TROUBLE SHOOTING OF COLUMN OPERATION USING GAMMA SCANNING TECHNIQUE

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ABSTRACT
Gamma Scanning is an online diagnostic tool which allows inspection of process column internals without interrupting operation. The technique uses a collimated beam of gamma rays which passes through the column wall. By measuring the intensity of the radiation exiting the column, one is able to determine the density of the material inside the column. Using gamma scanning, on-line detection of column problems like tray dislodgement, mechanical damage of packing/demisters, tray flooding, level control problems, foaming, vapour liquid mal-distribution, liquid hold up etc is possible.

Haldia Refinery has utilized gamma scanning to assess the process condition of four numbers of critical columns in primary and secondary processing units during the period of October 2010 to March 2011. The identified columns were experiencing irregularities in operation and hence were taken up for on-line gamma scanning to pinpoint the root cause of the problems experienced. The gamma scanning was done through external agency with the technical help of Bhabha Atomic Research Centre (BARC), Mumbai and IOCL R&D Centre, Faridabad. The gamma scanning results were analyzed and the exact problem areas were identified.

The paper deals with the details of the scanning technique adopted and the analysis of the data collected resulting in identification of the problem areas of the column.

Keywords: Process columns, Gamma Scanning, Collimated beam, Gamma rays

INTRODUCTION
The distillation, stripping or absorption columns are considered as one of the most critical components in petroleum refineries. The internals like trays, random packing, structured packing, demisters etc of these columns are designed for optimum functioning of the column. Improper functioning of these separation columns lead to huge losses in terms of productivity and product quality. The performances of these columns are strictly monitored during operation in terms of various process parameters. In case of any abnormality observed in the process parameters, it is essential to determine the root cause of the problem. The trouble shooting of the column operation can be done through simulation, which normally points out quite a few factors which can go wrong. However, to pinpoint the exact problem area, on-line real time gamma scanning is the only commercially available non-intrusive NDT method.

On-line gamma scanning was recently employed for trouble shooting of four nos. of distillation Columns at Haldia Refinery. These columns were identified to have product quality problems as well as poor draw in specific section of the columns. The Gamma scanning of these columns helped in identifying the problematic areas and helped to analyze the root cause of these problems.

BACKGROUND
The Gamma scanning of the following Columns were carried out:

<table>
<thead>
<tr>
<th>Sl.</th>
<th>Name of Column</th>
<th>Height (mm)</th>
<th>ID (mm)</th>
<th>Problems encountered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vacuum Column</td>
<td>61100</td>
<td>8400;</td>
<td>Problem in product draws.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9600;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6250</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Crude Distillation Column</td>
<td>41110</td>
<td>3300;</td>
<td>Problem in product draws.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3900;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2800</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Naphtha Stabilizer Column</td>
<td>25000</td>
<td>1376;</td>
<td>Reduced LPG production.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1764</td>
<td></td>
</tr>
</tbody>
</table>
4 OHCU Fractionator 59855 3000; 3800; 4500
Overlap of Diesel in the UCO stream was observed. Also the Diesel yield from Column was low.

METHODOLOGY OF GAMMA SCANNING

The gamma scanning process consists of a source of gamma($\gamma$) rays (usually Co-60) referred to as ‘SOURCE’ and a receiver of the gamma rays on the opposite side, (usually nucleonic meter with scintillation detector) referred to as ‘DETECTOR’. The transmission of $\gamma$-radiation through a material is governed by the equation:

$$ I = I_0 \times e^{-\mu \rho t} $$

where, $I$ = Intensity of transmitted radiation through the material
$I_0$ = Intensity of incident radiation
$\mu$ = mass absorption coefficient
$\rho$ = density of material
$t$ = thickness of material

Gamma scanning of columns is carried out by placing the collimated gamma ray source and detector at the same elevation at some reference level by hanging them from the top of the column using pulley arrangement. The scan chords are selected as per the nature and position of the internals of the column. The combination of source and detector is then pulled up or down in a synchronized manner and the transmitted radiation intensity is recorded at desired elevations. The data generated are plotted against column elevation and interpreted with reference to the internal hardware configuration of the column to derive the necessary information.

FINDINGS

The gamma scans of the four columns detected liquid vapor mal distributions, damaged tray internals and damage in structured packing. The major findings of the gamma scanning of the four columns are tabulated as given:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Column</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vacuum Column</td>
<td>Major damage observed in structured packing of Bed # 7. The stripping trays found missing/ dislodged.</td>
</tr>
<tr>
<td>2</td>
<td>Crude Distillation Column</td>
<td>Tray nos. 14 to 18 were observed missing/ dislodged.</td>
</tr>
<tr>
<td>3</td>
<td>Naphtha Stabilizer Column</td>
<td>Tray nos. 19 to 36 were observed missing/ dislodged.</td>
</tr>
<tr>
<td>4</td>
<td>OHCU Fractionator Column</td>
<td>Tray nos. 1 to 24 were observed missing/ dislodged or the trays were flooded. Vapor/ liquid mal distribution was observed at tray nos. 25 to 27 and 39 to 59.</td>
</tr>
</tbody>
</table>

The findings of the gamma scanning could satisfactorily explain the process problems encountered during column operation. Based on the findings of gamma scanning, action for material procurement was initiated for column internals. Also, action was taken to improve the liquid vapor distribution at the problem areas detected by gamma scanning which resulted in better performance of the column.

The Vacuum Column was opened during available opportunity and the actual condition of the column internals were observed in line with the findings of the online gamma scanning. As predicted by the gamma scanning, the structured packing of Bed # 7 was found severely damaged and coked up. Dislodgement of stripping trays were also observed.

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![Fig. 1: Movement of source and detector during gamma scanning](image-url)
CONCLUSION

Gamma scanning is a very effective on-line NDT tool for trouble shooting and optimizing the operations of distillation and separation columns which are of vital importance to the profitability and productivity of a refinery. Gamma scanning can successfully and conclusively detect damage/dislodgement of trays, location and extent of flooding, vapor-liquid mal distribution, foaming, abnormality in liquid levels and a variety of problems which affect the operation of a process column. It pin-points the hardware damages so that sufficient lead time can be obtained for procurement of the required materials before the column is actually opened for rectification of the problem.

ACKNOWLEDGEMENTS

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