CORE
Metadata, citation and similar papers at core.ac.uk
Provided by UMP Institutional Repository

Eur. J. Wood Prod. (2017) 75:203–213
DOI 10.1007/s00107-016-1106-2

CrossMark

ORIGINAL

Optimization of processing parameters of medium density fiberboard using response surface methodology for multiwalled carbon nanotubes as a nanofiller

Anuj Kumar[1,4] · K. V. Sharma[2] · Arun Gupta[3] · Jan Tywoniak[1,4] · Petr Hajek[1,4]

Received: 16 February 2016 / Published online: 19 October 2016
© Springer-Verlag Berlin Heidelberg 2016

Abstract In the present work, medium density fiberboard (MDF) panels were produced using multiwalled carbon nanotubes (MWCNT) reinforced urea formaldehyde resin. Response surface methodology was employed to optimize the relationship between the three variables, viz. pressing time, percentage of UF resin and percentage of MWCNT, used in the fabrication of MDF, and the influence of variables on the internal bonding (IB) and modulus of rupture (MOR) was studied. The optimum conditions based on the IB strength were determined as 8.18 % of UF resin, pressing time of 232 s, and MWCNT of 3.5 %. Similarly, the optimized conditions for MOR are also reported in this paper.

✉ Anuj Kumar
anuj.kumar@fsv.cvut.cz; anuj.saroha@gmail.com

[1] Faculty of Civil Engineering Department of Building Structures, Czech Technical University in Prague, Thákurova 7, 166 29 Praha 6, Czech Republic

[2] Centre for Energy Studies, Department of Mechanical Engineering, JNTUH College of Engineering, Kukatpally, Hyderabad, Telangana 500085, India

[3] Centre for Biocomposite and Innovative Materials, Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang, Tun Abdul Razak Highway, 26300 Gambang, Kuantan, Pahang, Malaysia

[4] University Centre for Energy Efficient Buildings of Technical University in Prague, Třinecká 1024, 273 43 Buštěhrad, Czech Republic

1 Introduction

Medium density fiberboards (MDF) are manufactured from hard- and softwood residuals combined with wax and resin binders to form panels by application of high pressure and temperature (Irle and Barbu 2010). Urea Formaldehyde (UF) resin is used as a binder/adhesive in the manufacture of MDF boards. During service life of MDF, the continuous exposure to moisture or water degrades the cross-linked structure of UF resin, and volatile formaldehyde emission is taking place (Kamoun et al. 2003). Wood fibers have free hydroxyl groups (–OH), which make them reactive towards humidity and moisture (Kumar et al. 2016a, b), and formaldehyde present in cured UF resin is also very reactive towards moisture. According to Hauptmann et al. (2004), formaldehyde is causing cancer to humans. Thus, various studies were conducted to reduce the formaldehyde emission from wood based panels by reducing the formaldehyde/urea (F/U) molar ratio.

Hydrolytic degradation, formaldehyde emission, and stress rupture developed due to humid conditions can be reduced by using di- and tri-functional amines. Hexamethylenediamine (HMDA), Bis-hexamethylene triamine (BHMTA) and poly(propyleneoxidetriamine) (PPOTA) are commonly used to modify the properties of UF resin (Ebewele 1995). The use of melamine in the preparation of wood panels gives better bonding strength, greater resistance to water absorption and lower formaldehyde emission compared to boards made of UF alone. Researchers (Kamoun et al. 2003; Weinstabl et al. 2001; Park and Jeong 2011). Tomita and Hse (1995) reported that the reaction mechanism of melamine modified UF resin and UF resins are similar, and that methylene and methylene-ether bonds are formed during the co-polymerization of urea and