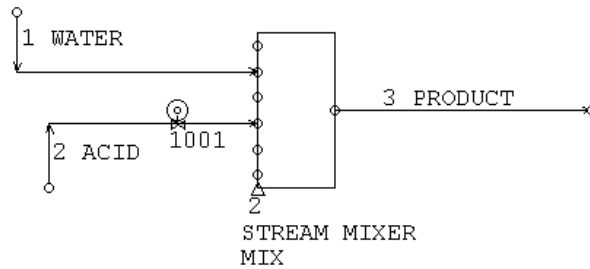


## Mass Balance Example 1



ACID MAKEUP SECTION

Stream Number & Stream Label

### PROBLEM DESCRIPTION

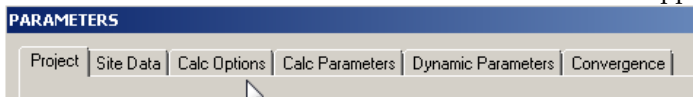
This example will be used to illustrate the mass balance capabilities of **METSIM**.

Water and Acid will be added to a Mixer so that a specified concentration of Acid will be achieved in the product, stream 3.

A Feedback control will be used to adjust the flowrate of Acid entering the Mixer in stream 2 to achieve the desired concentration of **65 GPL of Acid in the product**, stream 3.

### Problem Solution

1. Click on the **Model Parameters Button** . A window appears with a number of clickable tabs.



A. The window opens on the **Project** Entry window. From here a Title and a Case Identifier and other Project information may be entered.

B. Click on the **Calc Options Tab** and check the box next to Mass Balance.

C. Click on the **Calc Parameters Tab** and set the units of Mass and Time to **KG/Hr**.

2. Click on the **COMP Menu** and then "DBAS Component Database".

A. A window appears displaying a table of the elements. Select H, O and S and a list of all the components in the database composed of these elements will be called up. Select the aqueous **H2SO4**.

#### Components:

No.	Name	Formula	Phase	Type
1	Water	H2O	aqueous	
2	Acid	H2SO4	aqueous	

**IMPORTANT NOTE: Concerning Sorting Components.**  
Refer to **NOTE 1** on **Page 13**.

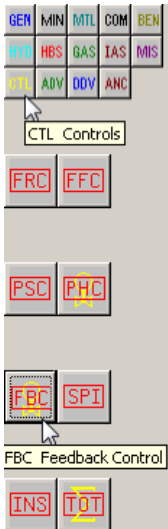
B. From the **Comp Menu** select "ICPL Insert Phase Labels on Component Names".



3. Click on the **Screen Object Button "GEN"** and then select a Stream Mixer, MIX







## PROCESS CONTROLS

The control strategy may now be entered. An FBC-Feedback Control may be entered which adjusts the flowrate of stream 2, Acid, until there is 65 GPL of acid in stream 3, the product. The Value Function to use is of the following form  $C \text{ VGPL } S$  and can be read as (Component Number) Grams Per Liter in (Stream Number).

Where C is the component number of the Acid and S is the stream number where the GPL of the Acid is calculated. The value function would be entered as;

$$c2 \text{ VGPL } s3$$

The small c in front of the component number in the Value Function above is used to update the component number if changes are made to the order of the components.

The small s before the stream number in the Value Function above is used to update the stream number if stream numbers are renumbered.

### Feedback Controller Entry Screens

#### FBC1 Screen

ID	CN	OP	NO	SN	LV	HV	FBC2 Screen VF	SP	SL
Control Salt Content	1001	2	2	s2	0	1000	c3 VGPL s3	0.1	-1

**FEEDBACK CONTROLLER**

FBC 1 | FBC 2 | Notes

FEEDBACK CONTROLS simulate PID controls and other constraints.

ON  Controller On

CN  Control Loop Number, (use with VCTL value functions).

TY  Controller Type: FRC, FFC, PSC, FBC

Controller Description

ID

OP  \* Unit operation number where set point is calculated.

NO  \* Unit operation number where controlled variable is used.

ADJUSTED STREAM OR MANIPULATED VARIABLE:

SN  \* If a stream or streams are to be adjusted, enter number(s) or a predefined vector of the numbers.  
If parameter 'vn' or a reaction extent is to be adjusted, enter 0.  
And: Enter 'vn+VCTL CN' in the unit op 'Controls CtB' field.  
Or: Enter 'VCTL CN' in the reaction 'EXPRESSION FOR EXTENT.'  
Also: Enter the starting value in the output field below.

OV  Output value of adjusted variable.

LV  \* Lower limit of adjusted variable.

HV  \* Upper limit of adjusted variable.

**FEEDBACK CONTROLLER**

FBC 1 FBC 2 Notes

VALUE FUNCTION for CONTROLLED/MEASURED VARIABLE \_SET POINT:  
 APL expression for the current value of the set point variable.

VF

SP  \* Set Point

DB  Not used

SL  Proportionality Switch

\* If VF increases with an increase in Controller Output, enter '1'.  
 If VF decreases with an increase in Controller Output, enter '-1'.

PID USED FOR DYNAMIC SIMULATION ONLY

CO  PID Method

PROPORTIONALITY CONSTANTS: PID control, KP\_KI required, KD optional

KP  \* Proportional gain

KI  \* Integral tuning constant

KD  Derivative tuning constant

CONTROLLER TUNING PARAMETERS

EE    - Controller Factors

PG    - Controller Outputs

PV    - Set Point Values

OK Cancel Help

### Saving Model Files

Each flowsheet is saved in a single file containing all data, graphics etc. All models are saved as internal format APL component files, (filename.SFW). After a model is loaded, all data becomes immediately available.

It is important therefore, to save the model regularly during development, and almost always prior to calculation.

After Calculating  the file the results may be viewed.

### Acid Tank - Stream Mixer Mass & Heat Balance with FBC & DDE

#### CASE DEFINITION

Project Information:  
 Owner :  
 Location :  
 Title : Acid Tank - Stream Mixer  
 Case:Mass & Heat Balance with FBC & DDE  
 Purpose : Training Example 1  
 Number :  
 Engineer :  
 Logo File:  
 Modeller :  
 Revision : A

Data Storage File Name : Example1.sfw

Mass Balance Option : ON

Units of Mass : kilogram

Units of Time : hour

#### STREAM DATA

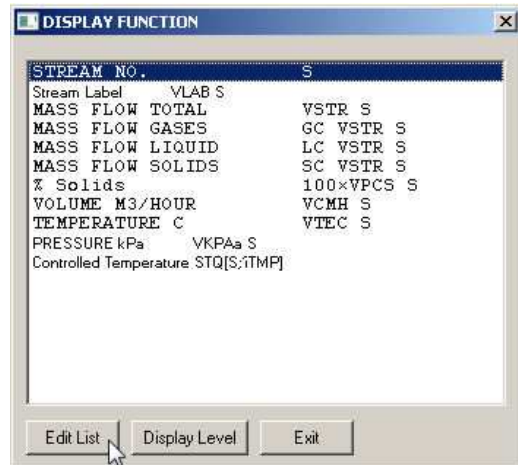
AQUEOUS - KG/HR			
NO. STREAM		H2O	H2SO4
1	Water Feed	50.0000	0.00000
2	Acid 93%	0.2525	3.35403
3	PRODUCT	50.2525	3.35403

AQUEOUS - WEIGHT PERCENT			
NO. STREAM		H2O	H2SO4
1	Water Feed	100.000	0.0000
2	Acid 93%	7.000	93.0000
3	PRODUCT	93.743	6.2568

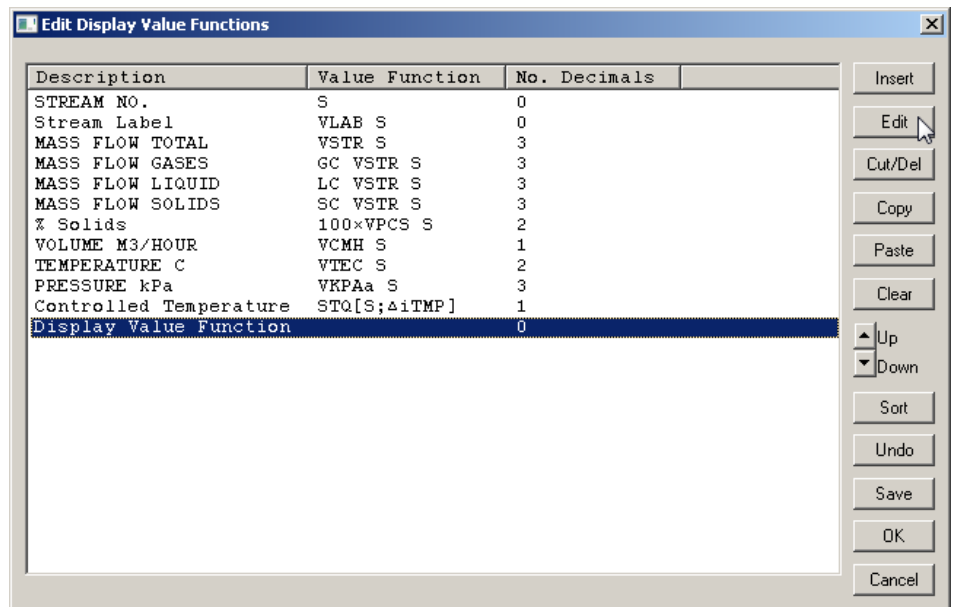
AQUEOUS - GRAMS PER LITER			
NO. STREAM		H2O	H2SO4
1	Water Feed	998.259	0.00
2	Acid 93%	128.270	1704.15
3	PRODUCT	973.875	65.00

 DISPLAY VALUE FUNCTIONS FOR STREAMS

Clicking on the Display Value Function For Streams Buttons calls up the following window.




Click on the EDIT LIST Button calls up the following window where you are able to create a new option.



Highlight the “Display Value Function” Line in the list displayed and Click on the EDIT Button. This calls Up the following Window where you Enter a Description which will be displayed on the Palette and any Value Functions you want displayed on a stream.


For “DS – Display Description” enter STREAM NUMBER AND ACID gpl in STREAM.

For “VF – Display Value Function” enter

S  c2 VGPL S

Where

S represents the Stream Number

 is the key combination which allows more than one statement on a line  
 c2 VGPL S is grams per litter (gpl) of component two (H2SO4) in the Stream

ALT ~

DISPLAY VALUE FUNCTIONS

Enter Value Function to Replace Stream Numbers on Flowsheet.  
 For example:  
 Stream Labels VLAB S  
 Tonnes per Hour VMTH S  
 80% Passing Size VP80 S  
 Copper gpl e29 VGLE S

To Enter More Than One Item, Separate Each with a ? (Alt ?).  
 For example:  
 Temp and Pressure VTEM S ? VPSI S

Note: Use capital S for all stream numbers.

Display Description  
 DS:

Display Value Function  
 VF:

ND:  Number of decimal places

OK Cancel Help

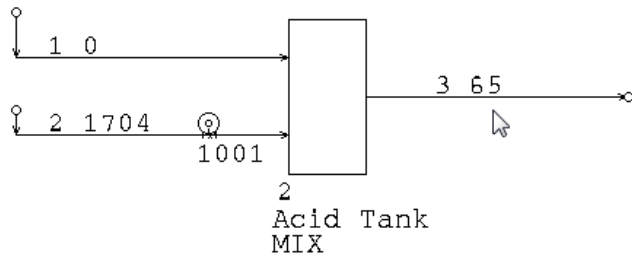
Clicking OK when you are finished entering the Value Functions to be entered calls up the following window.

DISPLAY FUNCTION

STREAM NO.	S
Stream Label	VLAB S
MASS FLOW TOTAL	VSTR S
MASS FLOW GASES	GC VSTR S
MASS FLOW LIQUID	LC VSTR S
MASS FLOW SOLIDS	SC VSTR S
% Solids	100xVPCS S
VOLUME M3/HOUR	VCMH S
TEMPERATURE C	VTEC S
PRESSURE kPa	VKPA S
Controlled Temperature	STQ[S;ITMP]
STREAM NUMBER AND ACID gpl in STREAM	S ? c2 VGPL S

Edit List Display Level Exit

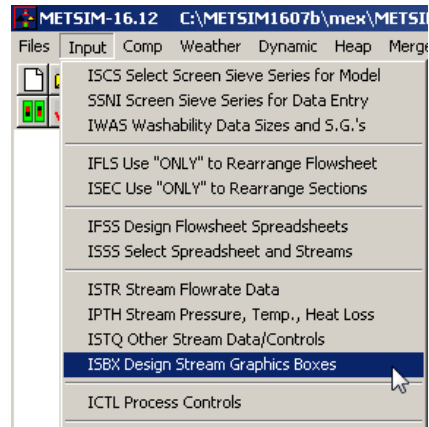
Click on the Display you just created to have it displayed on the streams.



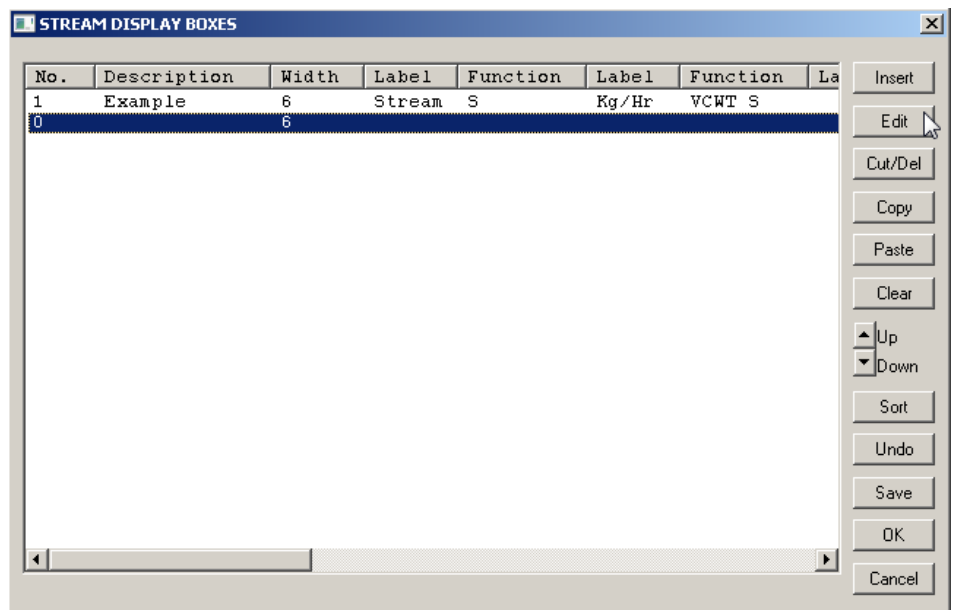
ACID MAKEUP SECTION      STREAM NUMBER AND ACID gpl in STREAM

### Design GRAPHIC STREAM BOXES

To design Graphic Screen Boxes select the “INPUT Menu” and then “ISBX Design Graphic Screen Boxes”.



This will call up the following List Screen.



To add a new Graphic Screen Box highlight a blank line in the List Screen and Click the “Edit” Button. This will call up the following Entry Screen.

Enter Design of Stream Box Data for Flowsheets

NO  \* Stream Box Number

BX  \* Stream Box Description

CW  \* Numeric Column Width

L1  Label 1

F1  Value Function 1

L2  Label 2

F2  Value Function 2

L3  Label 3

F3  Value Function 3

L4  Label 4

F4  Value Function 4

L5  Label 5

F5  Value Function 5

L6  Label 6

F6  Value Function 6

L7  Label 7

F7  Value Function 7


L8  Label 8

F8  Value Function 8

L9  Label 8

F9  Value Function 9

OK Cancel Help

With the “EDIT OBJECT DATA” Tool  click on the stream where you want the Graphic Display Box to be displayed. The following window is activated.

Stream 3

Description

Output Level  Design Factor  Maximum Flow

Box Number    Variables 1 2 3

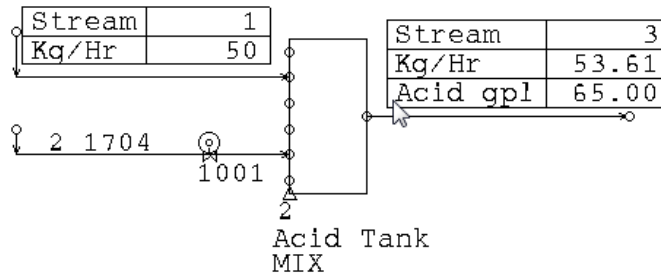
PRODUCT

OK Cancel


Product	Label	RC/HR	Wt. Frac.	gpl	RC/HR	Wt. Frac.	gpl	RC/HR			
SOLIDS	0		H2O	0.9374323	973.87529	50.252454	H	1	0.1061859	110.31396	5.6922557
SLD-ORG	0		H2O4	0.0625676	65.000002	3.3540328	O	8	0.8733591	907.31121	46.817714
AQUEOUS	53.606487						S	16	0.0204549	21.250126	1.0965172
ORGANIC	0										
MOLTEN	0										
MATTE	0										
SLAC	0										
GAS	0										
TOTAL	53.606487										

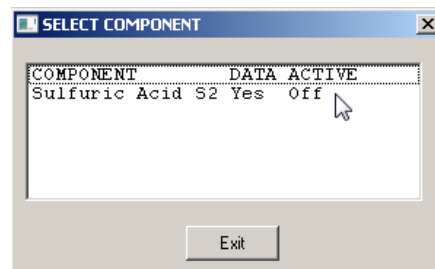
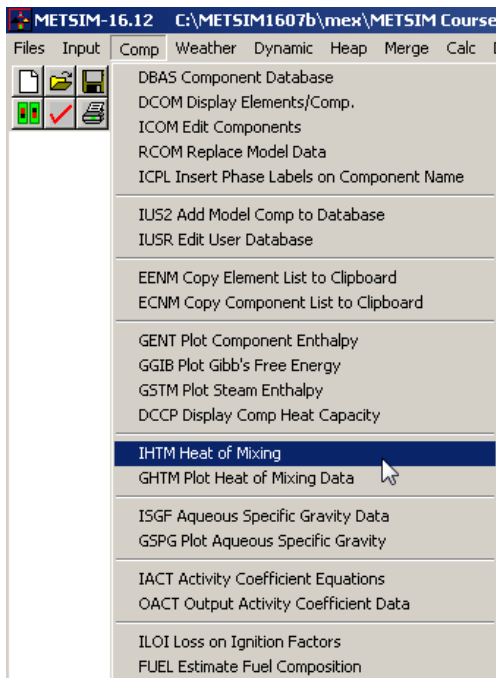
Enter the Box Number of the Graphic Screen Box you wish to use in the “BOX NUMBER” field then click OK.





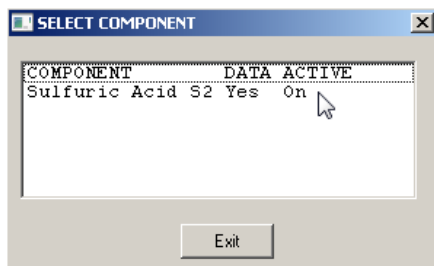
**Turning on the Heat Balance Module and Heat Of Mixing.**

- A. Click on the **Model Parameters Button** . A window appears with a number of clickable tabs.
- B. Click on the **Calc Options Window** and check the box next to Heat Balance and Heat Of Mixing Switch. Click OK to close the Menu.
- C. From the **COMP Menu** select “ITHM Heat Of Mixing”.

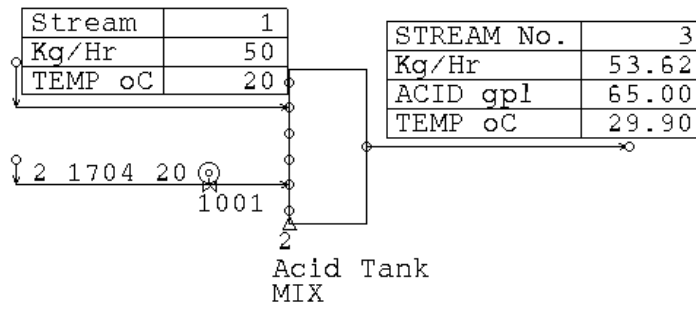


The window which is called up displays the Aqueous components and if they have “HTM-Heat Of Mixing Data” and if it is Activated. The above window shows Sulfuric Acid has HTM data but is not Activated.

To Activate the data click on the Sulfuric Acid in the List and a window displaying the HTM data for Sulfuric Acid is called up. Clicking OK Activates this data and returns you to the previous Window which now shows the Sulfuric Acid is Active.



SAVE the flowsheet then CALCULATE and view the results to see the temperatures in the streams.



ACID MAKEUP SECTION STREAM NUMBER, ACID gpl in STREAM & TEMP °C

Acid Tank - Stream Mixer  
Mass & Heat Balance with FBC & DDE

STREAM DATA

AQUEOUS - KG/HR

NO. STREAM	H2O	H2SO4
1 Water Feed	50.0000	0.00000
2 Acid 93%	0.2531	3.36284
3 PRODUCT	50.2531	3.36284

AQUEOUS - WEIGHT PERCENT

NO. STREAM	H2O	H2SO4
1 Water Feed	100.000	0.0000
2 Acid 93%	7.000	93.0000
3 PRODUCT	93.728	6.2721

AQUEOUS - GRAMS PER LITER

NO. STREAM	H2O	H2SO4
1 Water Feed	998.259	0.00
2 Acid 93%	128.270	1704.15
3 PRODUCT	971.336	65.00

HEAT BALANCE SUMMARY - 1 KILOCALORIES/HOUR

OP PROCESS STEP	INPUT STREAM	HEAT REACT	HEAT SOLUT	ENERGY INPUT	HEAT LOSS	HEAT REQD	OUTPUT STREAM	TOTAL
1 ACID MAKEUP SECT	0	0	0	0	0	0	0	0
2 Acid Tank	-257	0	508	0	0	0	-251	0

HEAT OF REACTION - 1000 KILOCALORIES/HOUR

NO PROCESS STEP -----TOTAL-----/MOLE---REACTION-----

STREAM TEMPERATURES AND ENTHALPIES

NO. STREAM	TEMP-C	TEMP-F	KCAL/HR	BTU/HR	KJ/HR
1 Water Feed	20.0000	68.0000	-250.00000	-991.00000	-1044.0000
2 Acid 93%	20.0000	68.0000	-7.00000	-27.00000	-29.0000
3 PRODUCT	29.9004	85.8207	251.00000	997.00000	1052.000