SCR

To: R. A. CONRAD, LCVCM

From: R. W. CHURNS, Houston
Date: January 20, 1987

Interoffice Communication

Subject: HCl COLUMN TRAY REVISIONS

VISTA

During October and November 1986, the VCM plant production was frequently 2.3 MM lb/day. At this throughput, the HCl Column (C202) was at the upper limit of stable operation. The column flooded at least once causing a shutdown of the VCM and oxychlorination sections. Production was eventually reduced to 2.1 MM lb/day.

PED, Mr. Stanley Marple, Vista's consultant, and Glitsch, Inc., one of three domestic tray manufacturers, have somewhat independently evaluated the HCl Column tray hydraulics. Each evaluation shows that column capacity is limited by restrictions in the seal pan below the feed tray and in the seal pan below the bottom tray.

It is recommended that Vista install the Glitsch proposal as shown on Figure 1. Their proposal is to remove tray 47 and tray 48, then install new feed tray 47, extend the downcomer from tray 49 to tray 47, and revise the liquid feed distributor to discharge onto new feed tray 47. This eliminates downcomer backup onto the tray above the feed tray from the feed tray. The FRI calculated liquid flood (downcomer backup) is reduced from 110 percent to 48 percent. Other upper section trays are 68 percent of liquid flood.

It is also recommended that the seal pan below the bottom tray be lowered by 3 inches, the downcomer clearance be reduced to 1.5 inches and the seal pan weir be reduced to 3.5 inches, as shown in Figures 2A and 2B. This change eliminates liquid backup from the seal pan onto the bottom tray and reduces the FRI calculated liquid flood from 124 percent to 82 percent. Other lower section trays are 86 percent of liquid flood.

The percent of capacity utilization of each of the revised trays is equal to or lower than any other tray in the respective section of the column. It is believed that these tray revisions along with proposed changes to the bottom product outlet line will allow stable operation at 2.3 MM lb/day VCM production and above. It is recommended that these trays be changed during the next VCM plant turnaround. The trays must be ordered early in February 1987 to arrive in time for a May 1987 turnaround.

At the beginning of this evaluation, it was hoped that revising the feed and bottom trays would increase the HCL Column capacity to 2.5 MM lb/day VCM (110 percent of 2.3 MM lb/day). These rates give a possibly attainable 96 percent of liquid flood for the lower section trays. The three tray manufacturers (Glitsch, Koch, and

Nutter) were asked to recommend revisions to achieve both 110 percent (2.5 MM lb/day) and 140 percent (3.2 MM lb/day) of present capacity. All three recommended replacing the 48 lower section trays for these throughputs. Additionally, Koch recommended replacing the upper section tray decks to achieve the 140 percent capacity. It is recommended that Vista not proceed with retraying the tower at this time because of the high cost plus the fact that other bottlenecks are expected to limit before the retrayed limit is reached. The two recommended changes will allow stable operation at 2.3 MM lb/day, and a little beyond, and the additional expense to get to 2.5 MM lb/day in the column is not justified.

Sketches of the proposed tray revisions, tray rating calculations, and other details of this evaluation are attached. Mr. Marple and I will discuss this with you at the VCM plant at 9:30 AM on Friady, January 23.

RW Churns

R. W. Churns

/mb

Attachments

cc: GEH, WPS, BF, APR, PEM, MLA, SCR, JRH, JAD - Westlake
CRM, CRD, PFF, JES, DKH, JRC, HEK - Houston
GWI, RTF (cover letter only) - Houston
Stan Marple (Consultant, Houston)

File: P-39

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HCl Column Tray Revisions
VCM Plant

Discussion

HCl Column Throughput

During much of October and November 1986, the VCM Plant produced 2.3 MM lb/day of VCM. At this rate the HCl Column was at the upper limit of stable operation and at least once became unstable and caused a shutdown of the VCM and oxychlorination sections. Rates were then reduced to 2.1 MM lb/day of VCM. It is assumed that conditions and flowrates associated with 2.3 MM lb/day define 100 percent of flood for the HCl Column.

The HCl Column was simulated using the PROCESS computer program. The column feed was calculated at 2.3 MM lb/day VCM, with equal moles of HCl, and EDC equivalent to 55 percent conversion of EDC to VCM. The total feed was split into vapor and liquid portions in the same ratio as seen in the 1975 VCM Plant Test Run. The reboiler duty was set at 12.5 MM BTU/hr which is the typical duty at 2.3 MM lb/day. The column simulation was then run to achieve 4 vapor ppm VCM in the overhead vapor HCl product. The EDC and VCM flowrates and reboiler duty define the vapor and liquid traffic in the bottom of the column. HCl flowrate and condenser duty define the vapor and liquid traffic in the top of the column. The simulation results are attached.

Tray Flooding

The vapor and liquid flowrates and physical properties from the simulation were used to calculate the column tray hydraulics. A new computer program using Fractionation Research Inc. (FRI) correlations and correlations from the tray manufacturers (Glitsch, Koch, and Nutter) was used for the tray hydraulic calculations. These correlations are the same ones as used in the Conoco sieve tray rating program.

The correlations define three ways to flood a sieve tray;

a. System Limit - The system limit is the ultimate capacity of any system and is independent of tray design or tray spacing. It occurs when vapor rates reach critical values in the intertray space and cause sufficient liquid to be entrained throughout the column to flood the trays.

b. Jet Flood - Flooding can occur from the projection of massive quantities of liquid to the tray floor by the eruption of vapor through the bubbling area of the tray below. Jet flood is calculated for a constant liquid flow and a constant liquid to vapor to liquid ratio.

c. Liquid Flood - When the downcomer fills with aerated liquid or foam and not all the liquid can be accommodated by the downcomer, the tray may become flooded by the liquid accumulating in the bubbling area. Liquid flood is indicated if the aerated froth height is greater than the tray spacing plus the outlet weir height. The tray is definitely flooded if the clear liquid height exceeds the tray spacing plus the weir height. Liquid rates exceeding the recommended maximum liquid velocity could result in the passage of a two-phase mixture through the downcomer. This

may cause premature flooding by increasing the flow of vapor by the recycled vapor. High liquid rates may also lead to flooding by not giving enough time for the liquid and vapor to separate in the downcomer. The design separation time is somewhat arbitrary and depends on the foaming characteristics of the liquid. Both the feed tray and bottom tray of the HCl Column have calculated floods above 100 percent of downcomer backup in situations where the column appears to be flooded giving credibility to this correlation for the HCl Column.

Proposed Tray Revisions

As shown below, most likely trays to flood in the HCl Column are the tray above the feed tray and the bottom tray. Both of these trays flood from liquid backing up the downcomer onto the tray above. The lower section trays showing a high percent of liquid flood - downcomer residence time are less likely to be flooded than downcomer backup flooded trays because a conservative design downcomer residence time (foamy system) was used. We have seen that the system is not particularly foamy by observing the nitrogen purged level gauge at the bottom of the column.

Downcomer backup is a function of liquid flowrate, downcomer volume (cross section area times tray spacing), liquid level on the tray at the outlet of the downcomer, and the downcomer clearance. Refer to Figure 1, a sketch of the present and proposed feed trays and other trays near the feed tray. Most of the HCl Column trays have a nominal 15 inches of downcomer liquid depth available (15" tray spacing plus 1.5" outlet weir less 1.5" outlet weir on the tray below). This is reduced on the tray above the feed tray because the seal pan has a 4 inch outlet weir. This gives an available liquid depth of 12.5 inches (15" TS + 1.5" OW - 4" OW). The available liquid depth is actually less than this because the column liquid feed must also pass through the seal pan increasing the crest of liquid over the outlet weir.

We recommend accepting the Glitsch proposal for modifications to the feed tray as shown on Figure 1. The seal pan below tray 49 and both tray 47 and 48 are to be removed. A new tray 47 would be installed to include a seal area for the liquid from tray 49 and the fresh liquid feed. A new liquid distributor onto tray 47 is required along with the extension of the tray 49 downcomer. This arrangement will give an available liquid depth of 34.5 inches (39" TS + 1.5" OW - 6" OW). The results of tray hydraulic calculations for the present and new feed trays and the other trays in the upper section of the HCl Column are shown below.

Upper Section Trays - 2.3 MM lb/day VCM	Tray Above Feed Tray Present	Tray Above Feed Tray Proposed	Other Trays
Percent Liquid Flood - Downcomer Backup	110	58	68
Percent Liquid Flood - DC Residence Time	50	20	50
Percent Liquid Flood - Downcomer Velocity	43	43	43
Percent Jet Flood - Constant Liquid	56	56	56
Percent Jet Flood - Constant Vapor/Liquid	58	58	58

Figure 2A and 2B show the present and proposed bottom trays, respectively. Most of the trays in the lower section of the HCl Column have the same nominal 15 inches of downcomer liquid depth available as in the upper section. This is reduced on the bottom tray because even though the seal pan is 18 inches below the tray, the seal pan has a 6 inch outlet weir. This gives an available liquid depth of 13.5 inches (18" TS + 1.5" OW - 6" OW). We recommend moving the seal pan down 3 inches for a 21 inch spacing and changing the seal pan outlet weir to 3.5 inches as shown on Figure 2. This gives an available liquid depth of 19 inches (21" TS + 1.5" OW - 3.5" OW). The results of tray hydraulic calculations for the present and proposed bottom tray and the other trays in the lower section of the HCl Column are shown below.

Lower Section Trays - 2.3 MM lb/day VCM	Bottom Tray Present	Bottom Tray Proposed	Other Trays
Percent Liquid Flood - Downcomer Backup	124	82	86
Percent Liquid Flood - DC Residence Time	82	64	88
Percent Liquid Flood - Downcomer Velocity	79	79	79
Percent Jet Flood - Constant Liquid	47	47	47
Percent Jet Flood - Constant Vapor/Liquid	41	41	41

Other information is shown on the attached output from the sieve tray rating program and in the summary of tray rating calculations (Table I).

Additional HCl Column Capacity

The tray rating calculations indicate that the HCl Column trays can handle throughputs up to 2.5 MM lb/day VCM. At this rate, the proposed feed tray and proposed bottom tray will be at 95 and 96 percent of liquid flood - downcomer backup. This rate is probably attainable because the column has operated (unstably) at 110 percent and 124 percent of liquid flood - downcomer backup on the present respective trays.

The three tray manufacturers were asked to make recommendations for tray revisions to allow operation at 110 percent (2.5 MM lb/day) and 140 percent (3.2 MM lb/day) of present operation (2.3 MM lb/day). Glitsch proposed the feed tray modification discussed above and a modification to the bottom tray. Koch and Nutter made no recommendations for operation at 2.53 MM lb/day. As shown in the center section of Table I, the percent of liquid flood (downcomer backup, residence time, and velocity) for the present bottom trays is between 85 percent and 112 percent. These companies were apparantly unwilling to recommend operation at this percent of flood.

Glitsch, Koch, and Nutter all recommended replacing the lower 48 trays for operation at 3.2 MM lb/day (140 percent). Glitsch and Koch recommend sieve trays while Nutter proposed V-Grid trays with seal pans. The V-Grid tray is a fixed valve, valve tray. Nutter installed them in the HCl Column at Formosa Plastics Company, Point Comfort, Texas, VCM Plant. In addition to replacing the lower 48 trays, Koch recommends replacing the decks of the 22 trays in the upper section of the column. As shown in the lower portion of Table I, each of the three proposals for the bottom trays will give between 57 and 93 percent of liquid flood and between 70 and 86 percent of jet flood.

Recommendations

It is recommended that the proposed revisions to the feed and bottom trays be made during the next VCM Plant turnaround. These revisions will allow stable operation at 2.3 MM lb/day VCM and will probably allow stable operation at 2.5 MM lb/day VCM production. When these revisions have been made, the plant throughput can be raised to 2.3 MM lb/day and then slowly and carefully on to 2.5 MM lb/day to find the HCl Column throughput limit. Based on past calculations made during VCM Plant expansion process designs, another limit to throughput will be found at or before the HCl Column limit. The new bottleneck will probably be the furnace and vaporizers or the quench column.

If the HCl Column is still the bottleneck and additional capacity is required, complete retraying of the column can then be considered for the next (January 1989?) VCM Plant turnaround.