

DEP SPECIFICATION

GLYCOL-TYPE GAS DEHYDRATION SYSTEMS

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DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design, material selection, fabrication, operation and maintenance of glycol-type gas dehydration systems based primarily on triethylene glycol (TEG).

The formation of gas hydrates in gathering systems can lead to substantial curtailment of production and potentially dangerous operating situations. This DEP is intended to provide guidance on the proper design and operation of a TEG dehydration system and it is intended to ensure that all regulatory, design, and HSE requirements are met or exceeded, assuring safe production of the reservoir fluids.

The requirements/recommendations in this DEP are intended to allow the user to:

- Select a concept (i.e., choose between alternative processes)
- Develop a project specification (i.e., develop the design of the selected process to a level suitable for use in plant layouts, assessing environmental impacts, EPC bids, etc.)

This is a revision of the DEP of the same number dated January 2005; see (1.5) regarding the changes.

1.2 DISTRIBUTION, APPLICABILITY AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorisation to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production and gas handling. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic, and legal aspects. In all cases, the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Term	Definition
absorber	See contactor
actual trays	Number of trays installed in a column or the equivalent number of actual trays for a packed column.
bubble cap tray	Contacting device that contains bubble caps.
bubble caps	Slotted metal caps attached over elevated nozzles (risers) on the bubble cap trays. The slots cause the gas to break up into small bubbles for intimate contact with the glycol.
condensate	Light hydrocarbon liquids.
condensation	Water dew pointing by cooling and or compressing gas
contactor (or absorber)	A vertical pressure vessel where gas and glycol are intermingled counter-currently to remove water vapour from the gas. The contactor usually contains bubble cap trays or structured packing.
dehydration	Process of removing water from a gas and or liquid such that no free water is present.
design pressure	Pressure used in the design of a vessel for the purpose of determining the minimum permissible wall thickness or physical characteristics of the different parts of the vessel.
dewpoint	Temperature at which vapour begins to condense into a liquid at a particular system pressure. A natural gas stream exhibits both hydrocarbon and water dewpoints. NB Sometimes the dewpoint is only a meta-stable condition – in the stable condition the condensed material is a solid (ice/hydrate) occurring at a higher temperature.
dewpoint depression	Difference in water dewpoint temperature between the gas entering and leaving the contactor.
downcomer	Vertical conduit between trays that allows liquid to pass from tray to tray.
flood	Condition wherein excess liquid hold-up occurs and normal counterflow action is prevented in the glycol contactor, regeneration still or stripping column. It is a design limit which when reached in operation causes an excessive loss of liquid from the top of the column.
free water	Liquid water which is not dissolved in any other substance.
gas/glycol heat exchanger	Heat exchanger employed to cool the lean glycol by the gas leaving the contactor before the glycol enters the contactor.
glycol	A hygroscopic liquid. mono-ethylene glycol (MEG) and di-ethylene glycol (DEG) are commonly used in hydrate inhibition service and tri-ethylene glycol (TEG) is most common in gas dehydration service.
lean glycol (or dry glycol)	Glycol that has been regenerated and has a low water content.
rich glycol (or wet glycol)	Glycol that has absorbed water and thus has a high water content.
glycol flash separator	Two or three phase separator which is used in the rich glycol stream to remove entrained gas and hydrocarbon liquids.

Term	Definition
glycol/glycol exchanger	Heat exchanger employed to recover heat from the outgoing hot lean glycol from the reboiler and for pre-heating the incoming cool rich glycol from the contactor.
heat duty	Rate of heat absorption by the process.
heat flux	Average heat transfer rate through the heat exchanger tube, to the fluid.
height of a transfer unit (HTU)	Height of packing required to give one mass transfer unit.
hydrate	Clathrate compound formed by a combination of methane, ethane, propane, iso-butane, H ₂ S or CO ₂ and water at elevated pressure and low temperature.
hydrate point	Temperature at which hydrates are formed at a particular system pressure.
inhibition	Process of adding chemical additives to a free water phase such that hydrates cannot form
inlet gas separator (scrubber)	Separator that removes free liquids from the inlet gas stream. The separator may be separate from or integral with the contactor.
packing	Material installed in the contactor, still column or stripping column that provides a large surface area for intermingling liquid and vapour to facilitate mass transfer during absorption, distillation or stripping. Random packing consists of shaped pieces (e.g. rings, saddles) that have been dumped, not stacked, in the column. Structured packing is essentially a series of parallel formed metal sheets.
pH	Measure of the acidity of a liquid on a scale of 0 to 14 with 7 being neutral. 0 to 7 is acidic and 7 to 14 is alkaline.
reboiler	Vessel for boiling water out of the glycol.
regenerator	Unit including reboiler, still column and other related facilities to regenerate (or re-concentrate) rich glycol to lean glycol.
reflux	Condensed liquid which flows back down a column to maximise separation efficiency.
standard (pressure and temperature)	Unit of ideal gas volume at reference conditions of 101.325 kPa (14.69 psia) and 15 °C (60 °F). Abbreviated: m ³ (st) (sft ³).
still reflux column	Vertically mounted distillation (fractionation) column on top of the reboiler.
stripping column stahl column	Packed column where glycol from the reboiler flows downward to the surge drum (see Figure 2.1) while gas flows upward stripping the glycol of water.
stripping gas	Gas that is contacted with glycol to help remove water from the glycol.
surge drum	Reservoir for regenerated glycol which may be integral with, or separate from, the reboiler.
swirltube	High capacity cyclone type contacting device. A number of tubes may be assembled on a deck or tray for gas/liquid separation (de-misting) or glycol contacting.

Term	Definition
transfer unit	Dimensionless distance within which every solute molecule has "unit opportunity" to transfer to the gas phase. A transfer unit can be calculated for a theoretical stage.
unit circulation rate (UCR)	Volumetric or mass flowrate of lean glycol per mass flowrate of water removed
valve tray	Horizontal plate holding valves and downcomers in the contactor. A valve consists of a liftable metal plate which covers a hole in the tray, providing a variable area for gas flow.
VOCs	Volatile organic compounds that potentially fall under environment/regulatory sanctions.

1.3.3 Symbols and abbreviations

A	Area	m ²	ft ²
A _S	Specific area of packing	m ² /m ³	ft ² /ft ³
BTEX	Aromatic components: benzene, toluene, ethylbenzene and xylene	-	
D	Inside diameter of column or vessel	m	ft
DEG	Diethylene glycol	-	
d	Nozzle inside diameter, or diameter (with subscript)	m	ft
F	Packing factor	m ⁻¹	ft ⁻¹
FF	Fraction of flood	-	
g	Acceleration due to gravity	9.81 m/s ²	32.2 ft/s ²
G	Gas mass flowrate/unit area	kg/(s·m ²)	lb / (s·ft ²)
h	Height	m	ft
H	Packing height	m	ft
HETP	Height equivalent to a theoretical plate	m	ft
HTU	Height of transfer unit	m	ft
L	Length of vessel between tangent lines	m	ft
LA (H)	High level pre-alarm		
LA (L)	Low level pre-alarm		
LCV	Level control valve	-	
LZA (HH)	High level trip	-	
m	Mass flowrate	kg/s	lb/s
MEG	Monoethylene glycol	-	
MTD	Mean temperature difference	°C	°F
NO _x	Nitric oxide (NO), Nitrogen dioxide (NO ₂) and Nitrous oxide (N ₂ O)	-	
NTU	Number of transfer units	-	
P	Pressure	Pa	inH ₂ O

PSV	Safety relief valve	-	
Q	Volumetric flow rate	m ³ /s	ft ³ /s
q	Heat duty	kJ/s	Btu/hr
Re	Reynold's number	-	
SMS	Schoepentoeter - mist mat - swirldeck separator		
SMSM	Schoepentoeter - mist mat - swirldeck – (secondary) mist mat separator		
T	Temperature	°C, K	°F, R
TEG	Triethylene glycol	-	
TREG	Tetraethylene glycol	-	
U	Overall heat transfer coefficient	W/(m ² ·K)	Btu/ft ² ·hr·F
UCR	Unit circulation rate	L/kg or kg/kg	USgpm/lb or lb/lb
v	Velocity	m/s	Ft/s
w	Width	mm	Inch

1.3.4 Greek symbols

Δ	Separation between plates in separator, difference in parameter values (as in $\Delta\rho$)	m, -	ft
ρ	Density	kg/m ³	lb/ft ³
λ	Gas load factor: $\lambda = \frac{Q_g^*}{A_g} = \frac{Q_g}{A_g} \sqrt{\frac{\rho_g}{\rho_l - \rho_g}}$	m/s	ft/s
η	Effective fraction of dehydration	-	
μ	Dynamic viscosity	Pa·s or mPa·s	lbf·s/ft ²
g	Ratio of ρ of water to ρ of glycol	-	
ϕ	Flow parameter: $\phi = \frac{Q_l}{Q_g} \sqrt{\frac{\rho_l}{\rho_g}}$	-	

1.3.5 Subscripts

c	Chimney tray gas riser (as in h_c)
d	Dewpoint (as in T_d) or droplet (as in d_d)
g	Gas (as in v_g)
gp	Guide pipe (as in d_{gp})
h	Hole (as in d_h)
in	Inlet (as in v_{in} , Y_{in})
l	Liquid

lam	Laminar flow, (as in $v_{t, \text{lam}}$)
lc	Liquid continuous (as in Q_{lc})
ld	Liquid dispersed
m	Mixture (as in v_m)
min	Minimum
max	Maximum
out	Outlet
p	Pipe
r	Riser (as in gas velocity in riser of chimney tray or liquid distributor v_r)
s	Slit in liquid distributor drip pipe (as in w_s)
sg	Superficial gas (as in v_{sg})
sl	Superficial liquid
st	Swirltube (as in λ_{st})
t	Terminal (as in v_t)

1.3.6 Superscripts

*	Maximum allowable
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1.4 CROSS REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (8).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a full revision of the DEP of the same number dated January 2005. It has been reorganized to provide additional clarity and ease of use. Content that was explanation and background material has been moved into a companion Informative document. As such, the changes are too numerous to list here.

1.6 COMMENTS ON THIS DEP

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DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://www.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.

DEP Standard Form (Other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .
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Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.