

Nickel Bed (Ni Bed)



❖ Features & Benefits

Triple Use: Reduced state: capture O₂

Oxidized state: capture H₂ Continuous Recombination

Inherently safe: No ignition source, reaction is

catalyzed

Robust: Catalyst is tolerant of high

temperature

Tritium compatible: Bellow Sealed valves, full Stainless-

Steel construction, high leak

tightness

Pressure Vessel: Registered to ASME Section VIII

Div 1

∜Typical Uses

- Secondary Enclosure Cleanup Systems
- protect hydrogen getter beds from oxidation
- remove hydrogen from inert gas streams
- continuous hydrogen recombiner for sampling



Overview

The Nickel Bed (Ni Bed) is a fully integrated device designed to remove either trace oxygen or hydrogen from inert gas streams.

When operating in the reduced state, trace oxygen is trapped as nickel oxide within the bed with no release of water vapor. This is ideal for removing oxygen from an inert gas stream before the gas is directed over components that are sensitive to damage by oxidation.

When operating in the oxidized state, hydrogen at low partial pressures will be converted to water vapor. This is ideal for recombining trace amounts of tritiated hydrogen from an inert gas stream for capture on a downstream drier bed for removal.

When operating in the recombiner mode, trace tritium in a stoichiometric mix with oxygen in a carrier gas can be converted to water vapor and condensed into a continuous water sample for sensitive activity measurements.

High temperature operation ensures a fast system response time and a large capacity.

Design Benefits

The Nickel Bed is designed for robustness. The ability to operate at high temperatures ensures that unexpected concentration spikes in the stream will not damage the bed. The stainless steel welded vessel, rugged band heater, sheathed thermocouples, insulation and protective stainless-steel jacket ensure a clean package that can operate continuously at 450°C without damage.

The Nickel Bed comes standard with metal bellows isolation hand valves fitted with copper stem tips and VCR-8 female nuts. The unit is helium leak tight to $1x10^{-9}$ scc/sec at the operating temperature which is suitable for tritium service.



Specifications

Carrier gas flow 1 to 10 SLPM 1 to 30 SLPM Reduced State Capacity 3.5 SL of O₂ 30 SL of O₂ Oxidized State Capacity 7 SL of H₂ 60 SL of H₂ Bed Residence time 2.1 s @ 5 SLPM 3 s @ 30 SLPM Modified Reynolds number 0.5 @ 5 SLPM 0.9 @ 30 SLPM Pressure 0 - 200 psig Temperature 100 - 450°C Humidity 0 - 90% Pressure Drop < 0.3 psig at full flow Carrier gas composition Inert gases, He NOT recommended: streams containing sulfur and/or potassium, volatile organic compounds Continuous Hydrogen conversion efficiency using > 0.6 O₂/H₂ molar ratio > 99% @ 5 sLPM, 250°C Max Operating Pressure Max Operating Temperature 496°C Physical 100 g Bed 1 kg Bed Dimensions 4.5" Dia x 15" length 6" Dia x 19.5 Length Isolation Valves Bellows sealed, manual, copper stem tip Wetted Materials Nickel, alumina, 304/316L Stainless Steel, Copper stem tip Leak Tightness 1 x10° cc/sec helium with 1 atm helium upstream Pressure Ves	Operating Conditions	100 g Bed	1 kg Bed	
Oxidized State Capacity 7 SL of H₂ 60 SL of H₂ Bed Residence time 2.1 s @ 5 SLPM 3 s @ 30 SLPM Modified Reynolds number 0.5 @ 5 SLPM 0.9 @ 30 SLPM Pressure 0 − 200 psig 0.9 @ 30 SLPM Temperature 100 − 450°C 0.90% Humidity 0 − 90% 0.3 psig at full flow Carrier gas composition Inert gases, He NOT recommended: streams containing sulfur and/or potassium, volatile organic compounds Continuous Hydrogen conversion efficiency using > 0.6 O₂/H₂ molar ratio > 99% @ 5 sLPM, 250°C Max Operating Pressure 200 psig Max Operating Temperature 496°C Physical 100 g Bed 1 kg Bed Dimensions 4.5" Dia x 15" length 6" Dia x 19.5 Length Isolation Valves Bellows sealed, manual, copper stem tip Wetted Materials Nickel, alumina, 304/316L Stainless Steel, Copper stem tip Leak Tightness 1x10° cc/sec helium with 1 atm helium upstream Pressure Vessel ASME Section VIII Div 1 Electrical 100 g Bed 1 kg Bed Number of Heaters 1 2	Carrier gas flow	1 to 10 SLPM	1 to 30 SLPM	
Bed Residence time	Reduced State Capacity	3.5 SL of O ₂	30 SL of O ₂	
Modified Reynolds number	Oxidized State Capacity	7 SL of H ₂	60 SL of H ₂	
Pressure 0 − 200 psig Temperature 100 − 450°C Humidity 0 − 90% Pressure Drop < 0.3 psig at full flow	Bed Residence time	2.1 s @ 5 SLPM	3 s @ 30 SLPM	
Temperature 100 − 450°C Humidity 0 − 90% Pressure Drop < 0.3 psig at full flow	Modified Reynolds number	0.5 @ 5 SLPM	0.9 @ 30 SLPM	
Humidity 0 – 90% Pressure Drop < 0.3 psig at full flow Inert gases, He NOT recommended: streams containing sulfur and/or potassium, volatile organic compounds > 99% @ 5 sLPM, 250°C Continuous Hydrogen conversion efficiency using > 0.6 O ₂ /H ₂ molar ratio Maximum Conditions	Pressure	0 – 200 psig	0-200 psig	
Pressure Drop	Temperature	100 – 450°C		
Inert gases, He NOT recommended: streams containing sulfur and/or potassium, volatile organic compounds > 99% @ 5 sLPM, 250°C	Humidity	0 – 90%		
NOT recommended: streams containing sulfur and/or potassium, volatile organic compounds Continuous Hydrogen conversion efficiency using > 0.6 O ₂ /H ₂ molar ratio Maximum Conditions Max Operating Pressure Max Operating Temperature 200 psig Max Operating Temperature 496°C Physical 100 g Bed 1 kg Bed Dimensions 4.5" Dia x 15" length 6" Dia x 19.5 Length Isolation Valves Bellows sealed, manual, copper stem tip Wetted Materials Nickel, alumina, 304/316L Stainless Steel, Copper stem tip Leak Tightness 1 100 g Bed 1 kg Bed Number of Heaters 1 2 Heater Power 300 W 400 W Heater Current 2.5 A 3.33 A ea, 6.66 A Total Heater Voltage Thermocouple 3 - Type K welded, braided wire, standard mini-connector,	Pressure Drop	< 0.3 psig at full flow		
potassium, volatile organic compounds Continuous Hydrogen conversion efficiency using > 0.6 O ₂ /H ₂ molar ratio Maximum Conditions Max Operating Pressure Max Operating Temperature 200 psig Max Operating Temperature 496°C Physical 100 g Bed 1 kg Bed Dimensions 4.5" Dia x 15" length Bellows sealed, manual, copper stem tip Wetted Materials Nickel, alumina, 304/316L Stainless Steel, Copper stem tip Leak Tightness 1x10-9 cc/sec helium with 1 atm helium upstream Pressure Vessel ASME Section VIII Div 1 Electrical 100 g Bed 1 kg Bed Number of Heaters 1 2 Heater Power 300 W 400 W Heater Current 2.5 A 3.33 A ea, 6.66 A Total Heater Voltage 120 VAC Thermocouple	Carrier gas composition	Inert gases, He		
Continuous Hydrogen conversion efficiency using > 0.6 O ₂ /H ₂ molar ratio Maximum Conditions 200 psig		NOT recommended: streams containing sulfur and/or		
efficiency using > 0.6 O ₂ /H ₂ molar ratio Maximum Conditions Max Operating Pressure Max Operating Temperature 200 psig Max Operating Temperature 496°C Physical Dimensions 4.5" Dia x 15" length Bellows sealed, manual, copper stem tip Wetted Materials Nickel, alumina, 304/316L Stainless Steel, Copper stem tip Leak Tightness 1x10° cc/sec helium with 1 atm helium upstream Pressure Vessel ASME Section VIII Div 1 Electrical 100 g Bed 1 kg Bed Number of Heaters 1 2 Heater Power 300 W 400 W Heater Current 2.5 A 3.33 A ea, 6.66 A Total Heater Voltage Thermocouple 3 - Type K welded, braided wire, standard mini-connector,		potassium, volatile organic compounds		
ratioMax immum ConditionsMax Operating Pressure200 psigMax Operating Temperature496°CPhysical100 g Bed1 kg BedDimensions4.5" Dia x 15" length6" Dia x 19.5 LengthIsolation ValvesBellows sealed, manual, copper stem tipWetted MaterialsNickel, alumina, 304/316L Stainless Steel, Copper stem tipLeak Tightness1x10°9 cc/sec helium with 1 atm helium upstreamPressure VesselASME Section VIII Div 1Electrical100 g Bed1 kg BedNumber of Heaters12Heater Power300 W400 WHeater Current2.5 A3.33 A ea, 6.66 A TotalHeater Voltage120 VACThermocouple3 - Type K welded, braided wire, standard mini-connector,	Continuous Hydrogen conversion	> 99% @ 5 sLPM, 250°C		
Max Image: Max Operating PressureMax Operating Pressure200 psigMax Operating Temperature496°CPhysical100 g Bed1 kg BedDimensions4.5" Dia x 15" length6" Dia x 19.5 LengthIsolation ValvesBellows sealed, manual, copper stem tipWetted MaterialsNickel, alumina, 304/316L Stainless Steel, Copper stem tipLeak Tightness1x10°9 cc/sec helium with 1 atm helium upstreamPressure VesselASME Section VIII Div 1Electrical100 g Bed1 kg BedNumber of Heaters12Heater Power300 W400 WHeater Current2.5 A3.33 A ea, 6.66 A TotalHeater Voltage120 VACThermocouple3 - Type K welded, braided wire, standard mini-connector,	efficiency using > 0.6 O ₂ /H ₂ molar			
Max Operating Pressure200 psigMax Operating Temperature496°CPhysical100 g Bed1 kg BedDimensions4.5" Dia x 15" length6" Dia x 19.5 LengthIsolation ValvesBellows sealed, manual, copper stem tipWetted MaterialsNickel, alumina, 304/316L Stainless Steel, Copper stem tipLeak Tightness1x10-9 cc/sec helium with 1 atm helium upstreamPressure VesselASME Section VIII Div 1Electrical100 g Bed1 kg BedNumber of Heaters12Heater Power300 W400 WHeater Current2.5 A3.33 A ea, 6.66 A TotalHeater Voltage120 VACThermocouple3 - Type K welded, braided wire, standard mini-connector,	ratio			
Max Operating Pressure200 psigMax Operating Temperature496°CPhysical100 g Bed1 kg BedDimensions4.5" Dia x 15" length6" Dia x 19.5 LengthIsolation ValvesBellows sealed, manual, copper stem tipWetted MaterialsNickel, alumina, 304/316L Stainless Steel, Copper stem tipLeak Tightness1x10-9 cc/sec helium with 1 atm helium upstreamPressure VesselASME Section VIII Div 1Electrical100 g Bed1 kg BedNumber of Heaters12Heater Power300 W400 WHeater Current2.5 A3.33 A ea, 6.66 A TotalHeater Voltage120 VACThermocouple3 - Type K welded, braided wire, standard mini-connector,				
Max Operating Temperature496°CPhysical100 g Bed1 kg BedDimensions4.5" Dia x 15" length6" Dia x 19.5 LengthIsolation ValvesBellows sealed, manual, copper stem tipWetted MaterialsNickel, alumina, 304/316L Stainless Steel, Copper stem tipLeak Tightness1x10-9 cc/sec helium with 1 atm helium upstreamPressure VesselASME Section VIII Div 1Electrical100 g Bed1 kg BedNumber of Heaters12Heater Power300 W400 WHeater Current2.5 A3.33 A ea, 6.66 A TotalHeater Voltage120 VACThermocouple3 - Type K welded, braided wire, standard mini-connector,	Maximum Conditions			
Physical100 g Bed1 kg BedDimensions4.5" Dia x 15" length6" Dia x 19.5 LengthIsolation ValvesBellows sealed, manual, copper stem tipWetted MaterialsNickel, alumina, 304/316L Stainless Steel, Copper stem tipLeak Tightness1x10-9 cc/sec helium with 1 atm helium upstreamPressure VesselASME Section VIII Div 1Electrical100 g Bed1 kg BedNumber of Heaters12Heater Power300 W400 WHeater Current2.5 A3.33 A ea, 6.66 A TotalHeater Voltage120 VACThermocouple3 - Type K welded, braided wire, standard mini-connector,		200 psig		
Dimensions 4.5" Dia x 15" length 6" Dia x 19.5 Length Bellows sealed, manual, copper stem tip Nickel, alumina, 304/316L Stainless Steel, Copper stem tip Leak Tightness 1x10-9 cc/sec helium with 1 atm helium upstream Pressure Vessel ASME Section VIII Div 1 Electrical 100 g Bed 1 kg Bed Number of Heaters 1 2 Heater Power 300 W 400 W Heater Current 2.5 A 3.33 A ea, 6.66 A Total Heater Voltage 120 VAC Thermocouple 3 - Type K welded, braided wire, standard mini-connector,	Max Operating Temperature	496°C		
Dimensions 4.5" Dia x 15" length 6" Dia x 19.5 Length Bellows sealed, manual, copper stem tip Nickel, alumina, 304/316L Stainless Steel, Copper stem tip Leak Tightness 1x10-9 cc/sec helium with 1 atm helium upstream Pressure Vessel ASME Section VIII Div 1 Electrical 100 g Bed 1 kg Bed Number of Heaters 1 2 Heater Power 300 W 400 W Heater Current 2.5 A 3.33 A ea, 6.66 A Total Heater Voltage 120 VAC Thermocouple 3 - Type K welded, braided wire, standard mini-connector,				
Isolation ValvesBellows sealed, manual, copper stem tipWetted MaterialsNickel, alumina, 304/316L Stainless Steel, Copper stem tipLeak Tightness 1×10^{-9} cc/sec helium with 1 atm helium upstreamPressure VesselASME Section VIII Div 1Electrical100 g Bed1 kg BedNumber of Heaters12Heater Power300 W400 WHeater Current2.5 A3.33 A ea, 6.66 A TotalHeater Voltage120 VACThermocouple3 - Type K welded, braided wire, standard mini-connector,				
Wetted MaterialsNickel, alumina, 304/316L Stainless Steel, Copper stem tipLeak Tightness $1x10^{-9}$ cc/sec helium with 1 atm helium upstreamPressure VesselASME Section VIII Div 1Electrical100 g Bed1 kg BedNumber of Heaters12Heater Power300 W400 WHeater Current2.5 A3.33 A ea, 6.66 A TotalHeater Voltage120 VACThermocouple3 - Type K welded, braided wire, standard mini-connector,				
Leak Tightness 1×10^{-9} cc/sec helium with 1 atm helium upstreamPressure VesselASME Section VIII Div 1Electrical100 g Bed1 kg BedNumber of Heaters12Heater Power300 W400 WHeater Current2.5 A3.33 A ea, 6.66 A TotalHeater Voltage120 VACThermocouple3 - Type K welded, braided wire, standard mini-connector,	Isolation Valves			
Pressure VesselASME Section VIII Div 1Electrical100 g Bed1 kg BedNumber of Heaters12Heater Power300 W400 WHeater Current2.5 A3.33 A ea, 6.66 A TotalHeater Voltage120 VACThermocouple3 - Type K welded, braided wire, standard mini-connector,	Wetted Materials			
Electrical100 g Bed1 kg BedNumber of Heaters12Heater Power300 W400 WHeater Current2.5 A3.33 A ea, 6.66 A TotalHeater Voltage120 VACThermocouple3 - Type K welded, braided wire, standard mini-connector,				
Number of Heaters12Heater Power300 W400 WHeater Current2.5 A3.33 A ea, 6.66 A TotalHeater Voltage120 VACThermocouple3 - Type K welded, braided wire, standard mini-connector,	Pressure Vessel	ASME Section VIII Div 1		
Number of Heaters12Heater Power300 W400 WHeater Current2.5 A3.33 A ea, 6.66 A TotalHeater Voltage120 VACThermocouple3 - Type K welded, braided wire, standard mini-connector,				
Heater Power300 W400 WHeater Current2.5 A3.33 A ea, 6.66 A TotalHeater Voltage120 VACThermocouple3 - Type K welded, braided wire, standard mini-connector,		100 g Bed	1 kg Bed	
Heater Current 2.5 A 3.33 A ea, 6.66 A Total Heater Voltage Thermocouple 3 - Type K welded, braided wire, standard mini-connector,	Number of Heaters	1	2	
Heater Voltage 120 VAC Thermocouple 3 - Type K welded, braided wire, standard mini-connector,	Heater Power	300 W	400 W	
Thermocouple 3 - Type K welded, braided wire, standard mini-connector,	Heater Current	2.5 A	3.33 A ea, 6.66 A Total	
	Heater Voltage			
ungrounded	Thermocouple			
ungrounded		ungrounded		



Drawings

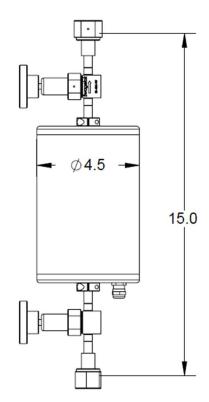


Figure 1: 100g Nickel Bed

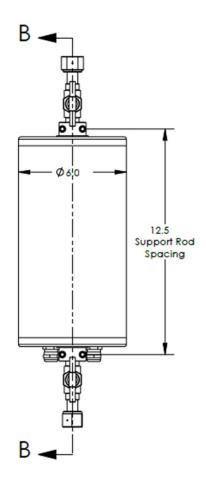


Figure 2: 1kg Nickel Bed