

**NW PlasGas Project
Scrubber Purchase Specification****Document Nr.: AC-NWPVR-SPE-23002****Revision: 2****Document Approval:**

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List of Acronyms & Abbreviations

The following acronyms and abbreviations are used in this document:

°C	degrees Celsius
CO ₂	Carbon dioxide
FAT	Factory Acceptance Test
HCl	Hydro chloric Acid
H ₂ O	Water
NW	Nuclear Waste
PlasGas	Plasma Gasification
kPa	kilopascal
kg/h	kilogram per hour
kg/m ³	kilogram per cubic metre
KOH	Potassium hydroxide
KCl	Potassium chloride
K ₂ CO ₃	Potassium carbonate
NO _x	Nitrogen oxides
m	metre
m ³	cubic metre
N ₂	Nitrogen
N.s/m ²	Newton seconds per square meter
O ₂	Oxygen
PP	Polypropylene

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SO _x	Sulphur oxides
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SS	Stainless steel
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1 Introduction

Gas scrubbing is required for the removal of entrained, toxic and acidic components from the process stream leaving the plasma reactor. The main toxic gas to be scrubbed is HCl and the scrubbing liquid of choice is KOH. The gas scrubbing is achieved through a packed bed column.

The scrubber will have two separate gas inlet streams (blow off line from the reactor and feed from the quench) below the bottom packing support. It should be noted the quench outlet is attached to the scrubber. The gasses will exit the scrubber at the top of the scrubber to building ventilation through HEPA filters and the flare.

The scrubbing liquid enters the packed bed at the top above the distributor hold down plate.

The scrubber has a level indicator (LI1502) to measure the level of scrubbing liquid and indicate over flooding. There is also the quench outlet has temperature transmitter (TT1501) to ensure the quench outlet temperature is not too high for the scrubber material. These instruments are shown in the P&ID AC-NWPVR-PID-21008 attached.

A schematic drawing of the scrubber and packing is shown in Figure 1 and Figure 2 respectively.

The scrubber will be mounted on top of a cylindrical sump tank. Which collects the aqueous scrubbing liquid. The aqueous scrubbing liquid is then recycled back to the top of the scrubber to scrub the gas again.

There should be a space allowance between the bottom of the packed bed column and the bottom packing support as well as the distributor hold down plate and the top of the packed bed Column.

The sump tank is connected to the scrubbing liquid makeup line.

Sampling and analysis will be done on the process streams leaving the plant. Radiological measurements will be done as required.

2 Purpose

The purpose of this purchase specification is to provide details of the requirements of a fully functional scrubber (S1501 in the P&ID AC-NWPVR-PID-21008) along with all accessories and auxiliaries to the scrubber supplier.

3 Scope of supply

The scope of work includes the detailed design and supply of one scrubber (packed bed) and associated accessories such as distributor hold down plate, packing and support etc. Developing a quality control plan for fabrication and assembly of the scrubber, FAT, sourcing of material, fabricating, and assembling the scrubber in accordance with supplier's design specification, testing and delivering the scrubber to purchaser's facility including installation and commissioning. The scrubber will be procured from a qualified supplier who meets the QMS requirements of SHEQ-INS-0271 – requirements for the supply of quality class 2 products for nuclear installation.

4 General requirements

The scrubber will have two main streams i.e. the gas stream and liquid stream. The gas stream will have a mixture of gases (HCl, CO₂, N₂ etc.), and the liquid side will have spent KOH solution, with KCl and K₂CO₃ dissolved salts. The materials of construction for the scrubber assembly will be a suitable polypropylene (PP) material.

5 Scrubber design

The scrubber will have both the liquid and gas streams, and will have a packed bed volume of 0.0785 m³. The mixture of gases will have a density of 1.22 kg/m³.

The gas side of the scrubber will operate at a maximum operating temperature of 100 °C, and a normal operating temperature of 80 °C. It will have a maximum operating pressure of -5 kPa, and normal operating

pressure of -10 kPa. It will have a maximum flow of 50.88 kg/h and a normal flow of 46.25 kg/h.

The liquid side of the scrubber will have a density of 1290 kg/m³. It will operate at a maximum operating temperature of 60 °C, and a normal operating temperature of 30 °C. It will have a maximum flow rate of 4670.4 kg/h, and a normal operating flow of 4245.8 kg/h.

The KOH pump (P1513 in P&ID AC-NWPVR-PID-21008_Scrubber & Filtrations) will have a maximum operating pressure of 4 bar (g), and normal operating pressure of 2 bar (g). It will have a maximum flow rate of 3.6 m³/h, and a normal and minimum operating flow of 3.3 m³/h. The scrubber packed bed height will be 2.5 m, and will have an internal diameter of 0.2 m.

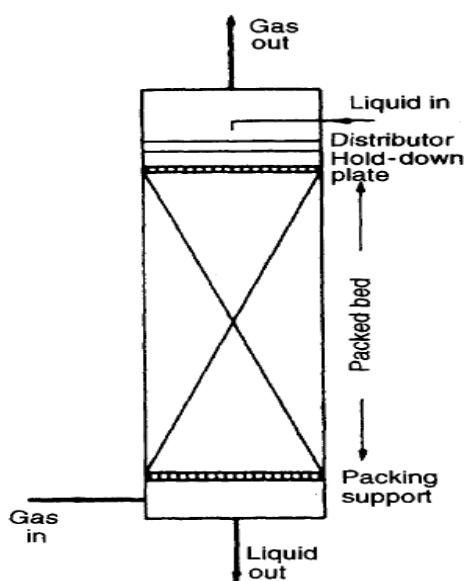


Figure 1: A schematic diagram, showing the main features of a packed absorption column

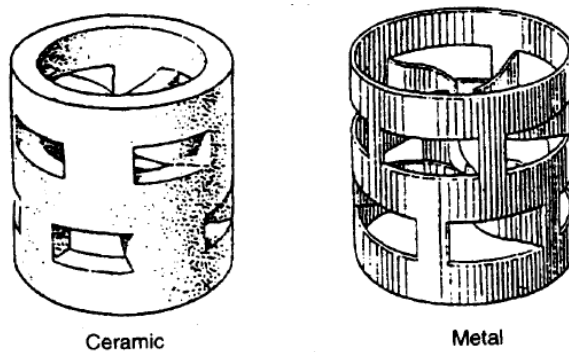


Figure 2: Pall rings type of packing

6 Materials of construction

The scrubber will be constructed from a suitable Polypropylene (PP) that will handle a maximum operating temperature of 100 °C.

7 Scrubber technical specification sheet

GENERAL DATA			
Item number	S1501	Preparer	O.P Rakereng
Revision number	0	Description SCRUBBER WITH DEMISTER	
Date	19 February 2022		
FLUID PROPERTY DATA		GAS	LIQUID
Fluid description		CO ₂ , HCl, H ₂ O, O ₂ , N ₂ , SO _x and NO _x	Aqueous solution with dissolved KOH, KCl & K ₂ CO ₃
Fluid state		GAS	LIQUID

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Density		1.2242 kg/m ³	1290 kg/m ³
Viscosity		0.018×10 ⁻³ N.s/m ²	0.7978×10 ⁻³ N.s/m ²
Temperature	Maximum	100 °C	60 °C
	Normal	80 °C	30 °C
	Minimum	25 °C	25 °C
Pressure	Maximum	-5 kPa (g)	4 bar (g)
	Normal	-10 kPa (g)	2 bar (g)
	Minimum	-15 kPa (g)	1 bar (g)
CAPACITY DATA			
Flow rate	Maximum	50.88 kg/h	4670.4 kg/h
	Normal	46.25 kg/h	4245.8 kg/h
	Minimum	41.63 kg/h	3821.22 kg/h
Packed Bed Volume	0.0785 m ³ , (L = 2.5 m , D = 0.2 m)		
Type of packing	Pall Rings		
Packing Material	Plastic		
Packing size	16 mm		
Sump Volume (Cylindrical)	2 m ³ (Radius = 0.8m, Height = 1 m)		
Accessories			

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	Spray nozzles for KOH recycle, Packing Support, Hold down plate & gas injection support
CONSTRUCTION DATA	
Process exposed material	Polypropylene
Code requirements	ASME B31.3 & SANS 347 (Latest editions)
Process connections	See P&ID AC-NWPVR-PID-21008: Scrubber & Filtration System
Notes: Demister to be included to minimize liquid entrainment in the vapour exiting the column.	

8 Scrubber fabrication and assembly

Scrubber material will be purchased and supplied with material certificates. The hit-numbers shown on the material certificate will correspond with the hit-numbers punched or engraved on the purchased material.

Material will be cut into sizes and shapes in accordance with the developed drawings, and fabricated. Butt weld will be used in areas where butt welds are required, and seal welding will be done in areas where it is required.

Non-destructive examination of the fabricated material will be done and signed off by the supplier QC department and by a 3rd part inspector where required.

9 Scrubber factory acceptance test

A pre-dispatch factory acceptance test will be carried out in presence of purchaser's engineers as follows:

- Verification of all quality control documents as mentioned under scope of supply under section 3.
- Verification of traceability of materials and components used in the scrubber.
- Non-destructive examination results and records, which will include pickling and passivation, dye penetration, x-rays, pressure test etc.
- A leak test of the complete scrubber will be done on completion of scrubber box-up.

The manufacturer shall perform all the above checks/verification in preparation of the test on their own prior to calling Necsa Engineers for pre-dispatch factory acceptance test.