2015년도 춘계학술대회 논문집 pp. 179~180

Application of Response Surface Methodology for optimize the Biostimulant ball and stabilize Heavy metals pollutants in contaminated coastal sediments

† *Young-chae Song · Bakthacachallam Subha · Jung Hui Woo**

Department of Environmental Engineering division, Korea Maritime and ocean university, Busan, Korea
**Nuclear Power Equipment Research Center, Korea Maritime and Ocean university, Busan, Korea*

Abstract: The variety of organic and inorganic pollutants are introduced to coastal sediment and making highly contaminated due to rapid development of industralization and economic development. Numerous contaminants are release into marine sediment and it significantly affect marine aquatic environment. In the present study stated the optimize the biostimulant ball (BSB) in coastal sedimentand stabilse the heavy metals present in the sediment. The effective variables like BSB size, distance and month variables on Cu stabilization was determined by using Response surface methodology(RSM). The analysis of variance (ANOVA) and coefficient determination (R2) of Cu reduction 0.9610 and maximum stabilisation was obtained in 3cm ball size and 5.5cm distance and 4 month interval time. This result revealed that the BSB in effective for Cu reduction in coastal sediment.

Key words *:Coastal sediment, Biostimulant ball, Response surface methodology, Cu stabilisation*

1. Introduction

The marine pollution includes a range of threads including from land based sources, heavy metals pollutants (McCook, 1999, Bellwood et al., 2004). Nowadays more 250 effective techniques used to treat contaminated coastal sediment, but there were some disadvantage was occur. Bioremediation is effective one and it enhance the activity of indigenous microganisms. Biostimulant ball(BSB) is an effective considerable attention because of its good efficiency and environmentally friendly nature. The aim of present study is application of RSM for optimization of BSB in contaminated coastal sediment and stabilise heavy metal contamination in marine sediment.

2. Materials and Methods

2.1 Methodology

The sediment was collected from busan Northport and characterized according to standard method (APHA, 1998).(Table 1). A three level factorial design was obtained by Design Expert software 9.0.3. RSM is a statistical tool for exploring relationship between response variable and design variable (Thakur et al., 2009).Central Composite Design (CCD) under RSM was employed with three selected variable like BSB size (X1), BSB distance (X2) and month interval (X3) were selected for analysis of VS. the system explained by second degree quadratic polynomial equation

Parameters	Busan northport
Sand (%)	14.3
Silt (%)	18.6
Clay (%)	67.1
pH (at 25°C)	7.56
COD_{mn} (g/Kg)	28.4
Water content (%)	49
TS (%)	51.33
VS (%)	11.06
AVS(mg S/Kg)	246

$$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_{11}X_1^2 + B_{22}X_2^2 + B_{33}X_3^2 + B_{12}X_1X_2 + B_{13}X_1X_3 + B_{23}X_2X_3$$

where, Y was predicted response, X1,X2,X3 were input variables are coded as -1.682, 0, 1.682 (Table 2)

2.2 Experimental Procedure

For BSB preparation, 1 kg uncontaminated sediment mixed with 0.5M sulfate,1M nitrate and 0.5M acetate and then dried it for room temperature. The BSB size and distance were prepared based on RSM model. After making the BSB and dried it at 60°C for 48 hrs, then the dried ball were coated with polymer solution of polysulfone (10 wt%). equential extraction of heavy metals analysed according to

† Corresponding author: soyc@kmou.ac.kr

Song et al., 2010 and it was measured by ICP-AES..

Table 2. Process variables and levels

Variables	Factors	Levels				
	X	-1.682	-1	0	+1	+1.682
Biostimulant ball size	X_1	1	1.75	3	4.25	5
Biostimulant ball distance	X_2	1	2.8	5.5	8.2	10
Time (month)	X_3	0	1.5	3	4.5	6

3. Results and Discussion

3.1. Fitting second order polynomial equation

Table 3 explained the full factorial design of the experiments and the relationship between actual and predicted value of Y. The interaction of the factor with p value less than 0.05 is considered as significant value of Y (Segurola et al., 1999). the final equation (2) obtained in coded factor of VS

$$pH\ (Y_1)=55.71+0.89X_1+0.36X_2+19.13X_3.\ 4.62X_1^2-5.19X_2^2-2.95X_3^2-5.74X_1X_2\ .1.78X_1X_3\ +1.28\ X_2X_3\ldots\ldots\ldots \quad (2)$$

Table 3. Full factorial design

Run order	Biostimulant ball size (X_1)	Biostimulant ball distance (X_2)	Month (X_3)	Cu reduction (%)	
				Exp value (%)	Pred value (%)
1	3	5.5	3	63.29	63.28
2	4.25	2.8	1	61.63	61.30
3	1.75	2.8	1	51.87	52.29
4	4.25	8.2	3	57.49	56.75
5	3	1	2	56.06	56.33
6	3	5.5	2	63.29	63.28
7	3	10	2	58.14	58.33
8	1.75	8.2	1	63.86	62.51
9	4.25	8.2	1	53.14	54.64
10	3	5.5	2	63.29	63.28
11	3	5.5	2	63.29	63.28
12	4.25	2.8	3	63.58	64.60
13	1	5.5	2	52.71	54.19
14	3	5.5	0	60.35	60.05
15	3	5.5	4	59.65	60.41
16	3	5.5	2	63.29	63.28
17	1.75	2.8	3	52.44	50.61
18	5	5.5	2	60.35	59.33
19	3	5.5	2	63.29	63.28
20	1.75	8.2	3	87.13	95.32

The statistical significance of the ratio of mean square variation due to regression and mean square residual error was tested using ANOVA. the associated p value is used to estimated whether F is large enough to indicate significant. The model R^2 value of 0.9610 and the value are high, high corelation between observed and predicted value. The ANOVA thus proves that form of the model was chosen to explain the relationship between the factor and the response is correct.Figure 1 a, b explained the BSB size has significantly interact with distance which is an evident from the elliptical nature in the 3D image. Figure a, c variables of size and month effect on VS reduction of coastal sediment. the result showed maximum reduction was observed in 3cm ball size, 5.5cm distance with 4month interval. This result revealed that BSB is effect for VS reduction in contaminated coastal sediment.

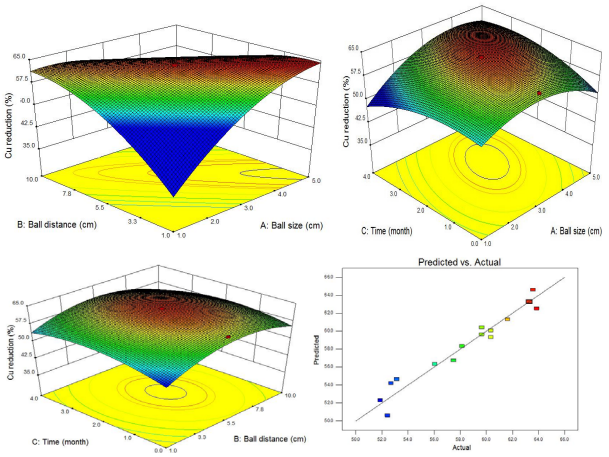

Figure 1. Three dimensional surface plot of VS reduction (a) BSB ball size distance (b) size and month c) distance and month interval. (d) actual and predicted value.

According to the Figure 1, although more than 63% of Cu was remediated by BSB. Moreover, the optimum condition was obtained 3cm size, 5,5 cm distance is effective and long month interval of 4 month is highly influnced for Cu stabilization in marine sediment.

Acknowledgments

This research was a part of the project titled "Development of Sustainable Remediation Technology for Marine Contaminated Sediments" funded by the Ministry of Oceans and Fisheries, Korea

References

[1] McCook, L.J., (1999). “Macroalgae, nutreints and phase shifts on coral reefs: scientific issues and managemnet consequences for the great barrier Reef. Coral Reefs”. 18, pp.357-367.

[2] Bellwood, D.R., Hughes, T.P., Folke, C., Nystrom, M. (2004). Confronting the coral reaf crisis. Nature, 429, pp.827-833.

[3] APHA, American Public Health Association,(1998) WWA, Washington, D.C

[4]Thakur, C., Srivastava, V.C., Mall.I.D., (2009). “Electrochemical treatment of distillery wastewater: Parametric and residue disposal study”. Chem.Eng.J., 148, pp. 496-505.

[5] Segurola, J., Allen, N.S., Edge, M., A.M., (1999). “Design of eutectic photo inhibitor blends for UV/curable acrylated printing inks and coating”, Prog.Org.Coat., 37, pp. 23-37.