Chapter 3
Basic Principles for Thermoplastic Parts Finishing With Impulse Thermal Energy Method

Sergiy Plankovskyy
O. M. Beketov National University of Urban Economy in Kharkiv, Ukraine

Olga Shypul
https://orcid.org/0000-0002-1356-5831
National Aerospace University "Kharkiv Aviation Institute", Ukraine

Yevgen Tsegelnyk
https://orcid.org/0000-0003-1261-9890
O. M. Beketov National University of Urban Economy in Kharkiv, Ukraine

Dmytro Brega
National Aerospace University "Kharkiv Aviation Institute", Ukraine

Oleg Tryfonov
National Aerospace University "Kharkiv Aviation Institute", Ukraine

Volodymyr Malashenko
National Aerospace University "Kharkiv Aviation Institute", Ukraine

ABSTRACT

Impulse thermal energy method (ITEM) as modification of the thermal energy method that is successfully used for finishing is considered for application to thermoplastics. The chapter focuses to highlight the basic principles of the thermoplastics treatment by acting heat fluxes inherent to ITEM providing the time-controlled production of combustion species. The properties of thermoplastics and the requirements for their treatment have the greatest impact on processing settings. Thus, the questions of the choice of the preferred fuel mixture, the type of its ignition, and combustion have been studied. By means of numerical situating, the processes of melting and healing of pores during processing are investigated. A method of defining processing settings has been developed, taking into account the limitations on critical temperatures. The promising possibilities of ITEM in relation to the processing of thermoplastics parts obtained by additive technologies are outlined.

DOI: 10.4018/978-1-7998-7864-3.ch003

INTRODUCTION

Due to the wide range of engineering and high-performance plastics (EP and HPP) application, the high demands on the accuracy are placed for thermoplastic parts quality (Drégelyi-Kiss and Horváth, 2018). Such quality indicators as reliability, lifetime, functional characteristics are mainly determined by the quality of surface cleaning and edges finishing. The formation of different contaminants at thermoplastic part production is inevitable and related with inaccurate fitting of the molds contact surfaces, deformations caused by high pressure and temperature, etc. (Muccio, 1991; Kumar and Davim, 2018; Hurina et al., 2020). At machining process, burrs and micro-particles are also inevitably formed (Jain and Jain, 2003; Altan and Altan, 2014; Aksonov et al., 2019; Kovalevsky et al., 2019; Xu et al., 2020; Adeniji et al., 2020). Finishing technologies of the thermoplastic parts, including blasting, ultrasonic vibration processing, mechanical cleaning, cryogenic deflashing, dry ice blasting and many other are widely used (Swavely, 1991; Muccio, 1999; Uhlmann et al., 2010; Woźniak, 2013; Izamshah et al., 2013; Mali et al., 2018). One of the most promising is the Thermal Energy Method (TEM) (Klocke and König, 2007; Lamikiz et al., 2011; Struckmann and Kieser, 2020) and it's variations – Impulse Thermal Energy Method (ITEM) and Impulse Thermal Energy Method with Shock Waves (ITEMSW), which provide the time-controlled production of combustion species and intensification of the heat transfer due to the action of a shock waves in the working chamber correspondingly (Plankovskyy et al., 2021a). They have unique benefits in terms of efficiency and technological capabilities. The technology for parts processing under TEM occurs in a closed chamber by burning the contaminants under the action of heat flows from the gas mixtures combustion

Advantageous features of ITEM and ITEMSW for metal processing are known and discussed in the work Plankovskyy et al. (2021a). By ITEM and ITEMSW it is possible to provide processing under the conditions of shock waves dramatically increases the heat exchange rate between the combustion products and parts, as well as treatment at deflagration combustion mode without shock waves formation. Processing of thermoplastic parts by mentioned methods has essential features. That is why the choice of the most suitable method should be based on an analysis of their capabilities and the part requirements. Apart from this, effective implementation of the processing technology involves several steps. One of the most important of them is defining processing modes, because wrong treatment regime may lead to high heat flux into the part and cause its melting and deformation. At the same time, it should be avoided soot formation and its deposition on the melted surfaces.

BACKGROUND

EP and HPP are commonly used in automotive and aerospace industries due to their low weight, high strength and corrosion resistance (Kumar and Davim, 2018; Nickels, 2019; Kondratiev et al., 2021). There are some trends in use of EP and HPP in the health care industry, numerous electronic gadgets and devices, as well as in the power electronics. For these applications, the most vital properties of thermoplastics are chemical resistance, dimensions stability and low electrical conductivity. An advantage of the thermoplastics is their ability to be recycled by melting without significant loss of their properties.

Typically, injection or compression molding are used for thermoplastics parts production process. For these manufacturing methods, flashes are often formed on casting surfaces, which should be removed during finishing operations. Flashes are formed due to inaccurate fitting of the molds contact surfaces,