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OUTGASSING TEST OF A SECOND D. G. MOTOR

Code:
VIR-TRE-PIS-3400-117

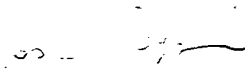
Date: 21/04/1997

LIGO-T970266-00-D

	<p>D. G. motor</p>	<p>Doc: VIR-TRE-PIS-3400-117 code Issue: 1 Date: 21/04/1997 Page: 2</p>
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CHANGE RECORD

<i>Issue/Rev</i>	<i>Date</i>	<i>Section affected</i>	<i>Reason/ remarks</i>

Authors:	Date	Signature
<p>M. Bernardini R. Poggiani</p>		
<p>Approved by:</p>		



 <p>The logo for VIRGO, featuring a stylized circular symbol composed of several curved lines above the word "VIRGO" in a bold, sans-serif font.</p>	D. G. motor	Doc: VIR-TRE-PIS-3400-117 code Issue: 1 Date: 21/04/1997 Page: 3
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In this note we briefly report the outgassing measurements performed with a customized motor from D. G., Parma, Italy. The measurement method is described in detail in VACPISA 025.

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1 - System performances

We performed a baking of the test chamber at 250 °C for 7 days and we got:

$t(h)$	$T(^{\circ}C)$	$p_1(mbar)$	$p_2(mbar)$	$Q(mbar\ l/s)$
after	25	3.1×10^{-8}	3.5×10^{-8}	4.0×10^{-8}

The main components of outgassing after baking were H_2 , H_2O , N_2/CO , CO_2 .
The internal surface of the chamber is 2500 cm².

2 - Measurement of the outgassing flow of D. G. motor

The experimental sample was a high torque UHV motor, cod. DG-TECH-050-1, from D. G., Parma. The main materials were: stainless steel and aluminum for the case and the bearings; polyamide/poylimide insulation for the windings (see notes VIR-TRE-PIS-3400-113 and VIR-TRE-PIS-3400-114). The motor was tested with the nominal cleaning from the factory.

We monitored the evolution of outgassing (time is measured from beginning of the test through the whole paper):

$t(h)$	$T(^{\circ}C)$	$p_1(mbar)$	$p_2(mbar)$	$Q(mbar\ l/s)$
0.75	25	5.1×10^{-4}	6.9×10^{-4}	3.6×10^{-3}
65	25	4.7×10^{-7}	6.9×10^{-7}	4.4×10^{-6}
69.5	23	3.3×10^{-7}	6.7×10^{-8}	5.3×10^{-6}
71.5	25	3.2×10^{-7}	6.3×10^{-8}	5.1×10^{-6}
89	25	3.1×10^{-7}	5.4×10^{-8}	5.1×10^{-6}
93	25	3.4×10^{-7}	6.0×10^{-8}	5.6×10^{-6}
96	23	3.3×10^{-7}	5.7×10^{-8}	5.4×10^{-6}
113	23	1.8×10^{-7}	3.4×10^{-8}	2.9×10^{-6}
118.5	23	2.2×10^{-7}	3.9×10^{-8}	3.6×10^{-6}
119	23	2.3×10^{-7}	4.0×10^{-8}	3.8×10^{-6}

The spectrum taken after 113 hours is shown in Fig. 1.

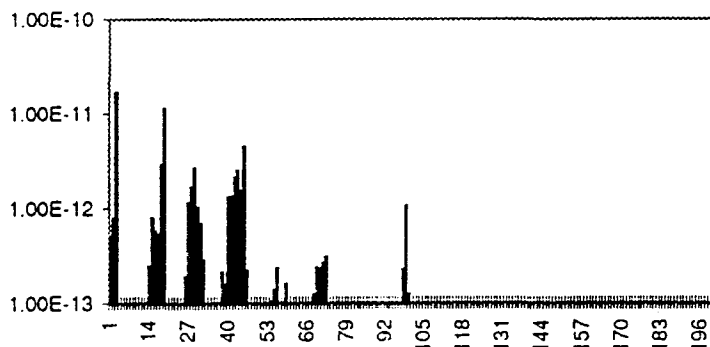


Fig. 1 Outgassing spectrum after 113 hours pumping at room temperature

There is evidence of some organic fragments around 40, 55, 70, 100.

We performed baking at 150 °C for 120 hours and monitored the evolution of outgassing:

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
119.25	47	2.8x10 ⁻⁷	4.3x10 ⁻⁸	4.7x10 ⁻⁶
119.5	103	7.9x10 ⁻⁶	9.6x10 ⁻⁷	1.4x10 ⁻⁴
119.75	145	2.0x10 ⁻⁵	3.9x10 ⁻⁶	3.2x10 ⁻⁴
120	150	2.4x10 ⁻⁵	4.3x10 ⁻⁶	3.9x10 ⁻⁴
120.25	150	5.3x10 ⁻⁵	1.0x10 ⁻⁵	8.6x10 ⁻⁴
120.5	150	2.5x10 ⁻⁴	6.8x10 ⁻⁵	3.6x10 ⁻³

An outgassing spectrum measured at 120.25 hours is shown in Fig. 2.

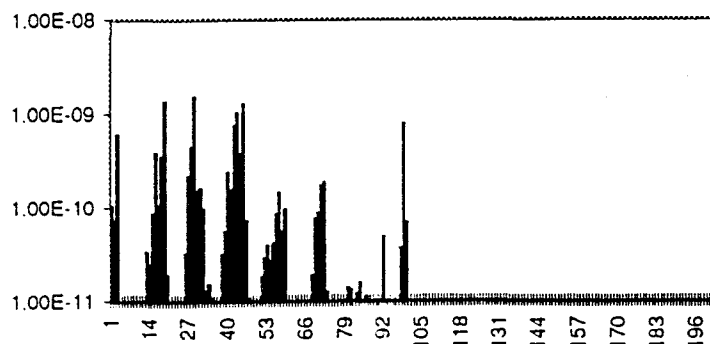


Fig. 2 Outgassing spectrum after 1 hour at 150 °C

The organic contamination cited above was increased.
We switched off the ion pump and used scroll and turbo due to the strong outgassing:

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
121	150	8.3x10 ⁻⁴	1.0x10 ⁻³	3.4x10 ⁻³
137	150	1.0x10 ⁻⁴	1.4x10 ⁻⁴	8.0x10 ⁻⁴
159.5	150	3.4x10 ⁻⁵	8.8x10 ⁻⁵	1.1x10 ⁻³
160.5	150	2.1x10 ⁻⁵	1.8x10 ⁻⁵	6.0x10 ⁻⁵
163	150	2.6x10 ⁻⁵	4.3x10 ⁻⁵	3.4x10 ⁻⁴
167	150	1.2x10 ⁻⁵	2.1x10 ⁻⁵	1.8x10 ⁻⁴
233	150	2.0x10 ⁻⁵	4.1x10 ⁻⁵	4.2x10 ⁻⁴
237.5	150	1.3x10 ⁻⁵	2.2x10 ⁻⁵	2.4x10 ⁻⁴
238	150	7.6x10 ⁻⁶	1.2x10 ⁻⁵	8.8x10 ⁻⁵
238.5	150	6.8x10 ⁻⁶	1.1x10 ⁻⁵	8.4x10 ⁻⁵

The spectrum measured after 120 hours at 150 °C is shown in Fig. 3. There is still evidence of organic contamination.

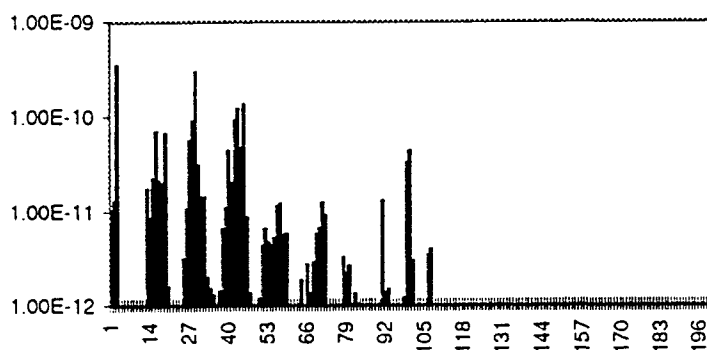


Fig. 3 Outgassing spectrum after 120 hours at 150 °C

We switched off the heating and we measured:

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
238.75	137	5.9x10 ⁻⁶	9.3x10 ⁻⁶	6.8x10 ⁻⁵
239	130	4.9x10 ⁻⁶	7.5x10 ⁻⁶	5.2x10 ⁻⁵



239.25	118	2.4×10^{-8}	3.8×10^{-6}	2.8×10^{-5}
239.5	111	1.8×10^{-6}	2.9×10^{-6}	2.2×10^{-5}
240	104	1.0×10^{-6}	1.8×10^{-6}	1.6×10^{-5}
258	25	1.6×10^{-8}	3.8×10^{-8}	4.4×10^{-7}
262.5	25	9.9×10^{-9}	2.7×10^{-8}	3.4×10^{-7}
282	25	7.3×10^{-9}	1.8×10^{-8}	2.1×10^{-7}
287	25	6.0×10^{-9}	1.6×10^{-8}	2.0×10^{-7}
304	25	6.3×10^{-9}	1.5×10^{-8}	1.7×10^{-7}

We switched back again to ion pump:

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
330.25	25	1.8×10^{-9}	2.2×10^{-9}	8.0×10^{-9}

The spectrum measured after 304 hours from beginning of the test is shown in Fig. 4 and there is a minor organic contamination contribution.

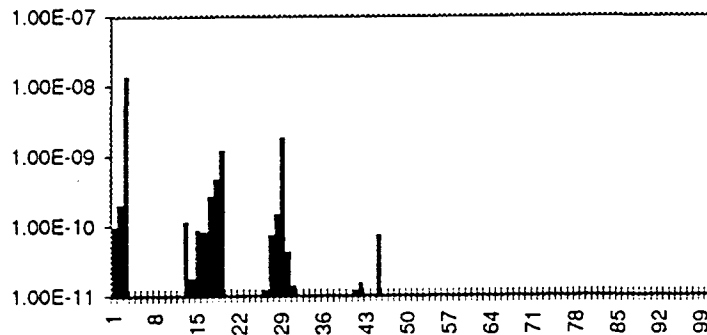


Fig. 4 Outgassing spectrum after vacuum baking at 150 °C

Due to the slow outgassing decreasing during baking we decided to test of the motor was effectively clean by heating it again:

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
334.75	100	2.4×10^{-8}	1.1×10^{-8}	2.6×10^{-7}
335.5	100	1.4×10^{-8}	8.3×10^{-9}	1.1×10^{-7}
401	100	1.7×10^{-7}	9.0×10^{-8}	2.0×10^{-7}

402.5	120	2.9×10^{-8}	2.1×10^{-8}	1.6×10^{-7}
402.75	135	7.5×10^{-8}	2.7×10^{-8}	9.6×10^{-7}
403	150	3.4×10^{-7}	8.8×10^{-8}	5.0×10^{-6}
406.75	150	2.3×10^{-6}	2.8×10^{-7}	4.0×10^{-5}

The spectrum measured at 100 °C is shown in Fig. 5. The organic contamination appeared again.

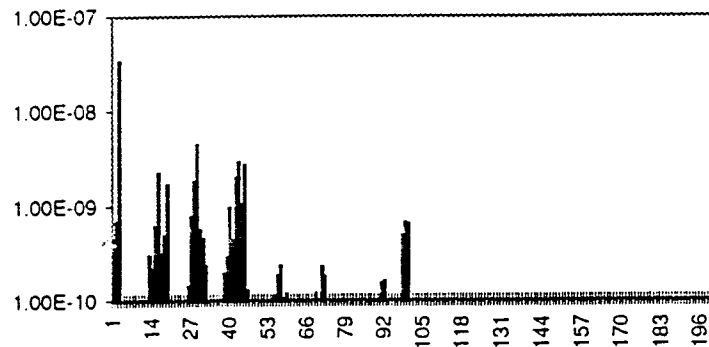


Fig. 5 Outgassing spectrum during new heating at 100 °C

We switched off heating:

t(h)	T(°C)	p ₁ (mbar)	p ₂ (mbar)	Q(mbar l/s)
407	130	2.3×10^{-6}	2.7×10^{-7}	4.1×10^{-5}
407.5	120	2.1×10^{-6}	2.5×10^{-7}	3.7×10^{-5}
408	110	1.7×10^{-6}	2.1×10^{-7}	3.0×10^{-5}
424	15	7.0×10^{-9}	6.6×10^{-9}	8.0×10^{-9}

The spectrum measured after 424 hours is shown in Fig. 6; it is quite similar to the spectrum of Fig. 4.

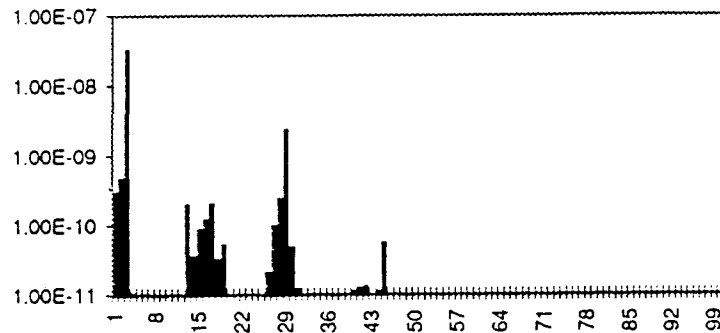


Fig. 6 Outgassing spectrum after the thermal cycles

The outgassing flow evolution is summarized in Fig. 7.

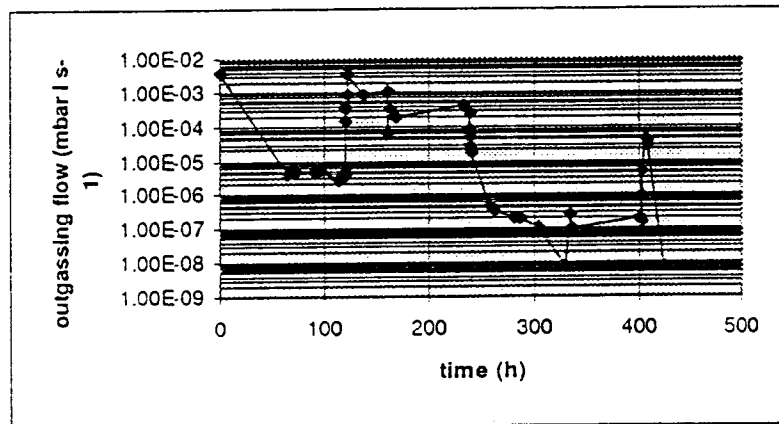


Fig. 7 Time evolution of the outgassing flow

3 - Discussion

The outgassing flow of the motor after vacuum baking at 150 °C was of the order of 10^{-8} mbar l s⁻¹. The outgassing composition showed several organic fragments before and especially during the baking itself. The organic peaks at the lower masses should come from solvents used for cleaning. The peaks at higher masses (around 100) are due to the cabling used for the windings (see notes VIR-TRE-PIS-3400-113 and VIR-TRE-PIS-3400-114). The first baking cycle at 150 °C was not effective to remove the solvents as shown in the second cycle. We suggest to investigate different cleaning procedures and to replace the windings materials.