Preparation of organic polymers for decontamination of surface radioactive contamination

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1. Introduction

Strippable coatings are innovative technologies for decontamination that effectively reduce loose contamination. These coatings are polymer mixtures, such as water-based organic polymers that are applied to a surface by paintbrush, roller or spray applicator [1]. In this study, the core-shell composite polymer for decontamination from the surface contamination was synthesized by the mothod of emulsion polymerization and blends of polymers.

2. Experimental

2.1 Materials

All water was distilled using an automated distillation apparatus. The monomers, styrene (St, Aldrich) and ethyl acrylate (EA, Aldrich) were washed three times with a 5 % sodium hydroxide solution and then three times with distilled water to remove their inhibitors and dried over calcium chloride and stored at 0℃. Ammonium persulfate (APS), sodium dodecyl sulphonate (SDS), polyvinyl alcohol (PVA, 88% hydrolyzed, Mw 89,000-98,000) and polyvinyl pyrrolidone (PVP, Mw 40,000) from Aldrich Co. were used without further purification.

2.2 Preparation of Strippable polymer solution

Before the polymerization was started, water, surfactant and monomer were fed to the reactor; the stirred speed was set at the desired value. In a typical polymerization, the seed was first prepared by emulsion polymerization in a three-necked glass reactor equipped with a condenser, a mechanical stirrer, and a gas inlet to maintain a nitrogen atmosphere. St monomer in distilled water were pre-emulsified in the presence of SDS by stirring at 85℃ for at least 20 min, before addition of APS to start the polymerization reaction. The reaction was maintained at 85℃ for at least 4 h. In the second stage of the reaction, quantitative EA was added into the seed latex emulsion. This mixture was kept under a nitrogen atmosphere and stirred for 5h. The poly(St-EA) polymer latex and PVA and PVP were blended with a mechanical stirrer. The blending was performed 85-90℃, employing a mechanical stirrer speed of 200 rpm. The system was cooled to room temperature and the final polymer was obtained without any post preparative treatments. The ingredients and reaction conditions were shown in Table 1.

Table 1. Ingredients and conditions for the synthesis of PS seed latex and the poly(St-EA)/PVA/PVP composite polymer

	PS seed latex	Poly(St-EA)/PVA/PVP composite particles
St (g)	5	
EA (g)		2.5
Seed latex emulsion (g)		5
DI water (g)	200	250
APS (g)	0.1	0.025
SDS (g)	0.004	
PVA (g)		12.5-37.5
PVP (g)		7.5-37.5

2.3 Determination of DF

The strippable polymer emulsion is composed of poly(St-EA) composite polymer, PVA and PVP. Decontamination factors for strippable coating materials were preformed as follow: Several aluminum disks (1 cm diameter) were prepared by adding contaminant solution (Sr-90). Each contaminated disks were analyzed via Low Background Counting System before being treated

with strippable coating. All coatings were allowed complete dry for 24 h. The coatings were removed from disks, and the disks were again analyzed via Low Background Counting System. Using the count rates before and after decontamination, decontamination factors were calculated using equation 1, where β_1 is the β count before decontamination and β_2 is the β count after decontamination.

$$Decontamination Factors(DF) = \beta_1/\beta_2 \quad (1)$$

2.4 Results and Discussion

The results for these coating are shown in Table 2. The decontamination factors obtained for Sr-90 on the disk plate studies were observed to decrease as the amount of contaminant on the disk increased. This was probably due to a conflict between the time required for the larger amounts of contaminant to permeate into the polymer and the drying time of the coating; in other words, it is likely that the coating dried before the larger amount of Sr-90 was drawn into it. It was shown the DF values of 8.9 to 12.8 at all the polymer composition. Poly(St-EA)-PVA-PVP coating have the ability to contamination for the contaminant.

Table 2. Decontamination factors for the decontamination of Sr-90 contaminated disk using poly(St-EA)-PVA-PVP

Polymeric Composition (wt%)		Initial (Bq/sample)	Final (Bq/sample)	DF
Poly(St-EA)	PVA 5 PVP 3	1138	111	10.3
	PVA 7 PVP 5	1042	107	9.7
	PVA 8 PVP 6	1039	81	12.8
	PVA 9 PVP 7	1187	92.4	12.8
	PVA 10 PVP 8	1169	124	9.4
	PVA 15	1155	129	8.9
	PVP 15	1965	211.7	9.3

3. Conclusions

These studies conclude that surfaces could be effectively decontaminated by the PVA and PVP based strippable polymer method. The products were made up of copolymers (St, EA) and blend polymers (PVA, PVP) with core-shell structure. Upon curing or drying, these coatings form strong films that can easily be peeled or stripped from the surface.

4. Reference

[1] M.A. Ebadian, Susan C. Madaris, Carmen Alicia Aponte, Assessment of strippable coatings for deactivation and decommissioning, U.S. Department of Energy, 1999.