

DEP SPECIFICATION

DESIGN AND INSTALLATION OF THE BOTTOM SUPPORT STRUCTURE FOR MOLECULAR SIEVE UNITS

DEP 31.22.50.31-Gen.

September 2012

(Amendment A01 has been incorporated - February 2013)

DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for the selection and installation of the bottom support of molecular sieve units (MSU), typically used for contaminant removal (e.g., dehydration, mercaptan removal, etc.), where the removal capacity is restored by high-temperature regeneration.

There are three types of bottom-support which can be applied in an MSU:

- Ceramic balls
- Johnson wedge wire screen type (V-shape wire) or of a similar standard
- "Classic" bottom support structure based on a series of mesh screens

The temperature-swing adsorption (TSA) process requires specific design and engineering requirements of the bottom support to prevent malfunctioning, premature failure and meet the life time of the unit.

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This DEP also covers the use of bottom supports in Silica Gel Units as used in Dewpointing Processes (or any other thermal swing adsorption process). To a lesser extent the DEP provides also standard drawings that can be used for mercury removal beds.

1.2 DISTRIBUTION, INTENDED USE 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, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. 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
Adsorption	Adsorption is the adhesion of atoms, ions, or molecules from a gas, liquid, or dissolved solid to a surface. This process creates a film of the adsorbate on the surface of the adsorbent. This process differs from absorption, in which a fluid (the absorbate) permeates or is dissolved by a liquid or solid (the absorbent).
Adsorbate	The species that is adsorbed to the surface.
Amine unit	Amine gas treating unit, also known as gas sweetening unit or Acid Gas Removal Unit, refers to a group of processes that use aqueous solutions of various alkylamines (commonly referred to simply as amines) to remove sulfur contaminants (e.g., hydrogen sulfide (H ₂ S) and carbonyl sulfide (COS)) and carbon dioxide (CO ₂) from gases.
Bulk Crushing Strength	The pressure at which cumulatively > 0.5 wt % fines are formed at standard temperature.
Dehydration	Removal of water from vapour and/or liquid phase
End-of-run water uptake capacity	The amount of water that can be adsorbed on a mol sieve (generally expressed in wt %) just before the mol sieve inventory is changed out.

1.3.3 Abbreviations

Term	Definition
AGRU	Acid Gas Removal Unit
BOD	Basis of Design
BCS	Bulk Crushing Strength
BDP	Basic Design package
BTL	Bottom Tangent Line
DEP	Design and Engineering Practice
DHU	DeHydration Unit
EOR	End-Of-Run
HSE	Health, Safety & Environment
LNG	Liquefied Natural Gas
MSU	Molecular Sieve Unit
SI	Système International (International System)
TSA	Temperature Swing Adsorption
USC	United States Customary

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets (). Other documents referenced by this DEP are listed in (9).

1.5 SUMMARY OF MAIN CHANGES

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This is a new DEP.

Section	Change
1.1	Added last paragraph
2	Changed DEP number from DEP 64.24.32.30-Gen. to DEP 44.24.32.30-Gen.
9	Changed DEP number from DEP 64.24.32.30-Gen. to DEP 44.24.32.30-Gen.
9	Added DEP 00.00.05.80-Gen.

1.6 COMMENTS ON THIS DEP

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Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
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 .

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.

2. BACKGROUND

A Molecular Sieve Unit (MSU) often consists of two or more adsorption vessels filled with molecular sieves which adsorb the contaminants that need to be removed during an adsorption period. The molecular sieve is regenerated with a heated stream of gas. The high temperature during regeneration causes the adsorbate to desorb from the mol sieve. This process is called temperature-swing adsorption (TSA). Although TSA is a discontinuous process, the overall MSU behaves like a continuous process because one or more vessels are in adsorption mode while the other vessel(s) is (are) in regeneration mode.

During regeneration of the saturated mol sieve, a hot dry treated gas is passed upwards through the mol sieve bed and the adsorbate desorbs. The regeneration gas is cooled, liquids separated and reprocessed, (at most LNG sites, regeneration gas is sent to inlet AGRU; in addition LP regeneration or regeneration with fuel gas/end flash gas is possible). With every regeneration swing, a small amount of the adsorption capacity is lost because the regeneration is not 100 % complete. The design of the MSU is therefore based on the End-Of-Run adsorption capacity of the mol sieve.

The minimum time required for the regeneration step to meet a certain removal of contaminant from the molecular sieve bed is a critical factor in the design of the MSU, because it limits the time that other vessel(s) can be in adsorption mode. Insulation of molecular sieve vessels is applied to minimise heat leaks during heating and for personnel protection. For gas and liquid applications, external insulation is feasible, where for gas also internal insulation may be applied. If a furnace is used the latter will save fuel gas as the heating of the beds will be more efficient which can also be seen as an environmental driver.

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Internal insulation can be of a castable refractory type or canister type, but is of no influence on the selection of the bottom screen type. The choice and installation of refractory shall be based on DEP 44.24.32.30-Gen.

A MSU is generally considered to be a critical process unit, and continuous operation is an essential requirement. The design, engineering and installation of the bottom support in molecular sieve beds is a proven failing device in this specific TSA process, jeopardising the availability of the molecular sieve unit. The root cause of failures is typically the different rate of thermal expansion between the vessel wall and the internals used as bottom support for the molecular sieve bed. It is, therefore, essential that design and installation of the bottom support follows the procedures as outlined in this DEP.

Note that although this DEP focuses on the design and first time installation of the bottom support of a MSU, the nature of a MSU ensures that the inventory of a MSU has to be changed out every couple of years. During this change out many of the issues addressed in the DEP will re-emerge. It should also be clear that specific HSSE procedures have to be followed during installation and initial loading of a MSU, where for unloading and loading of an existing MSU additional HSE procedures may have to be followed. These are not covered in this DEP.

3. GENERAL REQUIREMENTS

Design packages shall be clear about the details of the bottom support to avoid misinterpretation by the Contractor, resulting in a different as-built design than the one intended. For that reason, reference to this DEP should be made.

Additionally, it is recommended to mention the relevant installation best practices as notes to the mol sieve bed data sheet.