

SHELL INTERNATIONAL CHEMICALS B.V.  
AMSTERDAM - THE NETHERLANDS

**SHELL EO/EG PROCESS MEMORANDUM 118**

SUBJECT : WASTE STREAMS

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**INTRODUCTION**

This document provides information on vents and effluents. The design and engineering of necessary vent and effluent treatment facilities is the responsibility of licensee and contractor.

Local regulations must be followed in considering whether any of these effluent streams require special disposal facilities.

It should be noted that as more of the effluents are recycled back to the system, or as less volume is purged, levels of impurities may build up to such an extent that they will accompany the products and affect quality or possibly the EO reactor catalyst performance.

For continuous vents and effluents, the material balance stream number, if applicable, is shown. For continuous waste water streams a separate table summarising all waste water streams is included.

It should be noted that composition and flow of the various vent and effluent streams vary depending on process conditions. With respect to substances that are present in low concentrations, the figures in the material balance should be treated with care. If critical for some reason, the exact concentration of certain impurities may have to be studied separately in detail.

It should be noted that aldehydes generation in the process and thus aldehydes presence in the various streams depends on many factors and may vary quite significantly from the numbers shown in the material balance.

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## 1 VENTS

For additional information on the vents/gaseous waste streams reference is made to appendix 1. Items not covered in the information given in this memorandum include:

- Fugitive emissions: leakage to atmosphere from seals, valves, flanges etc.
- Equipment decontamination or clean-out.
- Safety Relief Valves to atmosphere

### 1.1 Process vent / 201

Inert gases such as argon and ethane enter the loop via the oxygen, ethylene and methane feed. These gases build up and therefore have to be removed by a bleed stream, the process vent.

Increasing the purity of the feedstocks will decrease the vent rate and enhance overall yield. The reaction selectivity to EO per mole of ethylene reacted is a function of the oxygen concentration, amongst others, in the reactor feed gas. The allowable oxygen concentration depends on the flammable limit of the reactor feed and product gas. The oxygen flammable limit is among others influenced by the concentration of inert gases, which originate in the feedstocks.

Since the bulk of these inert gases entering with the feedstocks are removed from the reactor recycle loop via the process vent, their concentration in the loop is dependent upon the process vent rate. Consequently, the process vent rate indirectly affects, via the inert gas concentration, flammable limits and oxygen concentration the selectivity to EO. On the other hand, the vent rate also gives rise to an associated ethylene loss.

The process vent can be vented to flare. However, since the process vent gas has a significant caloric value, the process vent is preferably sent to the fuel gas system during normal operation.



## 1.2 CO<sub>2</sub> vent

The CO<sub>2</sub> stripper overhead stream consists mainly of water and CO<sub>2</sub>. The CO<sub>2</sub> stripper overhead is, after partial condensation of the water, routed to an OBL methanol plant. Maximum CO<sub>2</sub> production rates are indicated by stream 211. However, during process upset conditions, it may be necessary to vent this stream to atmosphere. A small continuous vent stream of CO<sub>2</sub> to atmosphere may also be required, in case the downstream unit requires a fixed feed rate. The CO<sub>2</sub> vent is known to contain water, glycol, aldehydes, EO, ethylene, methane and chloride compounds.

The carbonate flasher, upstream of the CO<sub>2</sub> stripper, reduces the hydrocarbon concentration in the CO<sub>2</sub> stripper vent. Methane required as ballast gas in the gas loop is fed via the carbonate flasher. This methane helps in stripping out and recycling the ethylene entering the carbonate flasher. The carbonate flasher has to be operated at as low a pressure as possible for maximum hydrocarbon recovery. The overhead of the carbonate flasher is recycled to the recycle gas loop via the residual gas compressor.

## 1.3 Vacuum condensate vessel

The condensate collection vessel receives water and glycols from the vacuum systems in the glycol dehydration and purification sections, and condensate from the glycol bleed flasher overhead. The non-condensable gases evolving from the dehydration and glycol section vacuum systems are predominantly air that has leaked in, nitrogen used for pressure control and a small amount of light ends, glycols and decomposition gases, which give a slight odour to the gas effluent. The vessel is operated at atmospheric pressure and is open to the atmosphere through a vent at safe location. Vapour containing water and some glycols is vented to the atmosphere during filling of the vessel in case of pump trip and due to thermal breathing.

## 1.4 Deaerator

Oxygen and other dissolved gases are removed from boiler feed water in the deaerator by stripping of condensate and fresh demineralised water with CS 2K. The stripped-out gases are vented to the atmosphere together with some steam.



## **1.5 Clean and process condensate vessel vents**

2K clean condensate and 3K process condensate from the chilled water refrigeration package are returned to the clean condensate and process condensate vessels. Here the condensate streams are flashed to atmospheric pressure, releasing steam, which is vented to atmosphere. The process condensate contains small amounts of glycols and aldehydes. Flashing will be reduced if the condensate leaving the chilled water refrigeration package is subcooled.

## **1.6 Vents - Intermittent**

### **1.6.1 Moderator feed vessel**

The pressure in the moderator feed vessel is controlled on split range by venting to atmosphere and pressurising by ethylene. The ethylene and traces of moderator (ethyl chloride) are vented to atmosphere via an adsorbent bed if the pressure is above the setpoint. Also during filling of the vessel, gas is vented to the atmosphere unless the vessel is connected to the vapour cap of the supply container.

### **1.6.2 Carbonate storage tank and carbonate dissolving drum**

The carbonate storage tank and dissolving drum are vented to atmosphere. During filling of the tank and the vessel and during thermal out-breathing, air with traces of potassium carbonate will be vented to the atmosphere.

### **1.6.3 Caustic storage tank**

The caustic storage vessel is open to atmosphere. During filling of the vessel and during thermal out-breathing air with traces of caustic will be vented to the atmosphere.

### **1.6.4 Glycol slops tank**

The glycol slops tank is blanketed with nitrogen, and so it operates slightly above atmospheric pressure. Nitrogen blanketing is applied to prevent product degradation and corrosion, which would occur if air was applied. The pressure in the vessels is controlled on split range by venting to the atmosphere and pressurizing with nitrogen. The nitrogen



supply is reduced in pressure and the vent to atmosphere is on the nitrogen line to the vapour cap in order to prevent sweeping the tank vapour volume. Low concentrations of glycol can be expected in the nitrogen vented to atmosphere. The nitrogen fill and vent rate capabilities must be above the pumping rates. This tank is normally empty.

#### **1.6.5 Heavy glycol slops tank**

The glycol slops tank is vented to atmosphere. Out-breathing of air saturated with glycols will occur due to tank filling, and temperature change.

#### **1.6.6 Chilled water tank**

The chilled water tank operates slightly above atmospheric pressure because of the nitrogen blanketing. Nitrogen blanketing is applied to prevent ingress of air, which could cause corrosion. The pressure in the chilled water tank is controlled on split range by venting to the atmosphere and pressurizing with nitrogen. The nitrogen supply is reduced in pressure and the vent to atmosphere is on the nitrogen line to the vapour cap in order to prevent sweeping the tank vapour volume. Low concentrations of substances from the chemical dosing packages to treat boiler water can be expected in the nitrogen vented to atmosphere. The nitrogen fill and vent rate capabilities must be above the pumping rates.

#### **1.6.7 Steam systems**

##### Process steam system

The pressure of the process steam headers, process condensate flash drum and water surge drum is controlled in split range by let down to the lower pressure system and pressurizing by import from the higher steam pressure. In case of a temporary surplus, process steam containing traces of aldehydes and glycol may have to be vented to the atmosphere.

##### Clean steam system

The pressure of the clean steam headers and the steam condensate flash drum is controlled in split range by let down to the lower pressure system and pressurizing by import from the higher steam pressure. In



case of a temporary surplus, clean steam may have to be vented to the atmosphere.

#### **1.6.8 Demineralised water tank**

The demineralised water tank is vented to atmosphere. Out-breathing of air and water vapour will occur due to tank filling, and temperature change.

### **1.7 Vents – Normally no flow**

#### **1.7.1 Oxygen line**

During a trip of the oxygen shutdown system small quantities of oxygen trapped between the flow control valve and the block valves are vented to the atmosphere.

#### **1.7.2 Steam vents**

##### HP steam drum

During cool down of the coolant system from its operating pressure to 100°C, clean steam is vented to the atmosphere via the remote operated vent valve. The relief valve on the HP steam drum should be sized for the steam generated during a runaway reaction.

##### MP steam drum

The relief valve on the MP steam drum should be sized for the steam generated during a post-ignition.

#### **1.7.3 Vent of residual gas compressor suction KO drum**

The residual gas compressor suction KO drum vent is operated by the drum pressure controller. In normal operation the vent will remain closed, and drum pressure is controlled by compressor recycle flow. However, during process upset conditions the pressure may rise significantly, and in this case, the vent to atmosphere will open.

The principal process upset which would cause the vent to open is a trip of the residual gas compressor.

The compressor shutdown system is designed to react to a number of different situations. One of these is breakthrough of EO; the potential



for this is detected by low lean absorbent flow, or high residual gas flow to the residual absorber. In this situation, the compressor is stopped, and the oxygen system is tripped. The shutdown system also increases the set point of the KO drum pressure controller by 0.25 bar via the DCS system. This limits the amount of EO that will be released to atmosphere via the KO drum vent.

For other compressor trips, such as KO drum level and suction pressure, it is not necessary to activate the oxygen shutdown system. Although not recommended, the plant can continue to operate in this situation, with compressor feed flow being vented to atmosphere if regulatory permits have been obtained. The set point of the pressure controller is therefore left unchanged, in order to minimise disturbance to the upstream process.

Refer to process memorandum 114 for further details of the compressor shutdown system.

#### **1.7.4 Recycle compressor**

The compressor will be started up using nitrogen, which will purge the recycle gas loop, and then be vented to atmosphere at a safe location.

#### **1.7.5 Emergency vents**

Contractor must specify location, sizing, height and type of emergency relief equipment. The maximum flow rate of the relief system depends on the relief case as calculated by the contractor and the code and regulations to be applied. Relief valves are not shown on the process flow schemes. Relief valves must vent to a safe location. Relief valve outlet pipes must have a small weeping hole to drain condensate.

#### **1.7.6 Emergency EO vents**

There are several emergency relief EO vapour vents in the EO recovery, LE removal, and glycol reaction sections. These vents, which could contain up to 100% EO, must be vented to a safe location.

The emergency depressurisation of the recycle gas loop shall be routed to a dedicated flare.



## **2 EFFLUENTS**

For additional information on liquid and solid waste streams reference is made to appendix 1.

### **2.1 Effluent – Waste water**

#### **2.1.1 CO<sub>2</sub> vent condensate**

EO that is absorbed in the CO<sub>2</sub> absorber from the loop gas is mostly converted to glycols in the EO converter. CO<sub>2</sub> stripper overheads containing mainly CO<sub>2</sub> and water is cooled and partly condensed to about 60°C and separated in the CO<sub>2</sub> vent KO drum. The condensed fraction contains glycols. The condensate collected in this vessel is returned to the CO<sub>2</sub> stripper bottom to maintain the water balance in the CO<sub>2</sub> removal section. The surplus will be sent to waste water treatment.

#### **2.1.2 Quench bleed flasher overhead / 224**

The overhead vapour of the quench bleed flasher consists mainly of water with some glycols and EO and is condensed and sent to the waste water system. EO will react with the water to form glycols.

#### **2.1.3 Vacuum condensate**

Condensate from the vacuum ejector system consists of water with glycols and possibly some dissolved light ends and is collected in the vacuum condensate vessel. The contents of this vessel are transferred to the waste water system.

#### **2.1.4 Glycol dehydrator overhead / 411**

Any light aldehydes that leave glycol concentrator 3 via the bottom would leave the glycol dehydrator via the overhead condensate. This step hence acts as a polishing step, although some glycol aldehydes could be formed in the dehydrator. Depending upon the glycol concentration in the overhead, varying amounts may be recycled back as reflux to the glycol dehydrator. The rest is processed by the waste water treatment unit. If it contains excessive amounts of glycols it is possible to divert this stream to the slops tank for reprocessing. Part of the dehydrator overhead stream may be recycled to the water surge



drum as long as MEG quality is not affected, thereby reducing the amount of waste water.

#### **2.1.5 Process condensate from water surge drum**

The PS 3K condensate from the water surge drum is for the largest part recycled to the glycol reactor. It contains some glycol and aldehydes. The glycol concentration is determined by the operation of the glycol concentrators 1, 2, and 3. Aldehydes present in the glycol reaction product are carried overhead in the glycol concentrators and sent to the water surge drum. The excess PS 3K condensate from this vessel is discharged to the waste water system. Bleeding of PS 3K condensate helps to prevent build-up of impurities that may cause deterioration of the MEG quality. Under normal operation there will be a small surplus from the water surge drum that needs to be discharged to the waste water system.

#### **2.1.6 Process condensate from chilled water unit**

The flashed PS 3K steam from the water surge drum is used as heating medium for the chilled water unit. It contains aldehydes and may contain some glycols. The glycol concentration is determined by the operation of the glycol concentrators 1, 2 and 3, as well as the water surge drum. Aldehydes present in the glycol reaction product are carried overhead in the glycol concentrators and sent to the water surge drum. The condensate from the chilled water unit is sent to the waste water system.



## **2.2 Effluent – Disposal**

### **2.2.1 Quench bleed flasher bottoms / 225**

The quench bleed flasher bottoms stream totals about 0.4 t/hr. The residue stream contains about 40 wt% water, 50 wt% glycols, plus 10 wt% sodium bicarbonate and organic acid salts. The salts concentration will rise if the glycol make rate in the quench section is lower than currently assumed. The glycols in this streams could be recovered in a separate process. The stream is routed to the heavy glycols tank.

### **2.2.2 Glycol bleed flasher bottoms / 412**

The glycol bleed flasher bottoms stream is approximately 0.3 t/hr and mainly consists of glycols, with minor amounts of water and salts (mainly sodium carbonate and bicarbonate with small amounts of oxalates, acetates, formates and sodium chloride). The glycols in the stream could be recovered in a separate process. The stream is routed to the heavy glycols tank.

### **2.2.3 TEG Column Bottoms / 511**

The TEG column bottoms stream is approximately 30 kg/hr and contains around 40 wt% TEG and 60wt% TTEG. The glycols in this stream could be recovered in a separate process. The stream is routed to the heavy glycols tank.

## **2.3 Effluent - Intermittent**

### **2.3.1 Low point drains of recycle gas loop**

The low point drains, especially the ones between the EO reactor outlet and the quench section, have to be checked regularly for presence of liquid. The liquid will be drained to the drips system.

### **2.3.2 Recycle compressor suction knock out drum**

The recycle gas compressor suction knock out drum accumulates varying amounts of liquid that need draining. Generally very little or no liquid is collected in the recycle compressor suction knock out drum. Any liquid will be drained to the drips system.



**2.3.3 Glycol filters**

Glycol from filters during change over is drained to the glycol drips vessel.

**2.4 Solid waste****2.4.1 Carbon adsorber bed**

Saturated activated carbon from the guard filter in vent of the moderator feed vessel is sent to an incinerator.

**2.4.2 MEG polishing vessel**

Loaded ion exchange resin from the MEG polishing vessel is sent to an incinerator. The ion exchange resin is a sodium styrene sulfonate resin, which is used to reduce the iron content of the MEG product before it is sent to storage.

**2.4.3 Sulfur guard beds**

Saturated activated carbon from the sulfur guard beds in the fresh ethylene and methane feed is sent to an incinerator. The activated carbon reduces the sulfur content in the feed to protect the EO catalyst.

**2.4.4 EO reactors**

Spent catalyst from the EO reactors will be sent to a silver reclaimer. The typical replacement rate for the catalyst is once per two years for high selectivity catalyst, and once per 4 years for high activity catalyst.



## APPENDIX 1. HSE SUMMARY TABLES

### GASEOUS WASTE STREAMS

Project: 500 kta MEG Project Kharg

|                                                                  |                   | High activity catalyst |      |               |      |                             |       |                           |         | High selectivity catalyst |      |               |      |                             |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------------------------------------------------|-------------------|------------------------|------|---------------|------|-----------------------------|-------|---------------------------|---------|---------------------------|------|---------------|------|-----------------------------|-------|---------------------------|---------|--------------|--------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Source                                                           | Substance         | Composition            |      |               |      | Discharge                   |       |                           |         | Composition               |      |               |      | Discharge                   |       |                           |         | Frequency    | Treatment/Disposal                         | Remarks                                                                                                                                                                                                                                                                                                                                                                                                |
|                                                                  |                   | Mol %<br>SOC           | EOC  | Mass %<br>SOC | EOC  | Normal rate<br>SOC<br>kg/hr | EOC   | Max. rate<br>SOC<br>kg/hr | EOC     | Mol %<br>SOC              | EOC  | Mass %<br>SOC | EOC  | Normal rate<br>SOC<br>kg/hr | EOC   | Max. rate<br>SOC<br>kg/hr | EOC     |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| Process vent (D-2004)                                            | Water             | 0.4                    | 0.4  | 0.3           | 0.3  | 4.9                         | 4.9   | 483                       | 474     | 0.4                       | 0.4  | 0.4           | 0.4  | 4.9                         | 4.9   | 508                       | 497     | Continuous   | See remarks                                | Base case is process vent to fuel gas. Emergency depressurization is sent to dedicated MEG plant flare. The maximum rate shown in the table is the peak flow during emergency depressurization.                                                                                                                                                                                                        |
|                                                                  | Nitrogen          | 0.7                    | 0.8  | 0.9           | 0.9  | 12.6                        | 13.3  | 1238                      | 1290    | 0.7                       | 0.7  | 0.9           | 1.0  | 12.3                        | 13.2  | 1284                      | 1348    |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Argon             | 4.1                    | 5.0  | 7.3           | 8.6  | 103.7                       | 124.4 | 10225                     | 12041   | 3.2                       | 4.3  | 6.0           | 7.9  | 80.4                        | 108.5 | 8366                      | 11070   |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Oxygen            | 5.4                    | 4.5  | 7.7           | 6.3  | 108.9                       | 90.9  | 10733                     | 8801    | 6.1                       | 5.0  | 9.2           | 7.3  | 124.4                       | 100.4 | 12943                     | 10236   |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Methane           | 59.7                   | 58.3 | 42.6          | 40.6 | 604.7                       | 587.5 | 59606                     | 56867   | 64.1                      | 62.5 | 48.5          | 46.1 | 652.1                       | 632.3 | 67836                     | 64482   |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Ethylene          | 23.0                   | 22.8 | 28.6          | 27.8 | 406.2                       | 402.4 | 40041                     | 38956   | 23.1                      | 22.9 | 30.5          | 29.5 | 410.6                       | 405.4 | 42711                     | 41339   |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Ethane            | 0.6                    | 0.6  | 0.8           | 0.8  | 11.3                        | 12.0  | 1118                      | 1164    | 0.6                       | 0.6  | 0.8           | 0.8  | 10.6                        | 11.5  | 1104                      | 1176    |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Carbondioxide     | 6.0                    | 7.6  | 11.8          | 14.6 | 167.9                       | 210.8 | 16553                     | 20405   | 1.8                       | 3.5  | 3.7           | 7.0  | 50.4                        | 96.6  | 5245                      | 9850    |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Total             | 100                    | 100  | 100           | 100  | 1420                        | 1446  | 140000                    | 140000  | 100                       | 100  | 100           | 100  | 1346                        | 1373  | 140000                    | 140000  |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | CO2 vent (D-2005) | EO                     | 18.9 | 18.8          | 8.7  | 8.7                         |       |                           | 2164.1  | 2917.0                    | 19.0 | 18.9          | 8.8  | 8.7                         |       |                           | 1329.5  |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| Water                                                            |                   |                        |      |               |      |                             |       |                           |         |                           |      |               |      |                             |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| MEG                                                              |                   |                        |      |               |      |                             |       |                           |         |                           |      |               |      |                             |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| Nitrogen                                                         |                   |                        |      |               |      |                             |       |                           |         |                           |      |               |      |                             |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| Methane                                                          |                   | 0.1                    | 0.0  | 0.0           | 0.0  |                             |       | 5.1                       | 6.2     | 0.2                       | 0.1  | 0.1           | 0.0  |                             |       | 10.7                      | 10.3    |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| Ethylene                                                         |                   |                        |      |               |      |                             |       |                           |         |                           |      |               |      |                             |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| Carbon dioxide                                                   |                   | 81.1                   | 81.1 | 91.3          | 91.3 |                             |       | 22729.8                   | 30669.0 | 80.8                      | 81.0 | 91.2          | 91.2 |                             |       | 13816.1                   | 24654.9 |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| Aldehydes                                                        |                   |                        |      | 0.0           |      |                             |       |                           |         |                           |      |               |      |                             |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| Total                                                            | 100               | 100                    | 100  | 100           |      |                             | 24899 | 33592                     | 100     | 100                       | 100  | 100           |      |                             | 15156 | 27023                     |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| Vacuum system (PK-5001) / vacuum condensate vessel (D-5003) vent | Nitrogen          | 18.0                   |      | 24.7          |      | 113.1                       |       |                           |         | 18.0                      |      | 24.7          |      | 113.1                       |       |                           |         | Continuous   | To atmosphere                              | Leakage gasses from vacuum columns: dehydrator, glycol bleed flasher, MEG column, MEG recycle column, DEG column and TEG column. Flow depends on tightness of vacuum systems. Numbers shown are based on commercially tight system.                                                                                                                                                                    |
|                                                                  | Oxygen            | 4.8                    |      | 7.5           |      | 34.4                        |       |                           |         | 4.8                       |      | 7.5           |      | 34.4                        |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Water             | 77.1                   |      | 67.7          |      | 310.1                       |       |                           |         | 77.1                      |      | 67.7          |      | 310.1                       |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Glycols           | < 1                    |      | < 1           |      | < 0.5                       |       |                           |         | < 1                       |      | < 1           |      | < 0.5                       |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Aldehydes         | < 1                    |      | < 1           |      | < 0.5                       |       |                           |         | < 1                       |      | < 1           |      | < 0.5                       |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Acids             | < 1                    |      | < 1           |      | < 0.5                       |       |                           |         | < 1                       |      | < 1           |      | < 0.5                       |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Total             | 100                    |      | 100           |      | 458                         |       |                           |         | 100                       |      | 100           |      | 458                         |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| Deaerator vent (D-6001)                                          | Water             | 90-100                 |      | 90-100        |      |                             |       |                           |         | 90-100                    |      | 90-100        |      |                             |       |                           |         | Continuous   | To atmosphere                              |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Nitrogen          | minor                  |      | minor         |      |                             |       |                           |         | minor                     |      | minor         |      |                             |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Oxygen            | minor                  |      | minor         |      |                             |       |                           |         | minor                     |      | minor         |      |                             |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| Total                                                            |                   |                        |      |               | 1825 | 2066                        |       |                           |         |                           |      |               | 1163 | 1507                        |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| Clean condensate vessel vent (D-6051)                            | Water             | 100                    |      | 100           |      |                             |       | 1478                      | 1493    |                           |      | 100           |      | 1334                        | 1498  |                           |         | Continuous   | To atmosphere                              | Maximum rate quoted is based upon condensate returned from refrigeration package at saturation temperature. Rate to be confirmed by contractor, based upon vendor information regarding the amount of subcooling.                                                                                                                                                                                      |
| Process condensate vessel vent (D-6052)                          | Water             | 99.9                   |      | 99.9          |      |                             |       | 2222.78                   | 2276.72 | 99.9                      |      | 99.9          |      |                             |       | 2228.77                   | 2368.63 | Continuous   | To atmosphere                              | Maximum rate quoted is based upon condensate returned from refrigeration package at saturation temperature. Rate to be confirmed by contractor, based upon vendor information regarding the degree of condensate subcooling.                                                                                                                                                                           |
|                                                                  | Glycols           | < 0.1                  |      | < 0.1         |      |                             |       | <2.2                      | <2.3    | < 0.1                     |      | < 0.1         |      |                             |       | < 2.2                     | <2.4    |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Aldehydes         | < 0.1                  |      | < 0.1         |      |                             |       | <2.2                      | <2.3    | < 0.1                     |      | < 0.1         |      |                             |       | < 4                       | <2.4    |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Total             | 100                    |      | 100           |      |                             |       | 2225                      | 2279    | 100                       |      | 100           |      |                             |       | 2231                      | 2371    |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| Moderator feed vessel                                            | Ethyl chloride    | < 0.1                  |      | < 0.1         |      |                             |       |                           |         | < 0.1                     |      | < 0.1         |      |                             |       |                           |         | Intermittent | Vent to atmosphere via carbon absorber bed | Vent to atmosphere is opened by pressure controller when pressure rises above set-point. Significant venting should not occur when filling vessel, as vapour return line to supply container is provided.                                                                                                                                                                                              |
|                                                                  | Ethylene          | > 99.9                 |      | > 99.9        |      |                             |       |                           |         | > 99.9                    |      | > 99.9        |      |                             |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Total             | 100                    |      | 100           |      | 0.2                         |       |                           |         | 100                       |      | 100           |      | 0.2                         |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| Carbonate storage tank (TK-2001)                                 | Air               |                        |      | 99.3          |      | 108.2                       |       |                           |         |                           |      | 99.3          |      | 108.2                       |       |                           |         | Intermittent | To atmosphere                              | Continuous normal rate is caused by vapor displacement as result of tank filling. Intermittent peak is caused by simultaneous tank filling and thermal out breathing (rate to be determined by contractor). Thermal breathing peak emission shall be based on a conservative day time temperature difference. Thermal out breathing occurs only during limited day time when the air cap is heated up. |
|                                                                  | Water             |                        |      | 0.7           |      | 0.8                         |       |                           |         |                           |      | 0.7           |      | 0.8                         |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Carbonate         |                        |      | < 0.1         |      | <0.1                        |       |                           |         |                           |      | < 0.1         |      | <0.1                        |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Total             |                        |      | 100           |      | 109                         |       |                           |         |                           |      | 100           |      | 109                         |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| Carbonate dissolving drum (D-2010)                               | Air               |                        |      | 99.3          |      | 29.8                        |       |                           |         |                           |      | 99.3          |      | 29.8                        |       |                           |         | Intermittent | To atmosphere                              | Continuous normal rate is caused by vapor displacement as result of filling.                                                                                                                                                                                                                                                                                                                           |
|                                                                  | Water             |                        |      | 0.7           |      | 0.2                         |       |                           |         |                           |      | 0.7           |      | 0.2                         |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Carbonate         |                        |      | < 0.1         |      | <0.03                       |       |                           |         |                           |      | < 0.1         |      | <0.03                       |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Total             |                        |      | 100           |      | 30                          |       |                           |         |                           |      | 100           |      | 30                          |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
| Caustic tank (TK-2002)                                           | Air               |                        |      | 99.3          |      | 11.9                        |       |                           |         |                           |      | 99.3          |      | 11.9                        |       |                           |         | Intermittent | To atmosphere                              | Continuous normal rate is caused by vapor displacement as result of tank filling. Intermittent peak is caused by simultaneous tank filling and thermal out breathing (rate to be determined by contractor). Thermal breathing peak emission shall be based on a conservative day time temperature difference. Thermal out breathing occurs only during limited day time when the air cap is heated up. |
|                                                                  | Water             |                        |      | 0.7           |      | 0.1                         |       |                           |         |                           |      | 0.7           |      | 0.1                         |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Caustic           |                        |      | < 0.1         |      | <0.02                       |       |                           |         |                           |      | < 0.1         |      | <0.02                       |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                  | Total             |                        |      | 100           |      | 12                          |       |                           |         |                           |      | 100           |      | 12                          |       |                           |         |              |                                            |                                                                                                                                                                                                                                                                                                                                                                                                        |



|                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |           |             |                |               |           |           |             |                |                 |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-----------|-------------|----------------|---------------|-----------|-----------|-------------|----------------|-----------------|------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Glycol slops tank (TK-5001)                                                                                                                                                                                                                                                                                                                                                                                                                               | Nitrogen<br>MEG   |           | 99.8<br>0.2 | 74<br>0.1      |               |           |           | 99.8<br>0.2 | 74<br>0.1      |                 | Intermittent     | To atmosphere    | Glycol slops tank is normally empty. Actual emission depends upon tank utilisation. Continuous normal rate is caused by vapor displacement as result of tank filling. Intermittent peak is caused by simultaneous tank filling and thermal out breathing (rate to be determined by contractor). Thermal breathing peak emission shall be based on a conservative day time temperature difference. Thermal out breathing occurs only during limited day time when the air cap is heated up.                                                                                                                                                                                                                                                                              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |           |             |                |               |           |           |             |                |                 |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Total             |           | 100         | 74             |               |           |           | 100         | 74             |                 |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Heavy glycols tank (TK-5002)                                                                                                                                                                                                                                                                                                                                                                                                                              | Air<br>Glycols    |           | 99.8<br>0.2 | 0.998<br>0.002 |               |           |           | 99.8<br>0.2 | 0.998<br>0.002 |                 | Intermittent     | To atmosphere    | Continuous normal rate is caused by vapor displacement as result of tank filling. Intermittent peak is caused by simultaneous tank filling and thermal out breathing (rate to be determined by contractor). Thermal breathing peak emission shall be based on a conservative day time temperature difference. Thermal out breathing occurs only during limited day time when the air cap is heated up.                                                                                                                                                                                                                                                                                                                                                                  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |           |             |                |               |           |           |             |                |                 |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Total             |           | 100         | 1              |               |           |           | 100         | 1              |                 |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Chilled water tank (TK-6050)                                                                                                                                                                                                                                                                                                                                                                                                                              | Nitrogen<br>Water |           | 99.3<br>0.7 |                |               |           |           | 99.3<br>0.7 |                |                 | Intermittent     | To atmosphere    | Continuous normal rate is caused by vapor displacement as result of tank filling. Intermittent peak is caused by simultaneous tank filling and thermal out breathing (rate to be determined by contractor). Thermal breathing peak emission shall be based on a conservative day time temperature difference. Thermal out breathing occurs only during limited day time when the air cap is heated up.                                                                                                                                                                                                                                                                                                                                                                  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |           |             |                |               |           |           |             |                |                 |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Total             |           | 100         |                |               |           |           | 100         |                |                 |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| CS 2K header vent                                                                                                                                                                                                                                                                                                                                                                                                                                         | Water             |           | 100         |                |               |           |           | 100         |                | 28531.1 28553.3 | Intermittent     | To atmosphere    | During upset conditions. Indicated flowrate is during shutdown                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| PS 5K header vent                                                                                                                                                                                                                                                                                                                                                                                                                                         | Water             |           | 99.9        |                |               |           |           | 99.9        |                | 47104.6 47037.2 | Intermittent     | To atmosphere    | During upset conditions. Indicated flowrate is during shutdown                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Glycols           |           | < 0.1       |                |               |           |           | < 0.1       |                | < 47.2 < 47.1   |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Aldehydes         |           | < 0.1       |                |               |           |           | < 0.1       |                | < 47.2 < 47.1   |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Total             |           | 100         |                |               |           |           | 100         |                | 47151.7 47084.3 |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| PS 3K header vent                                                                                                                                                                                                                                                                                                                                                                                                                                         | Water             |           | 99.9        |                |               |           |           | 99.9        |                | 3203.12 3201.52 | Intermittent     | To atmosphere    | During upset conditions. Indicated flowrate is during shutdown                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Glycols           |           | < 0.1       |                |               |           |           | < 0.1       |                | < 3.2 < 3.2     |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Aldehydes         |           | < 0.1       |                |               |           |           | < 0.1       |                | < 3.2 < 3.2     |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Total             |           | 100         |                |               |           |           | 100         |                | 3206.32 3204.72 |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Demineralised water tank (TK-6001)                                                                                                                                                                                                                                                                                                                                                                                                                        | Air               |           | 99.3        |                | 201 222       |           |           | 99.3        |                | 128 163         | Intermittent     | To atmosphere    | Continuous normal rate is caused by vapor displacement as result of tank filling. Intermittent peak is caused by simultaneous tank filling and thermal out breathing (rate to be determined by contractor). Thermal breathing peak emission shall be based on a conservative day time temperature difference. Thermal out breathing occurs only during limited day time when the air cap is heated up.                                                                                                                                                                                                                                                                                                                                                                  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Water             |           | 0.7         |                | 1.4 1.6       |           |           | 0.7         |                | 0.9 1.1         |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Total             |           | 100         |                | 202 224       |           |           | 100         |                | 129 164         |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Anti-foam vessel (D-2003)                                                                                                                                                                                                                                                                                                                                                                                                                                 | Air               |           |             |                |               |           |           |             |                |                 | Intermittent     | To atmosphere    | Continuous normal rate is caused by vapor displacement as result of tank filling. Intermittent peak is caused by simultaneous tank filling and thermal out breathing (rate to be determined by contractor). Thermal breathing peak emission shall be based on a conservative day time temperature difference. Thermal out breathing occurs only during limited day time when the air cap is heated up.                                                                                                                                                                                                                                                                                                                                                                  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Total             |           |             |                |               |           |           |             |                |                 |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Oxygen line                                                                                                                                                                                                                                                                                                                                                                                                                                               | Oxygen            |           | 100         | Minor          |               |           |           | 100         | Minor          |                 | Normally no flow | To atmosphere    | During a trip of the oxygen shutdown system small quantities of oxygen trapped between the flow control valve and the block valves are vented to the atmosphere.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| HP steam drum (D-1007)                                                                                                                                                                                                                                                                                                                                                                                                                                    | Water             |           | 100         |                | 900000        |           |           | 100         |                | 900000          | Normally no flow | To atmosphere    | Emergency relief during runaway reaction.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| MP steam drum (D-1006)                                                                                                                                                                                                                                                                                                                                                                                                                                    | Water             |           | 100         |                | 381000 361000 |           |           | 100         |                | 461000 410000   | Normally no flow | To atmosphere    | Emergency relief during post ignition.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Residual gas compressor suction KO drum vent (D-3002)                                                                                                                                                                                                                                                                                                                                                                                                     | EO                | 0.1 0.0   | 0.1 0.1     |                | 4.8 5.3       | 0.1 0.1   | 0.1 0.1   |             |                | 3.3 3.9         | Normally no flow | To safe location | The flowrate shown in the table is the normal residual gas compressor feed flow. This would be released to the atmosphere during a compressor trip due to causes such as KO drum level or suction pressure. Although not recommended, plant operation can continue indefinitely in this situation, provided that methane make-up is injected directly into the gas loop. Special regulatory permits may be required for this mode of operation. EO breakthrough will also cause the compressor to trip. In this situation, the oxygen system shall also be shutdown, and the drum set point pressure is increased. Any release to atmosphere shall therefore be short in duration, but the EO content will be considerable. Refer to section 1.7.3 for further details. |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Water             | 4.2 5.0   | 2.5 2.8     |                | 158.9 241.3   | 3.6 3.8   | 2.8 2.5   |             |                | 96.6 118.4      |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Nitrogen          | 0.3 0.2   | 0.3 0.2     |                | 16.3 17.1     | 0.4 0.4   | 0.5 0.4   |             |                | 17.4 17.7       |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Argon             | 0.9 0.9   | 1.2 1.2     |                | 77.0 99.9     | 1.1 1.3   | 1.8 1.9   |             |                | 63.2 87.5       |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Oxygen            | 1.1 0.8   | 1.2 0.8     |                | 75.2 68.7     | 1.9 1.4   | 2.6 1.6   |             |                | 91.8 76.2       |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Methane           | 35.9 29.1 | 19.0 14.4   |                | 1217.5 1240.1 | 55.7 46.8 | 37.9 28.2 |             |                | 1330.2 1313.9   |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Ethylene          | 15.0 12.5 | 13.9 10.8   |                | 891.4 931.9   | 22.3 19.0 | 26.5 20.1 |             |                | 931.4 935.3     |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Ethane            | 0.2 0.1   | 0.2 0.1     |                | 10.1 11.3     | 0.2 0.2   | 0.3 0.2   |             |                | 10.0 11.0       |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Carbondioxide     | 42.4 51.2 | 61.7 69.6   |                | 3940.7 5982.9 | 14.7 27.2 | 27.5 44.9 |             |                | 965.9 2093.3    |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Hydrogen          | 0.0 0.0   | 0.0 0.0     |                | 0.0 0.0       | 0.0 0.0   | 0.0 0.0   |             |                | 0.0 0.0         |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Total             | 100 100   | 100 100     |                | 6392 8599     | 100 100   | 100 100   |             |                | 3510 4657       |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Recycle gas compressor vent (C-2001)                                                                                                                                                                                                                                                                                                                                                                                                                      | Nitrogen          | 100       | 100         |                |               | 100       | 100       |             |                |                 | Normally no flow | To atmosphere    | Purge/vent during start-up and shut-down.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <p>Note 1: Setting of the permit levels must take into account an ample margin for the reported emission values, which are either based on design calculations or plant measurements</p> <p>Note 2: Fugitive emissions can not be calculated or estimated during the process design stage since the number of flanges and valves is not defined. A very preliminary guess would be in the order of about 50-500 kg/hr for gaseous fugitive emissions.</p> |                   |           |             |                |               |           |           |             |                |                 |                  |                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |



AQUEOUS EFFLUENTS

Project: 500 kta MEG Project Kharg

|                                        |                                                                               | High activity catalyst |     |             |       |       |           | High selectivity catalyst |       |             |        |        |           |                  |                    |                            |                                                                                                                                                                                                                                                              |
|----------------------------------------|-------------------------------------------------------------------------------|------------------------|-----|-------------|-------|-------|-----------|---------------------------|-------|-------------|--------|--------|-----------|------------------|--------------------|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Source                                 | Substance                                                                     | Composition            |     | Discharge   |       |       | Max. rate | Composition               |       | Discharge   |        |        | Frequency | Other properties | Treatment/Disposal | Remarks                    |                                                                                                                                                                                                                                                              |
|                                        |                                                                               | Mass %                 |     | Normal rate |       |       |           | Mass %                    |       | Normal rate |        |        |           |                  |                    |                            |                                                                                                                                                                                                                                                              |
|                                        |                                                                               | SOC                    | EOC | SOC         | EOC   | kg/hr | SOC       | EOC                       | SOC   | EOC         | kg/hr  | SOC    | EOC       | kg/hr            |                    |                            |                                                                                                                                                                                                                                                              |
| CO2 vent KO drum condensate (D-2005)   | Waste water                                                                   |                        |     | 7340        | 7551  |       |           |                           | 18834 | 17145       |        |        |           | Continuous       |                    |                            | Normal discharge rate may be reduced by recycled some of the dehydrator condensate to the water surge drum, provided plant performance and product quality can be maintained. Max case applies when clean condensate is used as reflux to glycol dehydrator. |
| Quench bleed flasher overhead (T-2006) | Waste water                                                                   |                        |     | 8703        | 12486 |       |           |                           | 8106  | 9981        |        |        |           | Continuous       |                    |                            |                                                                                                                                                                                                                                                              |
| Vacuum condensate (PK-5001)            | Waste water                                                                   |                        |     | 4000        | 4000  |       |           |                           | 4000  | 4000        |        |        |           | Continuous       |                    |                            |                                                                                                                                                                                                                                                              |
| Glycol Dehydrator Overheads (T-4004)   | Waste water                                                                   |                        |     | 34829       | 34839 | 45109 | 45119     |                           | 34723 | 34749       | 45005  | 45029  |           | Continuous       |                    |                            |                                                                                                                                                                                                                                                              |
| Process condensate (D-4002)            | Waste water                                                                   |                        |     | 1114        | 4522  |       |           |                           | 0     | 6555        |        |        |           | Continuous       |                    |                            |                                                                                                                                                                                                                                                              |
| Process condensate (PK-6050)           | Waste water                                                                   |                        |     | 27525       | 28196 |       |           |                           | 26665 | 29333       |        |        |           | Continuous       |                    |                            |                                                                                                                                                                                                                                                              |
| Total                                  | Total Waste Water<br>Glycols (2)<br>Aldehydes (2)<br>Salts as NaCl (2)<br>COD |                        |     | 83511       | 91593 | 93791 | 101873    |                           | 92328 | 101763      | 102609 | 112043 |           | Continuous       |                    | Waste water treatment unit |                                                                                                                                                                                                                                                              |
|                                        |                                                                               |                        |     |             |       |       |           |                           |       |             |        |        |           |                  |                    |                            |                                                                                                                                                                                                                                                              |
|                                        |                                                                               |                        |     |             |       |       |           |                           |       |             |        |        |           |                  |                    |                            |                                                                                                                                                                                                                                                              |
|                                        |                                                                               |                        |     |             |       |       |           |                           |       |             |        |        |           |                  |                    |                            |                                                                                                                                                                                                                                                              |
|                                        |                                                                               |                        |     |             |       |       |           |                           |       |             |        |        |           |                  |                    |                            |                                                                                                                                                                                                                                                              |
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LIQUID and SOLID WASTES (1)

Project: 500 kta MEG Project Kharg

| Source                                                                                                                                                                            | Substance                                                                                    | High activity catalyst |     |                    |     |                  |      | High selectivity catalyst |     |                    |     |                                                                                                    |            | Frequency                                        | Other properties                                                                                               | Treatment/Disposal | Remarks |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|------------------------|-----|--------------------|-----|------------------|------|---------------------------|-----|--------------------|-----|----------------------------------------------------------------------------------------------------|------------|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------|--------------------|---------|
|                                                                                                                                                                                   |                                                                                              | Composition            |     | Discharge          |     |                  |      | Composition               |     | Discharge          |     |                                                                                                    |            |                                                  |                                                                                                                |                    |         |
|                                                                                                                                                                                   |                                                                                              | Mass %<br>SOC          | EOC | Normal rate<br>SOC | EOC | Max. rate<br>SOC | EOC  | Mass %<br>SOC             | EOC | Normal rate<br>SOC | EOC | Max. rate<br>SOC                                                                                   | EOC        |                                                  |                                                                                                                |                    |         |
| Quench bleed flasher bottoms (T-2006)                                                                                                                                             | Water                                                                                        | 40                     |     |                    |     |                  |      | 40                        |     |                    |     |                                                                                                    | Continuous |                                                  | Incinerator                                                                                                    |                    |         |
|                                                                                                                                                                                   | Glycols                                                                                      | 51                     |     |                    |     |                  | 51   |                           |     |                    |     |                                                                                                    |            |                                                  |                                                                                                                |                    |         |
|                                                                                                                                                                                   | Salts (sodium (bi) carbonate and organic acid salts)                                         | 9                      |     |                    |     |                  | 9    |                           |     |                    |     |                                                                                                    |            |                                                  |                                                                                                                |                    |         |
|                                                                                                                                                                                   | Total                                                                                        | 100                    | 416 | 411                |     | 100              | 415  | 414                       |     |                    |     |                                                                                                    |            |                                                  |                                                                                                                |                    |         |
| Glycol bleed flasher bottoms (T-4005)                                                                                                                                             | Water                                                                                        | < 0.1                  |     |                    |     |                  |      | < 0.1                     |     |                    |     | Continuous                                                                                         |            | Incinerator                                      |                                                                                                                |                    |         |
|                                                                                                                                                                                   | Glycols                                                                                      | 97.3                   |     |                    |     |                  | 97.3 |                           |     |                    |     |                                                                                                    |            |                                                  |                                                                                                                |                    |         |
|                                                                                                                                                                                   | Salts (sodium(bi)carbonates , oxalates, acetates, formates, sodium chloride) + heavy glycols | 2.7                    |     |                    |     |                  | 2.7  |                           |     |                    |     |                                                                                                    |            |                                                  |                                                                                                                |                    |         |
|                                                                                                                                                                                   | Total                                                                                        | 100                    | 317 | 324                |     | 100              | 297  | 305                       |     |                    |     |                                                                                                    |            |                                                  |                                                                                                                |                    |         |
| TEG column bottoms (T-5004)                                                                                                                                                       | Heavy glycols (TEG, TTEG)                                                                    | 100                    | 31  |                    |     |                  |      | 100                       | 31  |                    |     | Continuous                                                                                         |            | Incinerator                                      | Estimated TEG content 40 wt%                                                                                   |                    |         |
| Saturated activated carbon<br>(guard filter Z-1002 in vent of moderator feed vessel D-1003)                                                                                       | Ethyl chloride<br>Activated carbon                                                           | <20<br>>80             |     |                    |     |                  |      | <20<br>>80                |     |                    |     | Intermittent:<br>Replacement of carbon from one filter typically 9x/year (1350 kg/yr)              |            | Solid waste incinerator                          | Each filter contains 150 kg activated carbon                                                                   |                    |         |
| Loaded ion exchange resin<br>(MEG polishing vessel D-5001)                                                                                                                        | Sodium styrene sulfonate resin<br>Iron                                                       | >90<br><10             |     |                    |     |                  |      | >90<br><10                |     |                    |     | Intermittent:<br>Replacement of ion exchange bed, maximum 1x bed /year                             |            | Solid waste incinerator                          | MEG polishing vessel beds contain 1.97m³ (1625 kg) of fresh resin each.<br>Beds normally operated in parallel. |                    |         |
| Saturated activated carbon<br>(Sulfur guard beds in methane and ethylene feed lines, D-1004 and D-1005)                                                                           | Sulfur<br>Activated carbon                                                                   | <10<br>>90             |     |                    |     |                  |      | <10<br>>90                |     |                    |     | Intermittent:<br>Replacement carbon bed, maximum 1x/2 year                                         |            | Solid waste incinerator                          | D-1004 contains 1.1m³ (510 kg) activated carbon<br>D-1005 contains 9.6 m³ (4610 kg) activated carbon           |                    |         |
| Spent catalyst (R-1001 A/B)                                                                                                                                                       | Silver alumina catalyst                                                                      |                        |     |                    |     |                  |      |                           |     |                    |     | Intermittent:<br>Replacement of catalyst, typically 1x/4 year HA catalyst<br>1x/2 year HS catalyst |            | Spent catalyst will be sent to silver reclaimers | Reactors contain total of 283m³ (257900kg) of catalyst                                                         |                    |         |
| Note 1: Setting of the permit levels must take into account an ample margin for the reported emission values, which are either based on design calculations or plant measurements |                                                                                              |                        |     |                    |     |                  |      |                           |     |                    |     |                                                                                                    |            |                                                  |                                                                                                                |                    |         |
|                                                                                                                                                                                   |                                                                                              |                        |     |                    |     |                  |      |                           |     |                    |     |                                                                                                    |            |                                                  |                                                                                                                |                    |         |

