RECLAMATION
Managing Water in the West

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Durable Foul Release Coatings Final Report 2012-2013

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Materials Engineering and Research Laboratory
Denver, Colorado

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Introduction:

The Materials Engineering and Research Laboratory (MERL) staff have been evaluating foul release coatings at Parker Dam since May of 2008. The Parker Dam facility consists of a large forebay area created by a trash rack bridge structure that spans the length of the forebay opening (Figure 1). The current field study tests coatings in quasi static conditions on the upstream face of the dam (red line) and also in flowing conditions downstream of the trashrack structure (yellow line). Several coatings have shown potential in the field testing but questions regarding durability remain. In FY 2012, a new project was initiated to formulate coatings which would exhibit acceptable foul release performance as well as abrasion resistance.

Figure 1: Arial view of Parker Dam field test site

Executive Summary:

The initial scope in 2012 was to make a fluorinated polyurethane elastomer. This was accomplished by using hydroxyl terminated perfluorinated polyethers (PFPE). Several formulations were evaluated in field trials. Unfortunately, mussels attached to the coatings as seen in Figure 2. This approach was abandoned and a new approach using an elastomeric polyurethane with silicone was pursued.

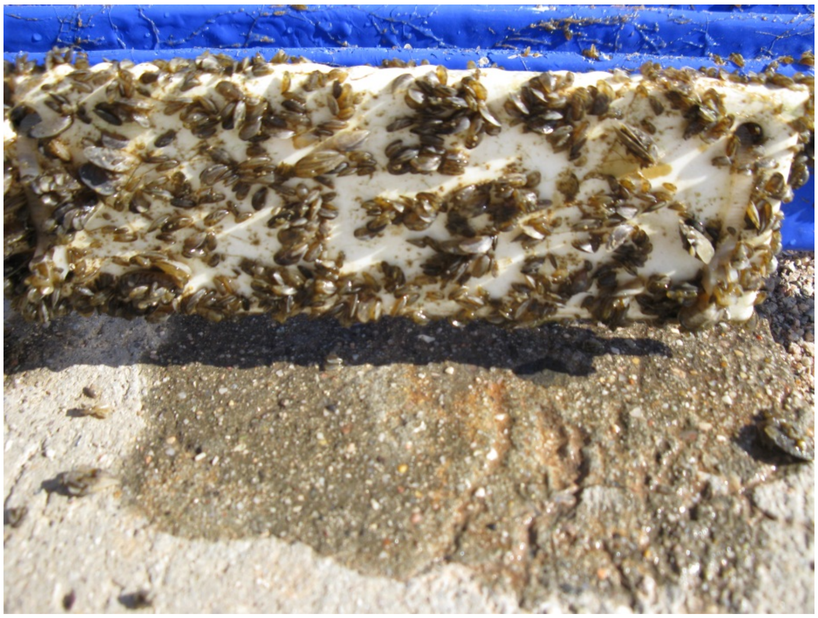

Figure 2. Fluorinated Polyurethane using PFPE

In December 2012 field trials of silicone based polyurethane elastomers were investigated. These formulations did not prevent mussel attachment as seen in Figure 3.

Figure 3. Silicone polyurethane elastomer formulations

Beginning in January 2013 the focus turned toward formulating silicone coatings with increased toughness. The field mussel adhesion results and laboratory ASTM D5618 pseudo-barnacle test results are shown in Table 1. The field test results were not obtained until December 2013. Some formulations prevented mussel attachment, while others heavily fouled. There was some correlation between field results and laboratory results. For example, formulations that prevented attachment have a pseudo-barnacle adhesion less than 0.15 MPa. The formulations had varying molecular weight polydimethyl siloxanes, and co-polymers, pigment loading, and crosslinkers. From the dataset, we are beginning to understand the surfaces that mussels prefer and dislike. This work was supplied as a Report of Invention on March 15, 2013, however a patent application was never filed.

In February 2013 a Cooperative Research and Development Agreement (CRADA) was developed with an industrial partner which terminated this project and a new proposal was developed.

Table 1: 2013 Formulations, high crosslink density silicones, highlighted formulations prevented mussel attachment or were easily released.

Form.	Dynamic Results	Dynamic Max force (lb)	Pseudo Barnacle Adhesion (Mpa)	Field Note
M3	0% mussel fouling	No mussels	0.046	
S2 (Damage)*	No mussels. Edges and zipties are fouled	No mussels	0.087	
M2 (Damage)	No mussels. Zipties are fouled	No mussels	0.129	
MP3	0% mussel fouling	No mussels		
M1*	20% mussel fouling	0	0.115	i
SP2	40% mussel fouling	0.107		p
CP1-Ph (1:1)	50% mussel fouling	0.331		p
S1	50% mussel fouling	0.489	0.227	p
CP1, (S(P60)1Stock	90% mussel fouling	0.531	0.326	p
M(P60)1 Ph (10:1)	50% remove	0.566	0.207	p
SP1	50% mussel fouling	0.635		p
MP2	50% mussel fouling	0.659		p
S(P60)1	70% remove	0.752		p
CP2	90% mussel fouling, leave in for additional testing	0.771		p
MP1	30% mussel fouling	0.89		p
MP 1,2 (3:1) P=60	70% remove	1.043	0.184	p
M(P60)1 T (20:1)	50% mussel fouling	1.151	0.284	p
M(60)1	90% mussel fouling, remove	1.196		p
CP1-Ph (3:1)	90% mussel fouling, leave in test for future comparison to 1:1	1.903		p