

Chapter 5

Recycling of Waste Epoxy–Polyester Powders for Foam Production

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ABSTRACT

This paper proposes a new foaming technology (solid-state foaming) to produce structural foams from waste thermosetting resins. The proposed technology is easy and does not require specific and expensive equipments. Solid tablets are produced by cold compaction of resin powder, and foam by heating in an oven. Composite foams can be produced by mixing fillers and resin powder before the cold compaction. In the experiment, an epoxy-polyester (EP-PE) resin powder, deriving from the waste of a manufacturer of domestic appliances, was used with montmorillonite (MMT) particles. Resulting foams with a filler content ranging from 0 to 10 wt% were characterized in terms of physical and mechanical properties (by compression tests). Although the effect of the MMT content seems to be negative for the adopted resin, the feasibility of producing composite foams by recycling waste industrial powders is shown. The properties of the unfilled foams are sufficient for many industrial applications.

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INTRODUCTION

The modern industrial development must take under consideration the enormous waste of materials and energy in these last years. Even if people have been made aware of the environmental risk connected with the industrial production, there are only few initiatives which allow to reduce the related energy consumption or to extract raw materials from waste. Nowadays the social and political attention on these themes is very strong but the Government agencies do not operate efficiently, and the scientific research is often inadequate. A typical example is given by the management of waste thermosetting resin powders used for coatings as the amount of this waste is considerable. In fact, powder coating is a settled technology thanks to its flexibility and to aesthetics and performances of final coatings. A large waste is generated in the coating chamber due to over-spray: actually the powder should be collected and re-used but, in such applications, the need of producing parts with zero defects makes it impossible, and manufacturers prefer to discard collected powders rather than coated parts. Moreover, large amounts of powders often remain on the chamber walls and are removed only during the ordinary maintenance operations or for color change. In conclusion, the amount of waste thermosetting powders is increasing every year and new technological solutions are necessary to overcome this problem.

The scientific community has proposed several technical solutions to recycle thermosets but generally only structural parts are considered rather than powders. Dealing with bulk thermosets, recycling operations can be divided in two categories: processes that involve mechanical comminution to reduce the size of the scraps; and thermal processes to produce materials and energy from scraps (Pickering, 2006). However, discarded thermosetting powders generally exhibit characteristics similar to fresh powders, and should be recycled exploiting their properties. A

recent study has compared the properties of re-used and recycled polyester resins with fresh and as-received resins in terms of shape, size, particle size distribution, moisture content, density, flowability, fluidity and chargeability (Lothongkum, 2007). The effect of the weight ratio of fresh and re-used polyester resins was analyzed in the case of electrostatic powder coating by measuring the film thickness. It was found that the optimal weight ratio of fresh and re-used polyester resin was 3:1. In order to prevent loss of powder particles in automatic electrostatic coating due to over-spraying, a simulation was proposed to define the relation between the movement of the spray gun and the distance from the conveyor.

Latest studies only deal with the use of waste powders from recycling of fiber reinforced plastics for the production of bulk molding compounds (Hwang & Jeon., 2010), filled concrete (Asokan et al., 2010), cement composites (Asokan et al., 2009), and natural rubber compounds (Ansarifar et al., 2009). Instead, apart from re-using, there is no way to recycle thermosetting resins in spite of their residual properties. In the present study, the authors propose to recycle waste epoxy-polyester (EP-PE) powders by a new foaming technology called "solid-state foaming" (Quadrini & Squeo, 2008), which has been recently developed to foam thermoset materials without using any external agent. The term "solid state foaming" comes from an analogy with some metal foams. In fact, titanium foams can be produced by the expansion of pressurized argon-filled pores within titanium at elevated temperature (Murray et al., 2003). The analogy depends on the fact that a solid tablet foams by heating but the involved physical mechanisms are very different. In particular, for thermosetting powders, this foaming technology is very promising because of its easiness and the absence of special equipments.

Even if porosity in dense engineering materials is often undesirable for load-bearing applications, it is highly beneficial for weight and cost reduction, damping, thermal insulation and specific strength.

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