EuroSciCon

JOINT EVENT

22nd International Conference on

Advanced Materials and Simulation

&

22nd Edition of International Conference on

Nano Engineering & Technology

December 10-12, 2018
Rome, Italy

Andrea Trevisi et al., Nano Res Appl 2018, Volume 4
DOI: 10.21767/2471-9838-C7-027

Vacuum insulation glass finite element analysis of temperature induced stresses and displacements: the Eensulate case study

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Vacuum insulate glass (VIG) are often employed in buildings where exists the necessity of reducing the U-value of the walls, without compromising the amount of sunlight in the inner spaces. The system is mainly made of two glass panes spaced through the presence of several support pillars applied on their surfaces and the insulation performance of this kind of glazing unit are obtained by removing the filling gas between the glasses and by creating the vacuum between them. As consequence, the heat transport due to the presence of the interposed gas is removed but at the same time, the atmospheric pressure and the thermal deformations act on the glass panes by inducing a deflection of the system and stress on its components (pillars, panes and sealing). In Eensulate European Project (HORIZON 2020 research program), an innovative light weight VIG glazing unit has been developed, by employing a low temperature durable edge seal system based on polymeric seal materials instead of glass frit. The aim of this paper is to describe the finite element model of the innovative system, developed to evaluate its behavior during its operative condition, considering the thermal expansion and the effect of vacuum pressure, focusing specifically on the interaction between glass panes and sealant. In particular, the induced deflection, the stress on both components and the strain on the sealant were investigated. In addition, the effects of glass dimension, temperature difference, type of sealant and sealant thickness were analyzed, by evaluating the behavior of VIG as function of the mentioned parameters. Simulations results were useful to optimize the design of the glazing unit and to support the choice of the employed materials.

Recent Publications

1. **P Henshall, P Eames, F Arya, T Hyde, R Moss and S Shire (2016) Constant temperature induced stresses in evacuated enclosures for high performance flat plate solar thermal collectors. Solar Energy 127:250-261.**
2. **Y Fang, T Hyde, F Arya, N Hewitt, R Wang and Y Dai (2015) Enhancing the thermal performance of triple vacuum glazing with low emittance Coatings. Energy and Buildings 97: 186-195.**
3. **Y Fang, T Hyde, F Arya, N Hewitt, P C Eames, B Norton and S Miller (2014) Indium alloy-sealed vacuum glazing development and context. Renewable and Sustainable Energy Reviews 37:480-501.**
4. **Y Fang, T Hyde, F Arya and N Hewitt (2013) A novel building component hybrid vacuum glazing-a modeling and experimental validation. ASHRAE Transactions 119(2):430-442.**
5. **Cioffi M, Di Gennaro F, Zinetti S, Bax L, Boudjabeur S, Bourdeau L, Dankl C, Herrmann E, Jadwiga F, Oakey J, Scalia M and Elvnert J (2012) Cross-ETP research and innovation roadmap for the energy efficiency in building. Steinbeis-Edition ISBN 978-3-943356-37-3.**

Biography

Andrea Trevisi is a Researcher at RINA Consulting S P A where, he is working as a Finite Element Method Analyst since 2017. He has expertise in FEM simulation, dealing with several types of analyses (structural, thermal, vibration and dynamic). Through his Master's degree in Materials Engineering and Nanotechnology, he has in-depth knowledge in composites, metallic materials and polymeric materials, covering main related topics, manufacturing processes and degradation phenomena.

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