An Analysis of the Influential Advantage of Bio Treatment over Mechanical Processing In Conversion of Cr (VI) To Cr (III) In Leather Industry Using Fuzzy Cognitive Maps

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Abstract— *The economy of any nation is determined by the development of its industrial sectors. One of the most vibrant industries is leather industry. The process of it comprises of three stages among which tanning is the core action as it gives glow to the product. But, at the same time the material Chromium used for tanning indeed exploit the environment as it has toxic effects on all the organisms. The discharge of effluents contains Chromium (Cr) VI which is very hazardous; therefore the industries apply certain mechanical filtration process of converting Cr VI to Cr III which is comparatively less harmful than Cr VI. The execution of such mechanical processing is not practically feasible so industries have begun to drift towards bio treatment. In general, the literature of earlier works sketch out many merits of switching from mechanical to bio processing, but the most influencing merit has not yet clearly stated. Therefore this research work is an effort of determining it so as to stimulate it for mitigating the toxicity in a most comprehensive manner. In order to accomplish this task systematically, the mathematical tool, Fuzzy Cognitive Map is used in this paper.*

Keywords— Cr VI, Cr III, Fuzzy Cognitive Maps, Bioremediation.

I. INTRODUCTION

Presently the industrial sectors are marching towards the status of green sectors due to the strict enforcement of the regulations by the government and the social responsibilities they own and leather industry is not an exception to it. This industry contributes to the development of nation as it induce high profit in exports, it is also fulfill its accountability by creating job opening to large number of people. Inspite of these benefits that are obtained from the production run of this industry, the other face of effects are the environmental degradation by the ejection of the effluents which pollutes the water and the land and altogether the sustainability of the environment. Other than these effluents certain heavy metals and metallic ions are also being expulsed after the process of tanning which affects physiological activities of plants such as photosynthesis, gaseous exchange and nutrient absorption and cause reduction in plant growth, dry matter accumulation and yield (Sharma and Agarwal, 2005). It also mortifies the human health and agriculture (Michalak, 2006). Naturally all the living organisms are resistant to such effects, but if the presence of such toxic elements is beyond the bound, then the crucial consequences come into picture.

The most toxic heavy metal Cr (VI) is emitted from tanneries, as this is highly noxious it is converted to Cr (III) using some mechanical processes such as metal plating or electro plating. These processes though effective in conversion are not economic friendly also adding to it demands high investment by all means. By profound analysis these mechanical processes also provokes environmental problems. To overcome these constraints an alternate mechanism has to be practiced. To handle such environmental issues bio treatment or bio processing or bio remediation techniques using micro organisms have to be implemented. If the leather industries replace mechanical processing by bio treatment then a pollution free environment can be developed.

One can wonder what the micro organisms can do better than mechanical processes? The study on this really amazes as these micro organisms has high resistant and tolerance towards the high concentration of heavy metals and it has the ability to relieve the toxicity present in it. The dominant native of bacterial isolate of the environment seems to play

a robust role in converting Cr VI to Cr III. Definitely this bio treatment has many benefits, but the most influencing aspect has to be found so as to encourage it for facilitating in an efficient manner (Cheng *et al*., 2008).

To determine it in a more scientific manner fuzzy cognitive map is used. Cognitive maps are signed digraph used to analyze the effects of alternatives of the casual assertions of an expert pertaining to specific domain introduced by Axelrod in 1976.This has been extended to Fuzzy Cognitive Maps (FCM) by Kosko in 1986 which is a graphical representation consisting of fuzzy sets as nodes denoting the related factors and its relationships by directed graphs in which the edges connecting the nodes represent the effect of one over the another. If the effect is positive then the value 1 is assigned, if the effect is negative the value – 1 is assigned and 0 is assigned for no effect. There are many techniques of FCM among which Induced FCM is very feasible and practically applicable result. Therefore in this paper the most influential merit of bio treatment is analyzed using IFCM.

The paper is organized as follows: Section 2 explains the methodology of IFCM, section 3 discusses the merits of bio treatment over mechanical processing, section 4 confers about the results and section 5 concludes the paper.

II. METHODOLOGY OF IFCM

Even though IFCM is an advancement of FCM it follows the foundation of FCM, it has a slight modification only in Algorithmic approaches. To derive an optimistic solution to the problem with an unsupervised data, the following steps to be followed:

Step 1 For the given model (problem), collect the unsupervised data that is in determinant factors called nodes.

Step 2 According to the expert opinion, draw the directed graph.

Step 3 Obtain the connection matrix, M_1, from the directed graph (FCM). Here the number of rows in the given matrix = number of steps to be performed.

Step 4 Consider the state vector C_1 which is in ON position. Find C_1 □□M_1. The state vector is updated and threshold at each stage.

Step 5 Threshold value is calculated by assigning 1 for the values > 0 and 0 for the values < 1. The symbol → represents the threshold value for the product of the result.

Step 6 Now each component in the C_1 vector is taken separately and product of the given matrix is calculated. The vector which has maximum number of 1‘s is found. The vector with maximum number of 1‘s which occurs first is considered as C_2.

Step 7 When the same threshold value occurs twice. The value considered as the fixed point. The iteration gets terminated.

Step 8 Consider the state vector C_1 by setting C_2 in ON state that is assigning the second component of the vector to be 1 and the rest of the components as 0. proceed the calculations discussed in Steps 4 to 7.

Step 9 Continue Step 8 for all the state vectors and find hidden pattern.

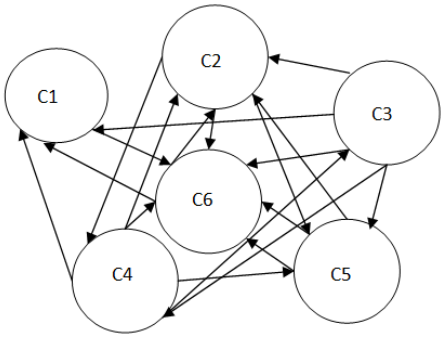
III. IMPLEMENTATION OF IFCM TO DETERMINE THE INFLUENTIAL EFFECT OF BIO TREATMENT

Using the study of earlier works and the expert’s opinion, the following six concepts (factors) as {C1, C2, C3, C4, C5, C6} were taken for this study. The following factors are taken as the main nodes for our studies:

C1 : Cost effective
C2: Environmental friendly
C3: No secondary pollution
C4: Reduction of toxicity level
C5: Remedial to environmental regulations
C6: Enhances the reliability and profitability of the Industry.

These concepts represent the advantages of bio processing in various dimensions such as capital investment, environmental sustainability and social responsibility.

Based on the Expert’s opinion, the directed diagraph is drawn as follows :



The connection matrix is as follows

M =

	C1	C2	C3	C4	C5	C6
C1	0	0	0	0	0	1
C2	0	0	0	1	1	1
C3	1	1	0	1	1	1
C4	1	1	1	0	1	1
C5	0	1	0	0	0	1
C6	1	1	0	0	1	0

Let us consider the Second concept C2 in on position (01000) and apply the steps to it, by repeating the same to all the concepts we get the implications as follows:

S.No	ON POSITION OF CONCEPT	Fixed Point
1.	C1(100000)	C4=C5
2.	C2(010000)	C2=C3
3.	C3(001000)	C2=C3
4.	C4(000100)	C2=C3
5.	C5(000010)	C2=C3
6.	C6(000001)	C2=C3

C1 = (010000)
C1*M = (000111) = C1'
The separate vectors of C2' are as follows
C1'*M = (000100) = 111011 = C2
C1'*M = (000010) = 010001
C1'*M= (000001)= 110010
C2*M = (2 3 0 2 3 4) → (110111) = C2'
C2'*M =(100000) = (000001)
C2'*M = (010000) = (000111)
C2'*M = (000100)=(111011) = C3
C2'*M =(000010) =(010001)
C2'*M =(000001)=(110010)
C2=C3

IV. RESULTS

From the above table it is very evident that the concept C2 (Environmental friendly) and C3 (No secondary pollution) seems to be the most advantageous of employing bio treatment over mechanical processing. The inference of this result clearly supports the drift towards bio processing. If C2 and C3 are stimulated then it altogether influences all other concepts.

V. CONCLUSION

This research work is an integration of Life science and Mathematical science. In this paper a systematic analysis of the most influential merits has made. This work has indeed a great scope as it duly insists the need of bio processing. In all other works related to it only theoretically many aspects were stated regarding to this and of course it is validated with the data related to the sample, but in this work it has been proved specifically by globalizing the perspectives integrated to it.

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