearance (m) Lower/Default/Upper	1.5           0.01         0.0381	
Load	Save	

On the other hand, if the Downcomer Area method is Koch then

$$FF_{DC backup} = \frac{A_{d, Koch}}{A_{d, Actual}}$$

Liquid will backup onto the tray if the downcomer is not large enough. The Downcomer Choke Fraction of Flood (**DC Choking FF**) is estimated from:

$$FF_{DC Choke} = \begin{cases} 0.9 (h_f - h_w) L_w / A_d & \text{if } h_f > h_w \\ 1 & \text{if } h_f \le h_w \end{cases}$$

where  $h_f$  is the froth height,  $h_w$  is the weir height,  $L_w$  is the weir length, and  $A_d$  is the cross sectional area of the downcomer.

The Weir Load is the volumetric liquid flow rate per unit length of weir.

$$Q_{L,W} = Q_L / L_W$$

The Weir Load FF is calculated from

$$FF_{Weir} = Q_{L,W} / Q_{L,W,max}$$

The maximum weir load is set on the Weirs tab of the Design Settings window:

Design Mode Models and Settings - c:\bp\bin\\tdesign.def							
General Sieve trays Bubble-Cap trays Valve trays Weirs	Downcomers Rounding						
Weir height (m) Lewes/Defealt/Upper	0.005	0.05408	0.1				
Maximum weir load (US-Gal/min/ft)	144	$\rightarrow$					
Maximum weir neight as fraction () of trayspacing	0.2						
Weir serration angle (rad)	0.7854						
Weir serration depth as fraction (-) of weir height	0.3333						
Weir notch depth as fraction (-) of weir height	0.3333						
Weir circular diameter as fraction (-) of weir length	0.9						
<u> </u>		1					
Load	Save	Cancel					

### Improved: Flow and Stream Tables

For two phase feeds, *ChemSep* shows the state of the combined feed and, in separate columns, the flow rate, composition and columns of the vapor and liquid portions of the feed. An example is shown below; note the 3 columns for Feed 5.

🕂 ChemSep (TM) - asua-	-02.sep								_			
File Edit Solve Analysis	Databanks	; Tools Help										
	⇒ ×  <mark>↓</mark> 1											
Title	Tables G	raphs McCabe-Thiele Rating	]									
Components	T ables											
	Select table: Streams XL Edit Copy Font Print											
Thermodynamic:		,										
Reactions	Stre	am	Feed3	Feed6	Feed1	Feed5	V Feeds	I Feeds	Feed2	4		
✓ Feeds	Stag		1	21	20	29	20	200 200	56			
□ ✓ Specifications	Pres	sure (bar)	1.30000	1.30000	1.30000	1.30000	1.30000	1.30000	1.30000			
✓ Pressures	Temp	ur fraction (-) erature (K)	0.000000 79.4410	1.00000	1.00000	0.0212529 82.3786	1.00000 82.3786	0.000000 82.3786	0.000000 92.0135			
Heaters/Coolers	Mole	flows (mol/s)										
✓ Efficiencies	Nitro Oxyg	ogen en	757.890 8.7185E-08	404.635 108.514	564.869 81.3335	970.175 533.579	28.0479 4.12718	942.127 529.452	6.3974E-11 0.194217			
🗸 Column specifica	Argoi	1	5.3052E-04	4.81709	5.15656	22.1397	0.254597	21.8851	0.0228359			
E-V Results	Tota	l molar flow	757.891	517.966	651.359	1525.89	32.4297	1493.46	0.217053			
Graphs	Mole	fractions (-)	n 000000	0 781200	0 967316	0 635909	D 964994	0 630834	2 94745-10			
McCabe-Thiele	0×yg	20	1.1503E-10	0.209500	0.124867	0.349683	0.127266	0.354513	0.894791			
- Units	Argor		7.0000E-07	0.00950001	0.00/91662	0.0145095	0.00/850/8	0.0146559	0.105209			
- Solve options	Mass   Nitro	tlows (kg/s) ogen	21.2315	11.3354	15.8242	27.1785	0.785733	26.3927	1.7921E-12			
- Paths	0xyg Argoi	en n	2.7898E-09 2.1193E-05	3.47234 0.192433	2.60259 0.205994	17.0740 0.884437	0.132066 0.0101707	16.9419 0.874266	0.00621475 9.1224E-04			
	Tota	l mass flow	21.2316	15.0002	18.6328	45.1369	0.927970	44.2089	0.00712700			
	Mass	fractions (-)										
	Nitro	ogen	0.999999	0.755685	0.849267	0.602134	0.846723	0.597000	2.5146E-10			
	Argo	1	9.9820E-07	0.0128287	0.0110554	0.0195945	0.0109601	0.0197758	0.127999			
	Vapor	ur:		20.0500	20 (0(1	20 6140	20 6140					
	Dens	sity (kg/m3)		4.51523	5.69055	5.69237	5.69237					
	Heat	cosity (N/m2.s) t capacity (J/kmol/K)		7.3075E-06 29132.6	5.6115E-06 29195.1	5.612/E-06 29195.7	5.612/E-06 29195.7					
	The	rmal cond. (J/s/m/K)		0.00990742	0.00805250	0.00805161	0.00805161					
	Liqu Mole	id: e weight (kg/kmol)	28.0140			29.6016		29.6016	32.8353			
	Den	sity (kg/m3) cosity (N/m2.s)	795.569 1.4481E-04			915.675 1.6207E-04		915.675 1.6207E-04	1160.49 1.8737E-04			
	Heat	t capacity (J/kmol/K)	57107.5			55865.9		55865.9	53316.6			
	Surf	face tension (N/m)	0.00840877			0.0104488		0.0104488	0.0125662			
										-		
									D			
Saved Converged 16	iterations	C:\ChemSen_\COCO\asua	a-02 sep							1		

## Improved: Internal Flow Table

*ChemSep* 6.3 now displays the mass flows (as well as the molar flows) in the output flow table. An example is shown below.

f ChemSep (TM) - PCW	5D1	0.sep								IX
<u>E</u> ile <u>E</u> dit <u>S</u> olve <u>A</u> nalysis <u>D</u> atabanks <u>T</u> ools <u>H</u> elp										
🕒 🚅 🖬 🕨 🍣 🚺	•	L× <mark>lt</mark> [	T 🖻 🖉							
Title	Ta	ibles Grap	hs McCabe-Thiel	e Rating FU	G					
Components	$\Box^{T}$	ables								
E V Properties		Select table	T/P/Flow profile	s	• ×	L Edit	Copy Font	Print		
Thermodynamic:			, .							
Physical properti Reactions		Stage	Tomponatur	Droccuro	Flow motor	(long) (h)				<u> </u>
✓ Feeds		stage	(oF)	(atm)	Liquid	(kmol/n) Vapour	Feed	Product		
☐ ✓ Specifications		1	360.826	1.00000	200.000	RR=4		50.0000	L	
Pressures		23	361.665 362.759	1.00000	200.000	250.000				
Heaters/Coolers		4	364.137	1.00000	200.000	250.000				
		6	365.797 367.694	1.00000	200.000	250.000				
Column specifica			369.739 371 809	1.00000	200.000	250.000				
E V Hesults		9	373.777	1.00000	200.000	250.000				
Graphs		10	375.541 377.085	1.00000	300.000 300.000	250.000 250.000	100.000			
McCabe Thiele		12	378.957	1.00000	300.000	250.000				
Rating		14	383.415	1.00000	300.000	250.000				
FUG		15	385.746 387.945	1.00000	300.000 300.000	250.000 250.000				
- Solve options		17	389.895	1.00000	300.000	250.000				
Paths		18	391.534	1.00000	300.000	250.000				
		20	393.868	1.00000	BR=5	250.000		50.0000	L	
		Stage	Temperatur (oF)	Pressure (atm)	Flow rates Liquid	(kg/h) Vapour	Feed	Product		
		1	360.826	1.00000	18940.7	RR=4		4735.18	1	
		2	361.665	1.00000	19022.3	23675.9			-	
		4	364.137	1.00000	19127.2	23757.5				
		5	365.797 367.694	1.00000	19409.4 19579.3	23992.0 24144.6				
		7	369.739	1.00000	19757.2	24314.5				
		9	371.809	1.00000	20093.2	24492.4 24667.1				
		10	375.541 377.085	1.00000 1.00000	30350.9 30531.5	24828.4 24973.4	10112.7			
		12	378.957	1.00000	30745.1	25154.0				
		13	383.415	1.00000	31232.0	25367.6 25605.8	I			
		15 16	385.746 387.945	1.00000	31474.9 31697.3	25854.5 26097.5				
		17	389.895	1.00000	31889.1	26319.8				
		18	392.850	1.00000	32170.4	26511.6				
		20	393.868	1.00000	BR=4.98243	26792.9		5377.47	L	
		<b>A</b>								<u>∽</u>
									التف	
Saved Converged 2	itera	tions	C:\BP\PCW5D1	0.sep						
1			1							14