

Air Liquide Confidential Information
This document is the property of Air Liquide S.A. or its (direct and indirect) affiliates and contains valuable confidential information.
Copyright and all other rights in this print are expressly reserved. No part of this print may be disclosed by the intended recipient to a third party, reproduced, copied, lent, or disposed of, directly or indirectly, nor used for any purpose other than that for which it is expressly furnished. This print is lent subject to return on demand.

CONFIDENTIAL-RESTRICTED



Process
Process Data Sheet
Cover

Cryogenics & Lurgi
technologies

CONFIDENTIAL-RESTRICTED

Business Owner Process Department Team Leader
Distribution List Check Project ACL (Access Control List)

624001C39 / 624001C39T01 / 624001C39T02

PROCESS DATA - TAIL GAS COMPANDER - NITROGEN WASTE EXPANDER

[Handwritten signature]

1	AFI	Approved for Inquiry	All	2026-06-05	M. JACQUEMIN	F. PÈRE	L. GRANADOS
0	AFI	Approved for Inquiry	All	2025-08-04	M. JACQUEMIN	L. GRANADOS	L. GRANADOS
Rev.	Status	Description	Sheet	Date	Prepared by	Checked by	Approved by

Index of Revisions

Project Name ACCSION	Project No. 53573	Document No. 53573-62-01-PR-013739-KH	Page / of 1 / 5	Revision 1
-------------------------	----------------------	--	--------------------	---------------

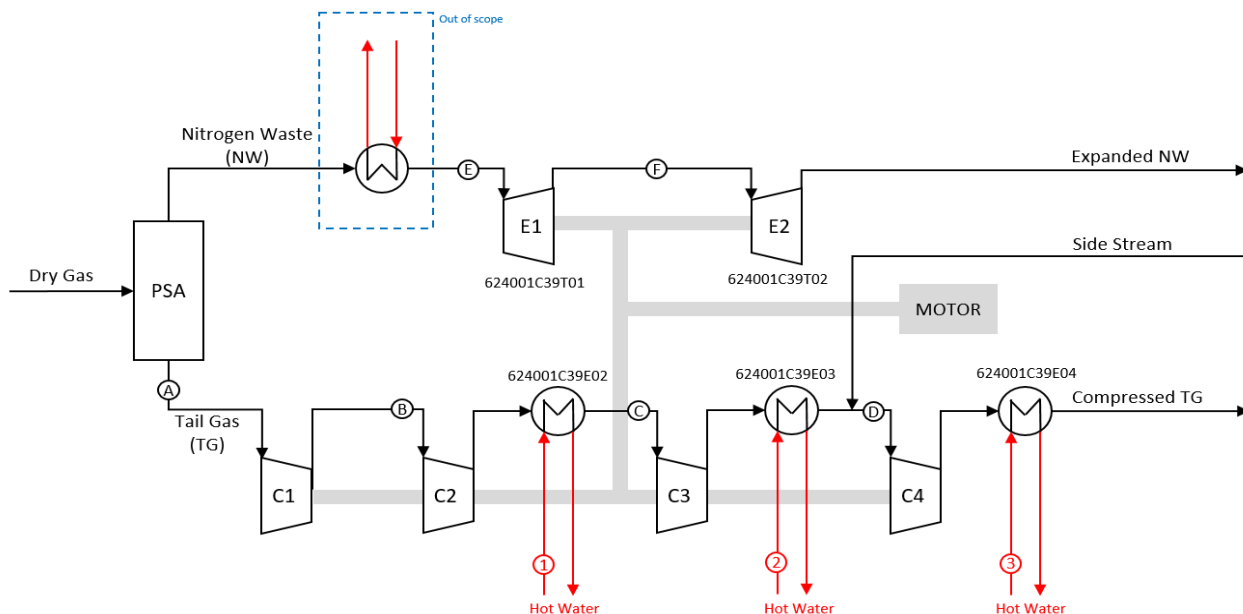


Process
Process Data Sheet
Compressor

Cryogenics & Lurgi
technologies

01	Item Number	624001C39 / 624001C39T01 / 624001C39T02	
02			
03	Designation	PROCESS DATA - TAIL GAS COMPANDER - NITROGEN WASTE EXPANDER	
04			
05	Number required	1	Supplier/Type
06	Driver	Electrical Motor	
07			

MACHINE ARRANGEMENT



Scheme is presented for illustrative purposes, vendor to advise on number of compression stages and coolers.

The turbine preheater is out of vendor scope, but turbine inlet temperature is linked to this exchanger which is heated using heat recovery from the Flue Gas Compressor. Refer to document 53573-62-01-PR-013712 for details on the impact on Flue Gas Compressor.

Process scheme is based on two turbines in series but supplier to recommend optimized number for best economic solution.

START-UP philosophy

Start-up is done with flue gas (see page 5 for start-up composition). Compressor running on its recycle line with discharge pressure ≥ 6 bar(a). Minimum flowrate and outlet pressure should be calculated by vendor based on machine and recycle valve sizing.

On expander side, gas is available by by-passing the PSA (available flowrate and pressure are given on page 4). Actual operating conditions should be calculated by vendor (lower pressure if required and lower flowrate if required are possible).

PSA constraint

The compressor and expander are placed after a Pressure Swing Adsorber (PSA). The cyclic nature of the upstream process induces cyclic fluctuations (30 sec) of inlet streams of the compander :

+0.5% / -1.2% on the molecular weight of the tail gas (see page 5)

Line revised under Rev. No. ↑

Project Name ACCSION	Project No. 53573	Document No. 53573-62-01-PR-013739-KH	Sheet / of 2 / 5	Revision 1
-------------------------	----------------------	--	---------------------	---------------

Air Liquide ENGINEERING & CONSTRUCTION		Process Process Data Sheet Compressor				Cryogenics & Lurgi technologies	
01	Item Number		624001C39 / 624001C39T01 / 624001C39T02				
02							
03	Designation		PROCESS DATA - TAIL GAS COMPANDER - NITROGEN WASTE EXPANDER				
04							
05	Number required		1				
06	Driver		Electrical Motor				
07	CASE (1)		RATED SUMMER	NOMINAL SUMMER	NOMINAL WINTER	START-UP	
08	Fluid		see page 5 for detailed composition and properties				
09							
10	SUCTION TAIL GAS COMPRESSOR						
11	Molar Flowrate	Nm³/h	282 946	249 170	249 226	(5)	1
12	Mass Flowrate	kg/h	466 699	412 977	413 074	v.t.a	1
13	Pressure	bar(a)	1.013	1.013	1.013	1.013	
14	Temperature	°C	12.4	12.3	12.2		1
15	Pipe diameter	DN	104"				
16	Design pressure	barg	-0.2 / 6				1
17	Design temperature	min. / max. °C	-20 / 65				
18							
19	SIDE STREAM TAIL GAS COMPRESSOR						
20	Molar Flowrate	Nm³/h	12 698	12 356	12 203	0.0	1
21	Mass Flowrate	kg/h	21 191	20 785	20 490	-	1
22	Available Pressure (can be lowered for optimization)	bar(a)	10.57	10.45	9.99	-	1
23	Temperature	°C	10.5	9.6	4.9	-	1
24	Pipe diameter	DN	10"				
25	Design pressure	barg	12.0				
26	Design temperature	min. / max. °C	-20 / 65				
27							
28	DISCHARGE TAIL GAS COMPRESSOR (2)						
29	Molar Flowrate (3)	Nm³/h	295 643	261 526	261 429	v.t.a	1
30	Mass Flowrate	kg/h	487 889	433 763	433 564	v.t.a	1
31	Pressure	bar(a)	25.6	24.5	24.0	v.t.a	1
32	Temperature	°C	46.1	41.7	36.4	v.t.a	1
33	Pipe diameter	DN	28"				
34	Design pressure	bar(g)	33.0				
35	Design temperature	min. / max. °C	-20 / 65				
36							
37	INTERCOOLERS TAIL GAS COMPRESSOR (see page 5 for hot water conditions)						
38	Outlet Temperature (gas side) First Intercooler	°C	v.t.a	v.t.a	v.t.a	v.t.a	v.t.a
39	Outlet Temperature (gas side) Second Intercooler	°C	v.t.a	v.t.a	v.t.a	v.t.a	v.t.a
40	Outlet Temperature (gas side) Aftercooler	°C	v.t.a	v.t.a	v.t.a	v.t.a	v.t.a
41							
42							
43	SUCTION NITROGEN WASTE EXPANDER						
44	Molar Flowrate	Nm³/h	447 520	410 909	410 973	(6)	1
45	Mass Flowrate	kg/h	572 258	524 805	524 888	v.t.a	1
46	Pressure	bar(a)	6.83	6.83	6.83	6.87	
47	Temperature	°C	v.t.a	v.t.a	v.t.a	v.t.a	1
48	Pipe diameter	DN	72"				
49	Design pressure	barg	9.0				1
50	Design temperature	min. / max. °C	-20 / 80				
51							
52	DISCHARGE NITROGEN WASTE EXPANDER (4)						
53	Molar Flowrate	Nm³/h	447 520	410 909	410 973	v.t.a	1
54	Mass Flowrate	kg/h	572 258	524 805	524 888	v.t.a	1
55	Pressure	bar(a)	1.087	1.080	1.080	1.080	
56	Temperature	°C	2	2	2	v.t.a	1
57	Pipe diameter	DN	104"				
58	Design pressure	bar(g)	0.15				1
59	Design temperature	min. / max. °C	-20 / 180				1
60	(1) The RATED case should be used for the sizing of the machine, IGV can be set to 0. The NOMINAL SUMMER case should						
61	be used for the power consumption optimization.						
62	(2) After final aftercooler. Aftercooler should be sized with an approach of 20°C between water inlet and gas outlet.						
63	(3) No leaks on the compressor as it is accepted to contaminate process fluid with seal gas						
	(4) Intermediate pressure between the two turbines should be optimized on the NOMINAL SUMMER case to reach 2°C at the outlet of the second wheel.						
	(5) For start-up, compressor flowrate with recycle can be around 80% of Nominal flow. To be defined by vendor according to available gas at Expander inlet.						
	(6) For start-up, expander available flowrate is 179 178 Nm3/h already preheated at the right temperature.						
Project Name		Project No.		Document No.		Sheet / of	
ACCSION		53573		53573-62-01-PR-013739-KH		3 / 5	
						Revision	
						1	

		Process Item Specifications & Data Sheets Process Data Sheet Compressor					
01	Item Number	624001C39 / 624001C39T01 / 624001C39T02					
02							
03	Designation	PROCESS DATA - TAIL GAS COMPANDER - NITROGEN WASTE EXPANDER					
04							
05	CASE	RATED SUMMER	NOMINAL SUMMER	NOMINAL WINTER	START-UP		
06							
07	ENERGY						
08	Isothermal efficiency compressor	%					
09	Thermodynamic power compressor	kW					
10	Mechanical losses (including main oil pump)	kW					
11	Power at motor coupling (including losses)	kW					
12	Power at motor terminals	kW					
13	Motor rating	kW					
14	Surge limit in % of nominal flow (p=constant)	%					
15	Driver rotating speed	RPM					
16							
17	UTILITIES						
18	Seal gas flowrate requirement (operation / standstill)	Nm³/h	/				
19	Leakage flowrate of seal gas in the process gas	Nm³/h					
20	Seal gas vent flowrate	Nm³/h					
21	Instrument air flowrate	Nm³/h					
22	Electrical frequency	Hz	50				
23							
24	HOT WATER CONDITIONS TO COMPRESSOR INTERCOOLERS						
25	ME - Glycol content in hot water	% vol	0%				1
26	Water fouling factor	m²°C/W	0.0001				
27	Water Inlet Pressure	bar(a)	19.5				1
28	Design Pressure	bar(g)	25.0				1
29	Design Temperature	°C	-20 / 230				1
30	Maximum Allowable Pressure Drop per Intercooler	mbar	2 500				1
31	Hot Water (1) (see scheme) Flow	m³/h					
32	Hot Water (1) (see scheme) Intercooler Inlet Temperature	°C	26.1	21.7	16.4	26.1	
33	Hot Water (1) (see scheme) Intercooler Outlet Temperature	°C	T Gas in - 6°C		T Gas in - 6°C		1
34	Hot Water (2) (see scheme) Flow	m³/h					
35	Hot Water (2) (see scheme) Intercooler Inlet Temperature	°C	26.1	21.7	16.4	26.1	
36	Hot Water (2) (see scheme) Intercooler Outlet Temperature	°C	T Gas in - 6°C		T Gas in - 6°C		1
37	Hot Water (3) (see scheme) Flow	m³/h					
38	Hot Water (3) (see scheme) Intercooler Inlet Temperature	°C	26.1	21.7	16.4	26.1	
39	Hot Water (3) (see scheme) Intercooler Outlet Temperature	°C	T Gas in - 6°C		T Gas in - 6°C		1
40	Overdesign on heat transfer area	%	10				
41							
42	COOLING WATER (for auxiliary equipment)						
43	Cooling water flowrate	m³/h	v.t.g				1
44	Water fouling factor	m²h°C/kcal	0.0002				1
45	Water inlet temperature	°C	23.1	18.7	13.4	23.1	
46	Maximum allowable water temperature increase	°C	15.0				
47	Water inlet pressure	bar(a)	4.0				
48	Allowable water pressure drop (skid)	mbar	1 000				
49							
50	OPTIMIZATION CRITERIA						
51	Running time	h/year					
52	Power evaluation	€/MWh					
v.t.a : values to be advised by vendor. : values to be guaranteed by vendor with the following tolerances : Pressure (- 0 %) ; Power construction tolerances (+ 0 %) ; Power measurement tolerances (< 1.5 %, advise if different) ; Discharged flow (- 0 %) ; Temperature (+ 1°C) ; Water flow (+ 5 %) ; Leakage flowrate of process gas (+ 0 %)							
Line revised under Rev. No. ↑							
Project Name		Project No.		Document No.		Sheet / of	Revision
ACCSION		53573		53573-62-01-PR-013739-KH		4 / 5	1



Process Data Sheet

Compressor

Cryogenics & Lurgi technologies

01	Item Number		624001C39 / 624001C39T01 / 624001C39T02					
02								
03	Designation		PROCESS DATA - TAIL GAS COMPANDER - NITROGEN WASTE EXPANDER					
04								
05	Number required		1		Supplier/Type			
06	Driver		Electrical Motor					
07								
08								
09	CASES		RATED	NOMINAL SUMMER	NOMINAL WINTER	START-UP		
10	SUCTION TAIL GAS COMPRESSOR		NMW	LMW	NMW	-		
11	Composition							
12	Carbon dioxide (CO ₂)	%mol	54.60%	52.94%	55.72%	21.55%		1
13	Water (H ₂ O)	%mol	0.00%	0.00%	0.00%	0.00%		1
14	Nitrogen (N ₂)	%mol	40.86%	42.50%	39.71%	70.38%		1
15	Oxygen (O ₂)	%mol	3.89%	4.00%	4.00%	6.97%		1
16	Argon (Ar)	%mol	0.50%	0.47%	0.47%	0.92%		1
17	Carbon monoxide (CO)	ppm	1 016	500	500	1 574		1
18	Nitric oxide (NO)	ppm	92.3	67.0	66.7	39.8		1
19	Nitric dioxide (NO2)	ppm	424.6	304.7	303.3	164.6		1
20	Sulfure dioxide (SO2)	ppm	22.8	26.0	23.7	9.3		1
21	Methane (CH4)	ppm	11.9	12.2	12.2	18.5		1
22	Density (1)	kg/m3	1.58	1.57	1.59	10.03		1
23	Molecular Weight (1)	g/mol	36.97	36.70	37.15	31.85		1
24	Molar Heat Capacity (1)	kcal/Nm3/°C	0.36	0.36	0.36	0.34		1
25	Viscosity (1)	kg/m/h	0.06	0.06	0.06	0.06		1
26								
27	SIDE STREAM TAIL GAS COMPRESSOR							
28	Composition							
29	Carbon dioxide (CO ₂)	%mol	55.78%	58.69%	58.22%	-		1
30	Water (H ₂ O)	%mol	0.00%	0.00%	0.00%	-		1
31	Nitrogen (N ₂)	%mol	38.06%	35.37%	35.77%	-		1
32	Oxygen (O ₂)	%mol	5.13%	5.04%	5.10%	-		1
33	Argon (Ar)	%mol	0.95%	0.86%	0.87%	-		1
34	Carbon monoxide (CO)	ppm	748	352	355.5	-		1
35	Nitric oxide (NO)	ppm	0.0	0.0	0.0	-		1
36	Nitric dioxide (NO2)	ppm	0.0	0.0	0.0	-		1
37	Sulfure dioxide (SO2)	ppm	0.0	0.0	0.0	-		1
38	Methane (CH4)	ppm	25.3	24.7	24.9	-		1
39	Density (1)	kg/m3	17.37	17.41	16.89	-		1
40	Molecular Weight (1)	g/mol	37.25	37.70	37.63	-		1
41	Molar Heat Capacity (1)	kcal/Nm3/°C	0.38	0.38	0.38	-		1
42	Viscosity (1)	kg/m/h	0.06	0.06	0.06	-		1
43								
44	NITROGEN WASTE EXPANDER							
45	Composition							
46	Carbon dioxide (CO ₂)	%mol	0.99%	0.85%	0.85%	21.55%		1
47	Water (H ₂ O)	%mol	0.00%	0.00%	0.00%	0.00%		1
48	Nitrogen (N ₂)	%mol	88.85%	89.18%	89.18%	70.38%		1
49	Oxygen (O ₂)	%mol	8.81%	8.82%	8.82%	6.97%		1
50	Argon (Ar)	%mol	1.16%	1.06%	1.06%	0.92%		1
	Carbon monoxide (CO)	%mol	0.19%	905	905	1 574		1
	Nitric oxide (NO)	ppm	0.0	0.0	0.0	39.8		1
	Nitric dioxide (NO2)	ppm	6.4	4.5	4.5	164.6		1
	Sulfure dioxide (SO2)	ppm	0.0	0.0	0.0	9.3		1
	Methane (CH4)	ppm	22.2	22.0	22.0	18.5		1
	Density (1)	kg/m3	5.54	5.44	5.45	10.03		1
	Molecular Weight (1)	g/mol	28.66	28.63	28.63	31.85		1
	Molar Heat Capacity (1)	kcal/Nm3/°C	0.32	0.32	0.32	0.34		1
	Viscosity (1)	kg/m/h	0.09	0.06	0.09	0.06		1
(1) Physical properties at suction								
Line revised under Rev. No. ↑								
Project Name			Project No.		Document No.		Sheet / of	
ACCSION			53573		53573-62-01-PR-013739-KH		5 / 5	
							Revision	
							1	