BUTYRALDEHYDE TOWER CAPACITY LIMITATIONS

By

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The Main Distillation tower in the only Oxo Alcohol Plant in South America was revamped in 2005. The tower experienced capacity limitations from the start. A study of the column capacity was begun in 2005. New trays were provided in 2007. The capacity only increased marginally with the new trays. In 2008 another detailed capacity study was enacted including gamma scans of the tower. During this study, the top few trays showed unusual absorption on the Gamma Scans and buildup of water in the tower was suspected. The spare pump line was drained and found to be totally full of water. However, upon further draining, an abundance of foam came out of the spare pump line. This paper will detail the lessons learned from this experience and the ultimate solution to this very interesting tower.

Background

In 2005, Sulzer Chemtech revamped the i/n Butyraldehyde tower T-2103 from RV-1 round valve trays to Shell Calming Section Trays™ on a tray for tray basis. A study was made as to the projected performance of the new trays after the revamp. Part of this study encompassed a full review of the existing trays. The existing trays were normal straight downcomer valve trays. The downcomers occupied 6.2% of the tower cross-sectional area and tray spacing ranges between 400mm and 450mm. There are 90 trays in this 1900 mm ID tower. The existing trays were limited to 9.5 mT/h of feed flow and the observed tray efficiency was about 71%.

The new tray design incorporated 2 calming section boxes above the feed. Below the feed where more liquid loading is experienced there were 3 calming section boxes employed per tray. The designs are shown in Figure 1.

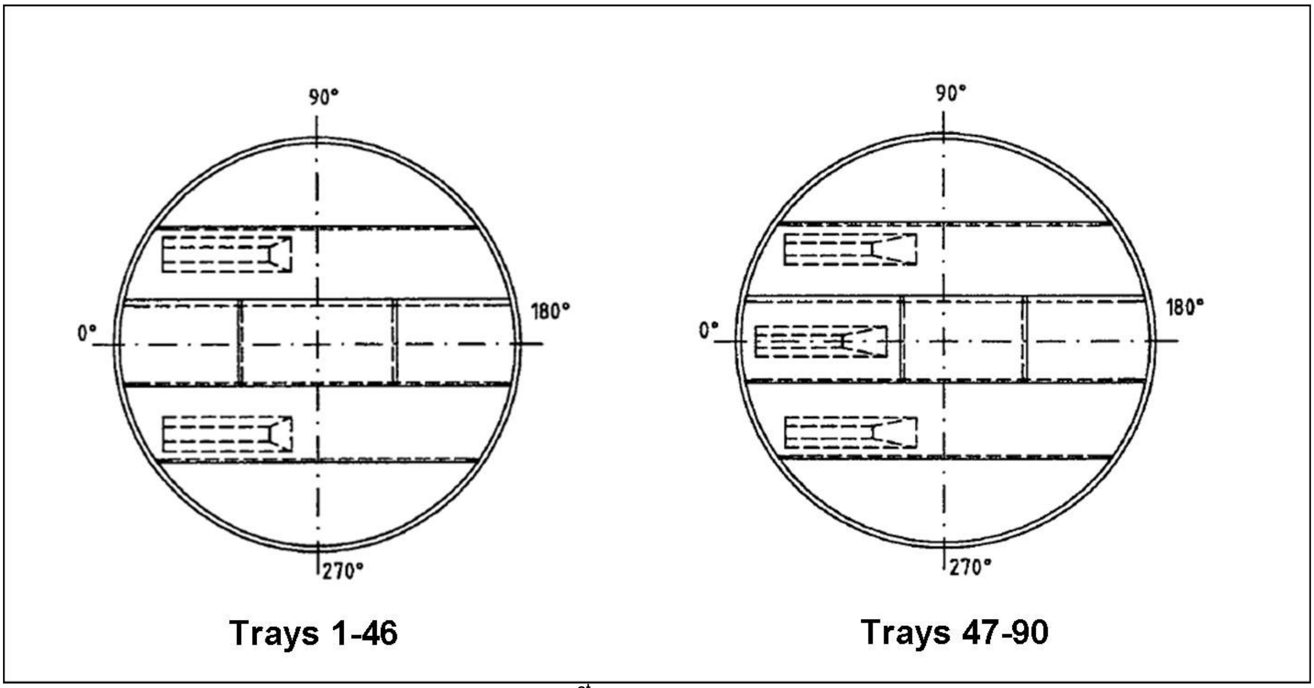


Figure 1 – 1st Tray Installation - 2005

Upon initial startup the tower was able to achieve improved capacity but the revamp was supposed to achieve a feed rate of 11.5 mT/h or about 20% more capacity. It was discovered that the reboiler return was not placing the thermosyphon return into the proper side of the bottom compartment and that the reflux return was not oriented correctly. This was corrected in May 2006, but the tower yielded no improvements. A visit to the plant followed. A thorough examination of the tower and ancillary equipment ensued. For example, the reflux feed and steam flow meters were all checked and found to be quite accurate(1).

A test of the tower was performed while the products were routed back to the feed tank. The overall steam load was increased to both reboilers while holding the reflux rate constant. As the overall steam load was increased from 6.9 T/hr up to 7.3 T/hr (a 5% change) it was noticed that the pressure drop increased only slightly (less than 1%). Above 7.2 T/hr of steam consumption, the tower became difficult to control. The operator had difficulty keeping a constant level in the reflux drum. It was also noticed that the temperature profile in the tower was rising. To counteract this rising temperature profile, the reflux rate was increased with the intent to drive the temperature profile back down the tower. This did not happen. In fact it appeared that increasing the reflux had no effect at all but to temporarily relieve the high liquid level in the reflux drum. This was very strange. Keep in mind that the reboiler duty is about 4.1 MMkcal and is about 25% less than design. Every change made in steam rate resulted in hardly any change in the column overall pressure drop and never any indication of a progressive liquid buildup indicative of a traditional flooding mechanism. Several data sets were compiled and a plot of observed tray efficiency against reflux rate was generated, see Figure 2.

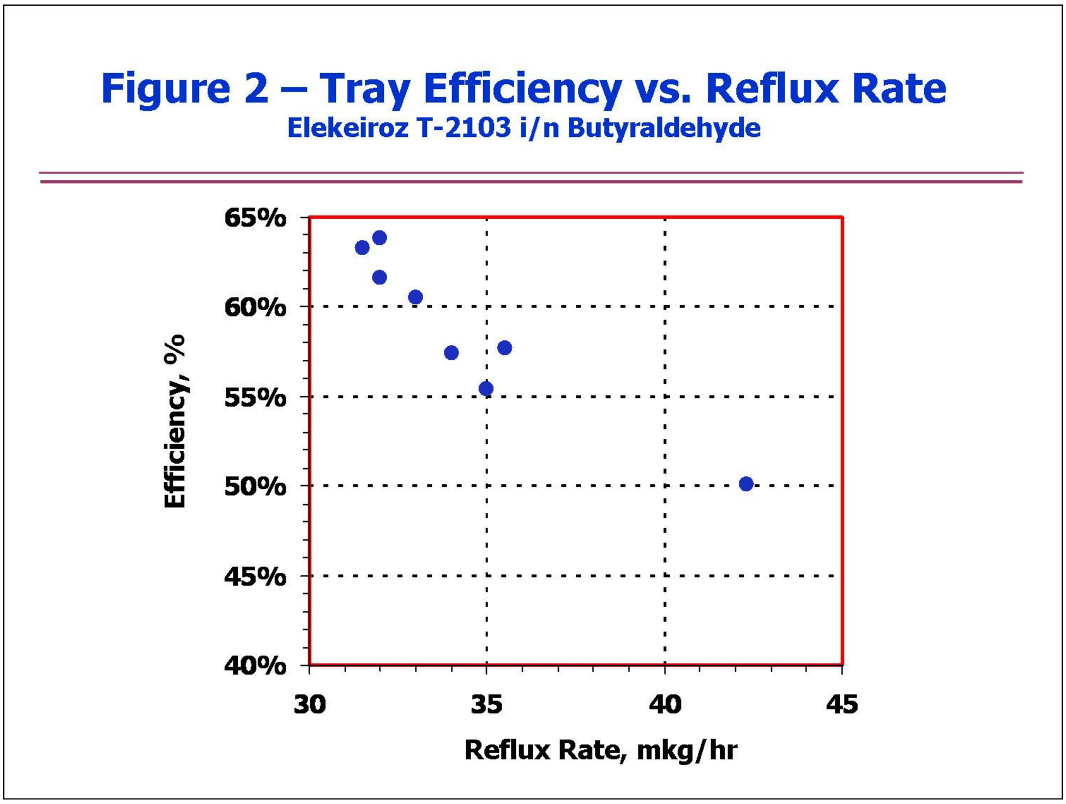


Figure 2 – Tray Efficiency vs. Reflux Rate from 2006

This reduction in tray efficiency at higher reflux rates is indicative of high entrainment on the trays. However, there are no typical signs of flooding or entrainment from the trays, and the predicted flood capacity of these trays is quite low. Several observations of tower operation led the authors to believe that there must have been a significant amount of carryover of liquid in the overhead vapor line from this tower. These observations were;

- lack of high pressure drop with increased reflux,
- lack of a heat balance on the tower,
- lack of temperature profile movement with increased reflux and
- a strong reduction in tray efficiency with increased reflux rate

A Gamma Scan of the tower was performed in November of 2005(2) which showed basically what appeared to be normal looking trays. Other than a slightly lower froth height on the second tray from the top (#89) and a higher froth on the top tray, the scan looked normal, see Figure 3.

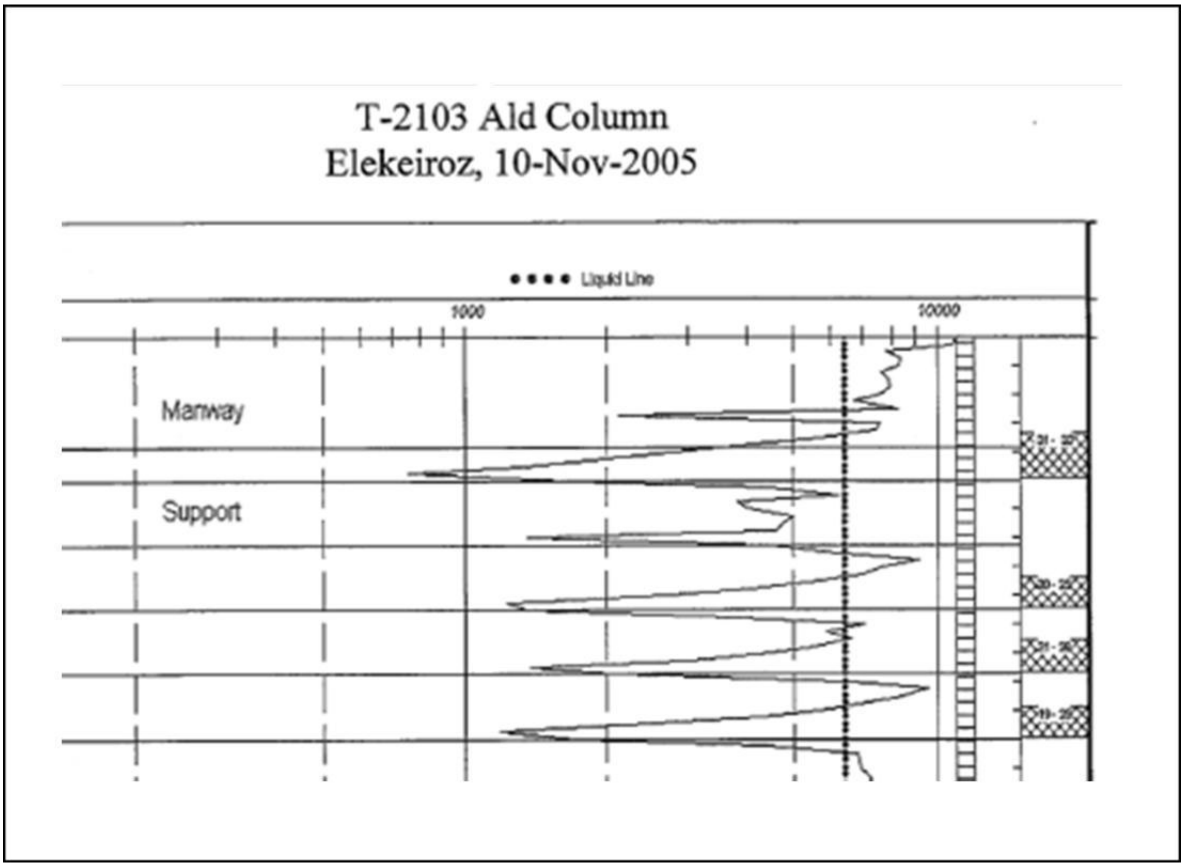


Figure 3 – Portion of Gamma Scan of Tower Top

In August 2006, Sulzer was thinking that with the large carryover in the top of the tower that the full reflux was not getting past the top few trays. This is basically "flooding" of the top tray but it was baffling that it was not affecting the whole tower. It was thought that there could have been several mechanisms that could result in a lack of liquid handling capacity on the top trays of such a tower. These were identified as:

- Massive Entrainment
- Entrainment from Downcomer Seal Pans
- Foaming
- Downcomer Restriction
- Spray Regime

Unfortunately, foaming was not seriously considered at the time to be the cause of the problem. It was thought that the Calming Section Trays (with side discharge of the downcomer liquid) were re-entraining their liquid. Therefore, in 2007 replacement VGPlus™ trays were provided that had MMVG™ valve units on the tray decks. The VGPlus trays were chosen primarily because Sulzer had recently revamped a larger but nearly identical Butyraldehyde tower in Taiwan the previous year and it was operating excellently. The tray efficiency of the Taiwan Tower was 70% based on Sulzer's UNIQUAC Liquid Activity Coefficient VLE model, see Figure 4.

The VGPlus trays needed side downcomers. The old bolting bars were removed when the Calming Section trays were installed. In addition, no welding to the vessel wall was allowed. The expansion rings for the Calming Section trays could be removed, but there was no place to hold the new side downcomers. It was felt that using envelope side downcomers was the only choice. However, extra capacity was deemed to be extremely important and the "wasted space" that normally exists behind envelope downcomers became extremely important. It was decided to employ "expansion downcomers" where the existing expansion rings were located, see Figure 5. With Sulzer's unique downcomer spout arrangement at the vessel wall, this was entirely possible.

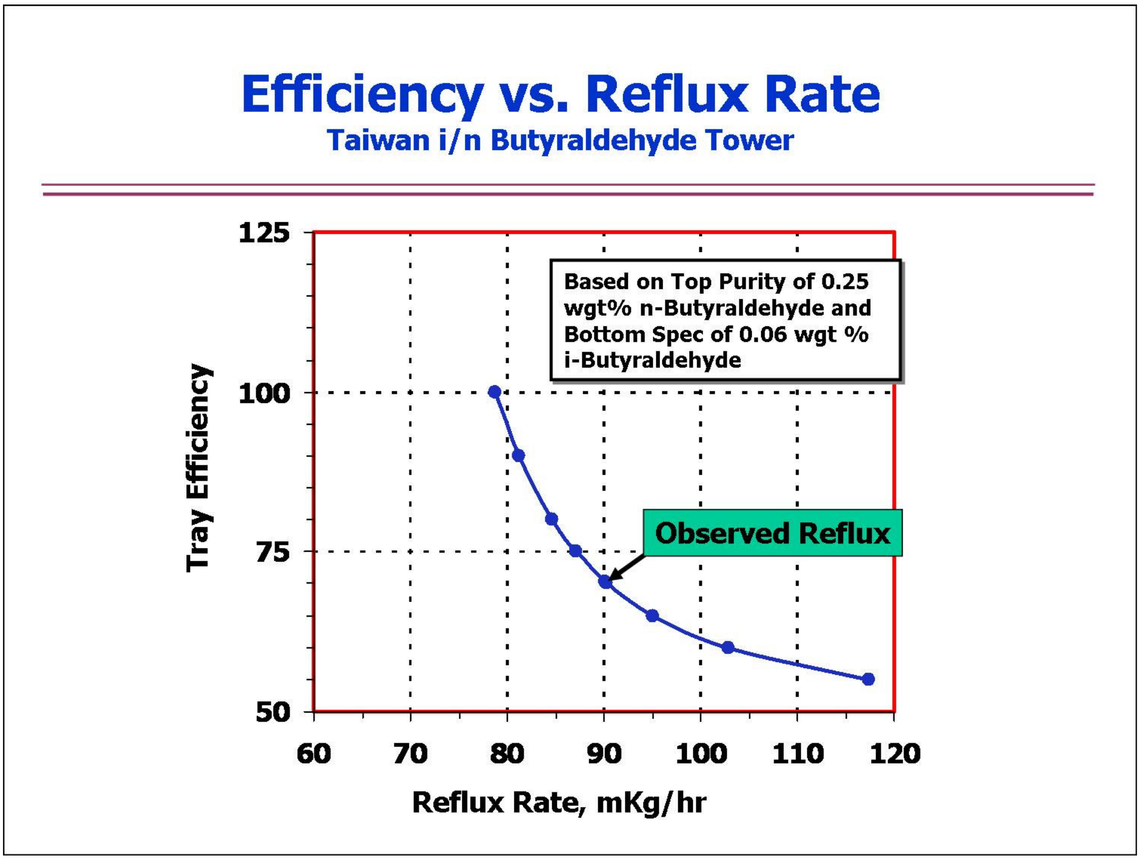


Figure 4 – Tray Efficiency determination of similar tower with but with VGPlus trays

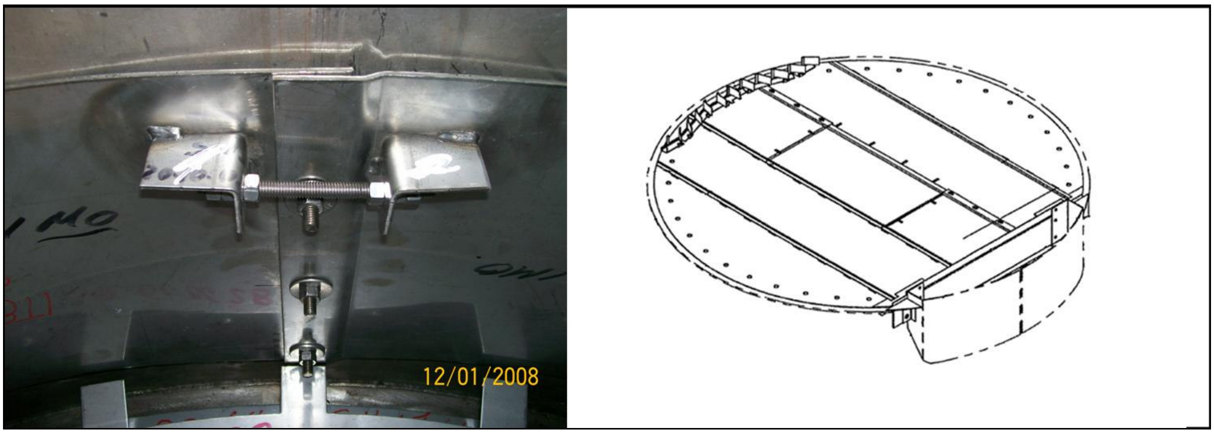


Figure 5 – Expansion Downcomers

The Tower was restarted in early 2008 and the tower showed marginal improvements. In early May 2008 another test run was performed on the new VGPlus trays. At this time with the new trays, all flooding alternatives were eliminated except foaming. One of the suspicions we had was Ross type[3,4] foam which is induced when there is an incipient second liquid phase. During the test run we visited the unit and looked at the spare (idle) reflux pump. In the line to the pump we found pure water in the drain line (low spot) which clearly tells us there is/was a second (water) phase present. While draining this water, the stream actually started to FOAM! The foam poured out on the ground but lasted only a few seconds. Two gamma scans of the upper part of the tower were conducted[5] and is shown in Figure 6. Other than a higher froth height on tray #90, the gamma scan does not clearly indicate foaming in the tower on the top trays.

It was recommended that the temperature of the reflux stream be increased to potentially enhance the solubility of water and get away from incipient second liquid phase type foaming. The temperature of the reflux was raised from 38ºC to 52ºC. Within hours the performance of the tower improved dramatically. Indications from before the reflux temperature increase, showed that the tray efficiency was as low as 65%. After the reflux drum temperature was increased to 52℃ a full set of operating data was taken. The resulting tray efficiency that was needed to match the tower's reflux rate was 71%. This was a dramatic increase in tray performance.

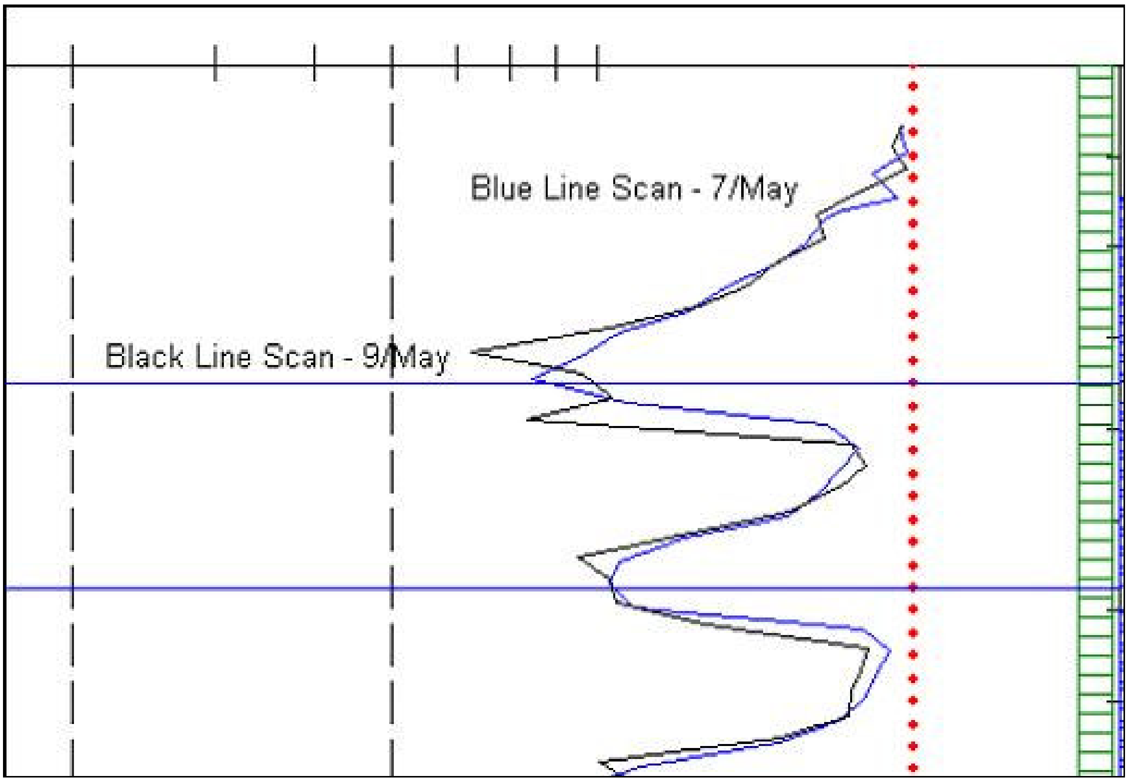


Figure 6 – Gamma Scans early May 2008

It was recommended in 2008 to add a "water boot" to the reflux drum to allow the water to accumulate and easily be removed. The theory is that when the water boot is added, the reflux temperature can be made as cold as possible to help remove as much water as possible from the system. In September 2011, the water boot was final added to the reflux drum with an interface controller. With the water boot in place, the heat exchangers cleaned out and the reflux temperature kept at 56ºC, the tower was able achieve the original revamp specifications and capacity.

A performance test run was made on July 31, 2012. At a feed rate of 10.2 mT/hr and steady state, tray data were taken, see Table 1. This table format is based on a previous paper by one of the authors[(1)]. These data were then simulated with Sulzer's UNIQUAC Liquid Activity Coefficient VLE model and determined the tray efficiency to be 67%, see Figure 7. Tray hydraulics were examined and the tower is operating at 80% of Jet Flood, see Table 2. The tower was pushed the hardest right after the water boot was added. In November of 2011, the reflux rate was as high as 36,000 Kg/hr. At these conditions the tower internal loadings are higher than what was experienced in July 2012. The loading sheets for November 2011 are shown as Table 3. Here the tower is operating at 82% of Jet Flood, a downcomer velocity of 0.342 ft/s (0.109 m/s) and a weir loading of 6.6 gpm/inch (59 m^3/m-hr).

Conclusions

Foaming is a difficult "beast" to identify and fix. Clearly, small amounts of water in a feed can build up with time in a tower when no method for removal is provided. A water "Boot" should always be provided on the bottom of the reflux drum when even the smallest amount of water is present and the water has the potential to form a low boiling azeotrope (along with a second liquid phase). Tray efficiency of the final trays was demonstrated to be within 5% of previous operations in identical service and the ultimate tray capacity achieved was as expected.

VGPlus trays ultimately proved their ability to achieve their expected tray capacity. The MMVG valve unit was successfully employed and expansion envelope downcomers proved their worth.

The perseverance demonstrated by Elekieroz and Sulzer to solve the problem over a number of years was admirable. This paper hopefully will help future distillation engineers identify similar problems earlier or prevent them in the first place.

References

1.) Summers, D.R., "Evaluating and Documenting Tower Performance," CEP, Feb 2010, pp38-45
2.) Haraguchi, Marcio – "TruScans of the T-2103 Ald Column on 10 November 2005", Report #566015
3.) Ross, Sydney – "A review of Foaming in Fractionation Towers", FRI Topical Report No. 68, June 15, 1974
4.) Ross, Sydney & Nishioka, Gary – "Foaminess of Binary and Ternary Solutions", The Journal of Physical Chemistry, Vol. 79, No. 15, pp 1561-1565 (1975)
5.) Loureiro, Leonardo & Veiga, Luciano – "Report of Execution Service Tracerco Diagnostics Tower Scan of the T-2103", Report BR-08-0692, May 2008

TABLE 1 – Operating Data

Aldehyde Purification Tower T-2103 Operating Data

Date: Tuesday, July 31, 2012
Time: Morning

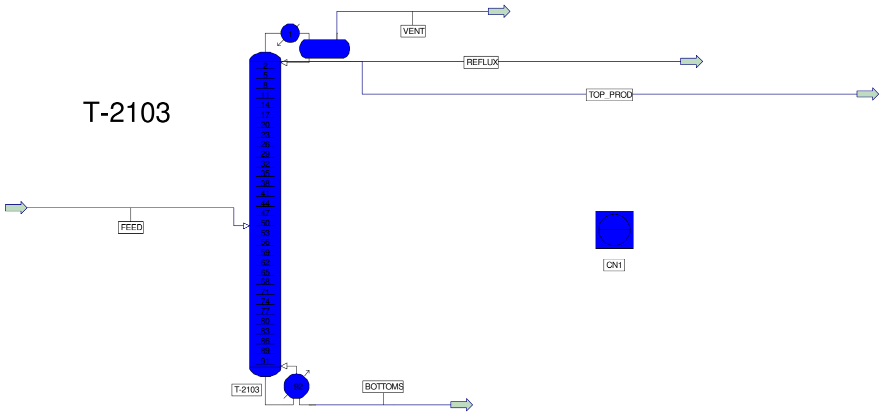
Description	Measurement	Tag No.	Units	Value	
Feed From E-2118	Liquid Flow	FIC-2134	tonnes/Hr	10.2	±0.2
	Temperature	Local at tower	°C	62	
	Location		Middle Feed		
E-2122 Steam	Flow	FIC-2139E	tonnes/Hr	4.3	±0.2
	Chest Pressure	PG 2153	Kg/cm2(g)	3.96	
E-2122B Steam	Flow	FC-1108	tonnes/Hr	2.7	±0.05
	Chest Pressure	PG 2153 B	Kg/cm2(g)	3.96	
Tower	Top Temperature	TR 28-8	°C	64.5	
	Top Pressure	PC-2130	Kg/cm2(g)	0.08	±0.02
	Bottom Temperature	TR-28-5E	°C	89.75	
	Bottom Pressure	PG-2152	Kg/cm2(g)	0.75	
	Delta-P		Kg/cm2	0.68	±0.02
Reflux	Temperature	TI-2416	°C	42	±0.5
	Temperature	Local at tower	°C	41	
	Flow	FIC-2138	tonnes/Hr	32.5	±0.4
Vent	Flow			Unknown	
i-Butyraldehyde Product	Flow	FR-2140	tonnes/Hr	1.5	±0.8
	Temperature	TI-2416	°C	42	
	Composition	Analyzer?	wgt%	0.18	
n-Butyraldehyde Product	Flow	FIC-2141	tonnes/Hr	8.5	±0.5
	Temperature	TR-28-5E	°C	89.75	
	Composition	Analyzer?	wgt%	0.1	

Figure 7

31 July 2012 Operation

Column Name		T-2103
Column Description		ALD Column
Condenser Duty	MM KCAL/HR	-4.2
Reboiler Duty	MM KCAL/HR	4.3
Column Tray Eff Fact		0.671
Reflux Ratio		17.80
Column Reflux Rate	KG-MOL/HR	491.5

T-2103



Stream Name Stream Description		FEED Feed Stream	BOTTOMS Bottoms	VENT Distillate	TOP_PROD	REFLUX
Phase		Liquid	Liquid	Vapor	Liquid	Liquid
Temperature	C	65.000	92.632	41.200	41.200	41.200
Pressure	KG/CM2G	2.000	0.740	0.080	0.080	0.080
Flowrate	KG-MOL/HR	143.951	116.332	0.916	26.704	491.500
Total Mass Rate	KG/HR	10200.000	8391.639	48.030	1760.330	32400.051
Total Weight Comp. Percents						
CO		0.0000	0.0000	0.0000	0.0000	0.0000
CO2		0.0800	0.0000	10.9529	0.1647	0.1647
METHANE		0.0000	0.0000	0.0000	0.0000	0.0000
PROPYLENE		0.2600	0.0000	14.7592	1.1038	1.1038
PROPANE		0.4700	0.0000	22.9565	2.0970	2.0970
CYCLOPROPANE		0.0000	0.0000	0.0000	0.0000	0.0000
H2O		0.4200	0.0000	1.7871	2.3849	2.3849
METHANOL		0.0000	0.0000	0.0000	0.0000	0.0000
ISOPROPYL_ALC		0.0000	0.0000	0.0000	0.0000	0.0000
i-Butyraldehyde		16.5500	0.1000	49.4952	94.0696	94.0696
n-Butyraldehyde		82.0500	99.6934	0.0491	0.1800	0.1800
ISOBUTYL_ALC		0.0200	0.0243	0.0000	0.0000	0.0000
n-BUTYL_ALC		0.0100	0.0122	0.0000	0.0000	0.0000
Pentanol		0.0000	0.0000	0.0000	0.0000	0.0000
i-Butyric Acid		0.0000	0.0000	0.0000	0.0000	0.0000
TOLUENE		0.1400	0.1702	0.0000	0.0000	0.0000
n-Butyric Acid		0.0000	0.0000	0.0000	0.0000	0.0000
Total Molar Comp. Percents						
CO		0.0000	0.0000	0.0000	0.0000	0.0000
CO2		0.1288	0.0000	13.0540	0.2467	0.2467
METHANE		0.0000	0.0000	0.0000	0.0000	0.0000
PROPYLENE		0.4378	0.0000	18.3969	1.7292	1.7292
PROPANE		0.7552	0.0000	27.3064	3.1348	3.1348
CYCLOPROPANE		0.0000	0.0000	0.0000	0.0000	0.0000
H2O		1.6520	0.0000	5.2032	8.7268	8.7268
METHANOL		0.0000	0.0000	0.0000	0.0000	0.0000
ISOPROPYL_ALC		0.0000	0.0000	0.0000	0.0000	0.0000
i-Butyraldehyde		16.2630	0.1000	36.0037	85.9980	85.9980
n-Butyraldehyde		80.6269	99.7313	0.0357	0.1646	0.1646
ISOBUTYL_ALC		0.0191	0.0237	0.0000	0.0000	0.0000
n-BUTYL_ALC		0.0096	0.0118	0.0000	0.0000	0.0000
Pentanol		0.0000	0.0000	0.0000	0.0000	0.0000
i-Butyric Acid		0.0000	0.0000	0.0000	0.0000	0.0000
TOLUENE		0.1077	0.1332	0.0000	0.0000	0.0000
n-Butyric Acid		0.0000	0.0000	0.0000	0.0000	0.0000

Table 2

SULZER
Sulzer Chemtech

Reference:	Elekeiroz
Customer:	
Service:	i/n Butyraldehyde Tower
Item:	T-2103
Date Run:	5-Aug-2012

TRAY DESIGN Section 1

Geometry: #46-90 VGPlus Tray

Deck Type:	MMVG	Tray Thickness [mm]:	2.00	Valve Density [1/m²]:	628.9
Number of Passes:	1	Material:	316 L	Valve Lift [mm]:	6.0
Inner Diameter [mm]:	1900	Tower Area [m²]:	2.84	Valves:	1640
Tray Spacing [mm]:	450	Active Area [m²]:	2.608	Open Area [m²]:	0.392
		Active Area [%]:	91.98	Open Area [%]:	15.05

Downcomer Dimensional Data

Type: TRUNCATED	Side
Top Width [mm]:	230.00
Bottom Width [mm]:	120.00
Clearance Height [mm]:	100
Outlet Weir Height [mm]:	38
Outlet Weir Length [mm]:	1240
Downcomer Spout Area [m²]:	0.0323

Downcomer Calculated Output

Downcomer Top Area [m²]:	0.20	Downcomer Area [m²]:	0.20
Downcomer Bottom Area [m²]:	0.07	Downcomer Area [%]:	6.88

Fluid Data: TOP

	Top	A_Feed
Gas:		
Flow Multiplier [%]:	100	100
Mult. Gas Rate [kg/h]:	34208.0	40707.0
Density [kg/m³]:	2.583	3.469
Viscosity [cP]:	0.0084	0.0087
QV [m³/s]:	3.68	3.26
Liquid:		
Flow Multiplier [%]:	100	100
Mult. Liquid Rate [kg/h]:	34160.0	38899.0
Density [kg/m³]:	753.63	727.76
Surface Tension [mN/m]:	22.06	16.82
Viscosity [cP]:	0.398	0.237
QL [m³/h]:	45.33	53.45
System Factor:	1.00	1.00

Hydraulic Data

Jet Flood [%]:	66	71
Downcomer Flood [%]:	38	45
Downcomer Froth Backup [%]:	39	44
Downcomer Clear Liquid [mm]:	88.26	100.66
Weir Loading [m³/mh]:	36.57	43.12
DryDrop [mmH2O]:	23.71	24.95
Pressure Drop [mbar]:	4.59	4.75

Number of trays: 45

Design Notes: July 31 Operation
Engineer Name: DRSummers File: C:\DRS\JOBS\Elekeir....y 31 Operation.sult

Table 2 Cont'd

SULZER
Sulzer Chemtech

Reference: Elekeiroz
Customer:
Service: i/n Butyraldehyde Tower
Item: T-2103
Date Run: 5-Aug-2012

TRAY DESIGN Section 2

Geometry: #1-45 VGPlus Tray

Deck Type:	MMVG	Tray Thickness [mm]:	2.00	Valve Density [1/m²]:	631.2
Number of Passes:	1	Material:	316 L	Valve Lift [mm]:	6.0
Inner Diameter [mm]:	1900	Tower Area [m²]:	2.84	Valves:	1640
Tray Spacing [mm]:	400	Active Area [m²]:	2.598	Open Area [m²]:	0.392
		Active Area [%]:	91.64	Open Area [%]:	15.10

Downcomer Dimensional Data

Type: TRUNCATED	Side
Top Width [mm]:	230.00
Bottom Width [mm]:	120.00
Clearance Height [mm]:	100
Outlet Weir Height [mm]:	38
Outlet Weir Length [mm]:	1240
Downcomer Spout Area [m²]:	0.0417

Downcomer Calculated Output

Downcomer Top Area [m²]:	0.20	Downcomer Area [m²]:	0.20
Downcomer Bottom Area [m²]:	0.07	Downcomer Area [%]: 6.88	

Fluid Data: Bottom

	B_Feed	Bottom
Gas:		
Flow Multiplier [%]:	100	100
Mult. Gas Rate [kg/h]:	41755.0	42669.0
Density [kg/m³]:	3.495	4.124
Viscosity [cP]:	0.0087	0.0089
QV [m³/s]:	3.32	2.87
Liquid:		
Flow Multiplier [%]:	100	100
Mult. Liquid Rate [kg/h]:	50147.0	51061.0
Density [kg/m³]:	727.67	719.76
Surface Tension [mN/m]:	16.82	16.22
Viscosity [cP]:	0.237	0.220
QL [m³/h]:	68.91	70.94
System Factor:	1.00	1.00

Hydraulic Data

Jet Flood [%]:	80	76
Downcomer Flood [%]:	57	59
Downcomer Froth Backup [%]:	59	58
Downcomer Clear Liquid [mm]:	109.15	108.87
Weir Loading [m³/mh]:	55.60	57.23
DryDrop [mmH2O]:	26.06	23.10
Pressure Drop [mbar]:	5.10	4.89

Number of trays: 45

Design Notes: July 31 Operation
Engineer Name: DRSummers File: C:\DRS\JOBS\Elekeir....y 31 Operation.sult

Table 3

SULZER
Sulzer Chemtech

Reference:	Elekeiroz
Customer:	
Service:	i/n Butyraldehyde Tower
Item:	T-2103
Date Run:	27-Mar-2013

TRAY DESIGN Section 1

Geometry: #46-90 VGPlus Tray

Deck Type:	MMVG	Tray Thickness [mm]:	2.00	Valve Density [1/m²]:	629.0
Number of Passes:	1	Material:	316 L	Valve Lift [mm]:	6.0
Inner Diameter [mm]:	1900	Tower Area [m²]:	2.84	Valves:	1640
Tray Spacing [mm]:	450	Active Area [m²]:	2.607	Open Area [m²]:	0.392
		Active Area [%]:	91.96	Open Area [%]:	15.05

Downcomer Dimensional Data

Type: TRUNCATED	Side
Top Width [mm]:	230.00
Bottom Width [mm]:	120.00
Clearance Height [mm]:	100
Outlet Weir Height [mm]:	38
Outlet Weir Length [mm]:	1240
Downcomer Spout Area [m²]:	0.0326

Downcomer Calculated Output

Downcomer Top Area [m²]:	0.20	Downcomer Area [m²]:	0.20
Downcomer Bottom Area [m²]:	0.07	Downcomer Area [%]:	6.88

Fluid Data: TOP

	Top	A_Feed
Gas:		
Flow Multiplier [%]:	100	100
Mult. Gas Rate [kg/h]:	42049.0	41334.5
Density [kg/m³]:	3.156	3.436
Viscosity [cP]:	0.0085	0.0087
QV [m³/s]:	3.7	3.34
Liquid:		
Flow Multiplier [%]:	100	100
Mult. Liquid Rate [kg/h]:	40044.6	39329.1
Density [kg/m³]:	730.39	728.11
Surface Tension [mN/m]:	15.10	16.82
Viscosity [cP]:	0.278	0.239
QL [m³/h]:	54.83	54.01
System Factor:	1.00	1.00

Hydraulic Data

Jet Flood [%]:	77	72
Downcomer Flood [%]:	49	45
Downcomer Froth Backup [%]:	48	45
Downcomer Clear Liquid [mm]:	106.09	101.96
Weir Loading [m³/mh]:	44.23	43.58
DryDrop [mmH2O]:	29.26	25.97
Pressure Drop [mbar]:	5.11	4.84

Number of trays: 45

Design Notes: Nov 16, 2011 Operation
Engineer Name: DRSummers File: C:\DRS\JOBS\Elekeir....2011 Operation.sult

Table 3 cont'd

SULZER
Sulzer Chemtech

Reference:	Elekeiroz
Customer:	
Service:	i/n Butyraldehyde Tower
Item:	T-2103
Date Run:	27-Mar-2013

TRAY DESIGN Section 2

Geometry: #1-45 VGPlus Tray

Deck Type:	MMVG	Tray Thickness [mm]:	2.00	Valve Density [1/m²]:	631.5
Number of Passes:	1	Material:	316 L	Valve Lift [mm]:	6.0
Inner Diameter [mm]:	1900	Tower Area [m²]:	2.84	Valves:	1640
Tray Spacing [mm]:	400	Active Area [m²]:	2.597	Open Area [m²]:	0.392
		Active Area [%]:	91.60	Open Area [%]:	15.11

Downcomer Dimensional Data

Type: TRUNCATED	Side
Top Width [mm]:	230.00
Bottom Width [mm]:	120.00
Clearance Height [mm]:	100
Outlet Weir Height [mm]:	38
Outlet Weir Length [mm]:	1240
Downcomer Spout Area [m²]:	0.0430

Downcomer Calculated Output

Downcomer Top Area [m²]:	0.20	Downcomer Area [m²]:	0.20
Downcomer Bottom Area [m²]:	0.07	Downcomer Area [%]:	6.88

Fluid Data: Bottom

	B_Feed	Bottom
Gas:		
Flow Multiplier [%]:	100	100
Mult. Gas Rate [kg/h]:	42373.4	43196.8
Density [kg/m³]:	3.463	3.954
Viscosity [cP]:	0.0087	0.0088
QV [m³/s]:	3.4	3.03
Liquid:		
Flow Multiplier [%]:	100	100
Mult. Liquid Rate [kg/h]:	51968.0	52791.4
Density [kg/m³]:	728.12	721.66
Surface Tension [mN/m]:	16.86	16.41
Viscosity [cP]:	0.239	0.223
QL [m³/h]:	71.37	73.15
System Factor:	1.00	1.00

Hydraulic Data

Jet Flood [%]:	82	79
Downcomer Flood [%]:	60	61
Downcomer Froth Backup [%]:	61	60
Downcomer Clear Liquid [mm]:	111.49	111.33
Weir Loading [m³/mh]:	57.58	59.02
DryDrop [mmH2O]:	27.13	24.69
Pressure Drop [mbar]:	5.22	5.05

Number of trays: 45

Design Notes: Nov 16, 2011 Operation
Engineer Name: DRSummers File: C:\DRS\JOBS\Elekeir....2011 Operation.sult