Test Report

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Issued by	:	NMi Certin B.V. Hugo de Grootplein 1 3314 EG DORDRECHT The Netherlands
Testadress	:	NMi Certin B.V. Hugo de Grootplein 1 3314 EG Dordrecht The Netherlands
Test specifications	:	Liquid volume conversion calculations according to: - ASTM D1250-04 23A, 23B, 24A, 24B, 24C - GPA-TP27 (= API 23E/24E) - AGA7 Gas volume conversion calculations according to: - AGA8 detailed - AGA8 gross 1 - AGA8 gross 2
Manufacturer	:	Dynamic Flow Computers 12603 Southwest Freeway 77477 Stafford United States of America
Pattern designation	:	Micro MV
Test period	:	1 October 2013 – 1 December 2013
Issue date	:	19 December 2013
Signatures	:	

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General information on the calculating and indicating device

Using manually input product temperature, product pressure and product density, volume at reference conditions is calculated from volume at measurement conditions or volume at measurement conditions is calculated from volume at reference conditions.
For the AGA-7 test volume at measurement conditions was simulated with impulses.

For these tests the calculating and indicating device make Dynamic Flow computers, type Micr MV, serial number DEMO024 was used.

Software identification
Liquid application: PC application version 2.19
Flow computer version 6.11.15
Flow computer application name MicroMVL

Gas application: PC application version 1.27
Flow computer version 6.11.00
Flow computer application name MicroMVG

Scope of investigation

Testing the volume conversion calculation methods according to the test specifications on page 1 of this report.

Test report

In this test report the following abbreviations are used:

t; t_{ref}	observed product temperature.
P; P_{ref}	observed product pressure.
rho_base	product density at reference conditions.
rho_t,P	product density at measurement conditions.
ind	indication
SG	specific gravity
C_{ind}	indicated volume conversion factor (or calculated from indicated measured density and base density
C_{ref}	indicated volume conversion factor
error C	error in the indicated conversion factor

Remark: for conversion from SG to Lb/ft^3 the factor 62,428 has been used.

Because the used standards do not specify maximum permissible errors, the report does not give maximum permissible errors as well.
For guidance, the maximum permissible errors from the OIML Recommendation R117-1, for liquid, and the maximum permissible errors from the standard EN12405-1, for gas can be used.

For liquid (methods 23 and 24), in metric values the maximum permissible density error in OIML Recommendation R117-1 is equal to 3 kg/m3. Assuming a largest density of 1200 kg/m^3, this is equal to 0,25%.
This is also true for a CTPL value.

The maximum permissible error in conversion factor C as specified by EN12405-1 is equal to 0,2 % of reading.
The test report shows that all detected errors are smaller than 0,2 %, and in most cases are much smaller.

Volume conversion calculation method ASTM D1250-04 23A
commodity: crude

input t °F	input P PSIG	input rho_t, P SG	reference rho_base SG	reference rho_base Lb/ft3	indicated rho_base Lb/ft3	error in ind rho_base %
-50	100	0,6780	0,6189	38,6343	38,6440	0,03
-50	500	0,6780	0,6165	38,4843	38,4950	0,03
-50	1000	0,6780	0,6134	38,2903	38,3020	0,03
-50	1300	0,6780	0,6114	38,1703	38,1820	0,03
50	100	0,6220	0,6155	38,4254	38,4260	0,00
50	500	1,1220	1,1173	69,7538	69,7540	0,00
50	1000	0,6440	0,6298	39,3168	39,3180	0,00
50	1500	1,1220	1,1141	69,5528	69,5530	0,00
150	100	0,5990	0,6462	40,3416	40,3370	-0,01
150	500	1,1240	1,1491	71,7358	71,7320	-0,01
150	1000	0,5990	0,6341	39,5862	39,5860	0,00
150	1500	1,1240	1,1454	71,5074	71,5040	0,00
302	100	0,5990	0,7166	44,7351	44,7230	-0,03
302	500	1,0111	1,0861	67,8020	67,7940	-0,01
302	1000	0,5990	0,7029	43,8808	43,8730	-0,02
302	1500	1,0111	1,0812	67,5000	67,4920	-0,01

Volume conversion calculation method ASTM D1250-04 23B
commodity: refined

input t °F	input P PSIG	input rho_t SG	reference rho_ref SG	reference rho_ref Lb/ft3	indicated rho_ref Lb/ft3	error in ind rho_ref %
-50	100	0,6880	0,6290	39,2678	39,2750	0,02
-50	500	0,6880	0,6268	39,1305	39,1380	0,02
-50	1000	0,6880	0,6240	38,9538	38,9620	0,02
-50	1500	0,6880	0,6211	38,7710	38,7800	0,02
50	100	0,6220	0,6155	38,4241	38,4240	0,00
50	500	1,1220	1,1168	69,7178	69,7180	0,00
50	1000	0,6440	0,6297	39,3117	39,3130	0,00
50	1500	1,1220	1,1136	69,5170	69,5170	0,00
150	100	0,5990	0,6474	40,4180	40,4140	-0,01
150	500	1,1240	1,1549	72,0961	72,0930	0,00
150	1000	0,5990	0,6350	39,6443	39,6450	0,00
150	1500	1,1120	1,1392	71,1199	71,1180	0,00
302	100	0,5990	0,7251	45,2640	45,2540	-0,02
302	500	1,0111	1,0988	68,5937	68,5810	-0,02
302	1000	0,5990	0,7114	44,4137	44,4080	-0,01
302	1500	1,0111	1,0938	68,2858	68,2740	-0,02

Volume conversion calculation method TP-27 23E

input t °F	input P PSIG	input rho_t SG	reference rho_ref SG	reference rho_ref Lb/ft3	indicated rho_ref Lb/ft3	error in ind rho_ref %
-50	0	0,5500	0,4613	28,7959	28,8070	0,04
50	0	0,4500	0,4395	27,4372	27,4350	-0,01
120	0	0,4000	0,4686	29,2525	29,2440	-0,03
50	0	0,5515	0,5445	33,9906	33,9900	0,00
150	0	0,3515	0,4709	29,3986	29,3810	-0,06
-50	0	0,5115	0,4077	25,4510	25,4700	0,07
55	0	0,5115	0,5074	31,6780	31,6760	-0,01
155	0	0,5115	0,5789	36,1385	36,1290	-0,03
199,4	0	0,5115	0,6053	37,7848	37,7690	-0,04
-50	0	0,5959	0,5208	32,5094	32,5240	0,04
55	0	0,5959	0,5929	37,0125	37,0150	0,01
155	0	0,5959	0,6475	40,4245	40,4140	-0,03
199,4	0	0,5959	0,6686	41,7368	41,7230	-0,03
-50	0	0,6880	0,6315	39,4225	39,4340	0,03
55	0	0,6880	0,6857	42,8042	42,8080	0,01
155	0	0,6080	0,6579	41,0706	41,0620	-0,02
199,4	0	0,6080	0,6784	42,3508	42,3410	-0,02

Volume conversion calculation method ASTM D1250-04 24A
commodity: crude

input t °F	input P PSIG	input rho_base SG	reference rho_t,P SG	indicated rho_t,P SG	error in ind rho_t,P %
-50	100	0,6120	0,6718	0,6718	0,00
-50	500	1,1220	1,1565	1,1565	0,00
-50	1000	0,6120	0,6768	0,6768	0,00
-50	1500	1,1646	1,2006	1,2006	0,00
50	100	0,6120	0,6185	0,6185	0,00
50	500	1,1220	1,1266	1,1266	0,00
50	1000	0,6120	0,6274	0,6274	0,00
50	1500	1,1646	1,1723	1,1723	0,00
150	100	0,6612	0,6150	0,6150	0,00
150	500	1,1220	1,0963	1,0963	0,00
150	1000	0,6512	0,6158	0,6158	0,00
150	1500	1,1640	1,1429	1,1429	0,00
302	100	0,7312	0,6159	0,6159	0,00
302	500	1,1220	1,0495	1,0495	0,00
302	1000	0,7222	0,6196	0,6196	0,00
302	1500	1,1640	1,0989	1,0989	0,00

Volume conversion calculation method ASTM D1250-04 24B
commodity: refined

input t °F	input P PSIG	input rho_base SG	reference rho_t,P SG	indicated rho_t,P SG	error in ind rho_t,P %
-50	100	0,6120	0,6718	0,6718	0,00
-50	500	1,1220	1,1628	1,1628	0,00
-50	1000	0,6120	0,6769	0,6769	0,00
-50	1500	1,1640	1,2072	1,2072	0,00
50	100	0,6120	0,6185	0,6185	0,00
50	500	1,1220	1,1272	1,1272	0,00
50	1000	0,6120	0,6274	0,6274	0,00
50	1500	1,1640	1,1723	1,1723	0,00
150	100	0,6612	0,6133	0,6132	-0,02
150	500	1,1220	1,0909	1,0909	0,00
150	1000	0,6512	0,6144	0,6144	0,00
150	1500	1,1640	1,1369	1,1369	0,00
302	100	0,7312	0,6057	0,6057	0,00
302	500	1,1220	1,0348	1,0348	0,00
302	1000	0,7222	0,6097	0,6097	0,00
302	1500	1,1640	1,0822	1,0822	0,00

Volume conversion calculation method ASTM D1250-04 24C

input t °F	input P PSIG	input rho_base SG	input alpha *1E6	reference CTPL unit/unit	indicated CTPL unit/unit	error in indicated CTPL %
-50	100	0,8010	240	0,8223	0,8223	0,00
-50	500	1,1220	930	1,2339	1,2339	0,00
-50	1000	0,8010	240	0,8252	0,8252	0,00
-50	1500	1,1640	930	1,2829	1,2829	0,00
50	100	0,8010	240	1,0030	1,0030	0,00
50	500	1,1220	930	1,0107	1,0107	0,00
50	1000	0,8010	240	1,0081	1,0081	0,00
50	1500	1,1640	930	1,0134	1,0133	0,00
150	100	0,8410	240	0,9790	0,9790	0,00
150	500	1,1220	930	0,9161	0,9161	0,00
150	1000	0,8410	240	0,9852	0,9851	0,00
150	1500	1,1640	930	0,9190	0,9190	0,00
302	100	0,8910	240	0,9419	0,9419	0,00
302	500	1,1220	930	0,7685	0,7685	0,00
302	1000	0,8910	240	0,9499	0,9499	0,00
302	1500	1,1640	930	0,7717	0,7716	0,00

Volume conversion calculation method TP27-24E, with pressure set to zero.

input t °F	input P PSIG	input rho_base SG	reference rho_t SG	indicated rho_t SG	error in ind rho_t %
-50	0	0,3500	0,4828	0,4828	0,00
50	0	0,3500	0,3686	0,3686	0,00
120	0	0,4000	0,2352	0,2352	0,00
-50	0	0,4515	0,5428	0,5428	0,00
50	0	0,4515	0,4614	0,4614	0,00
150	0	0,4515	0,3018	0,3018	0,00
-50	0	0,5115	0,5889	0,5889	0,00
55	0	0,5115	0,5155	0,5155	0,00
155	0	0,5115	0,4160	0,4160	0,00
199,4	0	0,5115	0,3300	0,3300	0,00
-50	0	0,5959	0,6577	0,6577	0,00
55	0	0,5959	0,5989	0,5989	0,00
155	0	0,5959	0,5333	0,5333	0,00
199,4	0	0,5959	0,4981	0,4981	0,00
-50	0	0,6880	0,7386	0,7386	0,00
55	0	0,6880	0,6903	0,6903	0,00
155	0	0,6880	0,6423	0,6423	0,00
199,4	0	0,6880	0,6195	0,6195	0,00
0	0	0,0000	0,0000	0,0000	0,00

Volume conversion calculation method TP27-24E, with pressure and eq. pressure.
Pressure conversion method ASTM 11.2.2
Equilibrium pressure calculation method ASTM-TP15, equation 2

input t °F	input P PSIG	input rho_base SG	reference rho_t,P SG	indicated rho_t,P SG	error in rho_t,P %
-50	100	0,5959	0,6583	0,6583	0,00
-50	1500	0,5959	0,6660	0,6660	0,00
140	100	0,5959	0,5449	0,5449	0,00
140	1500	0,5959	0,5660	0,5660	0,00
-50	100	0,4000	0,5065	0,5066	0,02
-50	1500	0,4000	0,5216	0,5216	0,00
100	100	0,5100	0,4731	0,4731	0,00
100	200	0,5100	0,4760	0,4759	-0,02
100	1500	0,5100	0,5029	0,5029	0,00

AGA 7 Impulse accuracy test

k-factor = 100 impulses / unit; two impulse channels counted

impulse frequency	pulses	K-factor	calculated volume units	indicated volume units	error in indicated volume %
500 Hz	50000	50	1000	1000	0,00
2500 Hz	50000	50	1000	1000	0,00
2500 Hz	50000	50	1000	1000	0,00
2500 Hz	100000	50	2000	2000	0,00
500 Hz	100000	50	2000	2000	0,00

impulse frequency	pulses	K-factor	meter factor	calculated volume units	indicated volume units	error in indicated volume %
500 Hz	50000	50	1,500	1500	1500	0,00
2500 Hz	50000	50	1,500	1500	1500	0,00
2500 Hz	50000	50	0,550	550	550	0,00
2500 Hz	100000	50	0,990	1980	1980	0,00
500 Hz	100000	50	1,111	2222	2222	0,00

Gas compositions

number	H_S MJ/m^3	d	N_2 fraction	CH_4 fraction	C_2H_6 fraction	C_3H_8 fraction	C_4H_{10} fraction
4	34,1600	0,5990	0,1000	0,7350	0,0330	0,0074	0,0012
5	36,6400	0,6860	0,0570	0,8120	0,0430	0,0090	0,0015
6	36,5800	0,6440	0,1170	0,8260	0,0350	0,0075	0,0012
7	44,8880	0,6733	0,0039	0,8375	0,0961	0,0331	0,0097
8	35,2670	0,6446	0,1393	0,8148	0,0290	0,0040	0,0015
9	39,7820	0,5646	0,0089	0,9827	0,0052	0,0016	0,0006

number	C_4H_{10} fraction	C_5H_{12} fraction	C_5H_{12} fraction	C_6H_{14} fraction	C_7H_{16} fraction	C_8H_{18} fraction	He fraction
4	0,0012	0,0004	0,0004	0,000200	0,0001	0,0001	0,0000
5	0,0015	0,0000	0,0000	0,000000	0,0000	0,0000	0,0000
6	0,0012	0,0004	0,0004	0,000200	0,0001	0,0000	0,0000
7	0,0000	0,0020	0,0000	0,000447	0,000133	0,00004	0,0000
8	0,0000	0,0007	0,0000	0,00028	0,0002	0,00004	0,0005
9	0,0000	0,0002	0,0000	0,000055	0,000016	0,000009	0,0002

Test results

AGA 8, gas composition no. 4

p_{ref} [PSI]	t_{ref} [°F]	p_{ref} [bar]	t_{ref} [°C]	C_{ind} unit/unit	C_{ref} unit/unit	error C [%]
100,00	0,1	7,90	-17,72	8,9654	8,9560	+ 0,10
1798,50	0,1	125,00	-17,72	183,5215	183,4841	+ 0,02
3611,40	0,1	250,00	-17,72	333,3763	333,3220	+ 0,02
5424,40	0,1	375,00	-17,72	406,0422	406,0083	+ 0,01
7237,40	0,1	500,00	-17,72	450,4547	450,4284	+ 0,01
7237,40	95	500,00	35,00	380,5320	380,4965	+ 0,01
5424,40	95	375,00	35,00	327,4779	327,4316	+ 0,01
3611,40	95	250,00	35,00	247,8854	247,8397	+ 0,02
1798,50	95	125,00	35,00	128,7919	128,7744	+ 0,01
100,00	95	7,90	35,00	7,3567	7,3491	+ 0,10
100,00	212	7,90	100,00	6,0398	6,0336	+ 0,10
1798,50	212	125,00	100,00	98,1420	98,1284	+ 0,01
3611,40	212	250,00	100,00	189,0106	188,9831	+ 0,01
5424,40	212	375,00	100,00	260,5153	260,4635	+ 0,02
7237,40	212	500,00	100,00	314,4787	314,4238	+ 0,02

AGA 8, gas composition no. 5

p_{ref} [PSI]	t_{ref} [°F]	p_{ref} [bar]	t_{ref} [°C]	C_{ind} unit/unit	C_{ref} unit/unit	error C [%]
100,00	0,1	7,90	-17,72	9,0315	9,0221	+ 0,10
1798,50	0,1	125,00	-17,72	225,3915	225,3600	+ 0,01
3611,40	0,1	250,00	-17,72	369,4513	369,4422	+ 0,00
5424,40	0,1	375,00	-17,72	426,1554	426,1521	+ 0,00
7237,40	0,1	500,00	-17,72	461,0966	461,0955	+ 0,00
7237,40	95	500,00	35,00	392,5931	392,5931	– 0,00
5424,40	95	375,00	35,00	345,8916	345,8894	+ 0,00
3611,40	95	250,00	35,00	270,8095	270,8019	+ 0,00
1798,50	95	125,00	35,00	140,0415	140,0264	+ 0,01
100,00	95	7,90	35,00	7,3857	7,3782	+ 0,10
100,00	212	7,90	100,00	6,0517	6,0456	+ 0,10
1798,50	212	125,00	100,00	102,1045	102,0944	+ 0,01
3611,40	212	250,00	100,00	199,3141	199,3071	+ 0,00
5424,40	212	375,00	100,00	272,0507	272,0472	+ 0,00
7237,40	212	500,00	100,00	323,9231	323,9217	+ 0,00

AGA 8, gas composition no. 6

p_{ref} [PSI]	t_{ref} [°F]	p_{ref} [bar]	t_{ref} [°C]	C_{ind} unit/unit	C_{ref} unit/unit	error C [%]
100,00	0,1	7,90	-17,72	9,0015	8,9921	+ 0,10
1798,50	0,1	125,00	-17,72	203,1722	203,1428	+ 0,01
3611,40	0,1	250,00	-17,72	349,5831	349,5699	+ 0,00
5424,40	0,1	375,00	-17,72	411,8834	411,8755	+ 0,00
7237,40	0,1	500,00	-17,72	450,0762	450,0703	+ 0,00
7237,40	95	500,00	35,00	382,8107	382,8067	+ 0,00
5424,40	95	375,00	35,00	334,3208	334,3150	+ 0,00
3611,40	95	250,00	35,00	258,4159	258,4058	+ 0,00
1798,50	95	125,00	35,00	134,4157	134,4004	+ 0,01
100,00	95	7,90	35,00	7,3727	7,3651	+ 0,10
100,00	212	7,90	100,00	6,0463	6,0401	+ 0,10
1798,50	212	125,00	100,00	100,1489	100,1382	+ 0,01
3611,40	212	250,00	100,00	193,7185	193,7099	+ 0,00
5424,40	212	375,00	100,00	264,9517	264,9457	+ 0,00
7237,40	212	500,00	100,00	316,8851	316,8806	+ 0,00

AGA 8, gas composition no. 7

pref [PSI]	tref [°F]	pref [bar]	tref [°C]	Cind unit/unit	Cref unit/unit	error C [%]
100,00	0	7,90	-17,72	9,0906	9,0810	+ 0,11
1798,50	0	125,00	-17,72	263,0228	262,9896	+ 0,01
3611,40	0	250,00	-17,72	378,4031	378,3929	+ 0,00
5424,40	0	375,00	-17,72	423,1842	423,1781	+ 0,00
7237,40	0	500,00	-17,72	451,6991	451,6945	+ 0,00
7237,40	0	500,00	35,00	389,3226	389,3195	+ 0,00
5424,40	0	375,00	35,00	349,0724	349,0677	+ 0,00
3611,40	0	250,00	35,00	282,8108	282,8016	+ 0,00
1798,50	0	125,00	35,00	150,3803	150,3621	+ 0,01
100,00	0	7,90	35,00	7,4108	7,4032	+ 0,10
100,00	0	7,90	100,00	6,0615	6,0553	+ 0,10
1798,50	0	125,00	100,00	105,3459	105,3342	+ 0,01
3611,40	0	250,00	100,00	205,7461	205,7373	+ 0,00
5424,40	0	375,00	100,00	276,0732	276,0676	+ 0,00
7237,40	0	500,00	100,00	323,8437	323,8397	+ 0,00

AGA 8, gas composition no. 8

pref [PSI]	tref [°F]	pref [bar]	tref [°C]	Cind unit/unit	Cref unit/unit	error C [%]
100,00	0,1	7,90	-17,72	8,9906	8,9812	+ 0,10
1798,50	0,1	125,00	-17,72	196,9288	196,9001	+ 0,01
3611,40	0,1	250,00	-17,72	344,4149	344,4003	+ 0,00
5424,40	0,1	375,00	-17,72	409,1595	409,1502	+ 0,00
7237,40	0,1	500,00	-17,72	448,8100	448,8027	+ 0,00
7237,40	95	500,00	35,00	381,2180	381,2130	+ 0,00
5424,40	95	375,00	35,00	331,7039	331,6971	+ 0,00
3611,40	95	250,00	35,00	255,0048	254,9940	+ 0,00
1798,50	95	125,00	35,00	132,6648	132,6495	+ 0,01
100,00	95	7,90	35,00	7,3679	7,3604	+ 0,10
100,00	212	7,90	100,00	6,0443	6,0382	+ 0,10
1798,50	212	125,00	100,00	99,5177	99,5069	+ 0,01
3611,40	212	250,00	100,00	192,1361	192,1271	+ 0,00
5424,40	212	375,00	100,00	263,2430	263,2363	+ 0,00
7237,40	212	500,00	100,00	315,5586	315,5532	+ 0,00

AGA 8, gas composition no. 9

pref [PSI]	tref [°F]	pref [bar]	tref [°C]	Cind unit/unit	Cref unit/unit	error C [%]
100,00	0,1	7,90	-17,72	9,0004	8,9909	+ 0,11
1798,50	0,1	125,00	-17,72	206,6344	206,6029	+ 0,02
3611,40	0,1	250,00	-17,72	357,0165	357,0019	+ 0,00
5424,40	0,1	375,00	-17,72	419,6464	419,6371	+ 0,00
7237,40	0,1	500,00	-17,72	458,0771	458,0697	+ 0,00
7237,40	95	500,00	35,00	389,1621	389,1568	+ 0,00
5424,40	95	375,00	35,00	339,9220	339,9151	+ 0,00
3611,40	95	250,00	35,00	262,3701	262,3589	+ 0,00
1798,50	95	125,00	35,00	135,2777	135,2617	+ 0,01
100,00	95	7,90	35,00	7,3731	7,3656	+ 0,10
100,00	212	7,90	100,00	6,0471	6,0409	+ 0,10
1798,50	212	125,00	100,00	100,5506	100,5394	+ 0,01
3611,40	212	250,00	100,00	195,5698	195,5604	+ 0,00
5424,40	212	375,00	100,00	268,3420	268,3350	+ 0,00
7237,40	212	500,00	100,00	321,3566	321,3509	+ 0,00

AGA8 Gross 1, gas composition 4

pref [PSI]	tref [°F]	pref [bar]	tref [°C]	Cind unit/unit	Cref unit/unit	error C %
14,31	32	2,0	0	1,9769	1,9776	-0,04
710,49	95	50,0	35	46,2066	46,2211	-0,03
1435,68	95	100,0	35	96,4125	96,4707	-0,06
1435,68	129,2	100,0	54	88,4174	88,4599	-0,05
1435,68	1,4	100,0	-17	133,4829	133,6699	-0,14

AGA8 Gross 2, gas composition 4

pref [PSI]	tref [°F]	pref [bar]	tref [°C]	Cind unit/unit	Cref unit/unit	error C %
14,31	32	2,0	0	1,9768	1,9776	-0,04
710,49	95	50,0	35	46,2066	46,2211	-0,03
1435,68	95	100,0	35	96,4125	96,4707	-0,06
1435,68	129,2	100,0	54	88,4174	88,4599	-0,05
1435,68	1,4	100,0	-17	133,4829	133,6699	-0,14