







Article

Construction Solutions, Cost and Thermal Behavior of Efficiently Designed Above-Ground Wine-Aging Facilities

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Abstract: The wine industry requires a considerable amount of energy, with an important fraction corresponding to the cooling and ventilation of above-ground aging warehouses. The large investments made in aging facilities can compromise the viability and competitiveness of wineries if their design is not optimized. The objective of this study was to provide guidance for the efficient design of new above-ground warehouses. To this end, multiple construction solutions (structure, envelopes, levels of integration, etc.) were characterized, and their costs and the resulting interior environments were analyzed. The results offer a comprehensive view of potential construction solutions and benchmark price ranges for viable and profitable designs. With a total cost of 300 EUR/m², an average damping of 98% per day can be achieved. Increasing the costs does not imply better effectiveness. A double enclosure with internal insulation—with or without an air chamber—can achieve excellent results. Greater integration as a result of several enclosures being in contact with other rooms and/or the terrain allows for a high effectiveness to be achieved without air conditioning. Perimeter glazing and ventilation holes can reduce the effectiveness of the construction, resulting in greater instability and a lower damping capacity.

Keywords: wine; aging; above-ground warehouse; construction; cost; damping



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1. Introduction

The wine industry is one of the industries that is the most affected by climate change [1], but on the other hand, it contributes significantly to global warming [2], and it can be considered an energy-intensive industry, as it produces approximately 0.3% of the annual global greenhouse gas emissions [3].

Some of these emissions are due to energy consumption in wineries, which is mainly associated with the process used in aging rooms to cool and ventilate warehouses [4]. This is because wine requires very strict environmental conditions for its aging and maturation, which must be maintained throughout many months of the year. Indeed, although an optimal interval has not been established, various authors have pointed out that if the temperature rises above 18–20 °C, the quality of the wine decreases [5–7] and evaporation losses occur [8]. It is also accepted that temperatures below 4–5 °C slow down the aging of wine [9]. Frequent temperature changes are also harmful and may compromise the wine's longevity [7,10]. In addition, ventilation must be promoted to avoid the appearance of