तेल एवं गैस उत्पादन प्रौद्योगिकी संस्थान

Institute of Oil and Gas Production Technology

पनवेल, नवी मुंबई

Panvel, Navi Mumbai

Project Report

on

एमएच परिसंपत्ति के पुराने जीडीयू में टीईजी की खपत का अनुकूलन

Optimization of TEG Consumption of Aging GDUs, MH Asset

नवंबर – 2022

तेल एवं गैस उत्पादन प्रौद्योगिकी संस्थान

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क.सं.: IO.22I.PT_MU.055S

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विषय: एमएच परिसंपत्ति के पुराने जीडीयू में टीईजी की खपत का अनुकूलन

Subject: Optimization of TEG Consumption of Aging GDUs, MH Asset

" एमएच परिसंपत्ति के पुराने जीडीयू में टीईजी की खपत का अनुकूलन" रिपोर्ट की प्रति आपके अवलोकनार्थ संलग्न है।

Please find enclosed a copy of the report on "Optimization of TEG Consumption of Aging GDUs, MH Asset" for your kind perusal.

नितिन बी. जोशी

Nitin B. Joshi

Head of Department, SF & PE

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Optimization of TEG Consumption of Aging GDUs, MH Asset

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Institute of Oil and Gas Production Technology

Panvel, Navi Mumbai

Executive Summary

This pertains to the project titled "**Optimization of TEG Consumption of Aging GDUs, MH Asset**" taken up by IOGPT as a scheduled project under AWP 2022-23.

GDU trains at BHS process complex were taken up for optimization study of glycol consumption at the request of Asset. The process complex has 2 GDUs at BHS platform of 2.4 MMSCMD capacity each and 2 GDUs at bridge-connected MSP platform of 1.9 MMSCMD capacity each. Glycol consumption of 37.5 Lit/ MMSCM, 63.2 Lit/ MMSCM and 57.9 Lit/ MMSCM is observed in BHS Train-B, MSP Train-A and MSP Train-B respectively; while BHS Train A is not running presently.

It is pertinent to mention that glycol losses in TEG-based units are normally categorized into vaporization losses, carryover losses and foaming losses besides mechanical leakages. A simulation study has been carried out using Aspen HYSYS process simulator to estimate vaporization losses. It indicates vaporization loss of ~ 27.6 lit/MMSCM, 9.3 Lit/ MMSCM and 11.0 Lit/ MMSCM in BHS Train-B, MSP Train-A and MSP Train-B respectively under present operating conditions. Further optimization of various parameters viz., gas inlet temperature, TEG flow rate & inlet temperature, reboiler temperature and stripping gas rate in the simulation model brings out that it is possible to reduce glycol vaporization losses by ~60%, 17% and 9% in BHS Train-B, MSP Train-A and MSP Train-B respectively.

Additional glycol losses may be due to carryover and foaming which may be result of inadequacy in capacity and damaged internals of various vessels. As per the data provided by the Asset, GDUs are being operated within the designed capacity, hence glycol losses due to inadequacy is ruled out. Further, any ingress of liquid hydrocarbon to contactor and inadequate filtration of rich glycol can lead to foaming. Accordingly, it is prudent to inspect vessels internals as per SOP to ascertain their conditions and take suitable remedial action.

Details of the study have been elaborated in the report.

Rajiv Nischal.

Rajiv Nischal
GGM-HOI IOGPT

Contents

1.0 Background

Mumbai High Asset of ONGC is facing issue of high glycol consumption in the aging Gas Dehydration Units (GDU). In the present study, GDU trains at BHS process complex were taken up for optimization study of glycol consumption at the request of Asset. BHS Process Complex (Figure 1.1) of MH Asset consists of six bridge-connected platforms namely SA, BHS, SLQ, WIS, MSP and NWIS-R. SA was commissioned in 1980, BHS and SLQ in 1984, WIS in 1987, MSP in 2005 and NWIS-R in 2021.

Figure 1.1: BHS Process Complex

Well-fluid from the connected wellhead platforms is received and processed at BHS Process Complex. A simplified schematic of the process flow diagram of BHS process complex is shown in Figure 1.2.

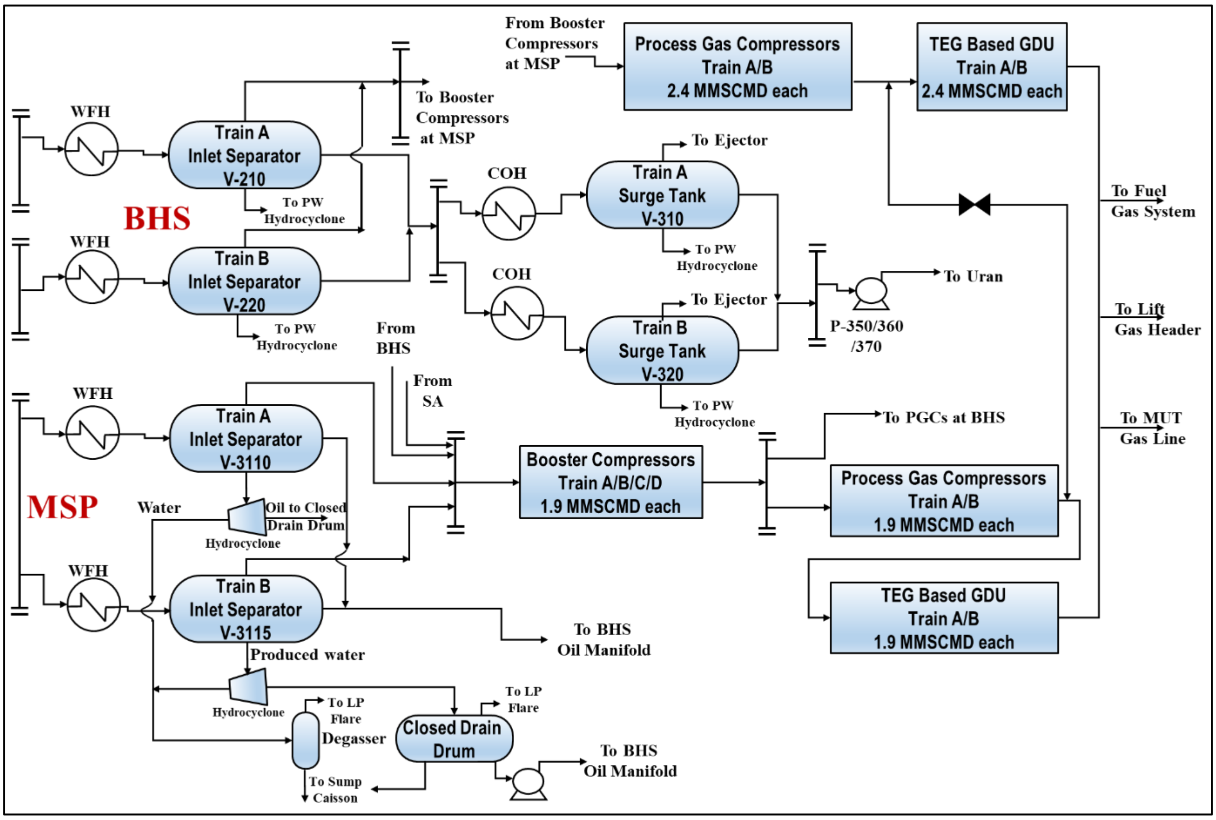

Figure 1.2: Process flow diagram of BHS process complex.

Presently, BHS process complex is processing around 110,000 BLPD (22,300 BOPD & 87,700 BWPD) and 7.4 MMSCMD of gas. Well fluid from 18 well head platforms is received in manifolds and routed to respective separators. The separated gas is routed to the booster compressors and then to process gas compressors and further routed to gas dehydration units.

The process complex has 2 GDUs at BHS platform of 2.4 MMSCMD capacity each and 2 GDUs at bridge-connected MSP platform of 1.9 MMSCMD capacity each. Glycol consumption of 37.5 Lit/ MMSCM, 63.2 Lit/ MMSCM and 57.9 Lit/ MMSCM is observed in BHS Train-B, MSP Train-A and MSP Train-B respectively; while BHS Train A is not running presently.

Asset desired to carry out optimization study of gas dehydration units for reducing glycol consumption. Accordingly, IOGPT has taken up the study titled "**Optimization of TEG Consumption of Aging GDUs, MH Asset**" as a scheduled project in AWP 2022-23.

2.0 Scope of Work

The scope of work includes:

- Review of existing process facilities
- Simulation study for optimisation of TEG consumption

3.0 Basis of study

Various input data considered for this study which were provided by Asset are given below:

3.1 Capacity of each of TEG train:

- BHS: 2.4 MMSCMD and MSP: 1.9 MMSCMD

3.2 Glycol flow rate for each TEG train:

- BHS: Flow meter not working & MSP: 2.2 m^3/hr

3.3 Stripping gas rate for each TEG train:

- BHS: Flow meter not working & MSP: 2.0 m^3/hr

3.4 Reboiler operating pressure at BHS & MSP: 0.1-0.13 Kg/cm^2g & temperature: 190-195^{0}C

3.5 Present glycol consumption:

- BHS GDU: Train-A - Unit not running & Train-B - 90 litre/day (37.5 Lit/ MMSCM)
- MSP GDU: Train-A -120 lit/day (63.2 Lit/ MMSCM) & Train-B - 110 litre /day (57.9 Lit/ MMSCM)

3.6 Water in dry gas :

- BHS GDU A: Unit not running
- BHS GDU B: 15 lb/MMSCF
- MSP GDU A: 10.71 lb/MMSCF
- MSP GDU B: 8.57 lb/MMSCF

3.7 Composition of gas inlet to GDU is shown in Table 3.1**:**

Table 3.1: Gas composition analysis of inlet to GDU (Mole %)

Components	Mole %
Methane	80.00
Ethane	8.27
Propane	4.70
Butane	3.89
Pentane	0.93
n-Hexane+	0.00
CO_2	2.12
N_2	0.09

4.0 Review of Existing System

Existing gas dehydration system of BHS & MSP is described and critically analyzed in following sections.

4.1 Brief description of BHS GDU

Schematic diagram of TEG-based Gas Dehydration Unit (GDU) at BHS process platform is shown in Figure 4.1.

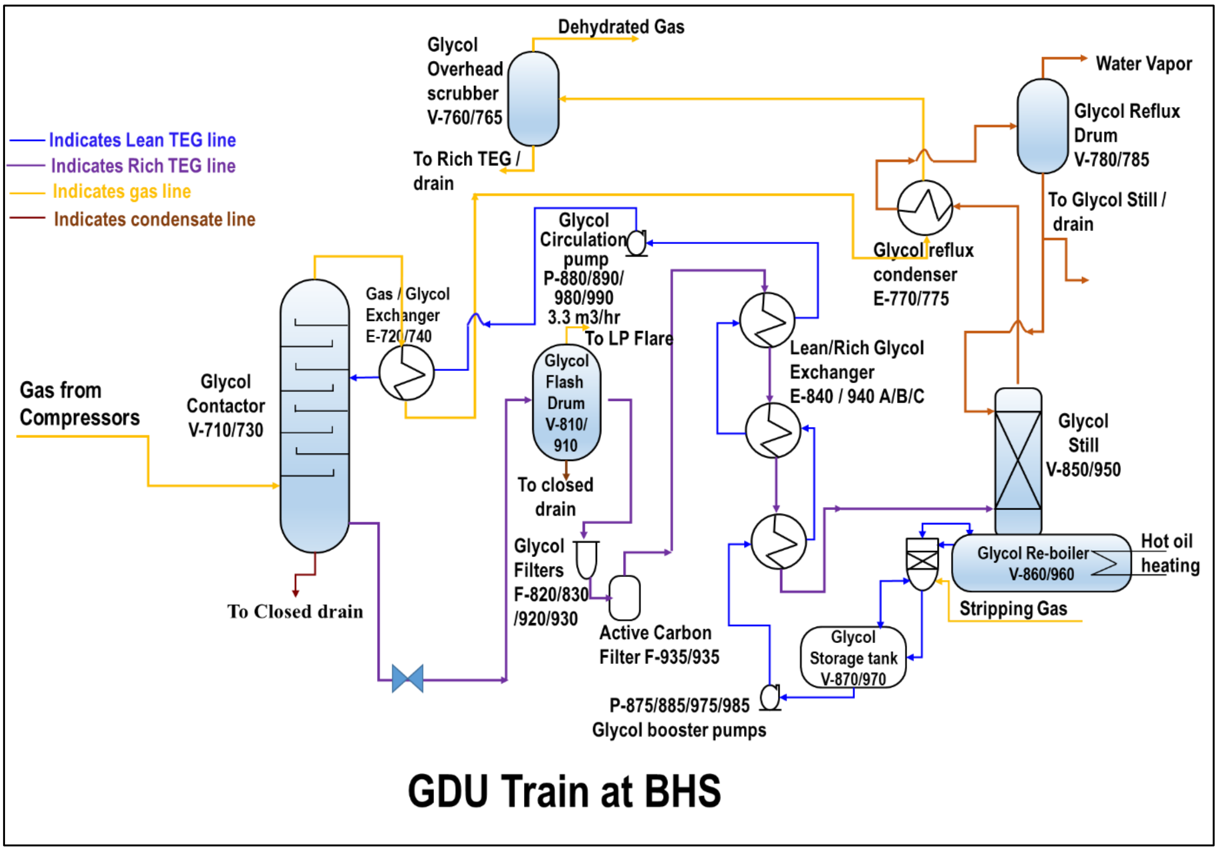

Figure 4.1: Schematic of TEG-based GDU at BHS

Process Description: In a GDU, compressed gas is routed to the bottom of glycol contactor and lean glycol is fed from its top. The dry gas from the contactor is routed to the gas/ glycol exchanger to cool the incoming lean glycol and further routed to the glycol reflux condenser. Dry gas from the reflux condenser is sent to overhead scrubber to remove liquid carryover, if any. Gas from the overhead scrubber is despatched to lift gas / trunk line.

Rich glycol from bottom of the contactor is routed to glycol flash drum to remove dissolved gasses, if any, and from there to glycol filters to remove rust materials and debris, if any. Afterwards the rich glycol is routed to glycol carbon filter to remove the colour & solids particles caused due to degradation of TEG. Rich glycol is then passed through a series of lean / rich glycol exchangers to exchange heat with lean glycol. After gaining heat, rich TEG is fed to the glycol still, i.e., regeneration system.

The regeneration system consists of glycol still, stripper column, reboiler, reflux condenser and reflux drum. Using hot oil, glycol is heated in glycol Reboiler. The vapour generated in glycol still is routed to reflux condenser and then to reflux drum. The vapour from the reflux drum is vented out to atmosphere. The condensed liquid from the reflux drum is routed to the glycol still. The stripping gas will be utilised to strip out the moisture from the glycol to increase the purity of the glycol. Lean glycol from the reboiler is sent to the glycol storage tank, from where it is pumped to the lean / rich glycol exchangers with booster pumps. After passing through the lean / rich exchangers, lean glycol is pumped to TEG contactor with glycol recirculation pumps after exchanging heat with the dry gas.

4.2 Brief description of MSP GDU

Schematic diagram of TEG-based Gas Dehydration Unit (GDU) at MSP process platform is shown in Figure 4.2.

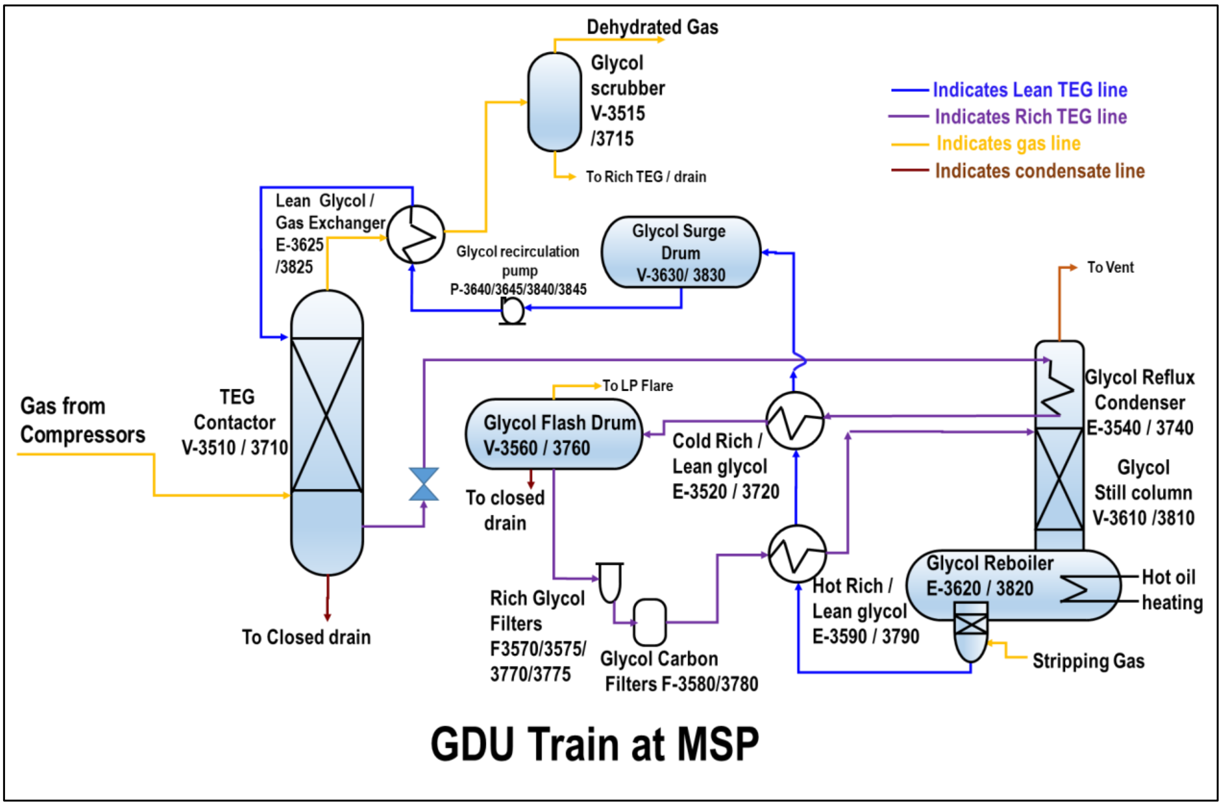

Figure 4.1: Schematic of TEG-based GDU at MSP

Process Description: The compressed gas enters the absorption column, i.e., contactor, where it comes in contact with the lean glycol which flows counter-currently. The gas after dehydration in the contactor exits from top of the contactor and exchanges heat with the lean glycol entering the contactor. After that the gas is routed to TEG scrubber for removal of carried over TEG if any. Rich glycol, after absorbing moisture from gas in the contactor, is routed to the reflux condenser to give the condensing duty. Further this rich glycol heated in heat exchanger by the hot lean glycol and routed to the flash drum to remove the dissolved hydrocarbons, if any. Afterwards it will be passed through a series of filters and then routed to heat exchangers, where the hot lean glycol from the regeneration column will transfer heat to the rich glycol. The preheated rich glycol will be routed to the regenerated column, where the absorbed moisture in the glycol will be vaporised through reboiler. The liberated water vapour is released from the top of the regeneration column. The stripping gas will be utilised to strip out the moisture from the glycol to increase the purity of the glycol. As mentioned above, the hot lean glycol from the regeneration column exchanges heat with the incoming rich glycol and is pumped back into the contactor.

5.0 Reasons for TEG loss in GDU

There are many reasons which contribute to glycol loss in a TEG-based GDU. These can be clubbed into the following categories.

Vaporisation losses: Loss of glycol in the form of vapour along with gas takes place in glycol contactor as well as in glycol still of regenerator. The vaporisation loss from contactor is primarily due to higher gas inlet temperature. In glycol still it is due to higher still temperature and high stripping gas rate.

Carryover Losses: This form of loss occurs due to sweeping of glycol in liquid form along with gas. The carry over loss in absorber is generally due to high gas velocity and inadequate mist eliminator at gas outlet in the contactor and overhead scrubber. The carryover loss in glycol still is due to high stripping gas velocity.

Losses due to foaming: This type of loss takes place due to hydrocarbon carryover to the inlet of contactor resulting in foaming and subsequently carryover losses from the contactor. This is due to inadequate nozzle sizes, damaged demister pad of the upstream KODs / scrubbers. If the active carbon filter and glycol filter are not in operation or the filter element is clogged, the rust material, debris and degraded glycol material will not be filtered. This may cause foaming resulting in carryover losses from the contactor and glycol still.

Mechanical Losses: This is due to leakage of glycol through pumps, valves, glands, drains, etc. Small leaks, if not addressed, can result in major glycol loss over an extended period of time. Sources for major glycol loss are recirculation pumps, drains, and filters. When changing filters, care should be taken that the filter vessels are drained fully, prior to removal and replacement of the filter.

6.0 Simulation study for optimisation of GDU

6.1 Simulation study for optimisation of BHS GDU

A simulation model was developed in Aspen HYSYS process simulator considering 2.4 MMSCMD of gas for design operating parameters and present operating parameters. The details of operating conditions are shown in Figure 6.1.

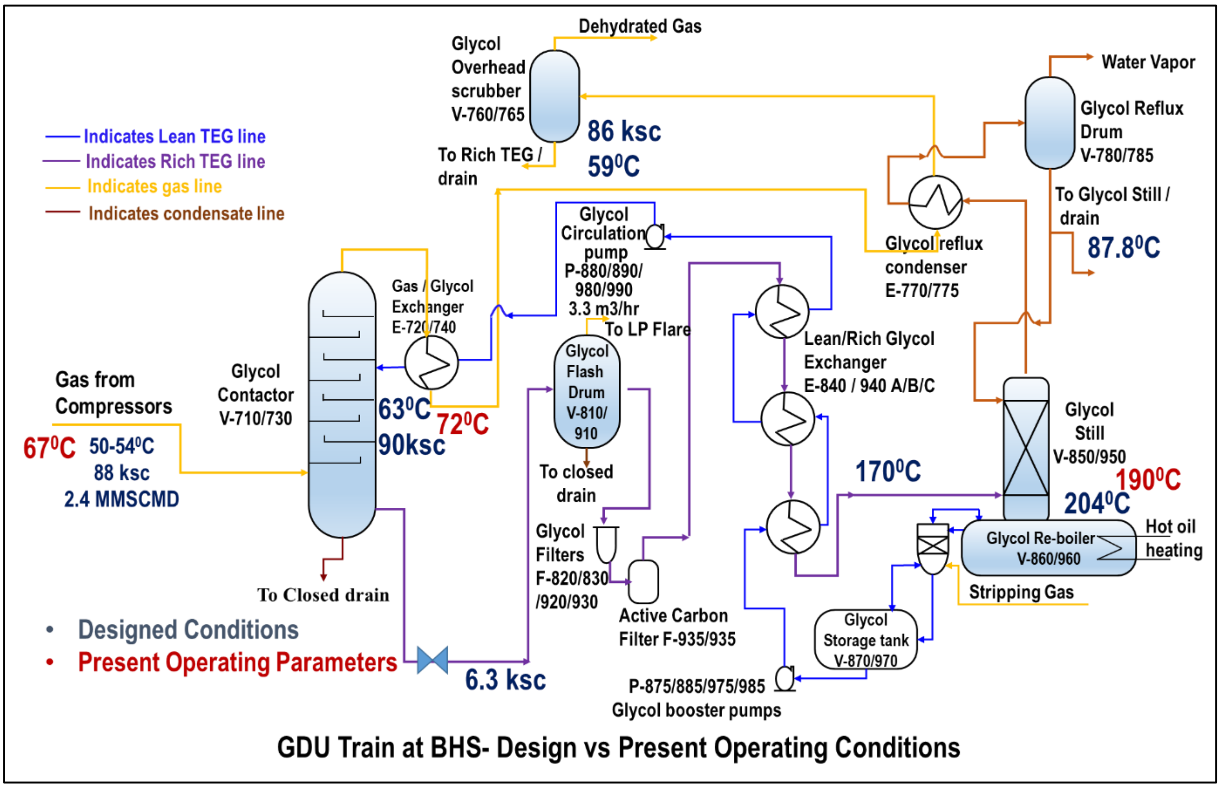

Figure 6.1: GDU Train at BHS: Design vs present operating parameters

Simulation was carried out presuming that the gas is fully saturated with water and glycol rate of 3.3 m^3/hr as per design. The results are shown in Table 6.1.

Table 6.1: Simulation results for the glycol loss at Design vs present operating conditions						
Case	Inlet gas	Inlet Gas T.	Inlet TEG T.	TEG Flow	Moisture in dry gas	TEG Loss
	MMSCMD	^{0}C	^{0}C	m3/hr	lb/MMSCF	Lit/MMSCM
Design Case	2.4	**54**	63	3.3	3.9	**11.1**
Present Case (Train-B)	2.4	**67**	72	3.3	15	**27.6**

From the above table, it is seen that TEG vaporisation loss varies from ~11.1 Lit/MMSCM in design conditions to 27.6 Lit/MMSCM with present operating parameters of BHS GDU.

As per the design, the inlet gas temperature of GDU is in the range of 50⁰C – 54⁰C. It is pertinent to mention that glycol loss is likely to be higher with increased inlet gas temperature due to the following reasons:

- With increase in gas temperature, volume of the gas will increase resulting in higher gas velocity and hence higher glycol loss due to carryover
- With increase in temperature, possibility of escaping lighter hydrocarbon in to the contactor and subsequent condensation may lead to foaming and cause more glycol loss.

As the present inlet gas temperature is very high, for optimisation, simulation study has been carried out considering inlet gas temperature as that of design inlet gas temperature along with optimization of the parameters like TEG flow rate, inlet TEG temperature, reboiler temperature and stripping gas flow rate etc.

The results of the optimisation study are shown in Table 6.2 below:

Table 6.2: Simulation results- Optimised case

Case	Inlet gas	Inlet Gas T.	Inlet TEG T.	TEG Flow	Moisture in dry gas	TEG Loss @ optimum conditions	TEG loss @ present conditions
	MMSCMD	^0C	^0C	m^3/hr	lb/mmscf	Lit/MMSCM	Lit/MMSCM
Optimised condition	2.4	54	**60**	3.0	3.9	**11 (Reduction~60%)**	27.6

The simulation study concludes that with lean TEG inlet temperature of 54^0C, TEG flow rate of 3.0 m^3/hr, stripping gas of 2,500 SCMD, Reboiler temperature of 200^0C and maintaining TEG purity of 99.5% (w/w), TEG vaporisation loss will get reduced to 11.0 lit/MMSCM from the present 27.6 Lit/MMSCM, i.e., around 60% reduction in glycol loss due to vaporisation.

Hence, Asset may make attempts to lower the inlet gas temperature to the extent possible, thereby reducing the glycol loss.

6.2 Simulation study for optimisation of MSP GDU

A simulation model was developed in Aspen HYSYS process simulator considering 1.9 MMSCMD gas for design operating parameters and under present operating parameters. The details of operating conditions are shown in Figure 6.2.

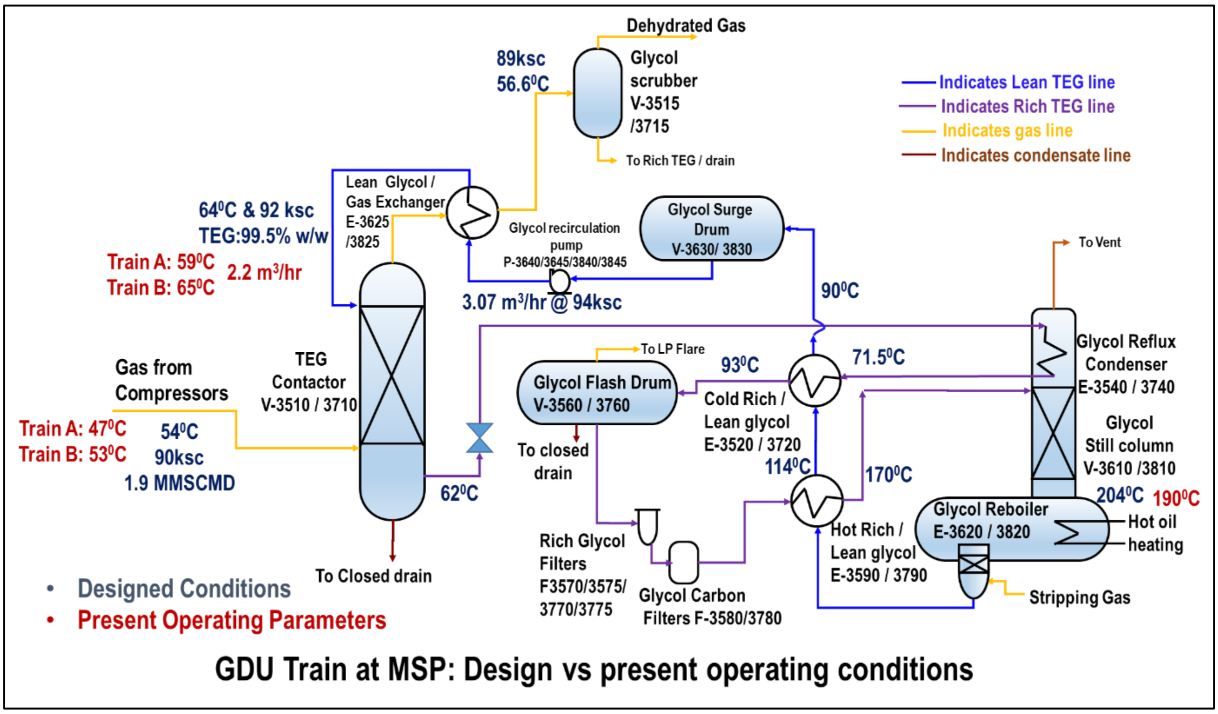

Figure 6.2: GDU Train at MSP- Design vs present operating parameters

The simulation study has been carried out presuming that the gas is fully saturated with water. The results are shown in table 6.3.

Table 6.3: Simulation results for the glycol loss at design vs present operating conditions for GDU trains at MSP

Case	Inlet gas	Inlet Gas T.	Inlet TEG T.	TEG Flow	Moisture in dry gas	TEG Loss
	MMSCMD	⁰C	⁰C	m3/hr	lb/MMSCF	Lit/MMSCM
Design Case	1.9	**54**	64	2.2	4.0	**11.4**
Present Case (A)	1.9	**47**	59	2.2	10.7	**9.3**
Present Case (B)	1.9	**53**	66	2.2	8.6	**11.0**

From the above table, it is seen that TEG vaporisation loss varies from ~11.4 Lit/MMSCM in design conditions to 9.3 &11.0 Lit/MMSCM for present operating parameters of Train A & B respectively. The vaporisation glycol loss in present operating parameters is less than the design operating parameters.

Further simulation study has been carried out to optimize the vaporization glycol loss considering the present inlet gas temperature. The parameters considered for optimization are TEG flow rate, inlet TEG temperature, re-boiler temperature and stripping gas flow rate.

The results of the optimisation study are shown in Table 6.4 below:

Table 6.4: Simulation results- Optimised case

Optimised condition	Inlet gas	Inlet Gas T.	Inlet TEG T.	TEG Flow	Moisture in dry gas	TEG Loss @ optimum conditions	TEG loss @ present conditions
	MMSCMD	^{0}C	^{0}C	m^3/hr	lb/mmscf	Lit/MMSCM	Lit/MMSCM
Train A	1.9	47	**52**	2.0	2.6	**7.6**	**9.3**
Train B	1.9	53	**60**	2.2	3.6	**10.0**	**11.0**

The simulation study concludes that by optimising the parameters as shown in above table and maintaining stripping gas rates of 1500 SCMD in Train A and 1700 SCMD in Train-B, reboiler temperature of 200^{0}C and lean TEG purity of 99.5% (w/w) in both the trains will result in reduction of TEG vaporisation loss to 7.6 lit/MMSCM from 9.3 Lit/MMSCM currently, i.e., around 17% reduction in Train A. Similarly it will result in reduction of TEG vaporisation loss to 10.0 lit/MMSCM from 11.0 Lit/MMSCM presently, i.e., around 9% reduction in Train B.

However, Asset may make attempts to lower the inlet gas temperature to the extent possible, for further reduction of glycol loss due to vaporisation.

6.3 Reasons for additional glycol loss at BHS & MSP GDUs

- In addition to the vaporisation loss, glycol loss may be due to carryover, foaming and mechanical spillages. It is pertinent to mention that presently the GDU units at BHS and MSP are operating at their design capacity and so the gas velocity is very close to its design velocity and hence carryover losses is likely to be on higher side.
- As intimated by the Asset, MSP GDU train B still column was inspected in January 2021. However, internal inspection for BHS GDU train A & B is not carried out after revamping in 2010 and that of MSP GDU train A is not carried out since commissioning. The inspection of vessel internals needs to be carried out as per SOP to ascertain their conditions.
- The inadequate dimensions of the vessels, nozzle sizes & demister pad of the contactor and overhead scrubber lead to carryover loss. As per the data provided by the Asset, GDUs are being operated within the designed capacity, hence glycol losses due to inadequacy is ruled out. However, plugging of the demister pad, damaged packing / trays or channelling through column

packing / flooding of trays may lead to lesser mass transfer and inefficient dehydration and hence may result in high glycol carryover loss.

- High stripping gas rate can also aggravate glycol carryover from the still.
- Any ingress of hydrocarbon to contactor and inadequate filtration of rich glycol may lead to foaming thereby resulting in glycol loss.
- Conditions of cartridge of glycol filter / activated carbon filter need to be checked for proper filtration of rust / debris material to avoid foaming and carryover loss. Filter element to be replaced or cleaned periodically as per the vendor's recommendations.
- The desirable pH of TEG is in the range of 7-8.5. The pH above 9.0 creates excessive foaming. Hence, the glycol quality needs to be examined regularly and degraded glycol needs to be replaced.

- Leakage of glycol through pumps, valves, glands, drains, etc. needs to be addressed. Even small leaks in these, if not addressed, can result in major glycol loss over an extended period of time. Sources for major glycol loss are recirculation pumps, drains, and filters. When changing filters, care should be taken that the filter vessels are drained fully, prior to removal and replacement of the filter.

7.0 General guidelines for operation of TEG based GDU to reduce the glycol loss

7.1 To Reduce Glycol Vaporization Loss

- Inlet gas temperature needs to be kept as low as possible. Recommended range is 80-100 F (26.7-37.8 ^{0}C). Higher the inlet gas temperature, the more will be glycol loss.
- Maintain TEG circulation rate in the range of 1.5 to 4 gallon of TEG per lb of water removed.
- Maintain temperature of lean glycol to the absorber 5-15 deg F warmer than the inlet gas.
- Maintain Reboiler temperature in the range of 380-400 F (193-204^{0}C)
- Maintain the top of the stripping still at 210 F (98.9^{0}C) without stripping gas and 190 F (87.8^{0}C) with stripping gas.

7.2 To reduce glycol loss due to Carryover

- Inadequate nozzle size, inlet device, vessel size- If the gas rate increased beyond the maximum handling capacity, the glycol loss will increase. The system should operate within the operating capacity.
- Inspection of various vessels needs to be carried out to ascertain condition of demister pad & inlet device of vessels; liquid distributor, packing of contactor & still column & filter element of filters.

7.3 To reduce glycol Loss due to foaming

- Optimum glycol pH is 7.0 - 8.5. A pH above 9.0 promotes foaming and emulsion formation.
- Filter elements to be checked / replaced to avoid the contamination in the glycol.
- Condensate carryover along with the inlet gas causes foaming and hence should be avoided.

7.4 To reduce glycol Loss due to Mechanical leaks

- Leaks through pumps, Valves, glands, drains, etc. need to be checked to avoid excessive glycol loss.

8.0 Summary & Conclusion

GDU trains at BHS process complex were taken up for optimization study of glycol consumption at the behest of Asset. The process complex has 2 GDUs at BHS platform of 2.4 MMSCMD capacity each and 2 GDUs at bridge-connected MSP platform of 1.9 MMSCMD capacity each. Glycol consumption of 37.5 Lit/ MMSCM, 63.2 Lit/ MMSCM and 57.9 Lit/ MMSCM is observed in BHS Train-B, MSP Train-A and MSP Train-B respectively; while BHS Train A is not running presently.

It is pertinent to mention that glycol losses in TEG-based units are normally categorized into vaporization losses, carryover losses and foaming losses besides mechanical leakages. A simulation study has been carried out using Aspen HYSYS process simulator to estimate vaporization losses. It indicates vaporization loss of ~ 27.6 Lit/MMSCM, 9.3 Lit/ MMSCM and 11.0 Lit/ MMSCM in BHS Train-B, MSP Train-A and MSP Train-B respectively under present operating conditions. Further optimization of various parameters viz., gas inlet temperature, TEG flow rate & inlet temperature, reboiler temperature and stripping gas rate in the simulation model brings out that it is possible to reduce glycol vaporization losses by ~60%, 17% and 9% in BHS Train-B, MSP Train-A and MSP Train-B respectively.

Additional glycol losses may be due to carryover and foaming which may be result of inadequacy in capacity and damaged internals of various vessels. As per the data provided by the Asset, GDUs are being operated within the designed capacity, hence glycol losses due to inadequacy is ruled out. Further, any ingress of liquid hydrocarbon to contactor and inadequate filtration of rich glycol can lead to foaming. Accordingly, it is prudent to inspect vessels internals as per SOP to ascertain their conditions and take suitable remedial action.

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