Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 127 (2017) 163–177

Energy Procedia

www.elsevier.com/locate/procedia

International Youth Nuclear Congress 2016, IYNC2016, 24-30 July 2016, Hangzhou, China

Development of Radiation Grafted Super Absorbent Polymers for Agricultural Applications

T.N Fernando[a], S.A Ariadurai[b]*, C. K Disanayaka[c], S Kulathunge[c] and A.G.B Aruggoda[a]

[a]*Department of Agricultural and Plantation Engineering, Faculty of Engineering Technology, The Open University of Sri Lanka, Nawala, Nugegoda, Sri Lanka. (10250)*
[b]*Department of Textile and Apparel Technology, Faculty of Engineering Technology, The Open University of Sri Lanka, Nawala, Nugegoda, Sri Lanka. (10250).*
[c]*Sri Lanka Atomic Energy Board, No 60/460, Baseline Road, Orugodawatta, Wellampitiya, Colombo, Sri Lanka. (10600).*

Abstract

Super Absorbent Polymers (SAPs) were prepared by radiation grafting polymerization of neutralized Acrylic Acid (AA) on to two cellulose samples separately from bagasse, which were extracted from alkaline hydrogen peroxide and microwave assisted alkaline pretreatments in the presence of N.N-methylenebisacrylamide (MBA) as a cross linker using mutual grafting by applying gamma radiation under an environment of nitrogen gas. Characteristics of grafting, morphological and soil degradation of developed SAPs were identified by using Fourier Transform Infra-Red Spectrometer (FT-IR), Scanning Electronic Microscope (SEM) and soil burial method respectively. Additionally, water absorbency in distilled water and prepared fertilizer solutions were measured. Further, different agricultural practices implemented for survival of transplanted seedlings of *Capsicum annuum*, cultivation of *Ipomoea aquatica and* survival of cut *Chrysanthemum instagram* flowers were evaluated. The results indicated that developed SAPs had cross-linked cellulose-g-PAA(Na) and PAA(Na) with water absorbency ratios that were 236-325 in distilled water. Cross-linked cellulose-g-PAA(Na) had highly porous morphological structure, good degradability in soil compared to PAA(Na) and expected to be useful for survival of transplanted seedlings, cut flowers and cultivation of crops under limited supply of water.

Peer-review under responsibility of the organizing committee of IYNC2016

Keywords: Super Absorbent Polymers, Acrylic acid, Cellulose, Mutual grafting, Agricultural applications

* Corresponding author. Tel.: +94777616138; fax: +94112822737.
E-mail address: saari@ou.ac.lk, nilanthifernando45@yahoo.com

1876-6102
Peer-review under responsibility of the organizing committee of IYNC2016
10.1016/j.egypro.2017.08.106

1. Introduction

Grafting can be defined as a polymer modification where a different monomer is attached to an existing polymer through a covalent attachment irreversibly [1]. Grafting is a free radical process, which can be initiated chemically, photo-chemically or by using ionizing radiations. Use of ionization radiations that initiates grafting processes is known as radiation grafting. Ionizing radiation is a type of radiation composed of photons that individually carry enough kinetic energy to liberate an electron from an atom or a molecule with which it interacts, e.g. gamma radiation, X-rays, beta and alpha particles or machine accelerated particles. Radiation grafting has several advantages such as being able to be carried out at room temperature with high efficiency, high purity, being environmental friendly and simple process. This process is a promising technology having several potential applications. It can be performed using three common methods; i) Grafting by simultaneous or mutual irradiation (polymer backbone and monomer are simultaneously irradiated using electron beam or gamma rays in a vacuum or an inert gas environment) ii) Grafting initiated by pre-irradiation in vacuum or inert atmosphere and iii) Grafting initiated by per oxidation (pre-irradiation in air) [2]. Many countries develop radiation grafted materials for industrial applications and environment preservation such as for water purification, fuel cell membrane, energy storage in battery cells and SAPs for agricultural applications. This paper discusses development of radiation grafted SAPs for agricultural applications.

SAPs are highly swollen, hydrophilic polymer networks capable of absorbing large amounts of water or saline solution, practically 10-1000 times of their original weight or volume [3]. In agricultural field, SAPs are mostly used to increase available water in the growth media, which enables the plants to survive longer under water stress and enhanced water holding capacity. Different types of SAPs are widely used in the agricultural field. These are produced as partial neutralization products of cross-linked polyacrylic acids, partial hydrolysis products of starch-acryloniyrile copolymers and polysaccharides & acrylic acid graft copolymers [4]. In Sri Lanka, cellulose is one of the most preferred polysaccharides for producing polysaccharide & acrylic acid graft SAPs.
Cellulose based biomaterials could be used as raw materials for developing SAPs with high biodegradability, having high strength after absorbing water, having less water soluble components, strong water retaining ability and mould proofing ability [5]. Most biomasses such as corn stove, wheat straw, rice straw and bagasse which are referred to as lignocellulosic materials are rich in cellulose fibres. Sugarcane bagasse is the one of those available in Sri Lanka. Raw bagasse consists of 30.2% cellulose, 56.7% hemicelluloses and 13.4% lignin [6].

The present study was focused on synthesis of SAPs (cellulose-g-PAA(Na)) by mutual grafting using gamma radiation under environment of nitrogen gas from cellulose, which was extracted from bagasse and AA in the presence of MBA as a cross linker (Fig. 1). Furthermore, developed SAPs are employed for application in the agricultural field to overcome problems of water scarcity and difficulty of continuous watering.

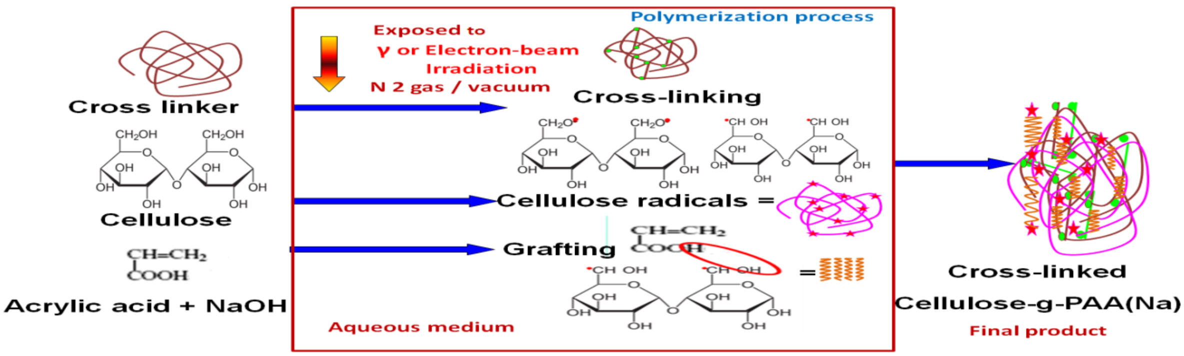

Fig. 1. Protocol of development of cross-linked cellulose-g-PAA(Na) SAP under mutual grating

Nomenclature

-g- Grafted