Gardner Denver

PRESSURE SWING ADSORPTION NITROGEN GENERATION SYSTEM

GDN2 Series

Where is Nitrogen Used?

In many applications, oxygen is the enemy. Oxygen can cause food to spoil, rubber to deteriorate and steel to rust. The best way to combat the negative effects of oxygen is to supplant it with nitrogen. After all, the air around you is 78% nitrogen. Below are a few examples of how nitrogen is vital to many applications.

Food Packaging

Removing oxygen from food packaging processes extends product shelf-life by preventing mold, moisture migration and insect infestation.

Beer & Wine Manufacturing

In addition to extending shelf life, nitrogen also helps in beer and wine manufacturing by providing an inert atmosphere during the mashing and lautering operations.

Chemical Processing

Nitrogen is used to propel liquids through pipelines, manufacturing ammonia, and removing oxygen from chemical processes where oxygen could become a safety hazard.

Metal Fabrication

Oxidation is a huge adversary when it comes to plasma and laser cutting. By introducing nitrogen into the process, it is possible to remove oxidized edges and the additional steps they cause.

Petroleum Refining

Nitrogen is used to maintain pressure in oil and gas reservoirs, blanketing storage tanks and for product loading/unloading. It also helps in petroleum refining by stripping out volatile organic compounds (VOCs) from waste streams.

Pharmaceuticals

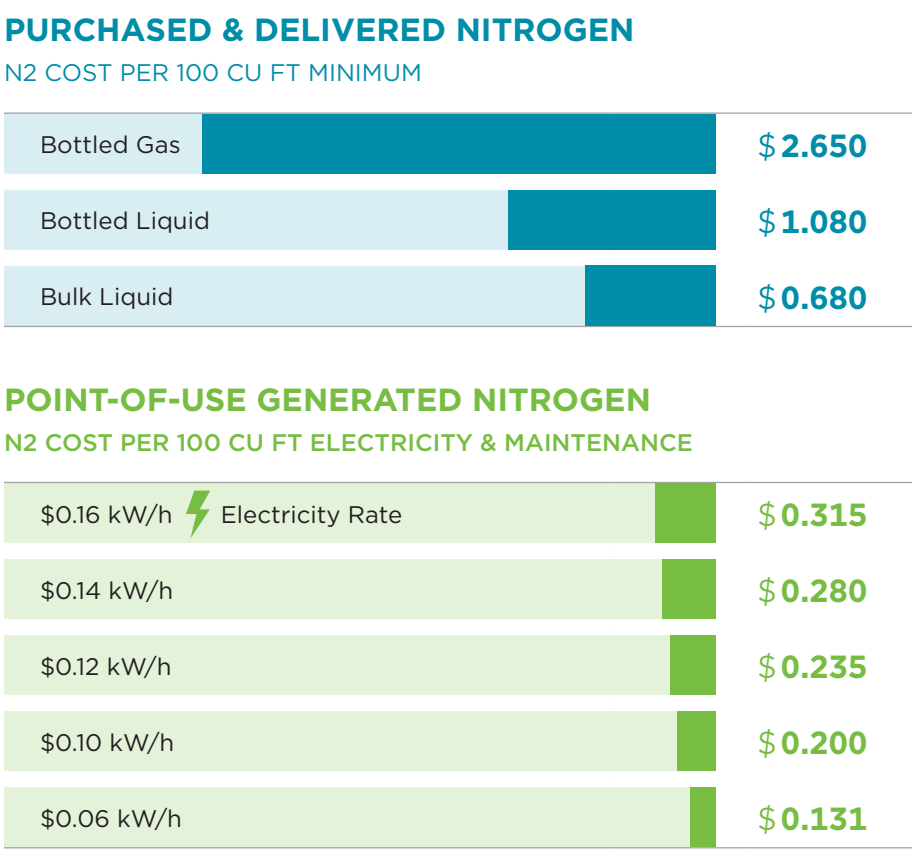
From packaging and moving mixtures between vessels to helping with fire suppression, nitrogen plays a vital role in the pharmaceutical industry.

An Alternative to Bottled Nitrogen

On the previous page we examined the importance of nitrogen in multiple applications. Once upon a time, nitrogen users in these industries had no choice but to purchase bottled nitrogen from suppliers that were free to charge pretty much whatever they wanted. Depending on the volume consumed, type of nitrogen and location, end users could be paying up to and over $2.50 per 100 cubic feet of nitrogen consumed. In addition to the base price, there are many other bottled nitrogen costs to keep in mind:

- Delivery costs
- Cylinder and tank rental fees
- Bulk evaporating losses
- Handling and procurement labor costs
- Liability insurance

The billion-dollar liquid nitrogen monopoly was turned upside down with the introduction of nitrogen generators. Nitrogen generators can produce the same quality of nitrogen for as little as $0.13 to $0.32 per 100 cubic feet. Even at the $0.32 level, that's a 88% savings versus bottled nitrogen. It's easy to see why the typical nitrogen generation system has a return on investment (ROI) of just 6 to 18 months.



Breaking Down a Cost Comparison

When you bring a nitrogen generator into your plant, you take on new expenses—namely the power and the maintenance of the equipment used to operate the generator. The charts at left compare total expenses for delivered nitrogen versus generated nitrogen. Even when power and maintenance are factored in, the choice is obvious.

Let's say a customer uses 1M cubic feet of nitrogen and experiences an electricity cost of $0.12 per kW/h. Their annual savings would be over $24,000 when compared to bottled gas nitrogen and over $8,000 when compared to bottled liquid nitrogen. Even versus bulk liquid, there is still an annual savings opportunity exceeding $4,000.

Benefits Beyond Cost Savings

Reliability

If nitrogen is used in your processes, then a missed delivery will most likely shut down your operation. Nitrogen generators can operate and supply nitrogen 24 hours a day. Nitrogen generators won't shut down due to inclement weather or because your bottled nitrogen supplier made a clerical error.

Environmental Impact

Between the energy consumed by a cryogenic separation plant and the process of transporting bottled nitrogen, the environmental footprint of an on site nitrogen generation system is tiny in comparison.

The main benefit of a nitrogen generation system is the cost savings. However, there are other nitrogen generator benefits you should also keep in mind.

Safety

Bottled nitrogen is stored at 2,200 PSI and liquid nitrogen is stored at -320°F (-196°C.) Both can dramatically increase the cost of liability insurance to your operation. Nitrogen generators bring no more liability to your company than that of an air compressor.

Nitrogen Purity

Nitrogen bottlers may claim that nitrogen generators can't reach the purities of bottled nitrogen. Nitrogen generators can supply purities up to 99.999%. There are very few instances where a purer nitrogen would be required. Keep in mind that the higher the purity, the more the bottler can charge. If your operation can operate at a lower purity, your cost of operation could be significantly lowered.

GDN2 Nitrogen Generators: Total Performance

With a typical ROI of 18 months or less, it quickly becomes evident that your operation is missing the boat if you are still purchasing bottled nitrogen instead of incorporating a nitrogen generator into your business. However, with a number of nitrogen generator alternatives out there, why should you invest in a Gardner Denver GDN2 system?

Pressure Swing Adsorption vs Membrane

The GDN2 Series of nitrogen generators from Gardner Denver use Pressure Swing Adsorption (PSA) technology. The following pages will explore what PSA technology is and how the GDN2 operates. Membrane generators are an outdated technology with limited capacity and purity levels. As opposed to a PSA unit that can reach levels of 99.999% purity, membrane units top out around 95%.

American Made

Every GDN2 unit is American Made in southeast Michigan. In addition to guaranteeing a quality product, this location ensures a quick turnaround for any nitrogen generator orders. The GDN2 is also supported out of American locations. Therefore, wherever you are located, you will have superior availability for maintenance and replacement items.

Quality Componentry

Quality nitrogen generators start with quality components. Since being founded in 1859, Gardner Denver has proven time and time again that all of our products feature the best components. Every component of a GDN2 generator has been tested and demonstrated to be superior.

Simple Design

It takes time, effort and attention to detail to make a simplified nitrogen generator. The GDN2 has its components laid out in a way that minimizes the footprint of the system as well as interconnecting tubing. By placing the nitrogen generator, the storage tanks, the dryer and the filters on one base unit, the GDN2 takes up less space and is easy to install.

GDN2 System Operation

GDN2 nitrogen generators have two adsorption chambers filled with Carbon Molecular Sieve (CMS). CMS separates oxygen and nitrogen by adsorbing the oxygen from the compressed air stream and letting the nitrogen pass.

STEP 1

Compressed air is directed into the right adsorption chamber where the CMS is allowed to perform the separation process. This creates a high purity level of nitrogen which exits the chamber and is stored in the nitrogen storage tank. Simultaneous to this happening, the left adsorption chamber is depressurized to atmosphere, allowing the CMS to release any oxygen it had adsorbed prior to this step.

STEP 2

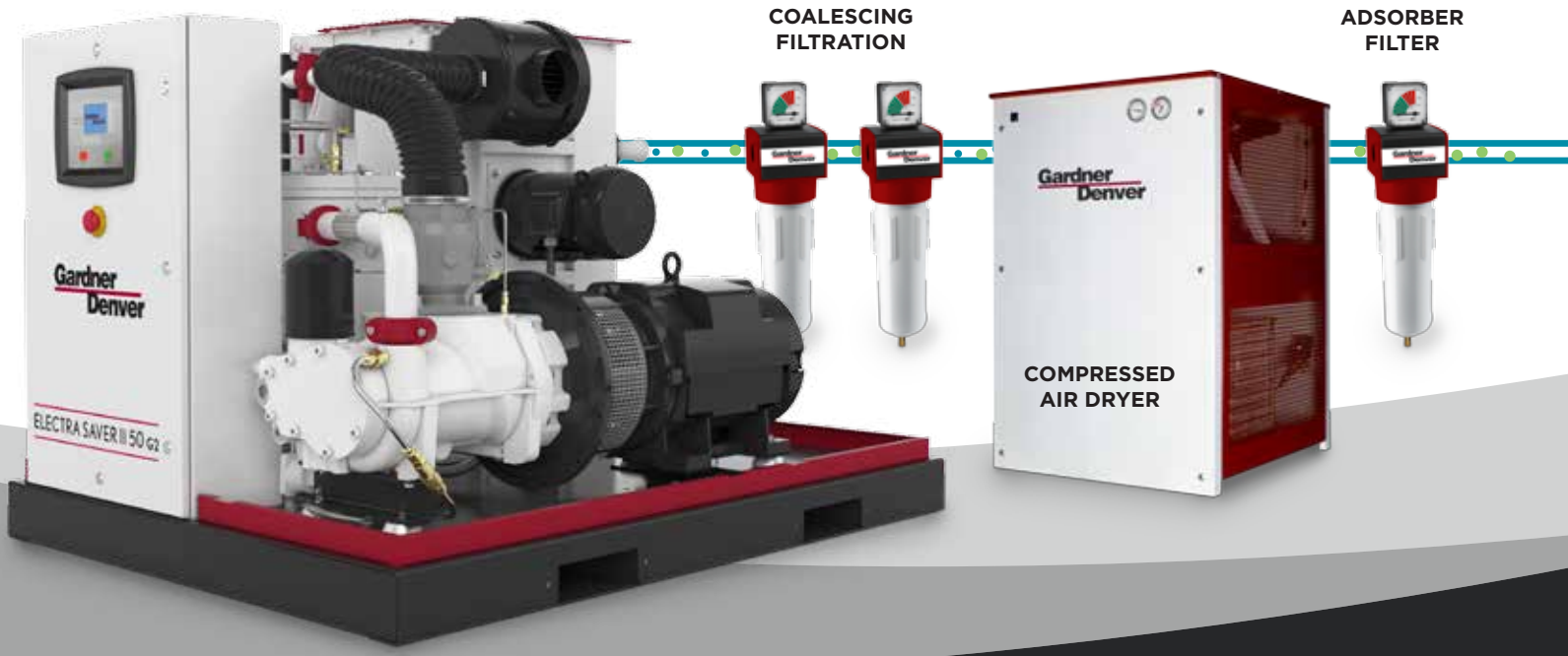
Right before Step 1 is completed, the exhaust valve in the left chamber closes and balance valves (BV) open to equalize pressure in the two adsorption tanks.

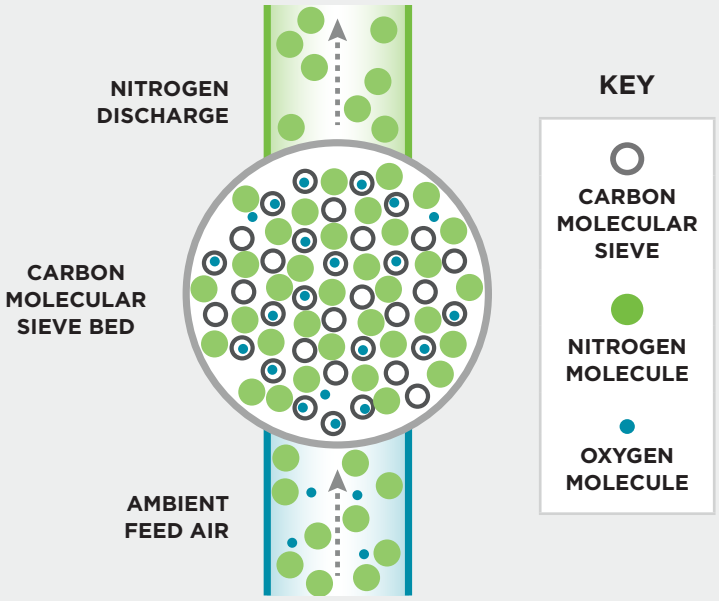
STEP 3

This step is the reverse of Step 1. Compressed air is routed into the left chamber while the right chamber is allowed to exhaust any adsorbed oxygen to atmosphere.

STEP 4

This cyclical process (known as Pressure Swing Adsorption, or PSA) continues allowing the GDN2 generator to produce a steady stream of high purity nitrogen.





CARBON MOLECULAR SIEVE

Both adsorption chambers are filled with a non-polarity based adsorbent called carbon molecular sieve (CMS). When operated within design conditions, and protected from contamination, CMS has a useful service life exceeding 10 years.

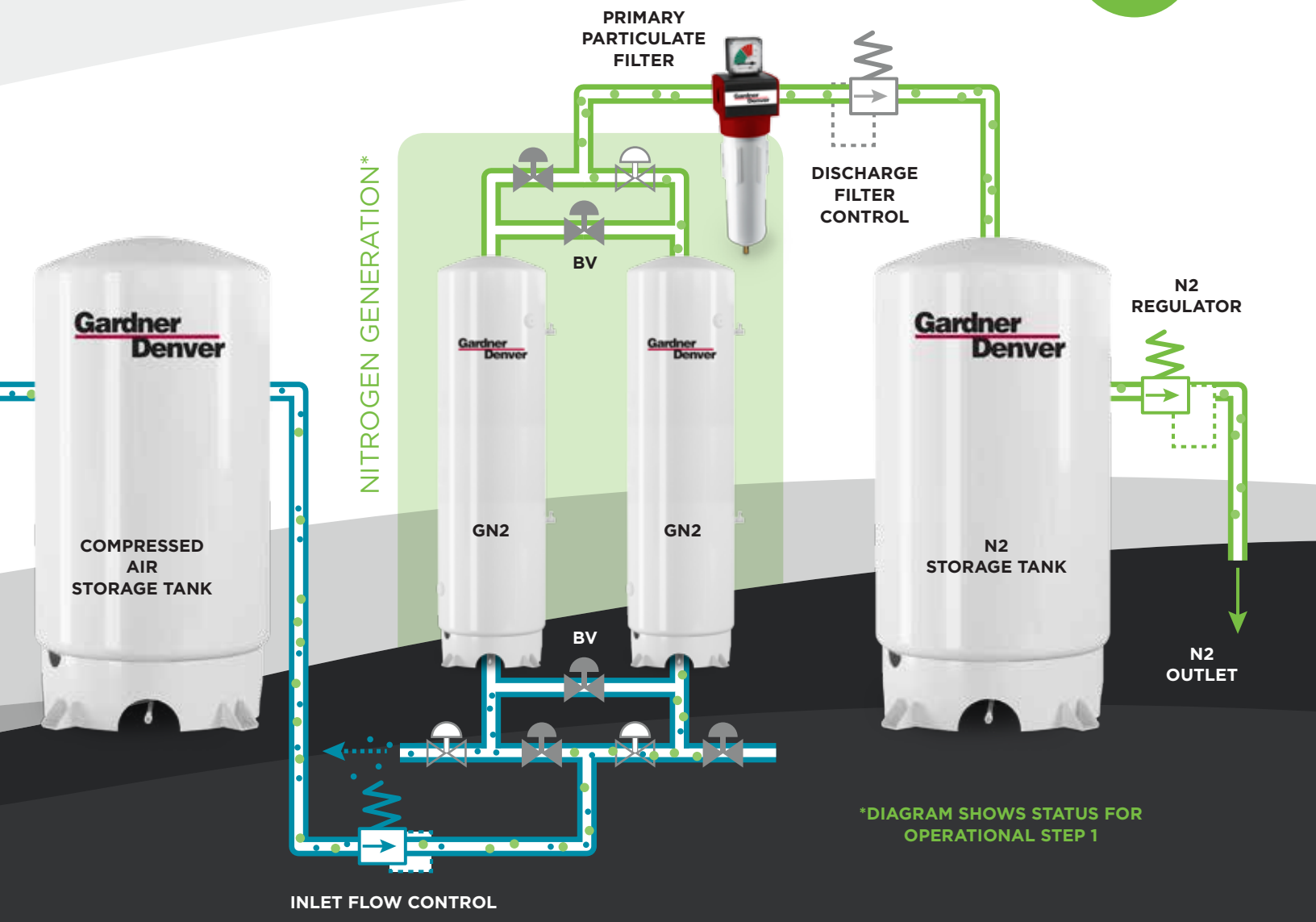


*DIAGRAM SHOWS STATUS FOR OPERATIONAL STEP 1

GDN2 Series Specifications

MODEL	VOLTAGE	INLET PORTS	OUTLET PORTS	GENERATOR ONLY DIMENSIONS H × W × D		WEIGHT		MIN STORAGE CAPACITY / STORAGE	
		NPT	NPT	INCHES	CM	LBS	KG	AIR	N2
GDN2-125	120/1/60 100/1/50	½″	½″	72 × 52 × 20	183 × 132 × 51	565	256	Purity U, A, AB, B & C = 2 gallons of storage per SCFM of feed air. Purity D & E = 4 gallons of storage per SCFM of feed air.	Purity U, A, AB, B & C = 2 gallons of storage per 60 SCFH of discharge Nitrogen. Purity D & E = 4 gallons of storage per 60 SCFH of discharge Nitrogen.
GDN2-175		½″	½″	74 × 70 × 25	188 × 178 × 64	675	306		
GDN2-250		¾″	¾″ (Purity D & E = ½″)	74 × 70 × 25	188 × 178 × 64	730	331		
GDN2-350		¾″	¾″ (Purity D & E = ½″)	75 × 70 × 25	191 × 178 × 64	1200	544		
GDN2-500		1″	1″ (Purity D & E = ¾″)	82 × 70 × 30	208 × 178 × 76	1286	583		
GDN2-650		1″	1″ (Purity D & E = ¾″)	89 × 81 × 30	226 × 206 × 76	1500	680		
GDN2-800		1½″	1½″ (Purity D & E = ¾″)	91 × 90 × 38	231 × 229 × 97	2425	1100		
GDN2-1000		1½″	1½″ (Purity D & E = ¾″)	87 × 90 × 40	221 × 229 × 102	2590	1175		
GDN2-1250		1½″	1½″ (Purity D & E = 1″)	102 × 90 × 42	259 × 229 × 107	2975	1349		
GDN2-1400		1½″	1½″ (Purity D & E = 1″)	109 × 90 × 42	277 × 229 × 107	3375	1531		
GDN2-1600		2″	2″ (Purity D & E = 1″)	107 × 90 × 48	272 × 229 × 122	3975	1803		
GDN2-1800		2″	2″ (Purity D & E = 1″)	117 × 100 × 48	297 × 254 × 122	4635	2102		
GDN2-2000		2″	2″ (Purity D = 1″; Purity E @ 150 PSIG = 1½″; other Purity E = 1″)	117 × 110 × 48	297 × 279 × 122	4950	2245		
GDN2-2500		2″	2″ (Purity D = 1″; Purity E = 1½″)	133 × 110 × 50	338 × 279 × 127	5620	2549		
GDN2-3000		2″	2″ (Purity D @ 150 PSIG = 1½″; other Purity D = 1″; Purity E = 1½″)	133 × 110 × 50	338 × 279 × 127	6520	2957		
GDN2-3500		2″	2″ (Purity D & E = 1½″)	141 × 100 × 50	358 × 254 × 127	7650	3470		
GDN2-4000		2″	2″ (Purity D & E = 1½″)	141 × 112 × 50	358 × 284 × 127	8800	3992		

100 PSIG COMPRESSED AIR SUPPLY

PURITY	U = 99.999%		A = 99.99%		AB=99.95%		B = 99.90%		C = 99.50%		D = 99.00%		E = 98.00%	
MODEL	FEED	OUTPUT	FEED	OUTPUT	FEED	OUTPUT	FEED	OUTPUT	FEED	OUTPUT	FEED	OUTPUT	FEED	OUTPUT
	SCFM @ 100 PSIG	SCFH @ 70 PSIG	SCFM @ 100 PSIG	SCFH @ 70 PSIG	SCFM @ 100 PSIG	SCFH @ 68 PSIG	SCFM @ 100 PSIG	SCFH @ 68 PSIG	SCFM @ 100 PSIG	SCFH @ 66 PSIG	SCFM @ 100 PSIG	SCFH @ 66 PSIG	SCFM @ 100 PSIG	SCFH @ 62 PSIG
GDN2-125	8	52	14	132	14	145	14	186	14	262	14	316	16	393
GDN2-175	10	66	18	170	18	187	18	239	18	337	18	406	21	506
GDN2-250	16	110	30	284	30	311	30	398	30	562	31	677	35	843
GDN2-350	23	155	41	397	41	435	42	558	42	787	43	948	49	1180
GDN2-500	29	199	53	510	53	560	54	717	54	1011	55	1219	63	1517
GDN2-650	39	265	71	680	71	746	71	956	72	1348	74	1625	84	2023
GDN2-800	49	331	89	851	89	933	89	1195	90	1685	92	2031	105	2529
GDN2-1000	59	398	106	1021	106	1119	107	1435	109	2023	110	2437	126	3034
GDN2-1250	75	508	136	1304	136	1430	137	1833	139	2584	141	3114	162	3877
GDN2-1400	85	574	154	1474	154	1617	155	2072	157	2921	160	3521	183	4383
GDN2-1600	98	663	177	1701	177	1866	179	2391	181	3371	184	4062	211	5057
GDN2-1800	108	729	195	1871	195	2052	196	2630	199	3708	203	4468	232	5563
GDN2-2000	121	818	219	2098	219	2301	220	2949	223	4158	227	5010	260	6237
GDN2-2500	154	1037	277	2661	277	2919	279	3740	283	5274	288	6355	330	7912
GDN2-3000	186	1253	335	3216	335	3527	337	4520	342	6372	348	7679	398	9560
GDN2-3500	218	1469	393	3770	393	4135	396	5299	401	7471	408	9003	467	11208
GDN2-4000	250	1685	450	4324	450	4743	454	6078	460	8570	468	10327	536	12856

120 PSIG COMPRESSED AIR SUPPLY

PURITY	U = 99.999%		A = 99.99%		AB=99.95%		B = 99.90%		C = 99.50%		D = 99.00%		E = 98.00%	
MODEL	FEED	OUTPUT	FEED	OUTPUT	FEED	OUTPUT	FEED	OUTPUT	FEED	OUTPUT	FEED	OUTPUT	FEED	OUTPUT
	SCFM @ 120 PSIG	SCFH @ 90 PSIG	SCFM @ 120 PSIG	SCFH @ 90 PSIG	SCFM @ 120 PSIG	SCFH @ 88 PSIG	SCFM @ 120 PSIG	SCFH @ 88 PSIG	SCFM @ 120 PSIG	SCFH @ 86 PSIG	SCFM @ 120 PSIG	SCFH @ 86 PSIG	SCFM @ 120 PSIG	SCFH @ 82 PSIG
GDN2-125	9	59	14	136	15	167	16	214	16	301	16	363	19	453
GDN2-175	11	76	18	175	19	215	21	275	21	387	21	467	24	582
GDN2-250	19	126	30	292	32	358	34	459	35	645	35	778	40	970
GDN2-350	26	177	43	408	44	501	48	642	48	903	49	1089	57	1358
GDN2-500	34	228	55	525	57	645	62	825	62	1161	63	1400	73	1746
GDN2-650	45	303	73	700	76	860	82	1101	83	1547	85	1867	97	2328
GDN2-800	56	379	91	875	95	1075	103	1376	104	1934	106	2333	121	2910
GDN2-1000	68	455	109	1050	114	1290	123	1651	125	2321	127	2800	145	3492
GDN2-1250	86	582	140	1341	146	1648	157	2109	159	2966	162	3578	186	4462
GDN2-1400	98	658	158	1516	165	1863	178	2384	180	3353	183	4045	210	5044
GDN2-1600	113	759	182	1750	191	2149	205	2751	208	3869	212	4667	242	5820
GDN2-1800	124	835	200	1925	210	2364	226	3026	228	4256	233	5134	267	6402
GDN2-2000	139	936	225	2158	235	2651	253	3393	256	4771	261	5756	299	7178
GDN2-2500	176	1187	285	2737	298	3362	321	4304	325	6052	331	7301	379	9105
GDN2-3000	213	1434	345	3307	360	4063	388	5201	392	7313	400	8822	458	11002
GDN2-3500	249	1682	404	3878	422	4763	455	6098	460	8574	469	10343	537	12899
GDN2-4000	286	1929	463	4448	484	5464	522	6994	528	9835	538	11864	616	14796

150 PSIG COMPRESSED AIR SUPPLY

PURITY	U = 99.999%		A = 99.99%		AB=99.95%		B = 99.90%		C = 99.50%		D = 99.00%		E = 98.00%	
MODEL	FEED	OUTPUT	FEED	OUTPUT	FEED	OUTPUT	FEED	OUTPUT	FEED	OUTPUT	FEED	OUTPUT	FEED	OUTPUT
	SCFM @ 150 PSIG	SCFH @ 115 PSIG	SCFM @ 150 PSIG	SCFH @ 115 PSIG	SCFM @ 150 PSIG	SCFH @ 113 PSIG	SCFM @ 150 PSIG	SCFH @ 113 PSIG	SCFM @ 150 PSIG	SCFH @ 101 PSIG	SCFM @ 150 PSIG	SCFH @ 101 PSIG	SCFM @ 150 PSIG	SCFH @ 97 PSIG
GDN2-125	11	74	18	169	18	207	20	265	20	374	20	450	23	561
GDN2-175	14	95	23	217	24	266	25	341	26	481	26	579	30	721
GDN2-250	23	158	38	361	39	443	42	568	43	801	44	965	50	1201
GDN2-350	33	221	53	506	55	620	59	795	60	1121	61	1351	70	1682
GDN2-500	42	284	68	650	71	797	76	1022	77	1442	79	1737	90	2162
GDN2-650	56	378	90	867	94	1063	102	1363	103	1922	105	2316	120	2883
GDN2-800	70	473	113	1083	118	1329	127	1704	129	2403	131	2895	150	3604
GDN2-1000	84	567	135	1300	141	1595	153	2044	155	2884	157	3474	180	4325
GDN2-1250	107	725	173	1661	181	2038	195	2612	198	3685	201	4439	230	5526
GDN2-1400	121	819	196	1878	204	2304	220	2953	224	4165	227	5018	260	6247
GDN2-1600	140	945	226	2167	236	2658	254	3407	258	4806	262	5790	300	7208
GDN2-1800	154	1040	248	2383	259	2924	280	3748	284	5287	289	6369	330	7928
GDN2-2000	173	1166	278	2672	291	3278	314	4202	318	5927	324	7141	370	8889
GDN2-2500	219	1478	353	3390	369	4159	398	5331	404	7519	411	9058	470	11276
GDN2-3000	265	1786	427	4096	446	5025	481	6441	488	9085	496	10946	568	13625
GDN2-3500	311	2094	500	4802	522	5891	564	7552	572	10652	582	12833	666	15974
GDN2-4000	356	2402	574	5508	599	6758	647	8662	656	12218	667	14720	763	18323

Completing the System

While the GDN2 is at the heart of a nitrogen generation system, it isn't the only component of the system. Allow Gardner Denver to tailor a system to your requirements by supplying the following.

Air Compressor

Your operation most likely already has an on-site air compressor, but the demands of a nitrogen generator usually call for a dedicated air compressor or an upgrade to your existing compressor. Gardner Denver has been producing world-class air compressors for decades. Whether your operation requires an oil-free/oil-less compressor a standard oil flooded compressor, Gardner Denver has you covered.

Compressed Air Dryer

The air around us is typically very wet. As a result, the compressed air coming out of an air compressor is also very wet. Before sending this compressed air into your GDN2 unit, it will most likely need to be treated by a refrigerated dryer. This will protect the components of the GDN2, especially the CMS beds. In most cases, the dryer can be added on a skid with the nitrogen generator for easy installation.

Filtration

A properly designed nitrogen generation system includes a number of filters. These filters protect the dryer, nitrogen generator and your downstream equipment from moisture and particulate. As with the dryer, all necessary filtration can be included on a nitrogen system skid.

Buffer & Storage Tanks

To ensure a steady supply of nitrogen into your system, storage tanks are needed both in front of and behind the GDN2 unit. These tanks can also typically be installed on the nitrogen generation skid.

High Pressure Booster Compressor

Sometimes the nitrogen required by a process needs to be at a higher PSI than what comes out of the nitrogen generator. In those cases, a high pressure booster compressor should be installed in the compressed air system after the nitrogen generator. Gardner Denver can help determine if a booster is needed and, if required, which booster would meet the demands of your operation.

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