

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

MANUAL

ACID GAS REMOVAL UNIT UTILISING SOLVENT

PTS 20.04.60.10

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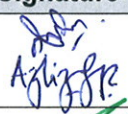
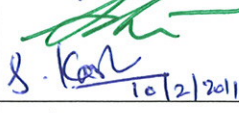
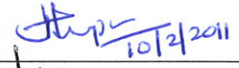
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For PTS Updates/Review

This PTS 20.04.60.10 – Acid Gas Removal Unit Utilising Solvent is a new PTS and has been developed and contributed by members of Gas Liquid Treating Community of Practice to incorporate PETRONAS Lessons Learnt, Best Practices and specific information issued by relevant industry code and standards.

The issuance of this PTS marked a significant contribution from the users of the technology in PETRONAS facilities to share relevant practices in response to known numerous operating and design issues encountered.

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PREFACE

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1 INTRODUCTION

1.1 SCOPE

This PTS specifies requirements and gives recommendations for the design, material selection, operation and maintenance of Acid Gas Removal Units (AGRU) utilising solvents.

There is no single industry standard which covers the scope of this PTS as the design, material selection, operation and maintenance is dependent on the solvent selection and the process licensor.

This PTS discusses the merits of and offers guidelines for various AGRU configurations. It is beyond the scope of this PTS to give specific recommendations for selection of a particular process. While it is acknowledged that there are various methods for gas sweetening, the scope of this document is only limited to AGRU utilising solvent.

The specific process design of the AGRU utilising solvent will depend on the selection of the solvent and the licensor of the process.

1.2 DISTRIBUTION, APPLICABILITY AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by PETRONAS, the distribution of this PTS is confined to companies forming part of the PETRONAS or managed by a Group company and, where necessary, to Contractors and Manufacturers nominated by them.

This PTS is intended for use in oil refineries, chemical plants, gas plants and exploration and production facilities and, where applicable, supply/marketing installations. When PTSs are applied, a Management of Change (MOC) process should 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 may be more stringent than those in this PTS, the Contractor shall determine by careful scrutiny which of the requirements are more stringent and which combination of requirements will be acceptable with regards to safety, environmental, economic, and legal aspects. In all cases, the Contractor shall inform the Principal of any deviation from the requirements of this PTS 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 with the objective of obtaining agreement to follow this PTS 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 chemicals, coating materials, equipment and services to perform the duties specified by the Contractor.

The **Licensors** is the party that provides process guarantee to the licensed process

The **Principal** is the party that initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. 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

Absorber	A vertical pressure vessel where the feed gas and solvent are in contact counter-currently to remove acid gas from the feed gas. The Absorber usually contains bubble cap trays, valve trays or structured packing.
Absorption process	A separation process involving the transfer of the desired component from gaseous phase to liquid phase (solvent) through the phase boundary.
Acid Gas	Impurities in a gas stream usually comprise of CO ₂ , H ₂ S, COS, RSH, and SO ₂ . Most common in natural gas are CO ₂ , H ₂ S, and COS.
Antifoam	A substance, usually a silicone or a long-chain alcohol, added to the circulated solvent to reduce the tendency of foaming.
Beta Factor	Method of specifying removal rating for filter. Ratio of the number of particles of a given size in the influent divided by the number of particles of the same given size in the effluent.
Chemisorption process	Chemical absorption process, reversible chemical reactions take place between the acid gas and the chemical reagents in the solvent.
Corrosion Inhibitor	A chemical substance that, when added to the solvent in a small concentration, effectively decreases the corrosion rate by inhibiting either the anodic or cathodic reaction to form a passivation layer on the metal.
Lean/Rich Heat Exchanger	A heat exchanger employed to recover heat from the outgoing hot lean solvent from the Regenerator bottom, and for preheating the incoming cool rich (fat)

	solvent from the bottom of the Absorber
Lean Solvent	Solvent which has been regenerated and has low acid gas content/loading.
Life Cycle Cost	Total cost of ownership of machinery and equipment, including cost of acquisition, operation, maintenance, conversion, and/or decommission.
Packing	Materials installed in the Absorber and/or Regenerator that provides a large surface area for contact of liquid and vapour to facilitate mass transfer during absorption, and/or stripping. Random packing consists of shaped pieces of metals or plastics (e.g. rings, saddles) loaded in the column. Structured packing is essentially a series of parallel formed metal sheets.
Reboiler	A heat exchanger connected to the bottom of fractionating tower (in this case the Regenerator), that provides the heating duty necessary for stripping of the absorbed acid gases from the solvent. The heating medium may be either steam or a hot-process fluid.
Reclaiming	A process that recovers the solvent, which usually utilises heat to vapourize the "good" solvent, leaving behind contaminants such as Heat Stable Salts (HSS) and other decomposition products.
Regenerator (or Stripping Column)	A vertical pressure vessel to regenerate (or re-concentrate) the rich solvent to lean solvent by stripping out the acid gas from the solvent. The Regenerator usually contains bubble cap trays, valve trays or structured packing.
Residence time	The time period for which a fluid will be contained within a specified volume
Rich Solvent (or Fat Solvent)	Solvent which has absorbed acid gas and thus has a high acid gas content
Skimming	Removing hydrocarbons from the surface of the bulk liquid (usually solvent)
Sour Gas	Gas containing undesirable quantities of H_2S , mercaptans, and/or CO_2 .
Sweet Gas	Gas which has no more than the maximum Sulfur and CO_2 content defined by: (1) the specifications for the sales gas from a plant; (2) the definition by a legal body
System Factor	Safety factors so operating velocities are at 75% to 85% of the true flood point of the system to account for foaming conditions when dimensioning tray or packed

columns This factor which is usually empirical is a de-rating factor which reduces the predicted capacity of the tray (increases % flooding, downcomer froth backup, and reduces maximum downcomer inlet velocity) to account for a known foaming system.

Thermal Oxidiser

Also known as Acid Gas Incinerator (AGI) or Acid Gas Oxidiser (AGO), to combust/oxidise the acid gases at very high temperature into SO_2 , CO_2 , and water in an environmentally acceptable manner.

1.4 SYMBOLS AND ABBREVIATIONS

ACF	Activated Carbon Filter
AGI	Acid Gas Incinerator
AGO	Acid Gas Oxidiser
AGRU	Acid Gas Removal Unit
CO ₂	Carbon Dioxide
COS	Carbonyl Sulfide
CS ₂	Carbon disulfide
DEA	Diethanolamine
DGA	Diglycolamine
DIPA	Diisopropanolamine
GPSA	Gas Processors Supplier's Association
H ₂ S	Hydrogen Sulfide
HSS	Heat Stable Salt
IPF	Instrumented Protective Function
K ₂ CO ₃	Potassium Carbonate
LCC	Life Cycle Cost
MDEA	Methyldiethanolamine
MEA	Monoethanolamine
MOC	Management of Change
N ₂	Nitrogen
O ₂	Oxygen
RSH	Mercaptans
SIL	Safety Integrity Limit
SO ₂	Sulfur Dioxide
TEA	Triethanolamine

1.5 CROSS-REFERENCES

Where cross-references to other parts of this PTS are made, the referenced section number is shown in brackets. Other documents referenced in this PTS are listed in Section (4).

2 PROCESS DESCRIPTION OF ACID GAS REMOVAL UNIT UTILISING SOLVENT

The principle of acid gas removal utilizing solvent is contacting a feed gas stream containing Carbon Dioxide (CO_2) and Hydrogen Sulfide (H_2S) with a solvent that physically and/or chemically absorbs the CO_2 and H_2S from the feed gas in an Absorber. After contacting with the feed gas, the solvent is regenerated in a Regenerator either by thermal regeneration and/or flashing. The regenerated solvent is then recirculated back to the Absorber.

There are variations to the process configurations which are dependent on the type of solvent and the process licensor. In general, the solvent consists of an active ingredient, which will react with the CO_2 and H_2S in the feed gas, and an activator which will speed up the absorption process. In some cases, a corrosion inhibitor is also added into the system.

Generally, the absorption process happens at a low temperature and high pressure while the regeneration (desorption) process occurs at an elevated temperature and low pressure.

2.1 BASIC FLOW SCHEME

The basic flow scheme is described below with reference to **Figure 2-1** and follows the two main streams, gas and solvent. It is typical and many variations are possible. The preferred scheme will be specific to the overall process plant and its location. **Figure 2-1** shows a typical amine type solvent system.