Reliance
Industries Limited
Growth is Life

PTA 5/6 OPERATION MANUAL

Entrainer Recovery

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(Revision 0)

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GLOSSARY:

1. COD: Chemical Oxygen Demand
2. CTA: Crude Terephthalic Acid
3. DCS: Distributed Control System
4. DH: Dehydration
5. ETP: Effluent Treatment Plant
6. FCV: Flow Control Valve
7. FI: Flow indicator
8. FO: Flow Orifice
9. FT: Flow Transmitter
10. FV: Full vacuum
11. HS: Hand Switch
12. LCV: Level Control Valve
13. LP: Low Pressure
14. LT: Level Transmitter
15. MSDS: Material Safety Data Sheets
16. n-PA: normal Propyl Acetate
17. P&ID: Process and Instrumentation Diagram
18. PCV: Pressure Control Valve
19. PFD: Process Flow Diagram
20. PI: Pressure indicator
21. PT: Pressure Transmitter
22. PTA: Purified Terephthalic Acid
23. RPM: Revolutions per minute
24. RV: Relief Valve
25. SS: Stainless Steel
26. TA: Terephthalic Acid
27. TCV: Temperature Control Valve
28. TI: Temperature Indicator
29. TOC: Total Organic Carbon
30. TOI: Temperature of Interest
31. TT: Temperature Transmitter

1. SCOPE

Scope of this manual covers recovery of entrainer from liquid and vapor feeds from the DH Column (in Recovery Column) and recycle of separated methyl acetate stream to the Reactor via G5-507A/B pumps suction. It also covers distribution of waste water from the Recovery Column bottoms to various users in the plant via Recovery Column Bottoms Pumps.

This operating manual covers PTA 5 plant. PTA 6 process being identical to PTA 5 with same tag numbers, a separate operation manual shall not be issued for PTA 6.

2. REFERENCE DOCUMENTS

This manual should be read in conjunction with following documents –

- PFD and Stream Summary (attached in Annexure A)
- Following Process P&IDs

10005-G41-GPZ105-00003	10005-G41-GPZ105-00603
10005-G41-GPZ105-00107	10005-G41-GPZ105-00802
10005-G41-GPZ105-00502	10005-G41-GPZ105-00804
10005-G41-GPZ105-00504	10005-G41-GPZ105-01003
10005-G41-GPZ105-00505	10005-G43-GPZ105-01402
10005-G41-GPZ105-00601	10005-G41-GPZ105-01407
10005-G41-GPZ105-00602	10005-G43-GPZ105-01602

- Following Vendor P&IDs:
  - Flowserve: 10005-GPZ105-MPPA17-7396241-C02-003

- Following P&IDs of Deluge stations and fume suppression system
  - 10005-U20-GPZ105-07003

- Following hazardous area classification drawing
  - 10005-E66-GPT105-002
  - 10005-E66-GPT105-003

- Following Fire & Gas Layout P&IDs:
  - 10005-U23-GPT105-001
  - 10005-U23-GPT105-002
  - 10005-U23-GPT105-003
  - 10005-U23-GPT105-004

- 10005-U23-GPT105-005

- Standard Operating Conditions(attached in Annexure B)
- Alarm and trip schedule (attached in Annexure C)
- Chemical information sheet / MSDS (attached in Annexure D)
- Inventory Summary in Vessels (attached in Annexure E)

3. PROCESS DESCRIPTION

3.1 General Introduction

Entrainer leaves the Solvent Dehydration section of the Solvent Recovery area in the aqueous and vapour streams leaving the DH Column Decanter, F5-608. To minimise losses, the entrainer leaving the Solvent Dehydration system must be recovered, and this is carried out in the Entrainer Recovery section of the Solvent Recovery area.

In addition to recovering entrainer, this section of the plant serves two further purposes:

1. To produce a liquid methyl acetate product for recycle to the Oxidation Reactor.

2. To produce waste water of a quality suitable for re-use by various water users on the PTA plant or for discharge to Effluent Treatment.

The Entrainer Recovery section consists of the Recovery Column, D5-631, plus ancillary equipment (product pumps, a condenser, bottoms cooler).

The Recovery Column is divided into three sections, a rectifying section containing 16 trays, a bottom stripping section containing 5 m of packing (with the two sections divided by a chimney tray) and the bottommost section for containment of waste water before being discharged via the Recovery Column Bottoms Pumps. The diameter of the top section is larger than the bottom one due to significant differences in vapour traffic. The chimney tray allows vapour to pass from the lower (stripping) section and diverts the two-phase liquid stream falling from the upper (rectification) section to the DH Column Decanter F5-608 for separation.

The vapour-phase overheads product from the Recovery Column is condensed in the Recovery Column Condenser E5-631. The liquid product (methyl acetate) gravity flows into the suction line to the Mother Liquor Pumps G5-507A/B. Uncondensed vapours are vented to the Atmospheric Scrubber D5-508. Boil-up for the Column is provided by direct injection of vapour entering from the DH Column Decanter at the bottom of the rectification section and by stripping flash steam from F5-1406 entering at the bottom of the stripping section.

The bottoms product, essentially water, passes to the Recovery Column Bottoms Pump G5-632A/B via the Waste Water Cooler E5-634 and is pumped away to various users and Effluent Treatment. However,

during an Oxidation Reactor hold, the recovered water from the Recovery Column is returned to the DH Column to maintain stable operation of the Dehydration Area.

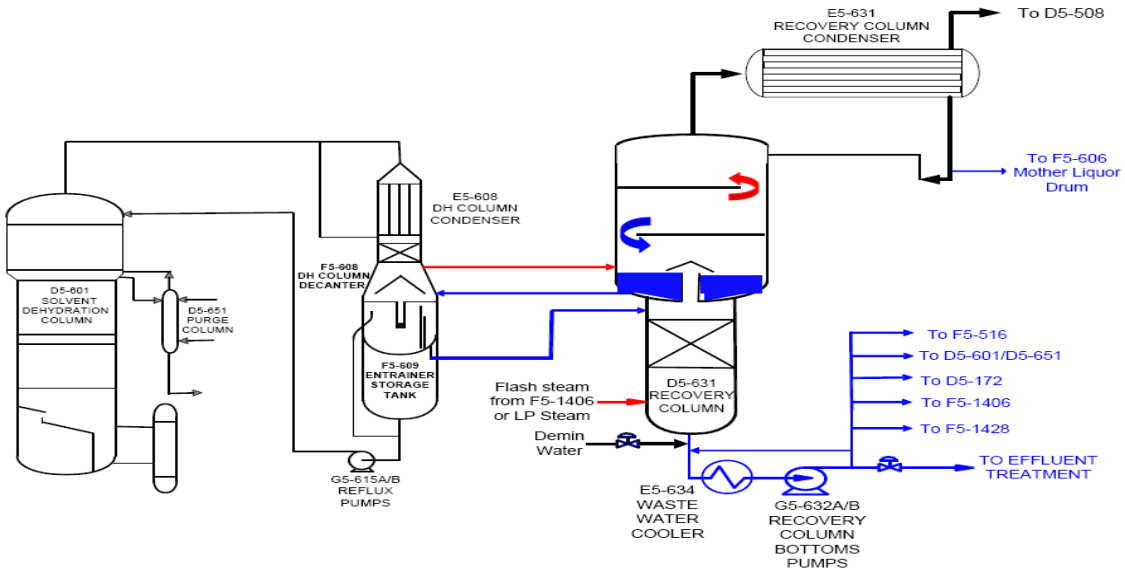


Figure 3.1 – Entrainer Recovery Section

3.2 Process Theory

Methyl acetate is produced in the Oxidation Reactor as a by-product by the involuntary oxidation of acetic acid. The formation of methyl acetate is an equilibrium reaction and by maintaining a high concentration in the mother liquor, nett formation can be reduced to zero, thereby leading to acetic acid savings. However, as a consequence of high concentrations and volatility, methyl acetate passes to the overhead systems of the Reactor and Crystallisers and ends up, via the water draw-off and Crystalliser flash streams, in the DH Column. Methyl acetate reaching the DH Column must then be purged, as described in the manual for Solvent Recovery, from where it passes in the vapour and aqueous phases from the DH Column Decanter to the Recovery Column.

4. EQUIPMENT LIST

Equipment Number	Description
D5-631	Recovery Column
E5-631	Recovery Column Condenser
G5-632A/B	Recovery Column Bottoms Pumps
E5-634	Waste Water Cooler

5. EQUIPMENT DESCRIPTION

5.1 Recovery Column, D5-631 (Vendor: CCMC)

5.1.1 General Information

The Recovery Column D5-631 is a vertical pressure vessel constructed from 304L SS, with an overall height of 26500 mm (tan to tan height). The Column is divided into three sections, a rectifying section containing 16 trays, a bottom stripping section containing 5 m of random packing (with the two sections divided by a chimney tray) and the bottommost section for containment of waste water before being discharged via the Recovery Column Bottoms Pumps. The randomly packed bed in the stripping section is provided with a liquid trough distributor at the top which allows aqueous liquid from DH Column Decanter to be distributed uniformly across the entire bed. Due to a significant difference in vapour flow in the rectifying and stripping sections, the stripping section, which contains a 5000 mm bed of random packing (IMTP 25 from Koch-Glitsch), has a diameter of 1750 mm and the rectifying section, which contains 16 trays (Flexitray valve trays from Koch-Glitsch), has a diameter of 3400 mm.

The design conditions for the Column are following :

Design pressure : 3.5 barg and full vacuum at the top of the vessel. Design pressure at the bottom of the column is based on the hydrostatic head to the top tubesheet of DH Column Condenser E5-608 (approx. 27m above D5-631 BTL), with a density of 1050 kg/m^3, 5% w/w caustic at 50-80°C.

Design temperatures are 185°C (overpressure) and 100°C (vacuum).

The Recovery Column is protected against overpressure by relief valve RV/D5-631A/B which is sited on the vapour line between D5-631 and E5-631.

The Recovery Column has the following branches:-

In the large diameter rectifying section:

- Manways (above top tray and below bottom tray)
- Vapour exit to E5-631

- Condensate return from E5-631
- Alongside trays 3, 6, 9, 12 and 15 are temperature transmitters
- Vapour feed from DH Column Decanter
- Recovered organics gravity flow to the DH Column Decanter
- In the bottom dished end, in addition to the chimney there is a drain that exits through the side wall of the lower section.

In the smaller diameter stripping section:

- Aqueous liquid feed from DH Column Decanter (above packing)
- Manway (above packing)
- Adjacent to the packed bed there are two temperature transmitters
- Steam feed from F5-1406 (or LP steam), below the packing

In the bottommost section:

- Two level transmitters
- A manway
- Bottoms outlet nozzle with a vortex breaker

Additional equipment details are provided below:

- Vessel Contents: Water, Methyl Acetate, Propyl Acetate, Propanol, Acetic Acid and Inerts
- Operating pressure (Top/Bottom): 0.06/0.2 barg
- Operating Temperature (Top/Bottom): 56.5/105°C
- Insulation Type: Heat Conservation Type of thickness 115 mm
- Gross Capacity of Column : 162 m^3
- Height of bottommost section: 2042 mm
- Diameter of bottommost section (water sump): 2500 mm
- Height of middle section: 10141 mm
- Height of top section: 11810 mm
- Chimney diameter: 750 mm

5.1.2 Operating Philosophy

The aqueous stream separated from the n-PA entrainer in the DH Column Decanter is fed into the stripping (middle) section of the Recovery Column above the packed bed. Heat is supplied to the stripping section using either low pressure flashed steam from the Fifth PTA Crystalliser Scrubber or LP steam, and the organic species in the aqueous stream are recovered (stripped) from the waste water stream and vented into the rectification section via the central chimney tray. The waste water is discharged from the base section to various waste water users or to the Effluent Buffer Tanks.

The vapour from the stripping section is joined in the bottom of the rectification (upper) section of the Recovery Column by the vapour stream containing nPA entrainer and methyl acetate from the DH Column Decanter. The vapour flows up the column trays countercurrently to condensed liquid from the Recovery Column Condenser in order to recover nPA entrainer from the methyl acetate vapour and vent

gas. The recovered entrainer is returned to the DH Column Decanter from the central chimney tray, methyl acetate is returned to the Mother Liquor Drum from the Recovery Column Condenser, and uncondensed gases are discharged to the Atmospheric Scrubber. There is a future provision to route the recovered methyl acetate from column top to Methyl Acetate Hydrolysis unit, if and when, it comes up in future.

This system is designed to operate at a constant vapour feed rate. The rectification section profile controller adjusts the reflux flow by controlling the distillate withdrawal flow to maintain methyl acetate product quality and the export of waste water from the Recovery Column base is level-controlled to the various users.

A block valve is installed in the vent line from E5-631 to D5-508 Atmospheric Scrubber. In the event of a DH Column high pressure trip (Z-191) this block valve is isolated which results in the vent from E5-631 being routed safely to the Relief Scrubber.

A block valve is installed in the common vent line from E5-631 and in the event of a DH Column low pressure trip (Z-190) this block valve is isolated to prevent air being drawn back from either the Atmospheric Scrubber or the Relief Scrubber which could result in the formation of a flammable atmosphere in the Column.

Propanol which is formed in dehydration system through hydrolysis of entrainner (nPA) is purged out through Recovery Column bottom stream so as to maintain its concentration to less than 2% in D5-601 organic reflux stream. If the normal purging does not help (by maintaining the right bottom temperature of D5-631), a provision is there for shock purge. A line connecting D5-631 rectification section sump to striping section sump is provided for this shock purge.

5.1.3 Instrumentation & Control

The primary feed flows to the Recovery Column are dictated by operation of the Solvent Dehydration system, with the vapour feed controlled by FICA-06209 (DH Column overheads condensation control). The Recovery Column control loops are designed to enable the system to take the feeds as supplied and deliver overheads and bottoms products of the specified quality.

There are three Recovery Column control loops:-

- Stripping steam feed
- Bottoms level control and export
- Overheads product quality and entrainer recovery

5.1.3.1 Stripping Steam Feed

In normal operation, the heat input into the Stripping Section is provided by process flash steam from the Fifth PTA Crystalliser Scrubber. An automatic LP steam back-up supply is provided for times when purification flash steam is not available.

The system is designed to operate with a constant temperature at the bottom of the packed bed. Temperature controller TICA-06313 provides an input to, and adjusts the setpoint of, steam flow controller FICA-06301. This controls the steam flow by adjusting pressure control valve PCV-14219C via split range controller FY-06301A and relay PY-14219B where PY-14219B is a low selector block which selects lower of the two signals coming from Fifth PTA Crystalliser pressure controller (PICA-14219B – output range 0-33% through splitter PY-14219A) and D5-631 stripping steam flow controller (FICA-06301-output range 0-50% through splitter FY-06301A). In the event of the Fifth PTA Crystalliser pressure falling below its pressure control setpoint, the relay will close PCV-14219C to maintain the Fifth PTA Crystalliser at the desired pressure. The split range controller FY-06301A will then adjust the LP steam flow control valve FCV-06301 according to 50-100% output range of FICA-06301 to provide sufficient steam to meet the Recovery Column demand. The combined flow of flash steam from F5-1406 and LP steam is measured by FT-06301 and indicated in the DCS as FICA-06301.

The stripping steam system is designed for fully automatic operation - however the operator has access to manual control of the LP and flash steam flows if required. Auto / manual selector HS-14219C is provided for this purpose to facilitate manual control of PCV-14219C if needed.

5.1.3.2 Bottoms Level Control & Export

In normal operation, the Recovery Column sump level is controlled by level controller LICA-06303 which controls through split range controller LY-06303 the waste water flows to F5-1428 and to the Effluent Buffer Tanks by adjusting LCV-06303A and LCV-06303B respectively. Branch lines are also provided to supply waste water to D5-172, F5-1406, D5-601, D5-651 and F5-516 the flows of which are controlled downstream by their respective control/globe valves. In the event of a falling sump level, LY-06303 provides input to high select block LY-06303C which also receives input from Recovery column bottom stream temperature controller TICA-06317 (discussed later). LY-06303C then opens LCV-06303C to import demineralised water into the outlet line from the base of the Recovery Column to ensure all critical water users are not deprived of water supply.

Waste water flow from the base of the Recovery Column is indicated in the DCS by FIA-06325 through FT-06325 located in the common discharge line of Recovery Column Bottoms Pumps, G5-632A/B. TOC analysis is done by on-line analyser AIA-06326.

Bottoms level is also measured by LT-06302 which provides an input to Z-133 on high high level of column bottoms sump.

Complex Loop LICA-06303: D5-631 Recovery Column Base Level

The Recovery Column level is normally controlled by the flow of process waste water to F5-1428 on the Purification Plant via LCV-06303A. If there is surplus waste water it is exported to the Effluent Buffer Tanks via LCV-06303B. If there is insufficient process waste water, the column level is maintained by importing demineralised water via LCV-06303C. The waste water is normally cooled via Waste Water Cooler E5-634 prior to being pumped to the users or to ETP. During periods that the Waste Water Cooler is out of use and being caustic washed, the demineralised water supply is used to mix with the

waste water to maintain the required temperature which is important to ensure adequate NPSH (net positive suction head) to G5-632 A/B is maintained to prevent cavitation.

In the event of falling level in the Recovery Column base, the level controller will first close the valve LCV-06303B, shutting off the flow to the Effluent Buffer Tanks. If this is not sufficient to restore the required level, then LCV-06303A is closed shutting off the flow to F5-1428. If the level is still falling, then demineralised water is imported via LCV-06303C.

In normal operation, the controller is expected to modulate only LCV-06303A.

During periods that the Waste Water Cooler E5-634 is being washed, the set point of controller TICA-06317 will be exceeded and LCV-06303C will open, via high select block LY-06303C, to import demineralised water and so reduce the Waste Water temperature. The set point for TICA-06317 will be between the high and high high temperature alarm settings. This allows the high alarm to indicate poor performance of E5-634 during normal operation, and the high high alarm to indicate potential cavitation of G5-632A/B when E5-634 is bypassed for caustic washing.

The operator may open LCV-06303C at any time via HS-06303C.

LOOP STRUCTURE AND CONTROLLER DETAILS

LICA-06303
PI control
ACTION Direct
Output goes to split range block LY-06303

LY-06303
3-way split range block with outputs to:
LCV-06303A
LCV-06303B
LCV-06303C via high select block LY-06303C and HS-06303C

LY-06303C
High select block with inputs from TICA-06317 and LY-06303

Output to LCV-06303C via HS-06303C

TICA-06317
PI control
ACTION Direct
Output goes to high select block LY-06303C

HS-06303C

Auto / manual station for LCV-06303C

SPLIT RANGE CUT POINTS
(Ignoring the effect of high select block LY-06303C)

LICA-06303 Output	LCV-06303A Opening	LCV-06303B Opening	LCV-06303C Opening
0 %	0 %	0 %	100 %
33 %	0 %	0 %	0 %
67 %	100 %	0 %	0 %
100 %	100 %	100 %	0 %

In addition to the 6" bypass provided across E5-634 to route Recovery Column bottom stream to G5-632 suction when E5-634 is isolated for caustic wash, another 6" bypass is also provided which is normally in use as explained below. Intended temperature at G5-632 A/B suction is 90°C which is an optimum vlue to prevent cavitation of G5-632 A/B as well as use the heat energy within as the waste water is used within the process at various places. At the same time, pressure drop permissible across E5-634 is also restricted to 0.1 bar to prevent cavitation of G5-632 A/B (NPSH requirement). To meet both these criteria, an optimized design of E5-634 is used which allows approx. 27% of the Recovery Column bottom flow to pass through E5-634 which meets 0.1 bar max pressure drop criteria and cools the stream to approx. 49°C. Balance approx. 73% flow bypasses E5-634 through this 2nd bypass line so that the mixed stream (cold stream from E5-634 and bypassed stream) achieves a temperature of 90°C. In fouled condition, approx. 33% of flow is expected to flow through the exchanger at an outlet temperature of 60°C. Temperature of the mixed stream is measured on TT-06341 and controlled through TIC-06341 which adjusts the bypass flow through TCV-06341 mounted on the bypass line. To ensure proper mixing is achieved before temperature measurement, a minimum mixing distance of 2 m is provided between the mixing point and TT-06341. The hot fluid joins the cold stream at 45° angle in the direction of flow to promote mixing. To prevent two phase flow (as cold stream at 49°C mixes with boiling stream at 105°C and to minimize flashing across the TCV), TCV-06341 is located close to the mixing point with maximum hydraulic head above. This is to prevent any vibration that may happen due to collapsing of vapour bubbles when they come in contact with cold fluid.

5.1.3.3 Overheads product Quality & Entrainer Recovery

Recovery column profile control GICA-06311 controls via FICA-05417 the export of methyl acetate from the top chimney tray of the rectification section to the Mother Liquor Drum suction line. The rectification section temperature profile is measured by TT-06305 - 06309 and a profile calculation by XY-06310 provides the input to GICA-06311. The temperature indicators are duplex type to ensure a high-reliability system. The profile controller maintains a constant temperature profile by adjusting the flow of overheads product from the Recovery Column, thus altering the internal reflux flow inside the rectification section.

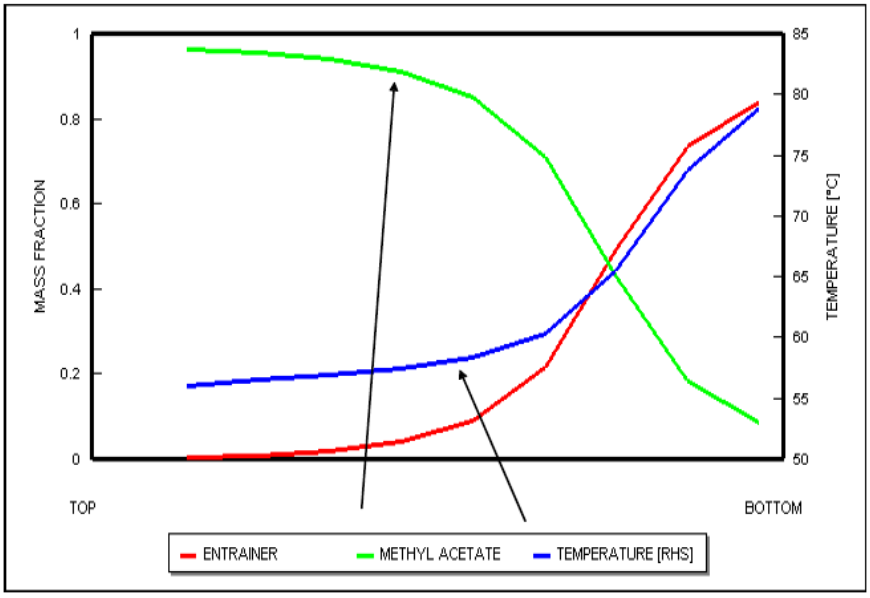


Figure 5.1.3.3 – A typical temperature and composition profile

Complex Loop GICA-06311: D5-631 Recovery Column Top Profile Control

In order to control the composition of the top of D5-631 and the composition of the return flow to F5-608, the temperature profile of the column must be maintained. At the point where the nPA entrainer composition falls quickly, the temperature rises moving further down the column. The position of the sharp temperature change is therefore controlled rather than a single temperature point as in conventional columns.

XY-06310 calculates the position of the nPA "front" from the temperatures in the column.

GICA-06311 controls the position of the nPA "front" by means of a cascade to distillate flow controller FICA-05417, which changes the flow of reflux to the column.

The temperature corresponding to the point at which the nPA entrainer concentration falls quickly is called the Temperature of Interest (TOI). The position in the column corresponding to this point is calculated by XY-06310.

The calculation looks at the temperatures measured by TT-06305, TT-06306, TT-06307, TT-06308 and TT-06309, and compares them with the TOI in order to find out at which position the TOI lies.

If TIA-06305 equals the Temperature of Interest then the position is 100%
If TI-06306 equals the Temperature of Interest then the position is 75%
If TI-06307 equals the Temperature of Interest then the position is 50%
If TI-06308 equals the Temperature of Interest then the position is 25%

If TI-06309 equals the Temperature of Interest then the position is 0%
If the TOI lies between these measurement points then the position is found by linear interpolation.

In response to a change in position of the nPA "front" GICA-06311 will adjust the distillate flowrate by changing the setpoint of flow controller FICA-05417. This causes a change in position of the control valve, FCV-05417.

If any temperature indicator is reading more than 1°C higher than the one below it then the output shall be held at the last value and an alarm shall be raised in the DCS.

The temperature indicators must be equi-spaced and straddle the position in the column where the TOI is found. Experience and dynamic simulation has shown that poor control will result if the probes are not equi-spaced.

Position algorithm

The output of this algorithm is the % position of interest. The setpoint is "Temperature of Interest" - not accessible to the operator. The algorithm looks at the temperature signals T1, T2, T3, T4 and T5 and compares them with the temperature of interest.

Linear interpolation is then used to calculate the % position.

Variable	Temperature	Position
T1	TIA-06305	100% (Top)
T2	TI-06306	75%
T3	TI-06307	50%
T4	TI-06308	25%
T5	TI-06309	0% (Bottom)

TOI Temperature of interest, initial value to be 65°C (to be confirmed during commissioning)
POSITION % Position output

Algorithm Definition

a) Input the data:
T1, T2, T3, T4, T5 (measured values) and TOI
b) Calculate position:
If T1 $\geq$ TOI, then POSITION = 100%
If T2 $\geq$ TOI > T1, then POSITION = 100 – 25*(TOI-T1)/(T2-T1) %
If T3 $\geq$ TOI > T2, then POSITION = 75 – 25*(TOI-T2)/(T3-T2) %
If T4 $\geq$ TOI > T3, then POSITION = 50 – 25*(TOI-T3)/(T4-T3) %
If T5 $\geq$ TOI > T4, then POSITION = 25 – 25*(TOI-T4)/(T5-T4) %
If T5 $\leq$ TOI, then POSITION = 0%

c) Output data:
OUTPUT = POSITION

Loop Structure and Controller Details

GICA-06311
PID control
ACTION Reverse
SETPOINT 50% (to be confirmed during commissioning)

I expected to be over 30 minutes

Master in cascade to FICA-05417

The process variable is the output of calculation XY-06310

FICA-06226

PI control

ACTION Reverse

P and I settings to be tuned for fast response

Slave in cascade from GICA-06311

5.1.3.4 Additional Recovery Column Instrumentation

In addition to the three control loops described above, additional temperature measurements, TT-06312 and TT-06313, are provided for process monitoring at the top and bottom of the stripping section packing. The bottoms temperature is also indicated locally by TI-06316, from which it is also possible to infer the Recovery Column base pressure.

A number of sample points are also provided on the inlet and outlet flows to and from the Recovery Column to allow process monitoring by laboratory analysis.

5.1.4 Trips & Alarms

5.1.4.1 Z-133

Z-133 provides a high level trip in the base of Recovery Column D5-631 to prevent the liquid level rising above the LP steam inlet and causing mechanical damage to the column.

The trip is initiated by an independent high level transmitter in the base of D5-631, which closes off the LP steam and flash steam of Purification Fifth Crystallizer to the base of D5-631 and the demineralised water make-up line.

Initiators

LT-06302	HH level in Recovery Column D5-631 base

Outputs

LCV-06303C	Close demineralised water make-up valve (via solenoid valve)
HS-06303C	Set hand switch HS-06303C to manual with 0% output (one-shot)
FCV-06301	Close LP steam valve to D5-631 from LP main (via controller FICA-06301)
PCV-14219C	Close Flash steam valve to D5-631 from F5-1406 (via hand switch HS-14219C)

Logic Operation

When the level goes high:
LCV-06303C shall close via solenoid SOV-06303C,
FCV-06301 shall close by setting flow controller FICA-06301 to manual with 0% output,
PCV-14219C shall close by setting hand switch HS-14219C to manual, 0% output.
HS-06303C shall also be set to manual with 0% output as a tidy up action.
No reset facility is required. The valves shall remain closed until the initiator clears, when the trip will return them to the operator's control.

5.1.4.2 Alarms

To warn against undesirable and/or unacceptable operating conditions the following alarms are provided:-

TIA-06305	High temperature at Tray 3 of Rectifying Section
LICA-06303	High/Low level in the Recovery Column Bottoms sump
FICA-06301	Low steam flow to the Recovery Column
TICA-06313	Low temperature in the stripping bed of the Recovery Column
FIA-06304	High DM Water Flow to D5-631 Bottoms
GICA-06311	High/Low position of nPA "front" alarms
FIA-06325	High/Low total waste water flow alarms
AIA-06326	High TOC in waste water alarm
XA-06326	Analyser AT-06326 "FAULT" alarm
FICA-05417	High/Low overheads product flow from the Recovery Column Condenser

Trips Z-190 and 191 are provided on the DH system to protect against the effects of under- and overpressure respectively (refer to Solvent Recovery Manual).

5.2 Recovery Column Condenser, E5-631 (Vendor: Godrej)

5.2.1 General Information

The Recovery Column Condenser E5-631 is a horizontal, one-pass shell-and-tube heat exchanger with cooling water on the shellside and recovery column overheads on the tubeside. The exchanger is tilted at an angle of 1.5° with the horizontal to allow free gravity draining of condensate from the exchanger. The shell is constructed from carbon steel and the tubes, header and baffles from 304L stainless steel. Cooling water is provided from the boosted cooling water system.

The shellside design pressure is 9.0 barg/FV and for the tubeside is 3.5 barg/FV. Design temperature is 185°C on shellside as well as the tubeside.

The cooling water side of the condenser is protected against over pressure by RV/E5-631 which is located on the cooling water exit line.

Additional equipment details are provided below:

- TEMA Type: NEN (Horizontal)
- Tubeside Fluid: Recovery Column Overheads at an inlet pressure of 1.054 bara
- Tubeside Fluid Temperature(In/Out): 56.5^{o}C/ 40^{o}C
- Shellside Fluid: Cooling Water at an inlet pressure of 6.3 bara
- Shellside Fluid Temperature(In/Out): 34^{o}C/ 43^{o}C
- Heat Duty: 11101 kW
- Tube length: 7406 mm (from ref. face to ref. face)
- Shell inside diameter: 1500 mm
- Effective Heat Transfer Area: 1290 m^2
- Both the dished ends are 2:1 ellipsoidal

5.2.2 Operating Philosophy

Vapour from the Recovery Column is condensed on the tubeside of the Recovery Column Condenser. Condensate returns under gravity through a luted line from the Condenser to the Recovery Column and is fed to the top tray, contacting the upflowing vapour stream. Uncondensed vapour is vented from the top of the condenser to the Atmospheric Scrubber D5-508.

The performance of the condenser is essentially uncontrolled. The design basis is for the exchanger to cool the vapour to 40°C before venting to the Atmospheric Scrubber, although increased cooling will benefit condensation of methyl acetate and so reduce the load on the Atmospheric Scrubber.

5.2.3 Instrumentation and Control

The supply flow of boosted cooling water to the condenser is measured by FT-06337 and indicated in the DCS by FI-06337. The cooling water exit pressure and temperature are measured and indicated locally by PI-06336 and TI-06340 respectively.

Butterfly valves on the cooling water supply and return can be used to balance cooling water flows around the boosted cooling water system if necessary. A flow orifice, FO-06314 provided in the cooling water exit line to create a pressure drop and prevent any vacuum formation at the outlet of the shell side.

Temperature is measured in the vapour exit line to D5-508 and is indicated locally by TI-06334.

5.2.4 Trips and Alarms

There are no trips & alarms associated directly with this equipment.
However, on activation of Z-190 (DH Column Low Pressure Trip), the isolation valve to Atmospheric Scrubber, XSV-06315 is closed and an alarm GIA-06315 is indicated in the DCS.

5.2.5 Relief Information

5.2.5.1 RST/E5-631/ E5-631 Shellside Pressure Relief Valve

Overhead vapour from Recovery Column D5-631 is condensed in Recovery Column Condenser E5-631 using cooling water.

E5-631, Recovery Column Condenser is provided with a relief valve, RV/E5-631 on its shellside which discharges to chemical drain. No special means of disposal are considered necessary.

The cold side of E5-631 has a design pressure of 9 barg. The relief valve set pressure is selected based on the elevation of the valve relative to the base of the condenser.

Overpressure protection is to restrict pressure attributed to the following cause:-

1. SYSTEM BLOCKED IN
B. System blocked in with thermal expansion due to heating by process fluid. Heat transfer is based on heat exchanger design duty multiplied by the ratio of clean to fouled heat transfer coefficients, and an appropriate coefficient of thermal expansion is considered to be 0.0006/°C.

Additional details are as under:

- Relief Valve Set Pressure: 9 barg
- Relieving Temperature: 56.5°C
- Phase while relieving: Liquid
- Required Relieving Capacity: 9035 kg/h
- Number off: 1

5.3 Recovery Column Bottoms Pumps, G5-632A/B (Vendor: Flowserve)

5.3.1 General Information

The Recovery Column Bottoms Pumps, G5-632A/B (1W, 1S) are 316L SS horizontal, centrifugal pumps, with single mechanical seals and are designed to deliver 90 m^3/hr at a discharge pressure of 7.54 barg.

Suction and delivery line isolation valves are installed along with suction and delivery drain lines to allow isolation, draining and maintenance.

Additional equipment details are as provided under:

- Normal/Rated capacity : 90 m^3/hr
- Rated differential head : 77.92 m
- Rated discharge pressure : 7.54 barg
- Efficiency (rated/maximum) : 65/68%
- Impeller type : Enclosed
- Impeller diameter (rated) : 256 mm (minimum : 250 mm / maximum : 325 mm)
- Maximum capacity at rated impeller: 111.8 m^3/h
- Minimum continuous flow : 40 m^3/hr
- Absorbed power rated impeller(rated /end of curve) : 28.1 KW / 34.5 KW
- Speed : 2950 rpm
- Seal type : Single mechanical seal with plan 32, 61M
- Seal flush fluid : LP seal water @ 0.24-0.36 m3/hr (seal cavity pressure: 7.75 barg) : Pressure in seal cavity is maintained through a self-regulating PCV on LP seal water supply line and seal flush flow is maintained using a glove valve
- Rotor: Overhung
- Casing type : single volute
- Casing design condition : 35 barg/ 185 ^{O}C min.
- Motor rated power : 37 KW

5.3.2 Operating Philosophy

The Recovery Column Bottoms Pumps operate with one running continuously and the other on stand-by. In event of pump failure the spare is on auto-start, activated by low delivery pressure. The pumps are protected against deadheading by flow-controlled kickback FCV-06324 back to the inlet of the Waste Water Cooler E5-634.

There are a number of users of Waste Water:-

1. Reslurry water to Residue Slurry Receiver F5-516.

2. Reflux to Purge Column D5-651.
3. Scrubbing water to Fifth PTA Crystalliser Scrubber F5-1406.
4. Spray water to PTA Drier Scrubber F5-1428.
5. Desuperheating water to Offgas Scrubber D5-172.
6. Solvent DH Column D5-601.

Excess water not required by the users above is exported under level control to Effluent Treatment (via the ISBL Buffer Tanks).

5.3.3 Instrumentation and Control

The pump delivery flow is measured by FT-06325 and indicated in the DCS by FIA-06325. This flow is also used by FY-06324 to maintain a safe flow through the kickback line by adjusting FCV-06324 in the line to the inlet of the Waste Water Cooler. The flow to the Effluent Buffer Tanks is measured by FT-06335 and displayed in the DCS by totaliser/indicator FQI-06335. An online TOC analyser, AT-06326 is provided in the pumps' discharge line which displays as AIA-06326 in the DCS.

Both pumps have local motor amps and delivery pressure indication, II-06319/PI-06318 and II-06321/PI-06320 on A and B pumps respectively.

An Auto-start system is provided which starts the stand-by pump in the event of low pressure being detected by PT-06322 (located in the pumps' common discharge line). Details of the system are discussed in Section 5.3.4.1.

COMPLEX LOOP FY-06324: G5-632A/B KICKBACK TO E5-634

Pumps G5-632A/B must maintain a minimum flow rate for pump protection.
FY-06324 in conjunction with FT-06325 maintains this flow by setting the kickback flow through FCV-06324.

In the event of the forward flow measured by FT-06325 falling below the minimum flow required for pump protection FY-06324 is designed to start opening FCV-06324 and keep opening it in proportion to the reduction of forward flow until when the forward flow is zero FCV-06324 will be sufficiently far open to pass a flow slightly in excess of the minimum required. This ensures that the minimum flow through the pump is maintained at all times.

If the kickback valve remains closed when the forward flow has fallen below the minimum required an alarm, GIA-06324 is initiated after a short delay to allow for valve travel.

Loop Structure and Controller Details
FY-06324
Positions valve FCV-06324 according to the profile shown in the table below.

FT-06325	FCV-06324
>Minimum	0%
Minimum	0%
0	100%

The profile must be specified, taking into account the kickback valve characteristic, such that the kickback flow increases approximately linearly as the forward flow decreases so that the total flow through the pump never falls below the minimum allowed.

The operator will have access to auto/manual switching on HS-06324.
The operator will not be able to alter the pre-determined value at which the valve FCV-06324 begins to open.

5.3.4 Trips and Alarms
5.3.4.1 I-139D

G5-632 A/B are provided with auto start facility to bring in the standby pump when the combined discharge line pressure drops below a set pressure due to snag developed in the in-line pump or the in-line pump trips. Combined discharge line pressure is monitored on PT-06322 which is used for the auto start logic I-139D.

Following alarms are associated with auto start logic which appear on DCS:

YA-06331 : Auto start unavailable : If either motor is electrically unavailable e.g. the stop button is latched in or the motor is de-energised at substation

YA-06332 : Both motors running : If both motors are running as a result of auto start action or manual operation

YA-06333 : Both motors stopped : If both motors are stopped. The alarm is delayed for 5 secs (adjustable 0-10 secs) to allow the standby pump to auto start when low pressure is detected.

PT-06322 : Low discharge pressure

5.4 Waste Water Cooler, E5-634 (Vendor: GEA Ecoflex)
5.4.1 General Information

The Waste Water Cooler E5-634 is a plate and frame type heat exchanger with cooling water as the cooling medium. The plates are constructed from CP Titanium. The design pressure of the exchanger is 10 barg/FV, and the design temperature is 185 °C. The cooler is provided with isolation valves to allow it to be taken out of service with the remainder of the systems on-line. Relief protection is provided by RV/E5-634 located on the waste water line leaving the cooler.

Additional equipment details are as under:

- Hot Fluid: Waste Water at an inlet pressure of 1.45 bara
- Hot Fluid Temperature(In/Out): 105°C/ 49°C (60°C in fouled condition)
- Cold Fluid: Cooling Water at an inlet pressure of 5 bara
- Cold Fluid Temperature(In/Out): 34°C/ 44°C
- Heat Load: 1306.2 kW
- Pressure drop calculated (hot side/cold side): 0.04/1.25 bar
- Heat Transfer Area: 8.10 m^2
- Number of plates: 32/15
- Plate thickness: 0.60 mm

5.4.2 Operating Philosophy

The function of the Waste Water Cooler is to cool a part of the Recovery Column bottoms stream to 49°C (60°C in fouled condition), prior to transfer by the Recovery Column Bottoms Pumps to various Oxidation and Purification plant users, or to Effluent Treatment. Cooling performance is essentially uncontrolled after initial setting up of the cooling water distribution system.

A temperature controlled bypass line from the Recovery Column bottoms to E5-634 exit is provided which allows passage of a quantity of waste water through a temperature control valve in order to maintain the downstream temperature at 90°C. The temperature control valve has a “minimum stop” which allows a minimum quantity of waste water to be bypassed always to prevent cavitation of G5-632A/B in case the TCV closes due to malfunction and thus ensures the minimum continuous flow requirement of G5-632 A/B is met. Detail of the scheme is explained under section 5.1.3.2.

Due to the potential for fouling in E5-634, provision has been made to allow it to be caustic washed while the plant is on-line. A caustic line serves the inlet side of E5-634 and a bypass is provided so that E5-634 can be isolated and caustic washed. During caustic washing, a higher proportion of demin water is imported to D5-631 in order to reduce the temperature of the waste water by dilution. A mechanical interlock system M-117A/B/C is fitted to the associated isolation valves to protect against the potential for caustic ingress into the waste water system. Only once the process inlet and exit routes to/from the Cooler are isolated can the caustic isolation valve be opened.

5.4.3 Instrumentation and Control

The temperature leaving E5-634 is measured downstream of the bypass line by TT-06317 and displayed in the DCS by TICA-06317. In the event of a rise in the process temperature leaving E5-634, TICA-06317 will open the Demin Water valve LCV-06303C via high select block, LY-06303C (receives input from LY-06303 also) to bring back the temperature of waste water to 90°C. The Demin water dilutes the Recovery Column bottoms exit stream and hence aids in reduction of the temperature of waste water.

The Waste Water temperature is also measured by TT-06341 (downstream of the bypass line) and displayed in DCS as TIC-06341 and is controlled by adjusting the bypass flow through TCV-06341-. Detail

of the scheme is explained under section 5.1.3.2. TCV-06341 is provided with a “minimum stop” at 20% opening (flow rate of 15000 kg/h). It has a position limit switch, GS-06341, which initiates an alarm in the DCS, GIA-06341 if the TCV reaches its “minimum stop” position.

There is also a local temperature indication, TI-06316 located on the waste water line inlet to E5-634.

5.4.4 Trips, Interlocks and Alarms

5.4.4.1 Manual Interlock M-117: Waste Water Cooler E5-634 Caustic Wash

This interlock allows caustic wash of the Waste Water Cooler, E5-634. Specifically there are two modes of operation, normal running and caustic wash. The interlock prevents the cooler being supplied with caustic if the correct valves are not closed. This ensures that caustic does not contaminate the normal process stream, which is particularly important for the supply to the Purification Plant.

DESCRIPTION OF VALVES

M-117 A	Feed flow to Waste Water Cooler E5-634
M-117 B	Waste Water Cooler E5-634 outlet
M-117 C	Caustic flush to Waste Water Cooler

INTERLOCK OPERATION

The interlock shall ensure that M-117 A and M-117 B must both be closed to open M-117 C.

To start caustic washing the interlock shall ensure the following sequence is followed:

Open bypass (not part of interlock)

1) Close M-117 B
2) Close M-117 A

Open drain (not part of interlock)

3) Open M-117 C

To restart after caustic washing the interlock shall ensure the following sequence is followed:

1) Close M-117 C
2) Open M-117 A

Flush to drain (not part of interlock)
Close drain (not part of interlock)

3) Open M-117 B

Close bypass (not part of interlock)

5.4.4.2 Alarms

TICA-06317	High and High High exit temperature alarms
TIC-06341	Low exit temperature alarm

5.4.5 Relief Information

5.4.5.1 RST/E5-634/ E5-634 Process Side Pressure Relief Valve

Waste water from Recovery Column D5-631 is cooled in Waste Water Cooler E5-634 using cooling water before being pumped to various users or to OSBL effluent treatment.

E5-634, Waste Water Cooler is provided with a pressure relief valve, RV/E5-634, which discharges to chemical drain. No special means of disposal are considered necessary.

The process side of E5-634 has a design pressure of 10 barg.

Overpressure protection is to restrict pressure attributed to the following cause:-

1. SYSTEM BLOCKED IN
A. External fire. Heat transfer based on the wetted surface area of the exchanger and process side piping inside the isolations. Area has adequate drainage as specified by API and prompt fire fighting response available.
Additional details are as provided under:

- Relief Valve Set Pressure: 10 barg
- Relieving Temperature: 188°C
- Phase while relieving: Vapour
- Required Relieving Capacity: 292 kg/h
- Number off: 1

6. Additional Pressure Relief Systems

6.1 RST/D5-631/ Recovery Column System Pressure Relief Valves

This relief system provides pressure relief for the following plant items (all 3.5 barg design pressure):

E5-608	DH Column Condenser (process side)
F5-608	DH Column Decanter
F5-609	Entrainer Storage Vessel
D5-631	Recovery Column
E5-631	Recovery Column Condenser (process side)

Relief valves RV/D5-631A/B are installed on the vapour line exit D5-631, and protect the Recovery Column system against overpressure. The relief valves discharge via Relief Header R-80202 to Relief Scrubber D5-840. The back pressure from the relief valve header is significant and requires the use of a balanced bellows valve.

Overpressure protection is to restrict pressure attributed to the following causes:-

1: SYSTEM BLOCKED IN
A. External fire with complete flame envelopment to the high liquid level for all relevant equipment. Normal process vapour flows into the system are assumed to cease. Area has adequate drainage as specified by API and prompt fire fighting response available.

B. Process Abnormality
i) Maximum inflow of steam through PCV-14219C and FCV-06301 (both fully open). The flow through these valves is calculated assuming upstream pressures of 6.5 barg and 5.5 barg respectively, and downstream system at relieving pressure.
ii) Maximum flow of nitrogen / inert gas through purge line CG-60202 via PCV-06201A and PCV-06201B (both fully open) into D5-601 overhead line (refer Operation Manual of Solvent Recovery). Note that the selected Cv for both valves is no more than 20% greater than that required for the stated flow. The flow of nitrogen / inert gas through PCV-06201A and PCV-06201B is calculated assuming upstream design pressures of 10.3 barg and 20.9 barg respectively, with downstream system at relieving pressure. Maximum flow through RV/D5-631A/B is assumed to be 50% of the total flow through the valves. Relief for the remaining 50% is provided by RV/D5-601A/B/C.
Liquid relief is disregarded on the basis that the system volume is large relative to the volumetric flow of feed streams under relief conditions. It is estimated that the column would take over 20 minutes to fill and the design pressure of the equipment accounts for liquid overfilling to E5-608 top tubesheet.

It should be noted that relief requirements for this system is calculated independently of the Solvent Dehydration system (RST/D5-601). As RV/D5-601A/B/C are sized for the maximum flow from D5-601 and have the same set pressure as RV/D5-631A/B the normal forward flows into this system from D5-601 are not included in these relief scenarios.

Additional details are as under:

- Safety valves set pressure: 3.5 barg
- Number off: 2

Case	Req. Relief Rate(kg/h)	Relieving Temperature(°C)	Phase while relieving
1A	22538	151	Vapor
1B.i)	52352	151	Vapor
1B.ii)	55250	45	Gas

7. Safety Aspects

7.1 Flammability Hazards

The entrainer (normal propyl acetate - nPA) and methyl acetate contained within the Solvent Dehydration area are well above their flash points (10°C and -9°C respectively) and some flashing will occur if liquid is released to atmosphere.

It is good operating practice to ensure that any loss of containment is minimised as this impacts upon the environmental and variable cost performance of the plant. In the event of minor losses or leaks

occurring then adequate water supply should be available around the base of the structures to enable any spillages/drainings to be washed away into the drain gulleys.

The entrainer recovery system is protected against over-pressure by relief valves. All relief valves that discharge toxic material are vented to the Relief Header, which discharges to the Relief Scrubber.

7.2 Hazardous Area Classification

Entire entrainer recovery section is classified as Zone 2 (IIA, T2). Even though the Waste Water Cooler, E5-634 and Recovery Column Bottoms Pumps, G5-632A/B do not handle flammable inventories, they come under Zone 2 (IIA, T2) due to their proximity to equipment such as D5-631 and D5-840.

7.3 Deluge and Fume Suppression Systems

D5-631 is provided with a fire water deluge ring (8 spray nozzles) to cool its structure/supports.

The fire water spray discussed above is used to quench equipment supports should there be any fire and prevent mechanical damage (buckling / collapse) of the equipment due to heat and flame impingement. The deluge system is controlled through a deluge station. D5-631 has a common deluge control station shared with F5-609, D5-511 and F5-516. The deluge system operates automatically based on quartzoid bulb thermal detectors placed around the equipment. These are all connected to an instrument air header which also supplies instrument air to the deluge valve. When any of thermal detectors melt under heat (should there be a fire), it depressurizes the instrument air header and opens the deluge valve. Deluge valve can also be operated remotely from F&G panel located in central control room. Following alarms are triggered on F&G panel on activation of the deluge system to warn the operator –

- Low instrument air header pressure alarm of the deluge system
- High deluge water pressure alarm (measured downstream of the deluge valve)

7.4 Fire and Gas Detection System

A propyl acetate vapor detector is provided near Recovery Column, D5-631.

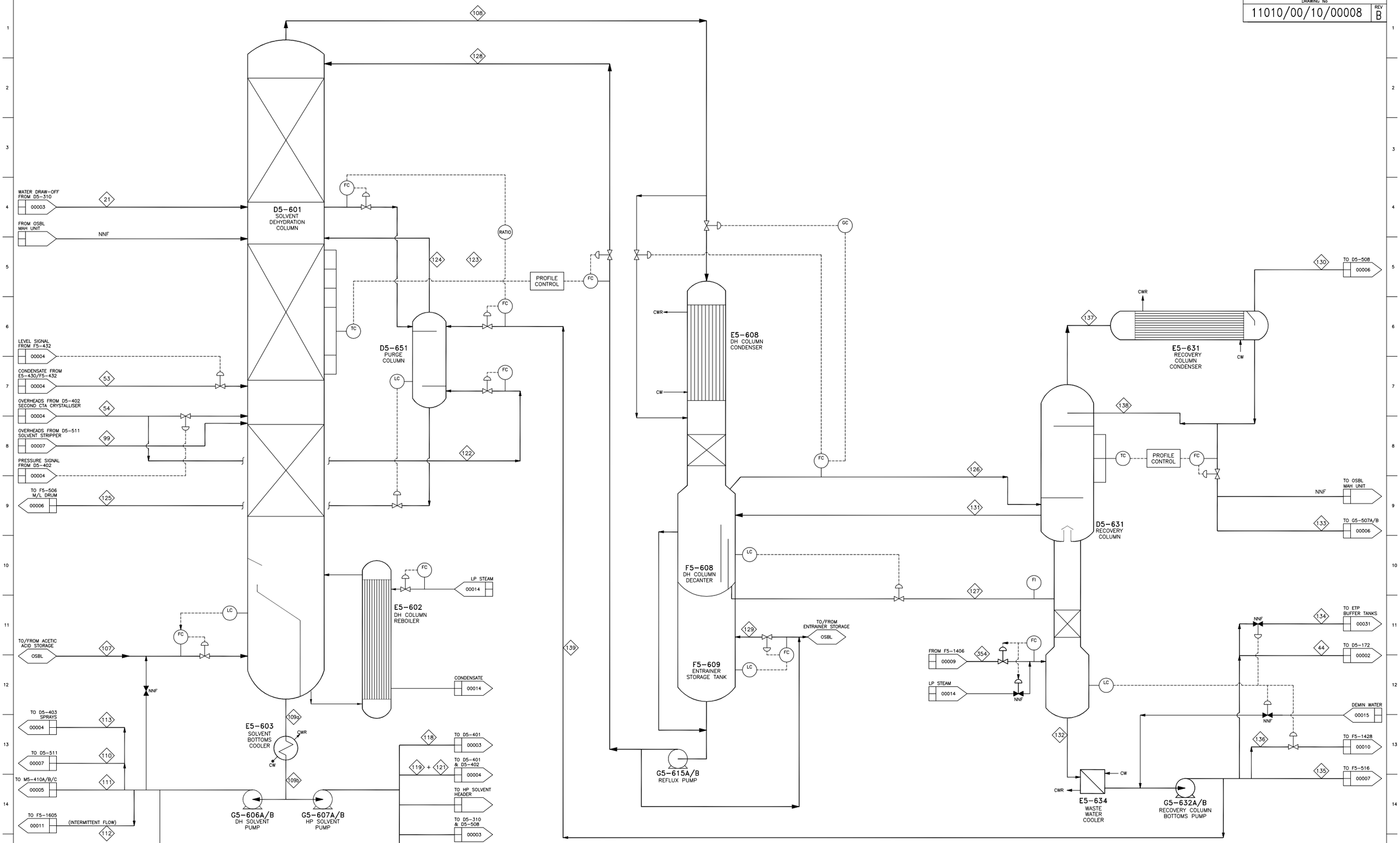
A methyl acetate vapor detector is provided near Recovery Column Condenser, E5-631.

8. Troubleshooting

Problem	Probable Causes	Actions to be carried out.
High TOC/COD in waste water	-Improper profile control in DH Column -Insufficient paraxylene removal from DHC -High Load on DHC -Improper profile control in Recovery Column	1. Check profile control in DH Column – If the profile is operating high in the Column, acetic acid will slip. 2. Check paraxylene removal from DH Column is operating correctly. Build-up of paraxylene will result in acetic acid slippage. 3. Check DH Column load – is there any evidence of flooding. 4. Consider reducing rate to stabilise DH Column operation. 5. Divert Waste water from Pure plant usage to ETP until TOC is within specification
High temperature exit E5-634 - May cause cavitation of the pumps	-Non commissioning of F5-1406 before E5-634 commissioning -Fouling in E5-634 -Failure open of TCV-06341	1. Check F5-1406 scrubber commissioned 2. Check sufficient water flow to scrubber 3. Caustic wash cooler 4. Check TCV-06341 failure opening.

Annexure A: PFD and Stream Summary

DRAWING No 11010/00/10/00008 REV B



ISSUE	REVISION	GRD	DRN	APP	DATE	FILMED
P8	FLAGS MODIFIED, MASS BALANCE INFO ADDED	A4/A13 M14/U13 U6/U7	PR		22.12.10	
P7	REVISED		GM		16.09.10	
P6	FLAG CORRECTED.		AP/L		06.09.10	
P5	REVISED FOLLOWING RIL TELECON.		JO'S		02.08.10	
P4	REVISED TO REFLECT P7 DEVELOPMENT.		JO'S		16.06.10	
B	FEEP ISSUE. FLAGS CORRECTED. DIAMOND DELETED. ARROW ADDED.	A14/A19	BR		21.06.11	

NOTES:

LINE IDENTIFICATION NUMBERS THUS ARE FOR REFERENCE TO MASS BALANCE SHEET 11010/00/11/00001

DRG TITLE:
RIL PTA PLANT 5 1120kte – Pure Terephthalic Acid Plant
OXIDATION – SOLVENT DEHYDRATION
PROCESS FLOW DIAGRAM

PROJECT No: 11010

WORKS:	BUILDING:	PLANT:	SECTION:
GEOG. AREA:	SYSTEM No:		
P.L.C'S:			
SCALES:			

DRG TYPE:	DO LOC:	
DRAWN BY:	DATE:	
CHECKED:	DATE:	
APPROVED	SECTION	DATE
J.LIMBACH	PROCESS	21.06.11
A.GOODRUM	PROJECTS	21.06.11

INVISTA™

DRG SIZE A0

DRAWING No 11010/00/10/00008 REV B

CONFIDENTIAL TO INVISTA

PTA 5/6 Operation Manual – Entrainer Recovery

Stream Number	44	126	127	130	131	132	133	134	135	136	137	138	139
Description	Water for De-superheating	Vapor from E5-608	Decanter Water	DH Section Vent	Oragnics from D5-631 to F5-608	Recovery Column Bottoms	Methyl Acetate Recycle	Water to Effluent Treatment	Residue Receiver Water	Water to PTA Drier Scrubber F5-1428	Vapor from D5-631 to E5-631	Reflux to D5-631	Water to Purge Column
ACETIC ACID	8.4	0.9	25.3	0	2.1	26.3	0	0	0.6	16.5	0	0	0.8
WATER	19185.1	4136.2	56872.8	95.2	8576.4	60102.9	230.7	0	1462	37658.9	1985.1	1659.2	1792.9
OXYGEN	0	85.1	0	85	0	0	0.1	0	0	0	85.7	0.7	0
NITROGEN	0	1301.8	0.1	1300.8	0.2	0	0.9	0	0	0	1308.5	6.8	0
CARBON MONOXIDE	0	10.3	0	10.2	0	0	0	0	0	0	10.3	0.1	0
CARBON DIOXIDE	0	221.1	0.4	215.6	0.8	0	5.2	0	0	0	258.4	37.6	0
HYDROGEN	0	0	0	0	0	0	0	0	0	0	0	0	0
PARAXYLENE	0	11.1	0	0	11.1	0	0	0	0	0	0	0	0
TA SOLIDS	0	0	0	0	0	0	0	0	0	0	0	0	0
CBA SOLID	0	0	0	0	0	0	0	0	0	0	0	0	0
P- TOLUIC ACID	0.4	0	0	0	0	1.2	0	0	0	0.7	0	0	0
BENZOIC ACID	0	0	0	0	0	0.1	0	0	0	0.1	0	0	0
METHYL ACETATE	0	11883.7	2268.2	3975.2	2571.9	0	7600.5	0	0	0	66272	54691.9	0
PROPYL ACETATE	0	16993.7	1074.8	3.9	18041	0	23.6	0	0	0	197.3	169.8	0
COBALT	0	0	0	0	0	0	0	0	0	0	0	0	0
MANGANESE	0	0	0	0	0	0	0	0	0	0	0	0	0
BROMIDE	0	0	0	0	0	0	0	0	0	0	0	0	0
METHYL BROMIDE	0	1.2	0	0	0.1	0	0.3	0	0	0	3.2	2.1	0
PROPANOL	0	553.6	500.4	0	1042.8	8.4	0	0	0	0	20.4	17.5	0.3
METHANOL	0	0	0	0	0	0	0	0	0	0	0	0	1
BYPRODUCTS	0	0	0	0	0	0	0	0	0	0	0	0	0
OXALATE	0	0	0	0	0	0	0	0	0	0	0	0	0
SODIUM	0	0	0	0	0	0	0	0	0	0	0	0	0
CARBONATES	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	19193.9	35198.6	60742.1	5686	30246.5	60139	7861.4	0	1462.7	37676.2	70140.9	56585.5	1794
MEAN MOL. WT.	18	56.7	18.9	50.2	42.9	18	67.9		18	18	66	67.9	18
TEMPERATURE	90	78	78	40	79	105	40		90	90	57	40	90
PRESSURE	6	1.17	1.17	1.04	1.17	1.2	1.04		6	6	1.05	1.04	1.28
DENSITY	959.3	2.3	958.2	2	858.2	947.8	909.4		959.3	959.3	2.6	909.6	959.2
ENTHALPY	-83179	-55605	-253130	-7026	-66769	-259550	-13654		-6339	-163270	-110060	-98268	-7774
SOLIDS	0	0	0	0	0	0	0	0	0	0	0	0	0
VISCOSITY	/0.3137	0.0094/	/0.3669	0.0114/0.3401	/	/0.2656	0.0114/0.3399	/	/0.3137	/0.3137	0.0091/	/0.3400	/0.3137

Stream Number	354
Description	D5-1406 Steam to D5-631
Acetic Acid	2.3
Water	7996.4
Inert Gas	0
Hydrogen	0
Benzoic Acid	0.1
TA Solid	0
Terephthalic Acid	0
P-Toluic Solid	0
P-Toluic Acid	0.5
4CBA	0
Oxidation Catalyst	0
TOTAL	8000
MEAN MOL. WT.	18.02
TEMPERATURE	151.5
PRESSURE	4.95
DENSITY	2.606
ENTHALPY	-29368
VISCOSITY	0.0136/

Annexure B: Standard Operating Conditions

Tag No	Fluid	State	min.	normal	max.	Units	Remarks	**Consequences of going above max or below min value** (only provided for parameters having impact on safety and equipment integrity)	**Protection provided** (only provided for parameters having impact on safety and equipment integrity)	**Corrective Actions** (only provided for parameters having impact on safety and equipment integrity)
PI-06318	Waste water	Liquid	-	7	-	bar g				
PI-06320	Waste water	Liquid	-	7	-	bar g				
PT-06322	Waste water	Liquid	-	7	13.8	bar g				
PI-06336	Cooling water	Liquid	-	0.6	-	bar g				
LT-06302	Waste water	Liquid	500	1000	1500	mm		Overfilling coupled with stripping steam flow may lead to slug flow of vapour which can damage the bottom packed bed	1. Two independent level measurements. 2. High level alarm on LT-06303. 3. High high level trip (Z-133).	1. Chcek demin water make-up valve for passing. 2. Check consumption of the users / whether the respective flow control(s) at user end is/are malfunctioning 3. Check whether LCV-0303B is stuck close

LT-06303	Waste water	Liquid	500	1000	1500	mm		Overfilling coupled with stripping steam flow may lead to slug flow of vapour which can damage the bottom packed bed	1. Two independent level measurements. 2. High level alarm on LT-06303. 3. High high level trip (Z-133).	1. Chcek demin water make-up valve for passing. 2. Check consumption of the users / whether the respective flow control(s) at user end is/are malfunctioning 3. Check whether LCV-0303B is stuck close
FT-06301	Steam	Vapour	2000	8000	10000	kg/h				
FT-06304	Demin water	Liquid	-	0	75000	kg/h				
FO-06314	Cooling water	Liquid	-	1062	-	t/h				
FT-06325	Waste water	Liquid	10000	60000	86000	kg/h				
FT-06335	Waste water	Liquid	-	0	86000	kg/h				
FT-06337	Cooling water	Liquid		1062000		kg/h				
TT-06305	Methyl acetate, water, nitrogen + traces	Gas/Liquid	-	56	-	DegC				
TT-06306	Methyl acetate, water, nitrogen + traces	Gas/Liquid	-	56-78	-	DegC				
TT-06307	Methyl acetate, water, nitrogen + traces	Gas/Liquid	-	56-78	-	DegC				
TT-06308	Methyl acetate, water, nitrogen + traces	Gas/Liquid	-	56-78	-	DegC				
TT-06309	Methyl acetate, water, nitrogen + traces	Gas/Liquid	-	56-78	-	DegC				
TT-06312	Water, propyl/methyl acetate + traces	Gas/Liquid	-		105	DegC				
TT-06313	Water, propyl/methyl acetate + traces	Gas/Liquid	-	105	-	DegC				
TI-06316	Waste water	Liquid	-	105	-	DegC				

TT-06317	Waste water	Liquid	-	90	105	DegC		High temperature may lead to cavitation of pump and consequentail damage	1. High temperature alarm provided. 2. Control logic brings in cold demin water at high high temperature	1. Reduce D5-631 bottom temperature (TICA-06313) 2. Check whether TCV-06341 is malfunctioning (open more than what is required for temperature control) - it is air fail to open.
TI-06334	Inerts,acetic acid, methyl acetate + traces	Vapour	-	40	-	DegC				
TI-06340	Cooling water	Liquid		43		DegC				
TT-06341	Waste water	Liquid		90	105	DegC		High temperature may lead to cavitation of pump and consequentail damage	1. High temperature alarm provided. 2. Control logic brings in cold demin water at high high temperature	1. Reduce D5-631 bottom temperature (TICA-06313) 2. Check whether TCV-06341 is malfunctioning (open more than what is required for temperature control) - it is air fail to open.
AT-06326	Waste water	Liquid			2500	ppm				
II-06319	G5-632A Pump Amperage			TBD		A	To be decided at time of commissioning			
II-06321	G5-632B Pump Amperage			TBD		A	To be decided at time of commissioning			

Annexure C: Alarm and Trip Schedule

Tag No.	Title	Low Alarm	High Alarm	Low Trip	High Trip	Units	Remarks
FT-06301	STEAM TO D5-631	5000				kg/h	
LT-06302	D5-631 BOTTOMS HIGH HIGH LEVEL				2600 $		D5-631 bottom tan line, $ High High Trip
LT-06303	D5-631 BOTTOMS LEVEL CONTROL	500	1500			mm	D5-631 bottom tan line
FT-06304	DEMIN WATER TO D5-631 BOTTOMS		12000			kg/h	
TT-06305	D5-631 TEMPERATURE (TRAY 3)		62			°C	
TT-06313	D5-631 BED TEMPERATURE (BOTTOM)	99				°C	
TT-06317	D5-631 BOTTOMS EXIT E5-634		92		96	°C	
PT-06322	G5-632A/B DISCHARGE LOW PRESSURE AUTO-START			5		bar g	
FT-06325	G5-632A/B Discharge	9000	90300			kg/h	
AT-06326	TOC IN D5-631 EFFLUENT		2500			ppm	
TT-06341	D5-631 to E5-634	88				°C	

Annexure D: Material Safety Data Sheets

a) n-Propyl Acetate

---

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION

Name: n-propyl acetate
Alternative Names: n-propyl ester, 1-Acetoxypropane

---

2. COMPOSITION/INFORMATION ON INGREDIENTS

HAZARDOUS INGREDIENT(S)	Classification	% weight	CAS No.	EC-No.
n-propyl acetate		100	109-60-4	203-686-1

---

3. HAZARDS IDENTIFICATION

Highly flammable.
Irritating to eyes.
Vapor/air mixture are explosive
Vapors may travel considerable distance to a source of fire and flash back.
High vapour concentrations may cause drowsiness and irritation of the eyes or respiratory tract.
Prolonged or repeated skin contact may cause drying, cracking, or irritation due to the defatting properties of the substance.

---

4. FIRST-AID MEASURES

Inhalation : Move to fresh air. Treat symptomatically. Get medical attention if symptoms persist
Skin Contact : Wash skin with soap and water immediately. Remove contaminated clothing.
Eye Contact : Immediately irrigate with clean water for several minutes and seek medical advice.
Ingestion : Do not induce vomiting without medical advice. Obtain medical attention immediately.

---

5. FIRE-FIGHTING MEASURES

Extinguishing Media : water spray, dry chemical, carbon dioxide, alcohol foam
Fire Fighting Protective Equipment : A self-contained breathing apparatus and suitable protective clothing should be worn in fire conditions.

---

6. ACCIDENTAL RELEASE MEASURES

Remove all source of ignition. Dam up and absorb with vermiculite or other inert material, then place in a container for chemical waste. For large spills use water spray to disperse vapours and dilute spill to a non-flammable mixture. Prevent from entering sewers or streams.

---

7. HANDLING AND STORAGE

7.1 HANDLING

Avoid breathing high vapour concentrations. Avoid prolonged or repeated contact with skin. Use only with adequate ventilation. Wash thoroughly after handling.

7.2 STORAGE

Keep away from heat and sources of ignition in a cool and well-ventilated place. Keep away from oxidising materials. Store in original container.

---

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Keep container tightly closed. Provide for adequate ventilation especially in confined areas. Wear safety glasses or coverall chemical splash goggles face shield when the possibility exists for eye and face contacts. Wear impervious clothing, such as gloves, apron, boots or whole body suit as appropriate.

Occupational Exposure Limits:

OES (EH40/99	LTEL 8hr TWA		STEL 15 min.	
	ppm	mg/m^3	ppm	mg/m^3
n-propyl acetate	200	849	250	1060

---

9. PHYSICAL AND CHEMICAL PROPERTIES

Form : liquid
Colour : colourless
Odour : sweet, ester (pear-like)
pH (Value) : no data available
Melting Point (Deg C) : -92
Boiling Point (Deg C) : 102
Flash Point (Deg C) : 13 (TCC)
Flammable Limits (Lower) (%v/v) : 1.7
Flammable Limits (Upper) (%v/v) : 7.9
Auto Ignition Temperature (Deg C) : 457
Explosive Properties : none
Oxidising Properties : none
Vapour Pressure (kPa at 20° C) : 3.5

Density (g/ml) : 0.9
Solubility (Water) : moderate
Partition Coefficient : 1.24 as log Pow
Vapor density: 3.5

---

10. STABILITY AND REACTIVITY

Hazardous Reactions : Stable at normal temperature and storage conditions. Can react violently with oxidizers.
Incompatibility : oxidizers, bases, acids moisture, heat
Decomposition products: carbon monoxide, carbon dioxide
Polymerization: Polymerization will not occur.

---

11. TOXICOLOGICAL INFORMATION

Animal data: LD50/oral/rat = 9370 mg/kg.
LC50/inhalation/4h/rat = 33.4 mg/l.
Inhalation : High vapour concentrations may cause drowsiness and irritation.
Skin Contact : Prolonged or repeated contact may cause drying, cracking or irritation
Eye Contact : High vapour concentrations may cause irritation.
Ingestion : Expected to be low ingestion hazard.
Long Term Exposure : no data available

---

12. ECOLOGICAL INFORMATION

The product has, a high biochemical oxygen demand and a potential to cause oxygen depletion in aqueous systems, a low potential to affect aquatic organisms and a low potential to bioconcentrate. When diluted with large amounts of water, this material released directly or indirectly into the environment is not expected to have a significant impact.

---

13. DISPOSAL CONSIDERATIONS

Incinerate under approved controlled conditions, using incinerators suitable for the disposal of noxious chemical waste. Disposal should be in accordance with local, state or national legislation.

---

14. TRANSPORT INFORMATION

UN No. : 1276 UN Pack. Group : II

AIR

ICAO/IATA Class : 3 Subsidiary risk : n.a.
Packing Group : II Label: Flammable Liquid
Proper Shipping Name : n-propyl acetate

SEA

IMDG Class : 3.2 Subsidiary risk : n.a.
Packing Group : II Label: Flammable Liquid
IMDG-Page: 3274 EmS: 3-07 MFAG: 330
Proper Shipping Name : n-propyl acetate

ROAD/RAIL

ADR/RID Class : 3 ADR/RID Item No : 3(b)
Label(s)(Packages) : 3 Label(s)(Tankers) : 3
HI/UN-No : 33/1276 TremCard: 519
Proper Shipping Name: n-propyl acetate, 3, 3(b), ADR
UK TANKER REGULATIONS - DANGEROUS GOODS
Emergency Action Code : 3YE
SI-No (UN) : 1276

---

15. REGULATORY INFORMATION

EC Classification : Highly Flammable and Irritating
Index No. : 607-024-00-6
EC-Label
Hazard Symbol : F-Highly Flammable, Xi-Irritating
Content : n-propyl acetate

Risk Phrases : R11 Highly Flammable
R36 Irritating to eyes
R66 Repeated exposure may cause skin dryness or cracking
R67 Vapors may cause drowsiness and dizziness

Safety Phrases : S16 Keep away from sources of ignition- No smoking
S26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S29: Do not empty into drains
S33: Take precautionary measures against static discharges

---

b) Methyl acetate/Methanol

---

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION

Name: Methyl acetate with upto 4% methanol

---

2. COMPOSITION/INFORMATION ON INGREDIENTS

HAZARDOUS INGREDIENT(S)	Symbol	% weight	CAS No.	R phrases
Methyl acetate	F	>75	79-20-9	R11
EC: 201-185-2				
Methanol	F,T	<4%	67-56-1	R11 R23/25

---

3. HAZARDS IDENTIFICATION

Harmful if swallowed.
Harmful by inhalation.
May cause irritation to skin, eyes and respiratory system.
Can be absorbed through skin causing systemic toxic effects.
Highly flammable.

---

4. FIRST-AID MEASURES

Inhalation : Remove patient from exposure. Apply artificial respiration if breathing has ceased or shows signs of failing. Obtain immediate medical attention.

Skin Contact : Wash skin with water. Remove contaminated clothing. If ill effects occur obtain medical attention.

Eye Contact : Immediately irrigate with eyewash solution or clean water, holding the eyelids apart, for at least 10 minutes. Obtain immediate medical attention.

Ingestion : Wash out mouth with water and give 200-300 ml (half a pint) of water to drink. Obtain immediate medical attention.

Further Medical Treatment

Symptomatic treatment and supportive therapy as indicated

---

5. FIRE-FIGHTING MEASURES

Highly flammable
Extinguishing Media : polar resistant foam, dry powder or carbon dioxide.
Water spray should be used for cooling containers.

---

6. ACCIDENTAL RELEASE MEASURES

Extinguish sources of ignition, but not draught induced furnaces.
Ensure full personal protection (including respiratory protection) during removal of spillages.
Do not empty into drains.
Contain and adsorb large spillages onto an inert, non-flammable adsorbent carrier.
Do not adsorb onto sawdust or other combustible materials.
Transfer to a lidded container for disposal or recovery.

---

7. HANDLING AND STORAGE

7.1 HANDLING

Avoid contact with skin and eyes. Do not breathe vapour.

Use only in well ventilated areas.

Atmospheric levels should be controlled in compliance with the occupational exposure limits

7.2 STORAGE

Keep in a cool, well ventilated place.

Keep away from heat and sources of ignition

Unsuitable containers: copper, aluminium

---

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Wear suitable protective clothing, gloves and eye/face protection.

Butyl rubber is better than PVC.

Occupational Exposure Limits:

Hazardous Ingredients	LTEL 8hr TWA		STEL 15 min.	
	ppm	mg/m³	ppm	mg/m³
Methyl Acetate	200	610	250	760
Methanol	200	266	250	333

---

9. PHYSICAL AND CHEMICAL PROPERTIES

Form : liquid
Odour : ester-like
Odour Threshold (ppm) : No data.
pH (Value) : No data.
Boiling Point (Deg C) : 53.4
Melting Point (Deg C) : No data.
Flash Point (Deg C) : -10
Flammable Limits : No data.
Auto Ignition Temperature (Deg C) : No data.
Explosive Properties : No data.

Oxidising Properties : No data.
Vapour Pressure (mm Hg) : No data.
Density (g/ml) : No data.
Solubility (Water) : No data.
Partition Coefficient : No data.

---

10. STABILITY AND REACTIVITY

Hazardous Reactions : Can react violently if in contact with oxidising agents
Keep away from strong acids, alkalis and chlorine

---

11. TOXICOLOGICAL INFORMATION

Inhalation : Harmful by inhalation.
High concentrations of vapour may be irritant to the respiratory tract. The vapour has anaesthetic properties and when inhaled at concentrations above the occupational exposure limit it may cause headache, fatigue, dizziness, incoordination and loss of consciousness.
Skin Contact : May cause skin irritation. Can be absorbed through skin causing systemic toxic effects. Will remove the natural greases resulting in dryness, cracking and dermatitis.
Eye Contact : May cause eye irritation.
Ingestion : Harmful if swallowed. Adverse effects similar to inhalation may occur.
Long Term Exposure : The following information is based upon the consideration of the the properties of methanol. Methanol is present in the mixture and may also be formed within the body as a result of repeated exposure to high levels of methyl acetate also present in the mixture. Repeated exposure to levels well above the occupational exposure limit may produce systemic effects and visual disturbances possibly leading to permanent blindness.

---

12. ECOLOGICAL INFORMATION

No information available

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13. DISPOSAL CONSIDERATIONS

Disposal should be in accordance with local, state or national legislation.

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14. TRANSPORT INFORMATION

UN No. : 1992 UN Pack. Group : II

AIR

ICAO/IATA Class
-primary: 3
-subsidiary: 6.1

SEA

IMDG Class

-primary: 3.2

-subsidiary: Toxic

Marine pollutant: Not classified as marine pollutant

Proper Shipping Name : Flammable Liquid, Toxic (contains methyl acetate and methanol)

ROAD/RAIL

ADR/RID Class : 3 ADR/RID Item No : 19(b)

Classification (Packages): 3

Classification (Tankers): 3

UK TANKER REGULATIONS - DANGEROUS GOODS

Emergency Action Code : 3WE

SI-No (UN) : 1992

---

15. REGULATORY INFORMATION

EC Classification : Highly flammable and harmful

Hazard Symbol : F +Xn

Risk Phrases : R22 harmful if swallowed
R20 Harmful by inhalation
R11 Highly flammable

Safety Phrases : S3/9 Keep in a cool ventilated place

---

c) TA Oxidation Waste Water

---

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION

TA Oxidation Waste Water

---

2. COMPOSITION/INFORMATION ON INGREDIENTS

Contains also trace amounts of :
Acetic acid
Methanol
Methylacetate
Paraxylene

---

3. HAZARDS IDENTIFICATION

This is essentially hot water. Unlikely to cause harmful effects under normal conditions of handling and use. Hot water will scald.

---

4. FIRST-AID MEASURES

Inhalation : Remove patient from exposure. Obtain medical attention if ill effects occur.
Skin Contact : Remove contaminated clothing. Wash skin with water. If symptoms develop, obtain medical attention.
Eye Contact : Irrigate with eyewash solution or clean water, holding the eyelids apart, for at least 10 minutes. Obtain medical attention.
Ingestion : Do not induce vomiting. Wash out mouth with water and give 200-300 ml (half a pint) of water to drink. Obtain medical attention if ill effects occur.

Further Medical Treatment

Unlikely to be required but if necessary treat symptomatically.

---

5. FIRE-FIGHTING MEASURES

Non-combustible

---

6. ACCIDENTAL RELEASE MEASURES

Drench spillages with water and wash to drain

---

7. HANDLING AND STORAGE

7.1 HANDLING

Extra care should be taken to prevent burns from contact with hot material. Avoid contact with skin and eyes.

7.2 STORAGE

No special requirements

---

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Good working practice suggests gloves and goggles should be worn.
No exposure limits assigned

---

9. PHYSICAL AND CHEMICAL PROPERTIES

Form : liquid
Colour : colourless
Odour : odourless
pH (Value) : 7 approx
Boiling Point (Deg C) : 100 approx
Melting Point (Deg C) : 0 approx
Flash Point (Deg C) : Not applicable.
Auto Ignition Temperature (Deg C) : Not applicable.
Explosive Properties : Not applicable.
Oxidising Properties : Not applicable.
Density (g/ml) : 1.0 approx
Solubility (Water) : miscible
Partition Coefficient : Not applicable.

---

10. STABILITY AND REACTIVITY

Hazardous Reactions: None known

---

11. TOXICOLOGICAL INFORMATION

Inhalation : Unlikely to be hazardous by inhalation.
Skin Contact : Repeated or prolonged skin contact may result in mild irritation. Hot material may scald.
Eye Contact : Unlikely to cause eye irritation. Hot material may scald.
Ingestion : Unlikely to be hazardous if swallowed.

Long Term Exposure : Chronic effects are unlikely.

---

12. ECOLOGICAL INFORMATION

No adverse effects would be expected.

Environmental Fate and Distribution

Medium tonnage material produced in partially contained systems. Liquid with moderate volatility. The product is soluble in water. The product has high mobility in soil.

Persistence and Degradation

no data available

Toxicity

no data available

---

13. DISPOSAL CONSIDERATIONS

Disposal in accordance with local, state or national legislation.

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14. TRANSPORT INFORMATION

Not classified as dangerous for transport

---

15. REGULATORY INFORMATION

EC Classification : Not classified as dangerous for supply/use.

d) Caustic Soda (2 - <5%)

---

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION

Name: Caustic Soda(2-<5%)

Alternative Names: Sodium Hydroxide Solution

---

2. COMPOSITION/INFORMATION ON INGREDIENTS

HAZARDOUS INGREDIENT(S)	Classification	% weight	CAS No.	EC-No.
Sodium Hydroxide	C; R35	2-<5	1310-73-2	215-185-5

R35 causes severe burns

---

3. HAZARDS IDENTIFICATION

Causes burns to all parts of the body

---

4. FIRST-AID MEASURES

Inhalation: Remove patient from exposure, keep warm and at rest. Administer oxygen if necessary.

Skin Contact: Remove contaminated clothing. After contact with skin, wash immediately with plenty of water.

Eye Contact: Immediately irrigate with eyewash solution or clean water, holding the eyelids apart, for at least 10minutes. Continue irrigation until medical attention can be obtained.

Ingestion: Do not induce vomiting. Provided the patient is conscious, wash out mouth with water and give 200-300 ml(half a pint) of water to drink.

Further Medical Treatment

Symptomatic treatment and supportive therapy as indicated. Administer oxygen if necessary.

---

5. FIRE-FIGHTING MEASURES

Non-combustible. Contact with some metals can produce flammable hydrogen gas. Contact with some organic chemicals can produce violent or explosive reactions.

Extinguishing Media : As appropriate for surrounding fire.

Fire Fighting Protective Equipment: A self-contained breathing apparatus and suitable protective clothing must be worn in fire conditions.

---

6. ACCIDENTAL RELEASE MEASURES

Ensure suitable personal protection during removal of spillages.
Drench spillages with water and wash to drain.
Spillages or uncontrolled discharges into watercourses must be alerted to the appropriate regulatory body.

---

7. HANDLING AND STORAGE

7.1 HANDLING

Keep away from acids and chlorinated hydrocarbons.
Avoid contact with skin and eyes. Avoid inhalation of high concentrations of mists. Atmospheric levels should be controlled in compliance with the occupational exposure limit.

7.2 STORAGE

Keep container tightly closed. Storage vessels should be made of mild steel. Where temperatures exceed 60 Deg C, tanks must be stress relieved.

---

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Wear close fitting goggles or full face shield.
Wear suitable protective clothing and gloves. PVC is recommended.
Occupational Exposure Limits:

OES (EH40/99	LTEL 8hr TWA		STEL 15 min.	
	ppm	mg/m³	ppm	mg/m³
Sodium Hydroxide	-	-	-	2

---

9. PHYSICAL AND CHEMICAL PROPERTIES

Form : Clear or slightly turbid liquid
Colour : colourless
Solubility (Water) : very soluble
Solubility (Other) : very soluble in: alcohol and glycerine
insoluble in: acetone and ether
Specific Gravity : 1.021 - 1.054 (at 20 Deg C)

---

10. STABILITY AND REACTIVITY

Hazardous Reactions: Can react violently if in contact with acids.
Can react with chlorinated hydrocarbons to form toxic and explosive chloroacetylenes.

Highly reactive with aluminium, zinc, tin and alloys of these metals producing flammable hydrogen gas.
Can react with sugar residues to form carbon monoxide.

---

11. TOXICOLOGICAL INFORMATION

Inhalation: Mist is severely irritant to the respiratory tract.
Skin Contact: Causes burns. Repeated or prolonged contact may cause dermititis.
Eye Contact: Severe/very severe irritant. May cause severe permanent impairment of vision.
Ingestion: Will cause corrosion of and damage to the gastrointestinal tract.

Long Term Exposure: Chronic effects are unlikely.

---

12. ECOLOGICAL INFORMATION

Environmental Fate and Distribution

Liquid with moderate volatility.
The substance does not bioaccumulate

Persistence and Degradation

Chemical Oxygen Demand (COD) zero.
Biological Oxygen Demand (BOD 5 DAY) zero
Sodium hydroxide degrades readily by reaction with the natural carbon dioxide in the air.

Toxicity

Concentrations greater than 10ppm, especially in fresh water, or a pH value equal to or greater than 10.5 may be fatal to fish and other aquatic organisms.
Can cause damage to aquatic plants.
Can cause damage to vegetation.

Effect on Effluent Treatment

Concentrations sufficient to render effluent alkaline may cause damage to effluent treatment organisms.

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13. DISPOSAL CONSIDERATIONS

Disposal should be in accordance with local, state or national legislation.

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14. TRANSPORT INFORMATION

UN No. : 1824 UN Pack. Group : III

AIR

ICAO/IATA Class : 8 Subsidiary risk : n.a.

Packing Group : III Label: Corrosive
Proper Shipping Name : Sodium Hydroxide Solution

SEA

IMDG Class : 8 Subsidiary risk : n.a.
Packing Group : III Label: Corrosive
IMDG-Page: 8226 EmS: 8-06 MFAG: 705
Proper Shipping Name : Sodium Hydroxide Solution

ROAD/RAIL

ADR/RID Class : 8 ADR/RID Item No : 42(c)
Label(s)(Packages) : 8 Label(s)(Tankers) : 8
HI/UN-No : 80/1824
Proper Shipping Name: 1824 Sodium Hydroxide Solution, 8, 42(c), ADR
UK TANKER REGULATIONS - DANGEROUS GOODS
Emergency Action Code : 2R
SI-No (UN) : 1824

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15. REGULATORY INFORMATION

EC Classification : Corrosive
Index No. : 011-002-00-6
EC-Label
Hazard Symbol : C
Content : Sodium Hydroxide(2-<5%)
Risk Phrases : R34 causes burns
Safety Phrases : S26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S37/39: Wear suitable gloves and eye/face protection.
S45: In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

Annexure E: Inventory Summary in Vessels

Equipment Tag No.	Description	Contents	Normal Working Volume(m^3)	Maximum Working Volume(m^3)	Minimum Working Volume(m^3)
D5-631	Recovery Column Bottoms	Waste Water	6.95	9.4 (High level alarm)	4.5 (Low level alarm)