Inert Gas in Anhydrous Ammonia Tank Cars

by Robert Roads

Operations Superintendent
Farmland Industries, Inc.
Enid, Oklahoma

Inert gas in a container of anhydrous ammonia can be of several different types of gas that cause or display pressures and temperatures not typical for that of anhydrous ammonia. A couple of inert gases most often found in anhydrous ammonia are air and nitrogen. These two inert gases can go undetected for some time until an increase in the atmospheric temperature occurs.

Where do these gases come from? Usually these gases are not normally present in a tank car unless it has been opened, breaking the barrier or seal between the pressurized tank car and the atmosphere. Following hydro-tank testing or qualification of the tank car a large volume of air is still present in the tank car when it leaves the testing facility. Some test facilities purge the tank cars with nitrogen before returning the tank car for service. Air can also be incorporated into the tank car during routine valve testing or replacement. It is common to inject nitrogen gas into anhydrous ammonia in the fall and spring months to purposely increase the pressure for agricultural application. Some facilities use an inert gas to pressurize the tank car for unloading purposes. The use of Corken compressors to off load a tank car can pull inert gas from the customers tanks back into a tank car.

When an anhydrous ammonia tank car is loaded, the vapor space of the tank car contains a volume or space for the ammonia vapors and if inert gas is present it also takes up some of the vapor space. As the sun heats the tank car, the ammonia begins to expand increasing the pressure of the product in the tank car. The ratio of pressure to temperature increase on a normal ammonia tank car should be well below the pressure relief valve setting on most tank cars, but when an inert gas is present the relationship between the pressure and temperature is dramatically affected causing a much higher pressure to temperature ratio.

It is very important to remove the inert gases from the anhydrous ammonia tank car before loading. If a tank car has been in the shop for tank test or qualification, it is possible to load the tank car and ship it without problem. If shipped to a climate cooler in nature you may be lucky and after a couple times loaded and unloaded the inert gas will be reduced to a tolerable range. If that same tank car is sent to a much hotter climate the pressure will increase and you may be running the danger of a non-accident release.

When it is decided to purge a tank car to a flare system, there is a danger if the contents of the tank car is air. On an explosion curve the mixture of air to gas, which is used for the pilot of the flare, could combine and have a devastating affect. The tank car should first be pressured with nitrogen to a safe pressure to absorb the air, then flared followed by hot ammonia vapor. Air incorporated into a tank car that can contain oxygen can lead to stress corrosion cracking and should be purged with nitrogen also.

As a result of an increase in tank car qualifications and the possibilities of problems resulting from inert gas in an anhydrous ammonia tank cars, it is recommended that time is taken to remove inert gas before loading occurs. It is also suggested that a pressure reading be taken on each tank car before shipment to ensure the possibility of pressure problems will not occur while in transportation.

PHYSICAL PROPERTIES OF ANHYDROUS AMMONIA

Chemical Formula.....	NH3
Specific Gravity of the Gas (Air=1.00).....	.588
Specific Gravity of the Liquid (Water =1.00).....	.617
Vaporization Point (Boiling Point.....	-28F
Vapor Pressure @ 0`F.....	15.7 psi
Vapor Pressure @ 70`F.....	114.1 psi
Vapor Pressure @ 100`F.....	197.2 psi
Vapor Pressure @ 130`F.....	315.6 psi
Vapor Pressure @ 150`F.....	418.4 psi
Cu.Ft. of Gas Per Gallon of Liquid.....	113.4
Cu.Ft. of Gas Per Pound of Liquid.....	22.1

TABLE OF THERMODYNAMIC
PROPERTIES OF AMMONIA

Gauge Pressure Pounds per sq. inch	Density of Liquid Pounds per gallon	Density of Vapor Pounds per gallon	Memo Temp. ` F
1	5.68	0.0074	-25.6
2	5.66	0.0084	-23.4
3	5.65	0.0088	-21.2
4	5.64	0.0093	-19.2
5	5.63	0.0098	-17.2
6	5.62	0.0102	-15.3
7	5.6	0.0107	-13.5
8	5.59	0.0111	-11.8
9	5.58	0.0116	-10.1
10	5.57	0.0120	-8.4
11	5.56	0.0125	-6.9
12	5.55	0.0129	-5.3
13	5.54	0.0133	-3.8
14	5.54	0.0139	-2.4
15	5.53	0.0143	-1
16	5.52	0.0148	0.4
17	5.51	0.0152	1.7
18	5.51	0.0156	3.0
19	5.50	0.0161	4.3
20	5.49	0.0166	5.5
21	5.48	0.0169	6.7
22	5.48	0.0175	7.9
23	5.47	0.0179	9.1
24	5.46	0.0184	10.2
25	5.46	0.0188	11.3
26	5.45	0.0192	12.4
27	5.45	0.0197	13.5
28	5.44	0.0202	14.5
29	5.43	0.0206	15.6
30	5.43	0.0211	16.6
31	5.42	0.0215	17.6
32	5.42	0.0219	18.6
33	5.41	0.0224	19.5
34	5.40	0.0228	20.5
35	5.40	0.0233	21.4
36	5.39	0.0236	22.3
37	5.39	0.0242	23.2
38	5.38	0.0246	24.1
39	5.37	0.0250	25.0
40	5.37	0.0255	25.8
41	5.36	0.0259	26.7
42	5.36	0.0263	27.5
43	5.35	0.0269	28.3
44	5.35	0.0273	29.2

TABLE OF THERMODYNAMIC PROPERTIES OF AMMONIA

Gauge Pressure Pounds per sq. inch	Density of Liquid Pounds per gallon	Density of Vapor Pounds per gallon	Memo Temp. ` F
45	5.34	0.0277	30.0
46	5.34	0.0281	30.8
47	5.33	0.0286	31.5
48	5.33	0.0290	32.3
49	5.32	0.0294	33.1
50	5.32	0.0299	33.8
51	5.32	0.0303	34.6
52	5.31	0.0307	35.3
53	5.30	0.0311	36.1
54	5.30	0.0317	36.8
55	5.29	0.0320	37.5
56	5.29	0.0325	38.2
57	5.29	0.0329	38.9
58	5.28	0.0334	39.6
59	5.28	0.0338	40.3
60	5.27	0.0342	40.9
61	5.27	0.0347	41.6
62	5.27	0.0351	42.3
63	5.26	0.0355	42.9
64	5.26	0.0360	43.6
65	5.26	0.0364	44.2
66	5.25	0.0368	44.8
67	5.24	0.0372	45.5
68	5.24	0.0377	46.1
69	5.24	0.0382	46.7
70	5.23	0.0386	47.3
71	5.23	0.0390	47.9
72	5.23	0.0394	48.5
73	5.22	0.0400	49.1
74	5.22	0.0404	49.7
75	5.21	0.0408	50.3
76	5.21	0.0412	50.9
77	5.20	0.0417	51.5
78	5.20	0.0421	52.0
79	5.20	0.0425	52.6
80	5.20	0.0430	53.1
81	5.19	0.0434	53.7
82	5.19	0.0438	54.3
83	5.19	0.0442	54.8
84	5.18	0.0448	55.3
85	5.18	0.0452	55.9
86	5.17	0.0456	56.4
87	5.17	0.0460	57.0
88	5.17	0.0465	57.5

TABLE OF THERMODYNAMIC PROPERTIES OF AMMONIA

Gauge Pressure Pounds per sq. inch	Density of Liquid Pounds per gallon	Density of Vapor Pounds per gallon	Memo Temp. ` F
89	5.16	0.0469	58.0
90	5.16	0.0473	58.5
91	5.16	0.0477	59.0
92	5.16	0.0482	59.6
93	5.15	0.0486	60.1
94	5.14	0.0490	60.6
95	5.14	0.0494	61.1
96	5.14	0.0500	61.6
97	5.14	0.0504	62.0
98	5.13	0.0508	62.5
99	5.13	0.0512	63.0
100	5.13	0.0517	63.5
101	5.12	0.0521	64.0
102	5.12	0.0525	64.5
103	5.12	0.0530	65.0
104	5.11	0.0535	65.4
105	5.11	0.0539	65.9
106	5.11	0.0543	66.4
107	5.11	0.0547	66.8
108	5.10	0.0552	67.3
109	5.10	0.0556	67.7
110	5.10	0.0560	68.2
111	5.09	0.0564	68.6
112	5.09	0.0569	69.1
113	5.09	0.0573	69.7
114	5.08	0.0577	70.0
115	5.08	0.0582	70.4
116	5.08	0.0587	70.8
117	5.08	0.0591	71.2
118	5.07	0.0595	71.7
119	5.07	0.0599	72.1
120	5.07	0.0604	72.6
121	5.06	0.0608	73.0
122	5.06	0.0612	73.4
123	5.06	0.0616	73.8
124	5.06	0.0621	74.2
125	5.05	0.0625	74.6
126	5.04	0.0630	75.1
127	5.04	0.0634	75.5
128	5.04	0.0639	75.9
129	5.04	0.0643	76.3
130	5.04	0.0647	76.7
131	5.03	0.0651	77.1
132	5.03	0.0656	77.5

TABLE OF THERMODYNAMIC
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Gauge Pressure Pounds per sq. inch	Density of Liquid Pounds per gallon	Density of Vapor Pounds per gallon	Memo Temp. ` F
133	5.03	0.0660	77.9
134	5.03	0.0664	78.3
135	5.02	0.0668	78.7
136	5.02	0.0673	79.1
137	5.02	0.0677	79.4
138	5.02	0.0682	79.9
139	5.02	0.0686	80.1
140	5.01	0.0691	80.6
141	5.01	0.0695	81.0
142	5.00	0.0699	81.4
143	5.00	0.0703	81.8
144	5.00	0.0708	82.2
145	5.00	0.0712	82.5
146	4.99	0.0716	82.9
147	4.99	0.0721	83.2
148	4.99	0.0726	83.6
149	4.99	0.0731	84.0
150	4.99	0.0735	84.4
151	4.98	0.0739	84.8
152	4.97	0.0743	85.1
153	4.97	0.0748	85.5
154	4.97	0.0752	85.8
155	4.97	0.0756	86.2
156	4.96	0.0760	86.5
157	4.96	0.0765	86.9
158	4.96	0.0770	87.2
159	4.96	0.0774	87.6
160	4.96	0.0778	88.0
161	4.96	0.0783	88.3
162	4.96	0.0787	88.6
163	4.95	0.0791	89.0
164	4.95	0.0795	89.3
165	4.94	0.0800	89.7
166	4.94	0.0805	90.0
167	4.94	0.0809	90.3
168	4.94	0.0814	90.7
169	4.94	0.0818	91.0
170	4.93	0.0822	91.4
171	4.93	0.0826	91.7
172	4.93	0.0831	92.0
173	4.92	0.0835	92.3
174	4.92	0.0839	92.7
175	4.92	0.0844	93.0
176	4.92	0.0849	93.4

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Gauge Pressure Pounds per sq. inch	Density of Liquid Pounds per gallon	Density of Vapor Pounds per gallon	Memo Temp. ° F
177	4.92	0.0855	93.7
178	4.92	0.0857	94.0
179	4.91	0.0863	94.3
180	4.91	0.0866	94.7
181	4.91	0.0870	95.0
182	4.90	0.0875	95.3
183	4.90	0.0879	95.6
184	4.90	0.0884	95.9
185	4.90	0.0888	96.2
186	4.89	0.0893	96.6
187	4.89	0.0897	96.9
188	4.89	0.0901	97.2
189	4.89	0.0905	97.5
190	4.89	0.0910	97.8
191	4.88	0.0915	98.1
192	4.88	0.0920	98.4
193	4.88	0.0924	98.7
194	4.88	0.0928	99.0
195	4.88	0.0932	99.3
196	4.87	0.0937	99.7
197	4.86	0.0941	100.0
198	4.86	0.0946	100.3
199	4.86	0.0950	100.6
200	4.86	0.0954	100.9
201	4.86	0.0959	101.2
202	4.86	0.0964	101.5
203	4.85	0.0969	101.8
204	4.85	0.0974	102.1
205	4.85	0.0977	102.3
206	4.85	0.0982	102.6
207	4.85	0.0987	102.9
208	4.85	0.0991	103.1
209	4.85	0.0995	103.4
210	4.85	0.0999	103.8
211	4.83	0.1003	104.1
212	4.83	0.1008	104.4
213	4.83	0.1012	104.6
214	4.83	0.1017	104.9
215	4.83	0.1021	105.2
216	4.82	0.1025	105.5
217	4.82	0.1030	105.8
218	4.82	0.1034	106.1
219	4.82	0.1039	106.4
220	4.81	0.1044	106.6

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Gauge Pressure Pounds per sq. inch	Density of Liquid Pounds per gallon	Density of Vapor Pounds per gallon	Memo Temp. ` F
221	4.81	0.1048	106.9
222	4.81	0.1053	107.2
223	4.81	0.1057	107.4
224	4.81	0.1062	107.7
225	4.80	0.1066	108.0
226	4.80	0.107	108.3
227	4.80	0.1075	108.6
228	4.80	0.1079	108.8
229	4.79	0.1084	109.1
230	4.79	0.1088	109.4
231	4.79	0.1092	109.7
232	4.79	0.1097	109.9
233	4.79	0.1101	110.1
234	4.79	0.1106	110.4
235	4.78	0.1111	110.7
236	4.78	0.1116	111.0
237	4.78	0.112	111.2
238	4.78	0.1125	111.5
239	4.78	0.1129	111.7
240	4.77	0.1134	111.9
241	4.77	0.1138	112.3
242	4.77	0.1142	112.6
243	4.76	0.1147	112.8
244	4.76	0.1151	113.0
245	4.76	0.1155	113.3
246	4.76	0.1159	113.6
247	4.76	0.1164	113.8
248	4.75	0.1169	114.0
249	4.75	0.1174	114.3
250	4.75	0.1178	114.6