

EZZE TOWER SIMULATION REPORT

URCOMPANY

UR TOWN & STATE

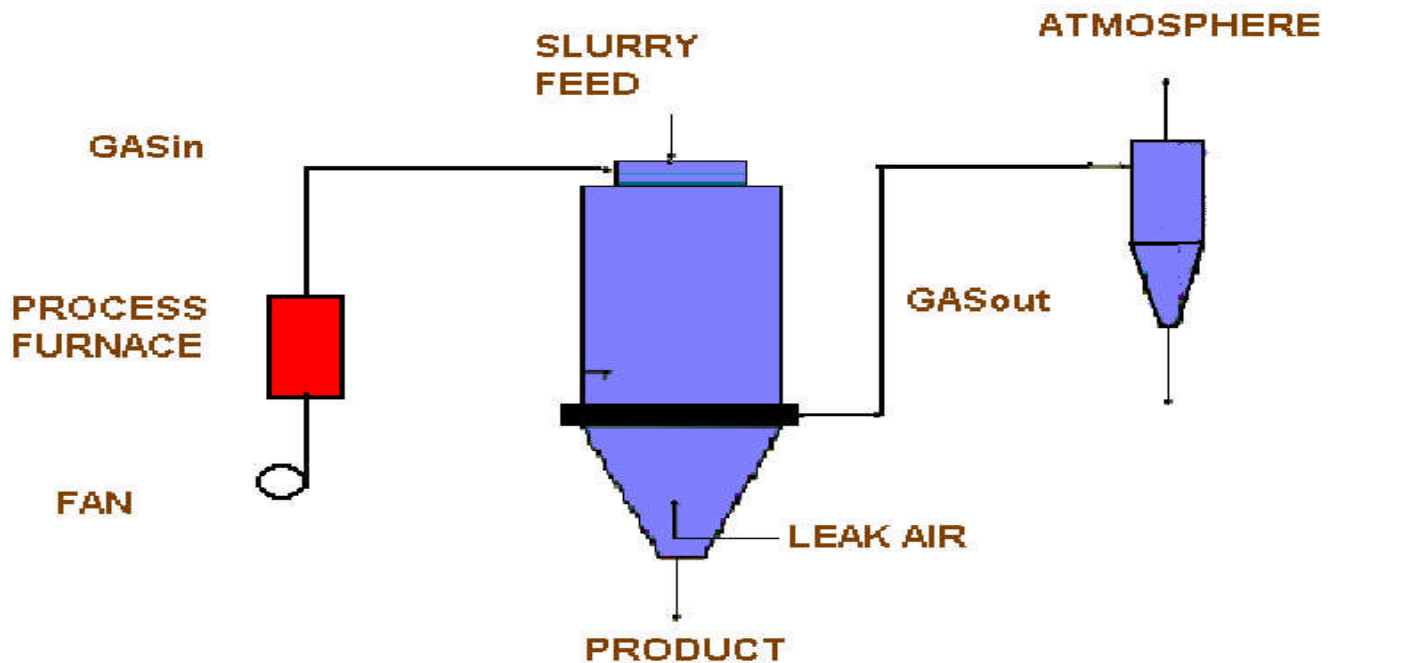
SIMULATOR TEST SUMMARY

PRODUCT 9G # OF TRIALS 5 ENERGY USAGE BTU/lb 1178.49

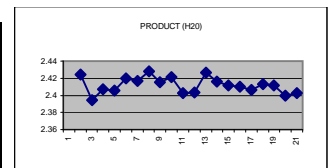
SIMULATION OBJECTIVE	Develop an accurate Simulation of the URTOWN Tower for use as a Process improvement tool.	SIMULATION RECORD	
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PROCESS CONDITIONS	FEEDRATE	water	GAS Tin	GAS Tout	PRODUCT	water
	9900	24.88	800.00	233.78	7619.29	2.40

SIMULATOR DATA REPORT



PROCESS VARIABLE	PROCESS STATISTICS				PROCESS VARIABLE USL	
	LSL	PROCESS VARIABLE	σ_{pop}	Cpk		μ_{range}
2		PRODUCT (H2O)	0.00935251	13.12269748	0.008991604	2.8
24		SLURRY (H2O)	0.11184609	2.457050295	0.12005666	26
190		EXHAUST (TOF)	4.418993934	1.845862607	4.794266641	250



PROCESS OPERATION MASS AND ENERGY BALANCES					
HEAT BALANCE	Btuh	%	TOTAL EXIT AIR @ Tout	LB	CuFt
FURNACE LOSSES	596815.6941	11.99%	AIR	16128.90817	262739.914
HEAT LOSS POWDER	522988.2819	10.51%	WATER	2333.551951	130982.271
HEAT LOSS AIR OUT	1231322.02	24.73%	CO2	634.2344006	887.9281608
HEAT LOSSES WATER	2311952.532	46.44%	N2	2171.895938	121908.519
HEAT LOSSES TOWER	315355.3358	6.33%	TOTAL/HOUR	21268.59045	516518.6322
TOTAL	4978433.864	100.00%	TOTAL/MINUTE	354.4765076	8608.643869

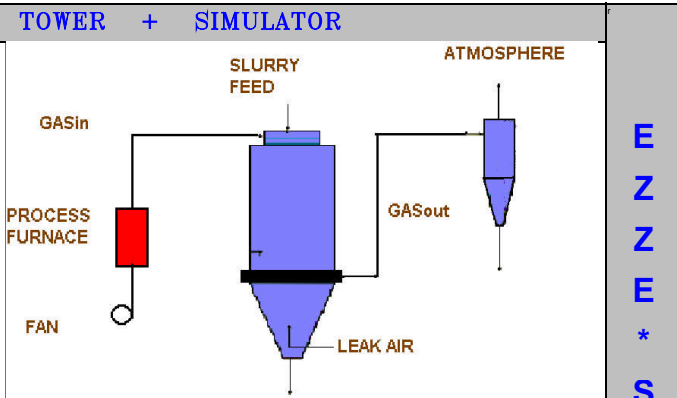
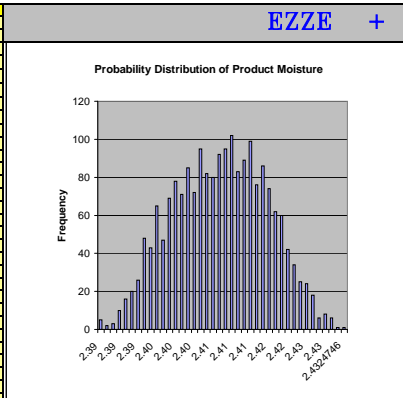
PREPARED 01/18/06

SUBMITTED BY GANDALF

EZZE + TOWER + SIMULATOR

EQUATION	PROGRAM	USER NAME	Probability (Profit%)	X
SIMPORtal	M1	30	Close to 100%	(72756.70)
SIMPORtal	M2	30	95%	2.39
Mvm	M3	9900	90%	2.40
SIMPORtal	M4	0	85%	2.40
pdf factor	M5	0	80%	2.40
hstar @ 200C	M6	0.01488	75%	2.40
RE3RC	M7	0.009	70%	2.40
Tout@Tamb	M8	0.7856	65%	2.40
Mout	M9	16708.60466	60%	2.41
Mrec	M10	0	55%	2.41
(Main)p	M11	16708.60466	Median = 50%	2.41
Mia	M12	12472.9853	45%	2.40
Mb1	M13	12472.9853	40%	2.41
Tb1	M14	68	35%	2.41
Meha	M15	16128.90817	30%	2.41
Qairb1	M16	96348.82228	25%	2.42
Qhot	M17	3745153.88	20%	2.42
Mfc	M18	198.91902	15%	2.42
FS	M19	2.508102421	10%	2.42
M0	M20	0	5%	2.42
M1	M21	0	Close to 0%	2.43
M2	M22	0	Close to 0%	2.41
M3	M23	0	Close to 0%	2.41
M4	M24	0	Close to 0%	2.41
M5	M25	0	Close to 0%	2.42
M6	M26	0	Close to 0%	2.42
M7	M27	0	Close to 0%	2.42
M8	M28	0	Close to 0%	2.42
M9	M29	0	Close to 0%	2.42
M0	M30	0	Close to 0%	2.42
M1	M31	0	Close to 0%	2.42
M2	M32	0	Close to 0%	2.42
M3	M33	0	Close to 0%	2.42
M4	M34	0	Close to 0%	2.42
M5	M35	0	Close to 0%	2.42
M6	M36	0	Close to 0%	2.42
M7	M37	0	Close to 0%	2.42
AIR CFH/W	M38	16.29		2.43
WATER	M39	56.13		2.43
CO2	M40	1.4		2.43
N2	M41	56.13		2.43
EXIT AIR @TouT	CFH			
HOT AIR	16128.90817	262739.914		
WATER	2333.551951	130982.271		
CO2	634.2344006	887.9281608		
N2	2171.895938	121908.519		
T(GASOUT)	21268.59045	516518.6322		
GAS OUT	CFM	8608.643869		

Moisture	Frequency
2.39	5
2.39	2
2.39	3
2.39	10
2.39	16
2.39	20
2.39	26
2.39	46
2.40	43
2.40	65
2.40	47
2.40	69
2.40	78
2.40	71
2.40	85
2.40	72
2.41	95
2.41	82
2.41	80
2.41	92
2.41	95
2.41	102
2.41	83
2.41	89
2.41	99
2.42	76
2.42	86
2.42	74
2.42	82
2.42	80
2.42	60



WHICH DISTRIBUTION TO USE?	DESCRIPTION
NORMAL	"bell-shaped curve" which is symmetrical about the mean used in statistics as an approximation to sampling distributions. In general, the normal distribution provides a good model for a random variable.
EXPONENTIAL	Time is distributed exponentially with parameter λ (lambda), often used as a model of time-to-failure measurements, when the failure (hazard) rate is constant over time.
UNIFORM	Flat or Constant - Use a constant value (a flat distribution curve) if there is thought to be little or no variation in the distribution.
TRIANGULAR	Use a triangular distribution if you know very little about the distribution. The Triangular Distribution Function can be completely defined by knowing the absolute minimum value, the most likely value, and the absolute maximum value. It can also be easily skewed to match reality.
BINOMIAL	is useful for describing distributions of binomial events, such as the number of males and females in a random sample of companies, or the number of defective components in samples of 20 units taken from a production process.
GEOMETRIC	Used for modeling rates of occurrence.
WEIBULL	Used for modeling time to failure when failure probability varies over time (see exponential). Often used in reliability testing of components (bearings, relays, etc.).
LOG NORMAL	Useful when the raw data are highly skewed, whereas the natural log of the data are normally distributed.
POISSON	distribution of rare events (photo win, etc) or cat number of catastrophic process defects.

PROCESS VARIABLE	LSL	USL
2		
24		
190		

ENERGY BALANCE	PROCESS CONDITIONS
FURNACE LOSSES 596815.6941 11.99%	SLURRY FEED 9900
TOWER LOSSES 315355.3358 6.33%	%H ₂ O 24.88204224
POWDER LOSSES 522988.2819 10.51%	EXHAUST TEMP 233.78
HEAT ON EXIT 1231322.02 24.73%	PRODUCT OUT 7619.293151
WATER EVAPORATE 2311952.532 46.44%	%H ₂ O 2.396749009
TOTAL 4978433.864 100.00%	FUEL USAGE 203.9338909

PROCESS VARIABLE	LSL	USL
2		
24		
190		

PROCESS VARIABLE	LSL	USL
2		
24		
190		

TESTING TEMP. NOTES
DETERGENT SPRAY TOWER SIMULATION ASSUMPTIONS
SLURRY FEED(SF) = Q (lbs/hr); Q RANDOMIZED TO LIMITS
SLURRY MOISTURE (SF(H ₂ O)) IS SET TO VC DISTRIBUTION THIS VALUE IS USED IN THE SIMULATION SEE NEXT
CORRELATION EQUATION USED FOR THIS SIMULATION FG(%H ₂ O)=SF*0.000075+SF*(H ₂ O)*0.0074-Tout*0.0008
ASSUMING NO MATERIAL LOSS & HAVE 5% AIR LEAK BUILD IN
BUNKER C: FUEL ASSUMED - IF CHANGED THEN MOISTURE FROM FUEL, NITROGEN/CO2 MIXTURE CHANGES - SEE BELOW
PROCESS DRYING PRACTISE - PAGES 82-83 FUEL MIXTURE CALCULATIONS DIRECT FIRED HEATER

SIMULATION VARIABLES, CONSTANTS AND EQUATIONS

EQUATION VARIABLES	VALUE	PROGRAM	USER NAME	VALUE	PROGRAM	USER NAME	VALUE	PROGRAM	USER NAME	VALUE	PROGRAM	USER NAME	VALUE	PROGRAM	USER NAME	VALUE	PROGRAM	USER NAME	VALUE	DISTRIBUTION	
h2a	47.42																				
portal	2.90																				
h1a	199.40																				
h1w	144.30																				
h2w	1136.00																				
h3a	1452.30																				
cpn2	0.27																				
cpco2	0.28																				
cpmwe	0.56																				
cpdm	0.32																				
cpmtr	0.39																				
cpzo	1074.80																				
cp	0.53																				
TI	140.00																				
CI	17.90																				
Ma1r	17.83																				
Q(H2O)	806691.00																				
Q(H2)	1278172.00																				
Q(CO2)	399424.00																				
Q(ha)	6039796.50																				
Q(ouT)	8523083.50																				
Q(in)	800.00																				
Q(ouT)	233.78																				
Qa	68.00																				
Qm	176.00																				
Qm	176.00																				
Qf	140.00																				
Qsp	4.98																				
Qsp	0.2407																				
Mout	41900.00																				
Mh20	10.42																				
Mh2	10.66																				
Mco2	3.11																				
P1	XXX																				
P2	XXX																				
h1a	199.43																				

EZZE * SIMULATOR

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WARRANTY

The author is not liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance or use of this material. **All technical application software is inherently complex and users are cautioned to verify the results.**

TERMINOLOGY

In the EZZE SIM program there is some terminology used which may not be familiar to you. Definitions and significance of calculated parameters can be found in the references listed below or the tutorial.

TECHNOLOGY

EZZE SIM contains two Monte Carlo Dryer (fluid bed & spray) simulations which use random process variable distributions, process correlations and process theory to emulate reality. The simulations can be used for your drying application or as templates to assist you in the development of your own process simulation. If your process can be described mathematically (mass - energy - process correlations) you can simulate the process!

Without the aid of simulation, a spreadsheet model will only reveal a single outcome, generally the most likely or average scenario. Spreadsheet risk analysis uses both a spreadsheet model and simulation to automatically analyze the effect of varying inputs on outputs of the modeled system. This is the power of simulation - you can try it first on the simulator to determine if there are any 'potential problems' to be resolved before trying it in the real world.

FYI QUOTE IN REPORT DELIVERED AT A SIMULATION CONFERENCE - WINTER 2002, SWEDEN

Despite significant cost savings and the stride towards developing and implementing the Virtual Factory, few companies have managed to fully integrate simulation as a daily tool in their engineering processes.

EZZE SIM REFERENCES

1. Masters, K., Spray Drying Handbook, John Wiley & Sons, New York, 1991
2. [Http://www.nzfst.org.nz/unitoperations/index.htm](http://www.nzfst.org.nz/unitoperations/index.htm)
3. [Www.spraydrying.net/About_Nubilosa/Spray_Drying/spray_drying.htm](http://www.spraydrying.net/About_Nubilosa/Spray_Drying/spray_drying.htm)
4. Fluidised-Bed Paddy Drying, Somchart Soponronnari, Science Asia 25(1999):51-56
5. Cook, E. Process Drying Practise, McGraw-Hill, New York 1985
6. [Www.taygeta.com/random/gaussian.html](http://www.taygeta.com/random/gaussian.html) 'Generating Gaussian Random Numbers'
7. [Www oulu.fi/atkk/tkpalv/unix/ansys-6.1/content/thy_pds.html](http://www oulu.fi/atkk/tkpalv/unix/ansys-6.1/content/thy_pds.html) 'Probabilistic Design'

1 USERS NOT FAMILIAR WITH SPC/SIMULATORS SHOULD REFER TO OTHER SOURCES FOR MORE DETAILED INFORMATION TO ENSURE YOU HAVE THE TOOLS TO UNDERSTAND AND CAN INTERPRETE DATA PROVIDED BY THE EZZE SIM TEMPLATE

2 READ "TUTORIAL" BEFORE USING THE EZZE SIM PROGRAM

3 DATA ENTRY

DATA ENTRY CELLS ARE HIGHLIGHTED

ALL CELLS CAN BE MODIFIED

CALCULATED DATA IS HIGHLIGHTED

ALL CELLS LINKED IN CALCULATIONS

PLEASE ENTER DATA THROUGH THE SIMULATOR PAGE

4 SHEETS THIS PROGRAM

HELP	MACRO INDEX & USEFUL INFORMATION
READMEFIRST	THIS PAGE WHICH INCLUDES
	THEORY & HOW TO USE THE PROGRAM
SIMULATOR	SIMULATION WORKSHEET "spray dryer"
SIMULATOR2	SIMULATION WORKSHEET "fluid bed dryer"
SIMULEQ	EQUATIONS USED THIS SIMULATION
SIMULATIONREPORT	SIMULATION REPORT
SIMULATIONREPORT2	SIMULATION REPORT2

5 GO TO THE TUTORIAL NEXT -IT'S PART THEORY AND PART HOW TO DO
 BUT BE SURE TO GET REFERENCE BOOKS TO HELP YOU USE THIS PROGRAM
 also check the HELP PAGE It contains macros to move quickly within the template and print reports plus
 useful data for your simulation work.

HOW TO USE EZZE SIM

**CAUTION - THE PROGRAM IS NOT COPY PROTECTED. THIS ENABLES YOU TO
 MODIFY AND/OR CREATE A SIMULATOR & FINE TUNE IT TO MAKE AN ACCURATE MODEL OF YOUR PROCESS.
 KEEP A CURRENT BACKUP BEFORE YOU MAKE CHANGES
 MAKE YOUR CHANGES AND DON'T WORRY - YOU STILL HAVE A WORKING COPY**

**NOTE:- SPECIAL FEATURE CHECK THE HELP PAGE FOR FAST NAVIGATION MACROS TO THE SHEETS
 LISTED ABOVE FROM ANYWHERE WITHIN THE SPREADSHEET**

;
 NOW SOME THEORY

What is a Monte Carlo simulation?

Monte Carlo Simulation is named after the famous Casino in the Mediterranean Principality of Monaco. However, the use of the name "Monte Carlo" does not mean to imply that the method is either a "gamble" or "risky". It simply refers to the manner in which individual numbers are selected from valid "representative collections of input data" so they can be used in an iterative calculation process. These "representative collections of data" are some sort of a "Frequency Distribution" that is converted to a Probability Distribution. Monte Carlo Simulation methods are primarily used in situations where:

- The system being studied can be mathematically described by a metric, which **can be either** parametric **or** anal
- The Input Data can be written as some sort of a frequency distribution.
- The "answer", or Output, must accurately represent the Input Data;
- The calculated distribution histogram of the "answer", or Output, must accurately reflect the Input data; and
- The calculated uncertainty in the "answer", or Output, must be an accurate measure of the validity of the model.

Since **Monte Carlo** is a Simulation technique, let's first define exactly what we mean by **Simulation**.
A true Simulation will merely describe a system, not optimize it!

(However, it should be noted that a true simulation may be modified in a manner such that it can be used to significantly enhance the efficiency of a system.)

Therefore, our primary goal in Simulation is to build an **experimental model** that will accurately and precisely describe the **real system**.

Monte Carlo Simulations are "**True Stochastic Simulations**" in that they describe the "final state" of a model by just knowing the frequency distributions of the parameters describing the "beginning state" and the appropriate metric that maps, or transforms, the beginning state to the final state. They can also be either static (easy) or dynamic (more difficult). If a prediction were required, then "every possible" option would have to be considered with a number of iterations for each required.

Statistical simulation methods may be contrasted to conventional numerical discretization methods, which typically are applied to ordinary or partial differential equations that describe some underlying physical or mathematical system. In many applications of Monte Carlo, the physical process is simulated directly, and there is no need to even write down the differential equations that describe the behavior of the system. The only requirement is that the physical (or mathematical) system be described by probability density functions (pdf's). For now, we will assume that the behavior of a system can be described by pdf's and process parameter equations(see below). Once the pdf's are known, the Monte Carlo simulation can proceed by random sampling from the pdf's. Many simulations are then performed (multiple ``trials" or ``histories") and the desired result is taken as an average over the number of observations (which may be a single observation or perhaps millions of observations).

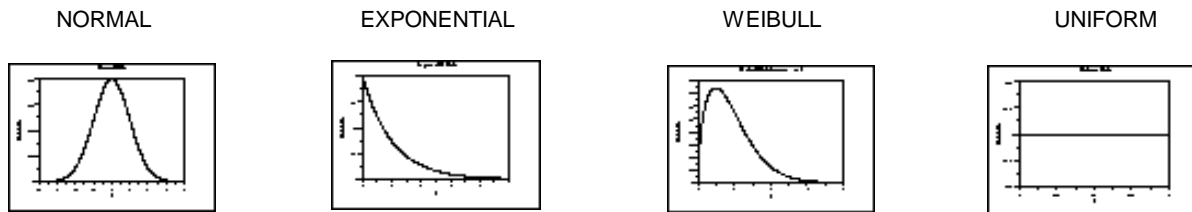
What happens during a simulation?

EZZE SIM has two programs "controlling the simulation" - the process equations within the spreadsheet which define the interactions and operation of the DRYER and the VBA (simulator) program which turns the static process equations into an active entity with change defined by distribution functions and correlation

The VBA program is used by both Simulator programs and interfaces with the simulation sheets at cell locations defined in the VBA program. In EZZE SIM these locations are identified and must be used for the simulation to work properly. This will be explained in more detail later.

A simulation calculates multiple scenarios of a model by repeatedly sampling values from the probability distributions for the uncertain variables and using those values for the cell.

For each uncertain variable (one that has a range of possible values), you define the possible values with a probability distribution. The type of distribution you select is based on the conditions surrounding that variable. Distribution types include:



To add this sort of function to an Excel spreadsheet, you would need to know the equation that represents this distribution. With EZZE SIM, these equations are automatically calculated for you. In addition, you can specify distribution limits for your variables, optimize random number generation for up to four discrete distribution controlled variables. For two 'controlled' variables (e.g.. slurry feed rate, inlet gas temperature) you can simulate controller "noise" by having the controlled variable randomly vary between limits you preselect. In addition to the 6 random variables you can input 28+ constants into 40+ user defined process equations. This can be increased by 40 if the MISCELLANEOUS VARIABLE SECTION IS USED. It should be noted that the spreadsheet equations use standard Excel functions and arguments

The Simulator page has a table of probability distributions to consider using in your simulation. Each has a brief description of where, when and how you would use them. The ones of special interest to this simulator are highlighted. To apply a specific variable simply cut and paste the equation into the VARIABLE DISTRIBUTION section. Check the distribution parameters, random number parameters and adjust to suit your variables normal 'reading range'. Run your Simulation by left clicking the "RUN SIMULATION" button on the SIMULATOR KEYPAD.

WHICH DISTRIBUTION TO USE?	
NORMAL	"bell-shaped curve" which is symmetrical about the mean used in statistics as an approximation to sampling distributions. In general, the normal distribution provides a good model for a random variable.
EXPONENTIAL	time is distributed exponentially with parameter λ (lambda). often used as a model of time-to-failure measurements, when the failure (hazard) rate is constant over time.
UNIFORM	1. Flat or Constant - Use a constant value (a flat distribution curve) if there is thought to be little or no variation in the distribution.
TRIANGULAR	Use a triangular distribution if you know very little about the distribution. The Triangular Distribution Function can be completely defined by knowing the absolute minimum value, the most likely value, and the absolute maximum value. It can also be easily skewed to match reality.
BINOMIAL	is useful for describing distributions of binomial events, such as the number of males and females in a random sample of companies, or the number of defective components in samples of 20 units taken from a production process.
GEOMETRIC	if independent Bernoulli trials are made until a "success" occurs, then the total number of trials required is a geometric random variable.
WEIBULL	exponential distribution often used when the failure rate is constant over time. When failure varies over time, then the Weibull distribution is used. Thus, Weibull is often used in reliability testing (bearings, relays, valves, etc.).
LOG NORMAL NOT ACTIVATED	The log-normal distribution is often used in simulations of variables such as personal incomes, age at first marriage, or tolerance to poison in animals.

VARIABLE DISTRIBUTION				DISTRIBUTION
PROGRAM	USER NAME	VALUE	LIMITS	
RANDOM	r(min)	0	81.75	
NUMBER	r	0.34755539	XXX	
GENERATOR	r(max)	1	73	
D1(V)	NORMAL	2.466072289	XXX	
RANDOM	r(min)	0	9.6	
NUMBER	r1	0.635578967	XXX	
GENERATOR	r(max)	1	XXX	
D2(P)	NORMAL	1.194225814	XXX	
RANDOM	r(min)	0	0.68	
NUMBER	r2	0.817459853	XXX	
GENERATOR	r(max)	1	XXX	
D3(Z)	GEOMETRIC	-85.34794735	XXX	
RANDOM	r(min)	0	190	
NUMBER	FUTURE	0.70755290	XXX	
WORK AREA		1	245	
D4(Y)	TRIANGLE	-817.5	XXX	

seconds. Time depends on computer configuration, complexity of your simulation and the number of iterations you wish to run for each scenario. During a single trial, EZZE SIM randomly selects a value from the defined possibilities (the range and shape of the distribution) for each uncertain variable and then recalculates the spreadsheet.

HOW DO YOU ANALYZE THE RESULTS OF A SIMULATION?

For every spreadsheet model, you have important outputs that you want to simulate and analyze. you define those outputs as **forecasts**.

A forecast is a formula or output that you want to simulate and analyze. In EZZE SIM you can watch a histogram of that output quite simply. Assume that the value you wish to track is located at M54. To track it go to cell p55 (E3) and enter "=M54". Cell P55 is a portal to the program for tracking values and generating a histogram. Associated with the histogram is cell F56(FAIL BENMK) this is where you enter the success or failure limit for the histogram.

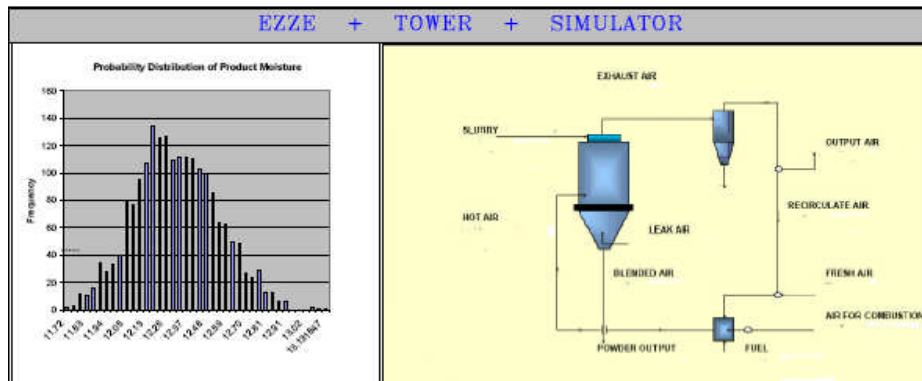
EQUATION VARIABLES	DISTRIBUTION CONSTANTS		
	PROGRAM	USER NAME	VALUE
NCVFh	C1	HEAT FUEL(Btu/lb)	17713.00
h3a	C2		8.64
h2a	C3		47.42
portal	C4	FAIL BENMK	12.90
h1a	C5	ENTHALPY inlet air	199.40
h1w	C6	ENTHALPY twater feed	144.30

The program is limited to generating 1 histogram per simulation. To generate another value(variable) use the "=" method to refer the next variable to the histogram portal and click the run simulation button.

PROGRAM	USER NAME	VALUE	PROGRAM	USER NAME	VALUE
E1	PRODUCT(FG)	3987.551711	non var	FG(%H2O)	12.25356694
E2	WATER(W off)	6186.448289	P	FG(%H2O)	12.07666832
E3	HISTOGRAM	12.25356694	VC	SF(%H2O)	65.00906454
E4	REQ. HOT AIR	43749.88236	Z	Z	42.23306453
E5	HEAT EVAP WATER	8723726.543	Y	Tout	202.8814363
E6	OUTLET AIR HEAT	1896401.888	RANDOM FIXED VARIABLES		
E7	TOTAL HEAT	10420128.23	PROGRAM	USER NAME	VALUE

In addition to the histogram, EZZE SIM creates CONTROL CHART DATA of the variable of interest in the simulation plus process SPC data for the studied variable plus 2 other variables select by you using the cell = link To the following program graphics portals F88 & F89. Spec limits for these variables are linked to the data and used to calculate SPC data. Imbedded on the worksheets are graphs of the variables for visual correlation checks of any 2 variables linked to the program portals. THE GRAPHS ARE ALSO LOCATED ON THE SIMULATION CHARTS & REPORT PAGES AS LINKED DATA

PROCESS STATISTICS			
PROCESS VARIABLE	σ_{pop}	Cpk	μ_{range}
PRODUCT (H ₂ O)	0.271641701	0.888202913	0.282297501
SLURRY (H ₂ O)	2.024349857	0.472786919	2.495714151
EXHAUST (T ^o F)	16.97052128	0.393266366	20.62748075



b

c

The program also calculates energy and gas balances and links this data to your report sheet.

HEAT BALANCE	Btuh	%	TOTAL EXIT AIR @ Tout	LB ³	CFH
FURNACE LOSSES	1430114.255	13.31%	AIR	39351.60796	641037.8937
HEAT LOSS POWDER	300876.7867	2.80%	WATER	11078.09795	621813.6382
HEAT LOSS AIR OUT	3068549.77	28.55%	CO2	1645.610021	2303.854029
HEAT LOSSES WATER	5840744.479	52.48%	N2	5635.288334	316308.7342
HEAT LOSSES TOWER	308501.2758	2.87%	TOTAL/HOUR	57710.60427	1581463.92
	10748586.57	100.00%	TOTAL/MINUTE	961.8434046	26357.732

A RECYCLE GAS MODULE IS AVAILABLE TO EVALUATE RECYCLE RATIOS FOR THE SPRY DRYER SIMULATION.

RECIRC	M5	AIR OPTIMIZE
Rhair@20OC	M6	0.01488
RECIRC	M7	60.00%
Tout>Tamb	M8	0.7856
Mout	M9	28354.98931
Mrec	M10	17012.99359
(Mair)Ip	M11	11341.99573
Mfa	M12	3458.757759
Mbl	M13	20471.75135
Tbl	M14	205.39633

MOUT	M9	28354.98931
Mrec	M10	17012.99359
(Mair)lp	M11	11341.99573
Mfa	M12	3458.757759
Mbl	M13	20471.75135
Tbl	M14	205.39633
Meha	M15	26973.87078
Qairbl	M16	982206.7552
Qtot	M17	5442294.918
Mfc	M18	307.2486263
FS	M19	15.28845045
	M20	

HOW DO YOU CHANGE INPUTS? (fluidised bed dryers also)

There are four variables which randomly change within the simulation, three (slurry and dry product moisture plus exhaust gas temp) are pdf, One (slurry feedrate) is a random fixed variable. PDF INPUTS ARE CHANGED BY CHANGING THEIR MEAN AND DISTRUBUTION LIMITS. FOR SLURRY WATER CONTENT YOU COULD CHANGE ITS MEAN TO 50

SIMULATION VARIABLE	PROGRAM NAME	NORMAL	
		MEAN	Sd
VC'	DV1	65	2
P	DV2	12	0.1
	DV3	2	1
	DV4	230	5

NEXT CHECK ITS DISTRIBUTION LIMITS. THEY ARE 61.75 AND 73 OBVIOUSLY YOU WOULD HAVE A PROBLEM IF LOWER LIMIT IS NOT <50 AND CONVERSELY THE UPPER>50

VARIABLE DISTRIBUTION				DISTRIBUTION
PROGRAM	USER NAME	VALUE	LIMITS	
RANDOM	r(min)	0	61.75	
NUMBER	r	0.34755539	XXX	
GENERATOR	r(max)	1	73	
D1(Vc)	NORMAL	2.466072289	XXX	
RANDOM	r(min)	0	9.6	
NUMBER	r1	0.635576967	XXX	
GENERATOR	r(max)	1	XXX	
D2(P)	NORMAL	1.194225814	XXX	
RANDOM	r(min)	0	0.66	
NUMBER	r2	0.817459853	XXX	
GENERATOR	r(max)	1	XXX	
D3(Z)	GEOMETRIC	-65.34794735	XXX	
RANDOM		0	190	

FIXED VARIABLES YOU CHANGE THE OUTPUT VALUE + THE MIN AND MAX VALUES

RANDOM FIXED VARIABLES		
PROGRAM	USER NAME	VALUE
Q	SLURRY FEED (SF)	10174
QMIN	SFMIN	9800
QMAX	SFMAX	10400
Q1	Q1	99

For example if you change the feed rate to 9000 you must change the minimum and maximum values to "strattle" the feed value you wish to use.

FINE TUNING THE SIMULATOR

For each product you wish to simulate collect 8 hours of plant operating data (SPC charts, lab data,etc) **do correlation analyses of the data and establish at minimum one key correlation equation - eg.**

$$\text{PRODUCT MOISTURE} = X * W_{in} - (Y * T_{out} + Z * T_{out}^2) - (C * P + D * P^2) + E * F$$

X,Y,Z,C,D,E are constants for Win - water in slurry feed(F) at nozzle pressure (P) and exhaust temp (Tout)

The equation is entered into the program and we run a simulation. If we're lucky it will react like the actual unit if it doesn't -determine is it not at all or only occasionally & under what conditions etc. and make corrections to compensate for deviation then rerun the simulation. The goal is to create a simulation which approximates reality.

Simulations are done of each product in case there is a difference in their operating characteristics. If there is a difference, it may be an opportunity to optimize process settings by determining why settings are different especially if you cannot find an assignable cause/reason.

With an accurate simulator model you have a powerful process tool which can be used for process optimization and troubleshooting. With the simulator you can make plant experiments more efficient by prescreening your trial on the simulator to identify potential problems and reduce the amount of information required from the trial(experiment).

REPORTS

There are two reports (ie 1 report per simulator).- SIMULATOR REPORT & SIMULATOR REPORT (2) the reports are linked to the simulator worksheets and consequently require minimal setup THE MACROS FOR PRINTING REPORTS AND NAVIGATION IN THIS TEMPLATE ARE LISTED BELOW AND ON THE 'HELP PAGE. To find the the help page click alt - h.

MACRO LIST

ctrl +	ACTION
a	GO TO SUMULATOR START BUTTON
b	GO TO SUMULATOR(2) START BUTTON
c	GO TO SIM2REPORT
d	GO TO SIMREPORT
h	GO TO HELP PAGE
t	GO TO READMEFIRST TUTORIAL PAGE
q	PRINT SIM2REPORT
p	PRINT SIMREPORT

HOW TO CREATE A NEW SIMULATION

In order to create a new simulation you must 'lose' a simulation. There are two simulators to select from. In this template each of the simulations is comprised of two programs - the process equations within the spreadsheet which define the interactions and operation of the DRYER and the VBA program which interacts with the process equations through "portals" to bring the simulation to life. So what we want to do is replace the old process' equations with the new process equations and maintain the portals to interact with the VBA program to create the new simulation. Sounds complicated but its not - if you look at the two templates you will see one is multi stage (fluid bed) and the other single stage (spray dryer) processing. Make your template selection - now you are ready to create your simulator.

PLAN YOUR SIMULATION!

- 1 If you spend a few minutes laying out your simulator page you will make it easier to debug and reduce the probability of making mistakes (eg. Inconsistent units of measurement, spreadsheet cell reference errors, etc.).
- 2 Determine the links between your equations to assist you in laying out the equations in logical order.

- 3 Determine your key process variables and which ones do you wish to vary randomly and which will be secondary variables influenced by the primary (random) variables. As you will recall you can use a probability density function (pdf) to define how each random variable will vary.
- 4 Write/type your process equations and variables on paper - Many times a simple 'typo' will give you hours of grief . (HINT - Type your equations as "text" first Its easier to check for typos then if its in the formula bar. After you've checked you can cut and paste the text into a formula cell.). Check and recheck your brackets because a misplaced bracket can make a big difference - Excel highlights bracket couples when you scroll through the equation on the formula bar which tells you the order that Excel uses in processing your equation

PREPARING THE SIMULATION PAGE

- 5 In order to help you set up simulation you need to know where to find and how to use the portals to the VBA program. Following is a cell colour code to assist you.

NAME	+	NUMBER	=	GRAPHICS PORTAL (see above)
NAME	+	NUMBER	=	RANDOM VARIABLE NUMBER GENERATED BY VBA
NAME	+	NUMBER	=	RANDOM FIXED VARIABLE LIMIT USER ENTRY
NAME	+	NUMBER	=	NORMAL FORMULA OR CONSTANT USER ENTRY
NAME	+	NUMBER	=	NORMAL FORMULA OR CONSTANT USER ENTRY
NAME	+	NUMBER	=	NONLINKED USER DEFINES USE AND VALUE(NUMBER)
NAME	+	NUMBER	=	USED ENTRY LINKED TO VBA PROGRAM FOR ADVANCED USER PROGRAMING IN THE VBA PROGRAM. DEACTIVATED IF YOU KNOW HOW TO ACTIVATE YOU HAVE THE ABILITY TO USE IT
NAME	+	NUMBER	=	USER DATA ENTRY TO 'P' DISTRIBUTION FOR ADVANCED PROGRAMING DEACTIVATED SEE COMMENT ABOVE .

- 6 In the Simulator Page there are two areas which are useful areas to exercise care when you delete old simulator data. The area names are 'Process Simulator Summary' and 'Testing Temporary Notes.' The later is for you to jot reminder notes of what you are doing so that you can troubleshoot your simulation with a better understanding of what has been done or discovered while doing the simulation The former is a link to the simulator report and the spc graphs created in the program so checking the cell links to this area is especially useful in preparing your report and graphs.
- 7 The simulator page has a histogram graph which is linked to the data in the histogram portal and therefore should not be erased. In addition there is a picture file of a process flowsheet which is also used in the report page. This picture file can be erased and replaced by a picture file showing a flowsheet of your process. A flowsheet is not essential for your simulation but does make the simulation look more professional and easier for others to understand.
- 8 When you have reviewed the old sheet and have decided what you can use from the old data you may erase the old data in preparation for your data.
- 9 Enter all your process equations and constants in the following areas--- EQUATION VARIABLES, DISTRIBUTION CONSTANTS, AND MISCELLANEOUS VARIABLES **BEFORE entering variables in the RANDOM AND RANDOM FIXED VARIABLES REREAD THE SECTION ON HOW TO ENTER THESE VALUES IN THIS TUTORIAL.**
- 10 As you enter data and work with your simulator periodically save your file. It may seem to be a bother to do so until the first time you 'muck up royally' and lose cells due to accidental erasure etc.This is a good thing to do before you try your simulator for the first time.Pay special attention to the graphics portals. This is how you decide which parameters you wish to use to generate SPC data .
- 11 Once you have the simulator set up the how to use your simulator instructions should apply to your new simulator.

GOOD LUCK WITH YOUR SIMULATOR!

SUPPORT

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