

CNRS *Centre National de la Recherche Scientifique*  
INFN *Istituto Nazionale di Fisica Nucleare*




OUTGASSING TEST OF COILS WITH  
POLYAMIDE-POLYIMIDE  
INSULATION

Code:  
VIR-TRE-PIS-3400-113

Date: 21/04/1997


L160-T970270-00-D

	Polyamide-polyimide insulation coils	Doc: VIR-TRE-PIS-3400-113 code Issue: 1 Date: 21/04/1997 Page: 3
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### CHANGE RECORD

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

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

 <p>The logo for VIRGO, featuring a stylized representation of a coil or wire above the word "VIRGO" in a bold, sans-serif font.</p>	Polyamide-polyimide insulation coils	Doc: VIR-TRE-PIS-3400-113 code Issue: 1 Date: 21/04/1997 Page: 4
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In this note we briefly report the results obtained on coils made of polyamide-polyimide insulation wires. The measurement method is described in detail in VACPISA 025.

## 1 - System performances

We performed a baking of the test chamber at 250 °C for 66 hours and we got:

t(h)	T(°C)	p <sub>1</sub> (mbar)	p <sub>2</sub> (mbar)	Q(mbar l/s)
after	33	6.3x10 <sup>-9</sup>	1.5x10 <sup>-9</sup>	9.6x10 <sup>-8</sup>

The main components of outgassing after baking were H<sub>2</sub>, H<sub>2</sub>O, N<sub>2</sub>/CO, CO<sub>2</sub>. The internal surface of the chamber is 2500 cm<sup>2</sup>.

## 2 - Measurement of the outgassing flow of the polyamide-polyimide insulation coils

The samples were four coils with polyamide-polyimide insulation (polyvinil acetate+nylon/Kapton coating) wires on a ceramic support, prepared by D.G., Parma, Italy. The exposed surface of cabling was 88 cm<sup>2</sup>. In the following it will be assumed that the contribution of the ceramic part to the outgassing is negligible. The coils were put in the vacuum chamber with the nominal factory cleaning.

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

t(h)	T(°C)	p <sub>1</sub> (mbar)	p <sub>2</sub> (mbar)	Q(mbar l/s)
22.5	25	9.7x10 <sup>-8</sup>	4.0x10 <sup>-8</sup>	1.1x10 <sup>-6</sup>
29.5	25	7.8x10 <sup>-8</sup>	3.4x10 <sup>-8</sup>	8.8x10 <sup>-7</sup>
96	23	1.9x10 <sup>-8</sup>	9.3x10 <sup>-9</sup>	1.9x10 <sup>-7</sup>
101	25	2.3x10 <sup>-8</sup>	1.0x10 <sup>-8</sup>	2.6x10 <sup>-7</sup>
103	25	2.5x10 <sup>-8</sup>	1.0x10 <sup>-8</sup>	3.0x10 <sup>-7</sup>
120.5	23	1.4x10 <sup>-8</sup>	7.5x10 <sup>-9</sup>	1.3x10 <sup>-7</sup>
124.5	23	1.8x10 <sup>-8</sup>	8.3x10 <sup>-9</sup>	1.9x10 <sup>-7</sup>
144.5	33	1.7x10 <sup>-8</sup>	8.1x10 <sup>-9</sup>	1.8x10 <sup>-7</sup>
149	33	1.8x10 <sup>-8</sup>	8.3x10 <sup>-9</sup>	1.9x10 <sup>-7</sup>

The spectrum taken after 149 hours is shown in Fig. 1.

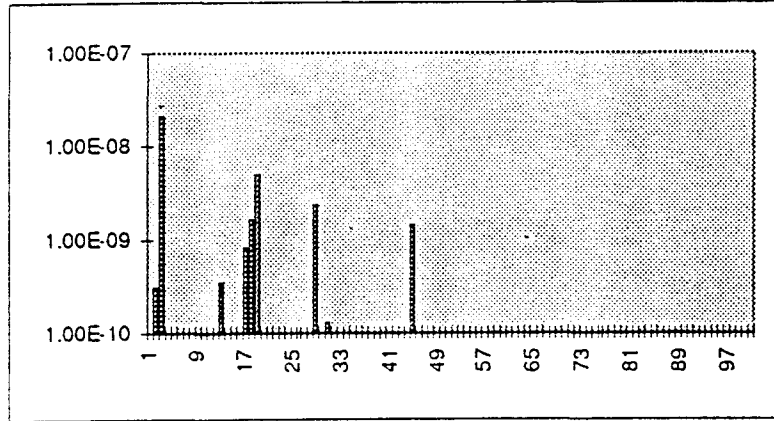


Fig. 1 Outgassing spectrum after 149 hours pumping at room temperature

We set temperature to 50 °C and monitored the evolution of outgassing:

t(h)	T(°C)	p <sub>1</sub> (mbar)	p <sub>2</sub> (mbar)	Q(mbar l/s)
149.75	50	5.5x10 <sup>-7</sup>	1.2x10 <sup>-7</sup>	8.6x10 <sup>-6</sup>
150	50	2.0x10 <sup>-7</sup>	6.3x10 <sup>-8</sup>	2.7x10 <sup>-6</sup>
150.25	50	1.3x10 <sup>-7</sup>	4.8x10 <sup>-8</sup>	1.6x10 <sup>-6</sup>
150.5	50	8.7x10 <sup>-8</sup>	3.6x10 <sup>-8</sup>	1.0x10 <sup>-6</sup>
151	50	5.6x10 <sup>-8</sup>	3.5x10 <sup>-8</sup>	4.2x10 <sup>-7</sup>
174	50	4.9x10 <sup>-8</sup>	1.8x10 <sup>-8</sup>	6.2x10 <sup>-7</sup>
192.5	50	4.5x10 <sup>-8</sup>	1.3x10 <sup>-8</sup>	6.4x10 <sup>-7</sup>
199.5	50	3.6x10 <sup>-8</sup>	1.2x10 <sup>-8</sup>	4.8x10 <sup>-7</sup>
264.5	50	1.7x10 <sup>-8</sup>	7.3x10 <sup>-9</sup>	1.9x10 <sup>-7</sup>
270	50	1.8x10 <sup>-8</sup>	7.4x10 <sup>-9</sup>	2.1x10 <sup>-7</sup>

The spectrum measured after 270 hours is shown in Fig. 2. Some organic fragments (around mass 30 and mass 40) appeared.

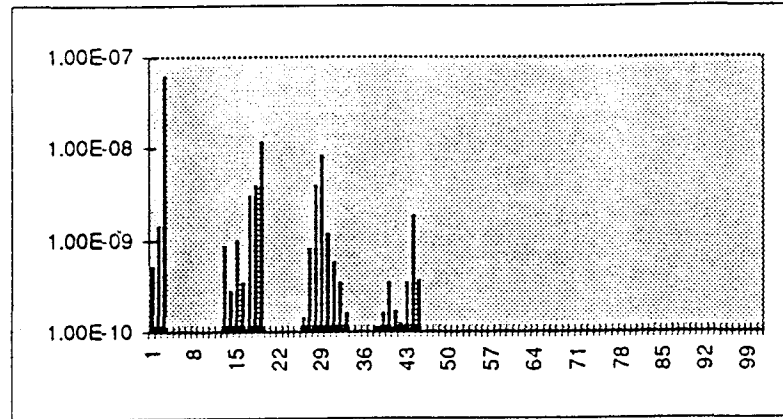


Fig. 2 Outgassing spectrum after 120 hours at 50 °C

We set the temperature at 100 °C and we measured:

t(h)	T(°C)	p <sub>1</sub> (mbar)	p <sub>2</sub> (mbar)	Q(mbar l/s)
270.5	100	3.4x10 <sup>-6</sup>	4.6x10 <sup>-7</sup>	5.9x10 <sup>-6</sup>
271	100	1.5x10 <sup>-6</sup>	2.7x10 <sup>-7</sup>	2.5x10 <sup>-5</sup>
271.25	100	2.6x10 <sup>-6</sup>	4.2x10 <sup>-7</sup>	4.4x10 <sup>-5</sup>
271.5	100	1.8x10 <sup>-6</sup>	3.4x10 <sup>-7</sup>	2.9x10 <sup>-5</sup>
312	100	9.3x10 <sup>-7</sup>	6.7x10 <sup>-8</sup>	5.3x10 <sup>-6</sup>
316.5	100	2.2x10 <sup>-7</sup>	4.8x10 <sup>-8</sup>	3.4x10 <sup>-6</sup>
336	100	2.1x10 <sup>-7</sup>	4.1x10 <sup>-8</sup>	3.4x10 <sup>-6</sup>
342	100	2.2x10 <sup>-7</sup>	4.2x10 <sup>-8</sup>	3.6x10 <sup>-6</sup>

The spectrum measured after 342 hours is shown in Fig. 3. There are some evident peaks at 87, 98, 99 and an increase of the low mass organic fragments around mass 30 and 40.

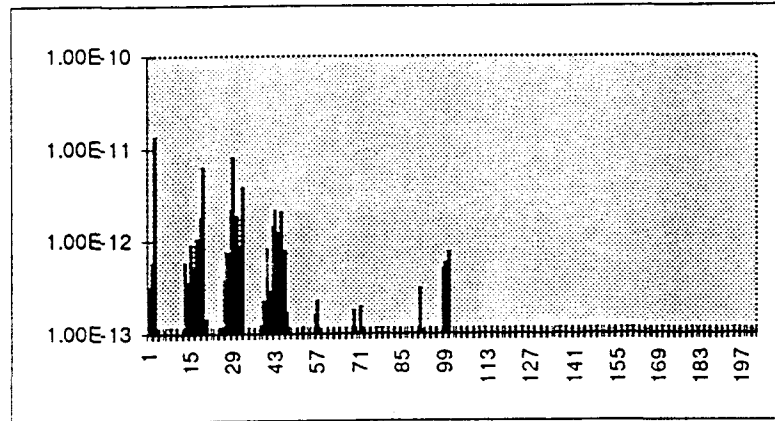


Fig. 3 Outgassing spectrum after 71 hours at 100 °C

We set temperature to 150 °C and we measured:

t(h)	T(°C)	p <sub>1</sub> (mbar)	p <sub>2</sub> (mbar)	Q(mbar l/s)
342.25	150	1.0x10 <sup>-6</sup>	2.0x10 <sup>-7</sup>	1.6x10 <sup>-5</sup>
342.5	150	1.2x10 <sup>-5</sup>	1.9x10 <sup>-6</sup>	2.0x10 <sup>-4</sup>
342.75	150	1.6x10 <sup>-5</sup>	3.5x10 <sup>-6</sup>	2.5x10 <sup>-4</sup>
343	150	1.6x10 <sup>-5</sup>	4.4x10 <sup>-6</sup>	2.3x10 <sup>-4</sup>
343.25	150	1.4x10 <sup>-5</sup>	3.4x10 <sup>-6</sup>	2.1x10 <sup>-4</sup>
343.5	150	1.3x10 <sup>-5</sup>	2.5x10 <sup>-6</sup>	2.1x10 <sup>-4</sup>
343.75	150	1.4x10 <sup>-5</sup>	2.7x10 <sup>-6</sup>	2.3x10 <sup>-4</sup>
344.5	150	1.0x10 <sup>-5</sup>	2.0x10 <sup>-6</sup>	1.6x10 <sup>-4</sup>
360.5	150	1.7x10 <sup>-6</sup>	3.5x10 <sup>-7</sup>	2.7x10 <sup>-5</sup>
384	150	4.7x10 <sup>-7</sup>	8.3x10 <sup>-8</sup>	7.7x10 <sup>-6</sup>
390	150	7.3x10 <sup>-8</sup>	1.8x10 <sup>-8</sup>	1.1x10 <sup>-6</sup>
433.5	150	4.5x10 <sup>-8</sup>	1.1x10 <sup>-8</sup>	6.8x10 <sup>-7</sup>

The spectrum measured after 433.5 hours is shown in Fig. 4. While the contribution of peaks at 87, 98, 99 with respect to the other peaks is reduced, there is still some organic contamination.

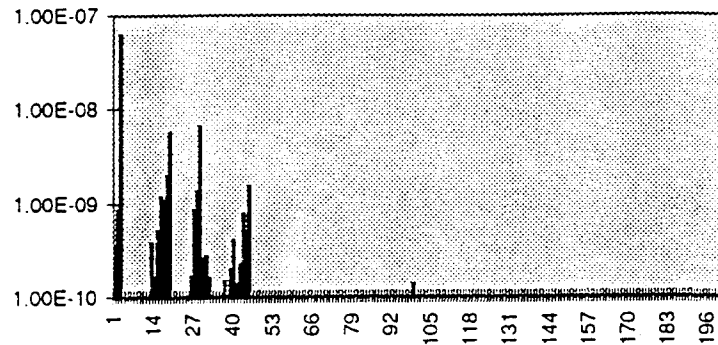


Fig. 4 Outgassing spectrum after 90 hours at 150 °C

We switched off the heating and we measured:

t(h)	T(°C)	p <sub>1</sub> (mbar)	p <sub>2</sub> (mbar)	Q(mbar l/s)
439	40	2.0x10 <sup>-9</sup>	1.8x10 <sup>-9</sup>	4.0x10 <sup>-9</sup>

The spectrum measured at the end of the test is shown in Fig. 5. There are no more organic fragments.

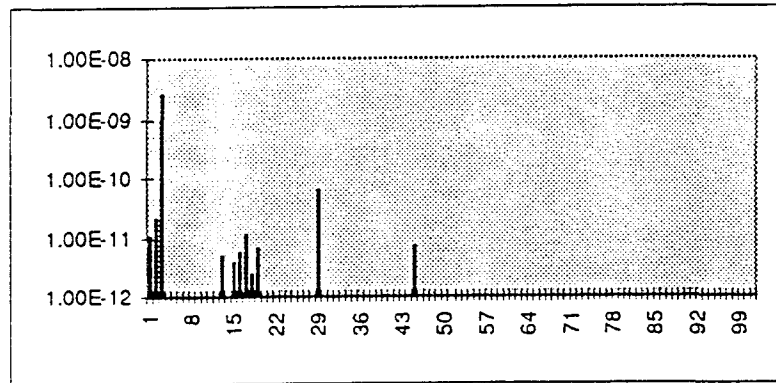


Fig. 5 Outgassing spectrum after vacuum baking at 150 °C

The outgassing flow evolution is summarized in Fig. 6.



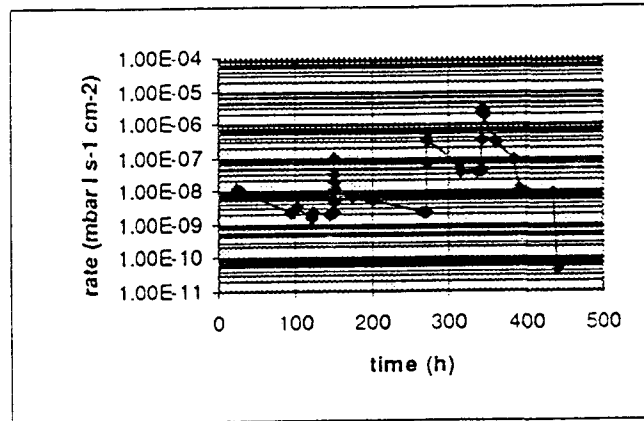


Fig. 6 Time evolution of the outgassing rate

After vacuum baking we tested coils with different currents. There was no sizeable outgassing increase for dissipation up to a few W.

### 3 - Discussion

The outgassing rate of the coils after the thermal cycle was  $\sim 10^{-10}$  mbar l s<sup>-1</sup>cm<sup>2</sup>. We observed an emission of organic fragments strongly increasing with the temperature. The low mass organic fragments should be due to solvents used for cleaning. The other peaks should be due to: polyamide content of the insulation; incomplete polymerization. In no case should this cabling be used in the lower part of the towers and it should not be baked in situ. We suggest to investigate different methods both for cleaning and for insulation preparation.