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COMPARISON OF THE ENERGY ABSORPTION OF CLOSED-CELL ALUMINUM FOAM PRODUCED BY VARIOUS FOAMING AGENTS

N. Movahedi[a,1] and S. M. H. Mirbagheri[b]

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This work investigates the effect of two different foaming materials on the energy absorption of closed-cell aluminum structures. For this purpose, two different cellular aluminum samples were prepared by incorporating TiH_2 and $CaCO_3$ as foaming agents into molten A356 aluminum alloy at 700°C. The SEM observation of the foam samples revealed that the cell structure of the foam produced with $CaCO_3$ is comprised of a smaller and more uniform structure than the sample produced with TiH_2. Uniaxial compressive tests were performed on the foam samples to evaluate the mechanical properties of closed-cell aluminum foams. The results indicated that in a 50% strain, the energy absorption of aluminum foam with calcium carbonate is about 100% more than a closed-cell structure, which has been foamed with titanium hydride.

Keywords: closed-cell aluminum foam, foaming agent, cell structure, energy absorption.

Introduction. Aluminum foam (AF) is one of the most important types of cellular metals that can be produced with an open or closed-cell structure. This material has a broad range of applications in a variety of industries such as transportation, building, aerospace, and automotive. Aluminum foams can be produced with powder metallurgy or melting techniques. On an industrial scale, the most promising method for the production of aluminum foam is melting. According to the bubble formation mechanism, there are two methods for the production of closed-cell aluminum foams through melting: air injection [1] or incorporation of foaming agent [2] in powder form to the aluminum melt. In both methods, the aluminum melt would first be thickened by appropriate additives such as SiC_p [3], Al_2O_3 [4] particles, or calcium granules [5]. Then, the foaming process would be completed by the injection of air or the addition of an appropriate foaming agent. Titanium hydride (TiH_2) is the material most frequently used as a foaming agent in the aluminum foam production industry. But there are some important considerations that should be taken into account during the fabrication of aluminum foam with TiH_2, in order to avoid deterioration of the mechanical properties of the resultant foam. For example, Matijasevic and Banhart showed that heat pre-treatment of the TiH_2 powder is necessary to improve cell size distribution [6]. The price of this material is also a controversial topic, which exists among producers of aluminum foam on an industrial scale. And, one of the important factors that influence the final price of closed-cell aluminum foam in the market is related to TiH_2 cost. Other foaming agents, such as $CaCO_3$, have also been applied successfully to produce closed-cell aluminum foams [7]. In this research, two distinct closed-cell aluminum foams are produced with TiH_2 and $CaCO_3$ as foaming agents at the same foaming temperature with a casting method. In spite of availability of studies separately producing closed-cell aluminum foams with these foaming materials, no comparative study to analyze the cellular structures and mechanical properties of relevant foams has been done yet. The main objective of this study is to evaluate and compare the mechanical properties and cellular structures of these foams. This will help to determine, which of these

[a]Department of Materials and Industrial Engineering, Semnan University, Semnan, Iran ([1]Nima.movahedi@gmail.com). [b]Department of Mining and Metallurgical Engineering, Amirkabir University of Technology, Tehran, Iran. Translated from Problemy Prochnosti, No. 3, pp. 128 – 134, May – June, 2016. Original article submitted April 27, 2015.

