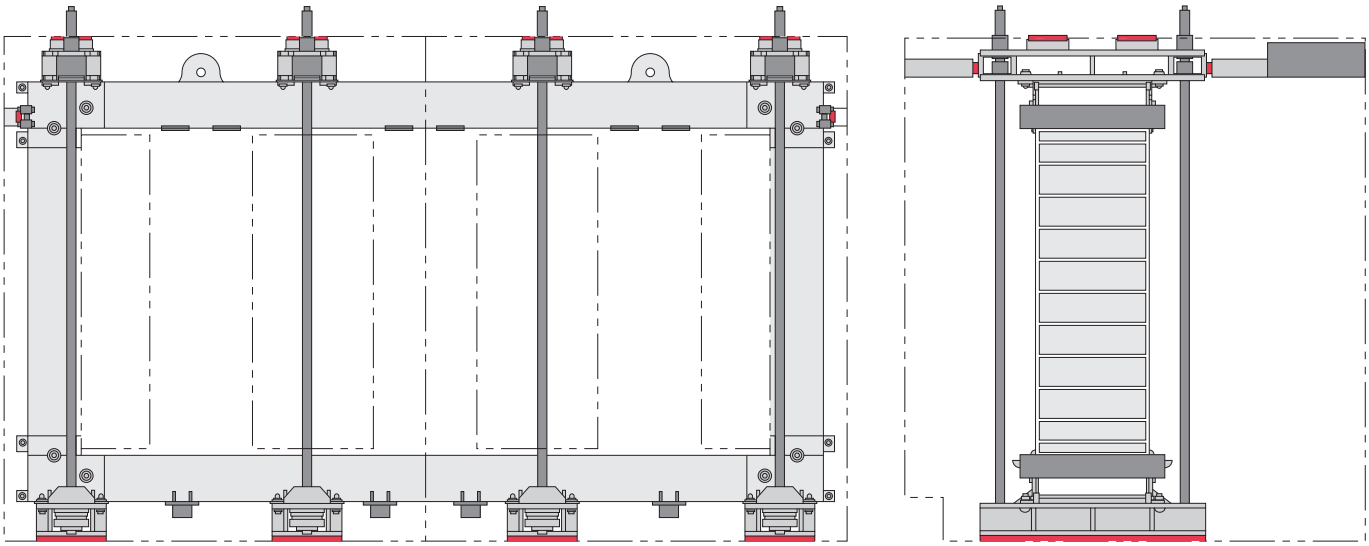
Power Industry

Technical bulletin

VC2100 internal vibration control

AMORIM
CORK
COMPOSITES

Accelerated ageing



Power Transformers are now often installed in close proximity to residential areas, where strict noise level requirements are imposed. The demand for low and ultra-low noise transformers and reactors, has intensified in metropolitan areas around the world.

The main sources of noise radiated by transformers are:
a. The core
b. The windings (and tank)
c. The cooling equipment.

The core sound, primarily consisting of a double power frequency tone and its harmonics, is generally dominant in overall level. However, in some transformers with forced air cooling, the cooling equipment sound can dominate.

A power transformer is the most expensive equipment in an electrical network; during a transformer operation the insulation oil and core mechanical properties are continuously degrading as are components such as vibration control materials. This alteration constitutes an irreversible change.

Amorim Cork Composites has been supplying VC2100 internal vibration control material to the industry for several years, thereby gaining and developing specific knowledge and experience in the application of vibration control materials immersed in oil over the lifetime of the transformer. VC2100 is used by low and ultra low noise transformer manufacturers and recognized as a superior noise abatement product.

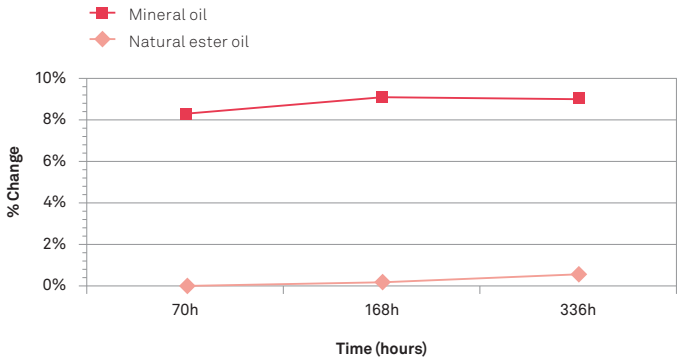
Transformer noise is caused by mechanical movement of the individual lamination of the core under magnetization. The pulsation will cause not only air disturbances, thus producing noise, but also physical vibration of the core structure and everything attached to it.

Amorim VC2100 vibration control material is used as vibration pads placed beneath the core as well as decoupling supports between the core structure and the tank wall or tank cover. VC2100 appropriately applied is able to reduce overall transformer noise by up to 5dB.

Material ageing in oil

Volume change @ 125ºC up to 336h in mineral and ester insulation oil

In the transformer industry, chemical compatibility between the material and the oil is important - to ascertain that there is no significant contamination to the insulation oil, which would reduce its dielectric function in the transformer. From the VC2100 point of view, volume change and hardness/flexibility change are tested to determine whether the fluids (insulation oils) have a negative effect on the polymer life.



Properties change @ 125ºC, 504h in mineral insulation oil

A moderate and stable positive volume change of the VC2100 indicates chemical resistance to the oil, meaning that the material will not experience chemical breakdown due to its immersion in the insulation oil. Hardness of the material (an indicator of the compressibility/Young modulus) is practically unaltered, as well as the flexibility of the material.

Hardness Change [Shore A]	2
Flexibility	3*

*1 flex above original value

VC2100 has been tested at Nynas Labs for oil compatibility as well as at M&I Materials (Midel oil manufacturer), and were considered compatible.

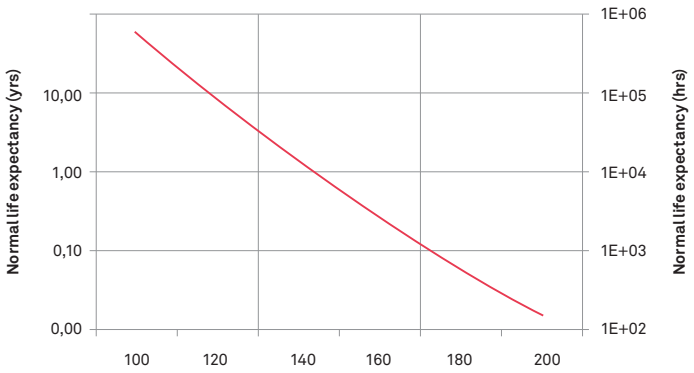
Reports available upon request.

Accelerated ageing testing procedure

Ageing was performed to simulate the performance in the application considering an Arrhenius reaction rate adapted for insulation deterioration of transformers.

The practical use of this finding is to estimate the life of electrical insulation, but it can also be transposed to other materials used in the transformer, to accomplish an accelerated life test.

At 106ºC the average life expectancy (based on statistical values) is calculated at 30 years, following the curve down to an acceptable accelerated testing time required at 160ºC for 2224h (approx. 92 days).



$$\log_{10} \text{life(h)} = -11.269 + \frac{6328.8}{T}$$

Real temperature		$\log_{10}$(h)	Expected life	
106 ºC	379 ºK	5,43	268 956 h	31 yrs
160 ºC	433 ºK	3,35	2 224 h	0,25 yrs
Test temperature		$\log_{10}$(h)	Test time	

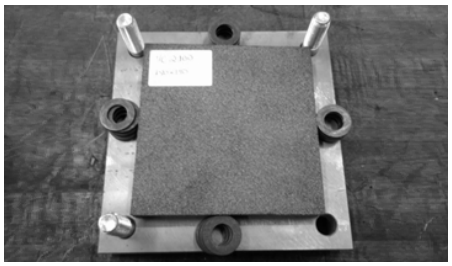
Did you know?

The Arrhenius equation is a simple, but accurate formula for the temperature dependence of the reaction rate constant, and therefore, the rate of a chemical reaction. The equation was first proposed by the Swedish chemist Svante Arrhenius in 1884. Five years later, in 1889, the Dutch chemist J. H. van 't Hoff provided a physical justification and interpretation for it. Currently, it is best seen as an empirical relationship. It can be used to model the temperature-variance of diffusion coefficients, like creep rates, and many other thermally-induced processes/reactions.

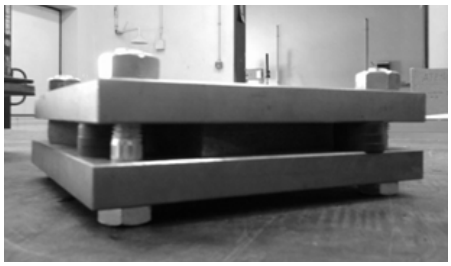

Svante Arrhenius, 1859 – 1927

Accelerated ageing testing assembly and results

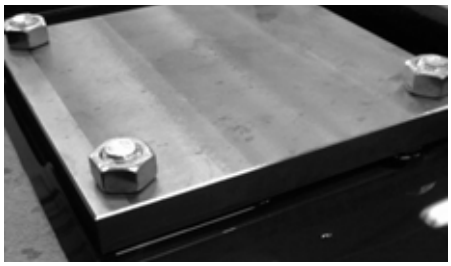
VC2100 pad (20mm thick) was subject to the thermal conditioning immersed in Diala D mineral insulation oil for 93days (2232 hours) @ 160ºC, compressed to 15% of thickness.



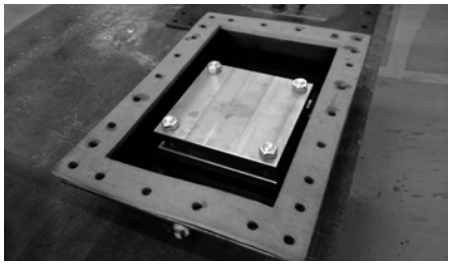
Pad Assembly



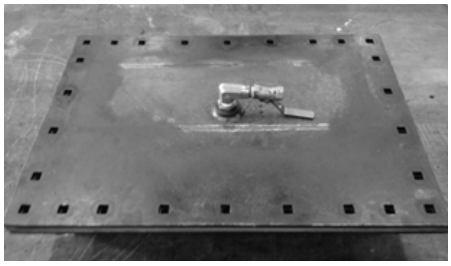
Pad compressed into position



Assembly immersed in mineral insulation oil

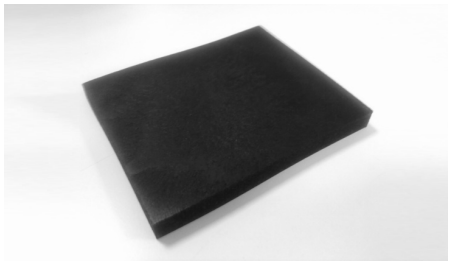


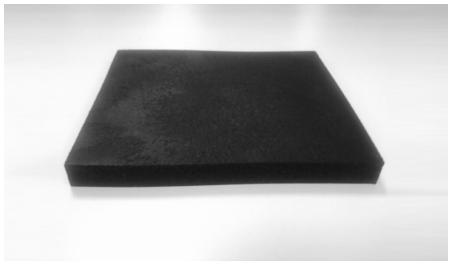
Assembly immersed in mineral insulation oil

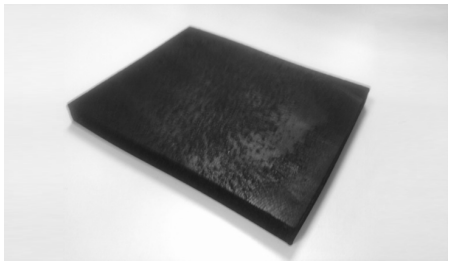


Metal Box sealed and closed, was placed in oven at 160ºC for 93 days

VC2100 vibration control material (20mm thick) after thermal conditioning immersed in Diala D mineral insulation oil







Pad at end of test, after disassembly

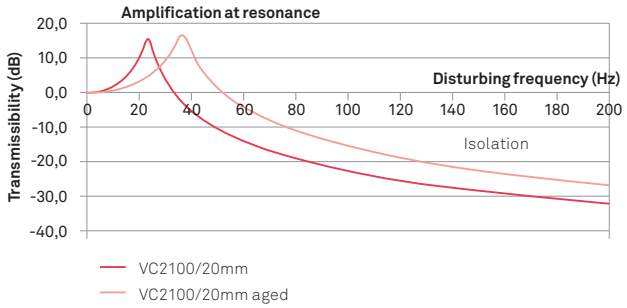
Disassembly showed no deterioration, i.e. no material disaggregating from the pad or stress cracks were observed, showing that it resisted to the load/compression under the chemical and thermal conditions imposed. Oil was visually clean and transparent with a slight yellowish colour.

VC2100 vibration isolation characterization after thermal conditioning

After thermal conditioning, the pad was evaluated for isolation characteristics, namely to determine the new natural frequency after the accelerated ageing test. Comparison of the transmissibility curves of the aged and un-aged VC2100 at 20mm is provided below.

The graph shows an increment in natural frequency for the aged VC2100 which is expectable, taking into account that it was subject to an accelerated ageing test.

Isolation values obtained through dynamic testing of an aged VC2100 pad (after thermal conditioning, representative of 30 years in service under transformer application conditions at 105ºC in mineral insulation oil), reveal that the material continues to exhibit a high isolation performance at the requested frequencies, when compared to the un-aged material.



	Unaged	Aged
Tg δ	0,17	0,15
Pad Natural Frequency – fn [Hz]	23,5 Hz	36,6 Hz
Isolation at 100 Hz [dB]	-22,8 dB	-15,6 dB
Isolation at 100 Hz [%]	92,8 %	83,3 %
Isolation at 120 Hz [dB]	-25,6 dB	-18,9 dB
Isolation at 120 Hz [%]	94,7 %	88,6 %

The VC2100 affords physical, chemical and thermal resistance, and continues to isolate the transformer disturbance frequencies effectively throughout the life of the transformer

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