Modeling and Evaluation of Queuing Systems Use of Artificial Neural Net work for Estimation of the Dissolved of Rutile Ore.

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Abstract

This paper use artificial neural net work for state the fractional of dissolution rutile ore (TiO2) with different condition (Reaction temperature and acid concentration ,HCl) at different leaching time ,tow neural net wok was proposed each one contain 20 samples (in put data) for training the net work then 5 samples use to test the net work after training at different condition .

The results show the net work NO.1 give perfect estimation ,but the network No.2 was failed to estimate the result ,also correlation factor is the most important factor in ANN(Artificial Neural Net work) to give estimation for matching between experimental and target data.

Key word: Artificial Neural Net work, rutile ore ,leaching metallurgy .

الخلاصة

تهدف الدراسة الحالية إلى استخدام الشبكات العصبية لغرض تحديد إذابة خام الروتايل (ثنائي وكسيد التيتانيوم) بظروف مختلفة من درجة حرارة وتركيز حامض الهيدروكلوريك عند أزمان نض مختلفة , تم تحضير شبكتان عصبيتان كل واحدة تحتوي على 20 مدخل لغرض تدريب الشبكة ثم استخدام 5 نماذج لغرض اختبار الشبكة عند ظروف مختلفة .

ومن النتائج تبين أن الشبكة الأولى التي درست تأثير تركيز حامض الهيدروكلوريك كانت مثالية في تخمين النتائج أما الشبكة التي درست درجة حرارة التفاعل فقط أخفقت في الاختبار , وكذلك بينت الدراسة أن معامل الارتباط مهم جدا" في تدريب واختبار الشبكات العصبية لكي يتم استخدامها مستقبلا بظروف مقاربة للدراسة .

Introduction

Rutile is a mineral composed of titanium dioxide, TiO_2 and one of three distinct titanium dioxide polymorphs ; ruble, anatase and brookite .Natural rutile may contain up to 10% iron and significant amount of niobium and tantalum ,it has among the highest refractive indices of any known minerals and also exhibits high dispersion ,these properties have led to several industrial applications ,especially in the manufacture of refractory ceramics ,pigment and titanium metal [1].

A variety of problem such as high energy cost , shortage of high grade ore, processing of low and complex ores and exploitation of smaller deposits have prompted the development of low temperature hydro metallurgical process for the extraction of base metals from their ores and concentrates .The conventional hydro metallurgical process for the extraction of a base metal from a named ore concentrate consist of a catalytic sulphating ,roasting ,leaching of the metallic vales ,solvent extraction and selective stripping [2] .

Chloride system in hydrometallurgy has been used for the treatment and recovery of precious metals for a number of years, the leaching of minerals including rutile is the most important method in extraction metallurgy [3]

Titanium dioxide is an important inorganic chemical material, especially the best – quality white pigment; titanium dioxide also has a high potential application in environmental purification, gas sensor and in photovolativ cell due to its unique characteristics [4].

Instead of developing analytical or empirical models, use of artificial neural networks (ANN) were proposed as a third option a long time ago and have been used for many applications from speech recognition to classification of military targets [5,6]. Among the different ANN algorithms, back propagation (BP) type ANN is the most commonly used. Genetic algorithm (GA) was developed by mimicking the natural evaluation process. Although the GA is slow, many researchers prefer this approach since it can optimize large number of parameters; it may effectively use multiple processors, and convergence probability to local minimums is very low ANNs may be classified as supervised or unsupervised depending on the learning process. The best known ANN algorithm is BP. Neurons are generally located on three layers. The number of the neurons at the first and the last layer are equal to the inputs and outputs of the ANN. The user determines the number of neurons at the intermediate layer (hidden layer) with trial and error.

In most of the BP applications, each neuron is connected to all the neurons of the following layer. Each neuron has a weight and nonlinear component to let it make the yes/no decisions. The supervised neural networks such as BP require training before it is used for mapping or classification purposes. During the training, BP calculates the weights of the ANN to represent the relationship between the inputs and outputs. Unsupervised neural networks may start classifying the inputs without a separate training session; however, they may not be used for mapping purposes. BP is a perfect fit for modeling applications as long as there are no excessive amounts of abrupt changes in the characteristics of the input–output relationship of the system. User selects the number of the input and output nodes by considering the system. The number of the hidden nodes is selected either by experience or the best one is chosen after several models are fitted by considering the [7,8].

Yongjie Zhang and et al study the novel preparation of titanium dioxide from titanium slag their work state , a new process for the production of titanium dioxide from titanium slag. Based on the principles of cleaner production, the new technology can serve as a moderate process with the recycling of alkaline and acid solution [9] .

Ernest Alan , use leaching treated process for ilmenite with hot hydrochloric acid under pressure. atmospheric-pressure hydrochloric acid leaching process, which has been successfully operated at pilot-plant scale on a wide range of ilmenite types, including some from the Murray Basin. In every case it has been possible to make a low-chrome, high-grade synthetic rutile of 95% TiO ,content or higher. When this leaching system is coupled with Austpac's proprietary Enhanced Roasting and Magnetic Separation (the “ERMS” Process) short leaching cycles are possible without the need for the aggressive conditions and high capital cost associated with pressure leaching [10].

P.S.Mukherjes and et al study the leach ability of TiO2 rich slag produce from melt separation of the metalized ilmenite their works observe that apart from acid concentration and duration of leaching, ,leach ability also depended on thermal plasma parameters ,heat treatment of slag and additives [11].

David liu and et al use Artificial neural networks for optimization of gold-bearing slime ,the neural network model for estimating the gold contents with different slag compositions is presented. On the basis of the neural network model, an algorithm for searching the optimum flux compounding in the gold-slime smelting process is proposed, and the optimum flux compositions are obtained accordingly [12].

V. K. Kalyani and et al study of a laboratory scale- froth flotation process using artificial neural net work A three-layer feed-forward artificial neural network (ANN) model, trained using the error back propagation algorithm, has been established to simulate the froth flotation process for the beneficiation of coal fines. The network model validates the experimentally observed qualitative and quantitative trends. The optimal model parameters in terms of network weights have been estimated and can be used to compute the parameters of the coal flotation process over wide-ranging experimental conditions [13].

T.sarac and R.u.lujic , study the applying of artificial neural net work in maintains planning of metallurgical equipment ,the paper used a few different neural net work algorithm used for different predication problems and review of achieved results [14].

The Proposed Neural Network Model

The main object of this research is to develop a network model for modeling the fraction of rutile ore dissolved with leaching time per min. at different (HCL) acid concentration from 0.5 to 8 mole , also another network fraction of retile ore dissolved with leaching time at different temperature from 28 ^{0}C To 80 ^{0}C .The ANN –base model of dissolution of rutile ore is presented in figure(1) ,the flow chart of dissolution of rutile ore also is presented in figure (2) .

Experimental Work

Experimental data was collected during the 100 ml of solution of predetermined polarity was charged in to the reactor and heated to required temperature 55 °C, there after 1.0g of rutile was added to reactor and the content were well agitated , the concentration of HCL which give the maximum dissolution 4mole was subsequently used for optimizing of the other leaching parameter. Table (1) explain the experimental parameter [15] used in the model

Table (1) data for network parameters

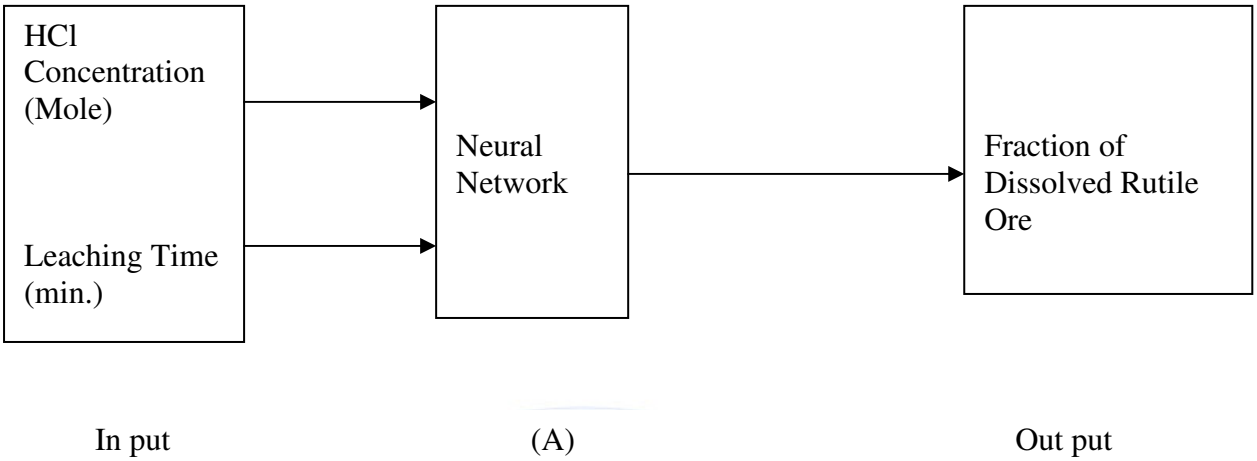
Leaching time min	HCl concentration mole	Temperature ^{o}C
20	0.5	28
40	1	40
60	2	60
80	4	70
120	8	80

Table (2-a) network training samples

Network No.	HCl concentration mole	Leaching time min
1	0.5	5
1	1	10
1	2	30
1	4	60
1	8	120

Table (2-b) network training samples

Network No.	Temperature ^{o}C	Leaching time min
2	28	5
2	40	10
2	60	30
2	70	60
2	80	120



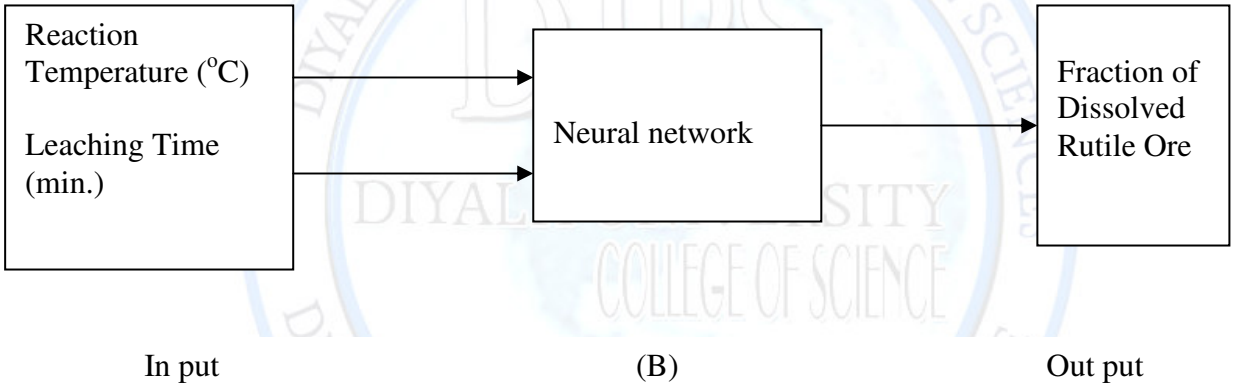


Fig. No.1 Neural Network Model .

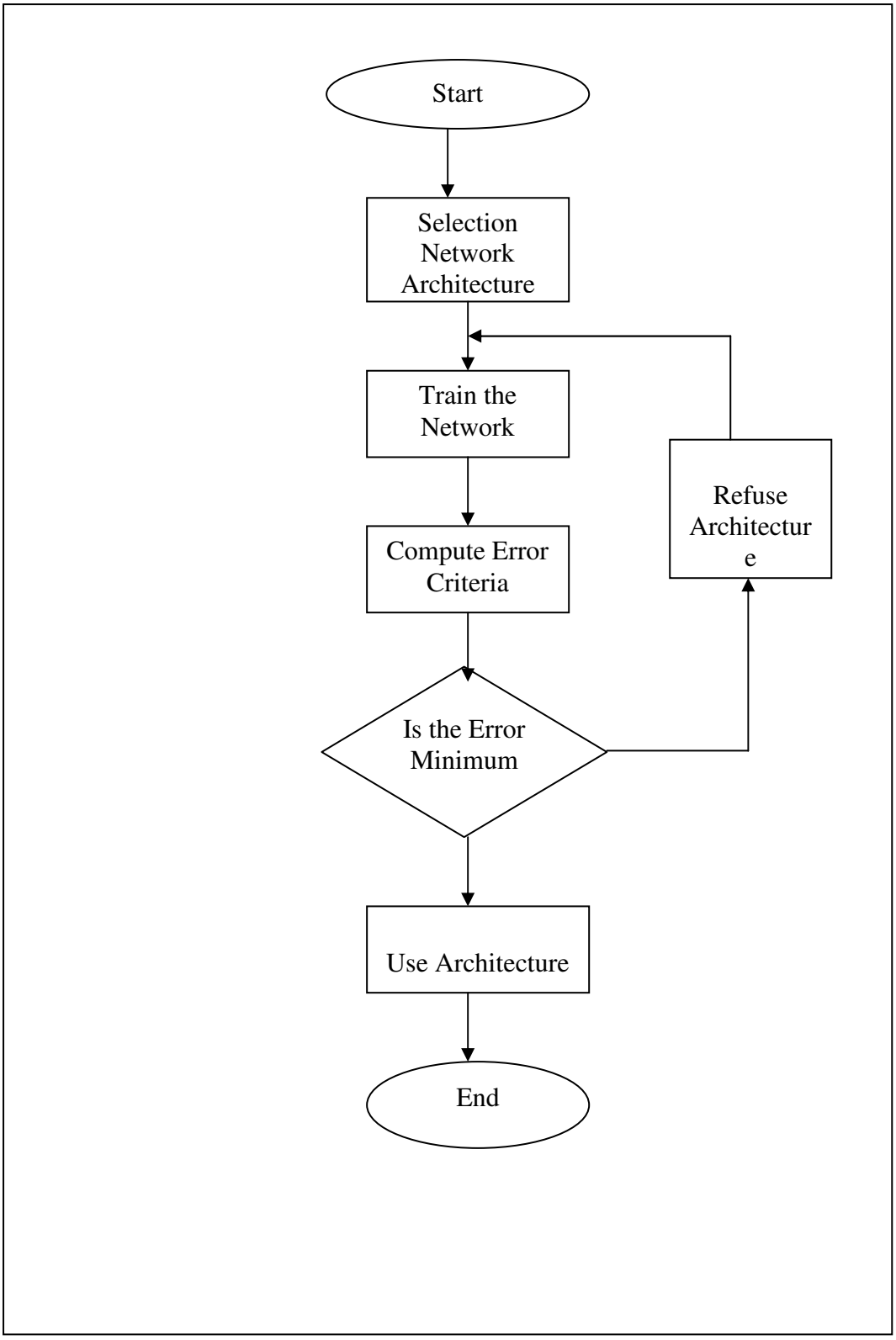


Fig. No.2 Algorithm Flow Chart for Proposed ANN

Result and Discussion .

Matlab(2006b)based computer program ,was developed to train the network using training algorithm the algorithm is based on the idea of iteratively removing single weight and biases with a view to maintain the original input – output behavior [16] .

After pruning accomplished, a network with 20 in put for each network and biases have been obtained as illustrated in table (1) which represented the network parameters .

For network No.1 the results showing Fig.(3) explained the training network process the relationship between the mean square error and number of training epochs samples the results show the error decrease from ($10^{-1)}$ then stay constant at (10^{-3}) .

Figure (4) explain the relationship between number of samples and the fractional of rutile dissolved the result explain the matching experimental data and the results of training data target get from ANN .the correlation factors (R) is equal (0.994) and the relationship between the ANN and experimental data (target) is linear relationship is showing in Fig.(6). Fig.(5) explain the test pattern after training the network five samples with different conditions are showed in table (2-a) .

The results shows perfect training condition R=0.994 and linear relationship between target(experimental data) and the out put of ANN the results showed in figure(7).
In the experimental the effect of HCl concentration (0.5- 8.06 mole) on the dissolution of 1 g/L ore was investigation at 55^{o}C the fraction of the ore dissolved as function of leaching time for different HCl concentration is presented in figure (4) the maximum percentage dissolved did not vary appreciable when HCL concentration was doubled from 4 to 8 mole.

For network No.2 the result showing in figure(8) .explain the training network process the relationship between the mean square error and number of truing epochs samples the result show the error decrease from (10^{-1}) then stay constant over (10^{-3}) ,also the relationship between number of samples and fraction of dissolved rutile ,the result give

perfect estimation but when training the network and use five samples from different condition table (2-b)) ,the result shows miss matching and R factor will be not approach from 1 ,so the network was failed to estimations the experiment result, the result were been showed in fig(9,10,11and12) respectively .

In the experimental the effect of temperature on dissolution 10 g/L rutile ore in 4mole HCl solution in the 28 -80 ^{o}C temperature range was investigated. From the result in Fig (9) it can be observed that increasing the temperature is combined with increase in the dissolution rate at 80^{o}C . At about 82.37 % of the rutile ore was dissolved within 120 min. However, test at higher temperature that's being less suitable due to increase loss of HCl vapor [16].

Conclusion

1- ANN is very important method to decrease experiment work and test in same conditions with different factor value, and may be used for searching the optimal operating condition in future work.
2- Network No.1 give perfect estimation with R= 0.994 for test training samples.
3- Network No.2 was filed to estimate the results because of (R) factor will not be approach to 1, so net work not suitable to estimate the experimental work in future.
4- The most important factor in ANN is matching between training data and experimental test in training the network the correlation factor is the most important factor is estimation the result and use the network in future work in same conditions.

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Fig .No.3 The training error in net work process.

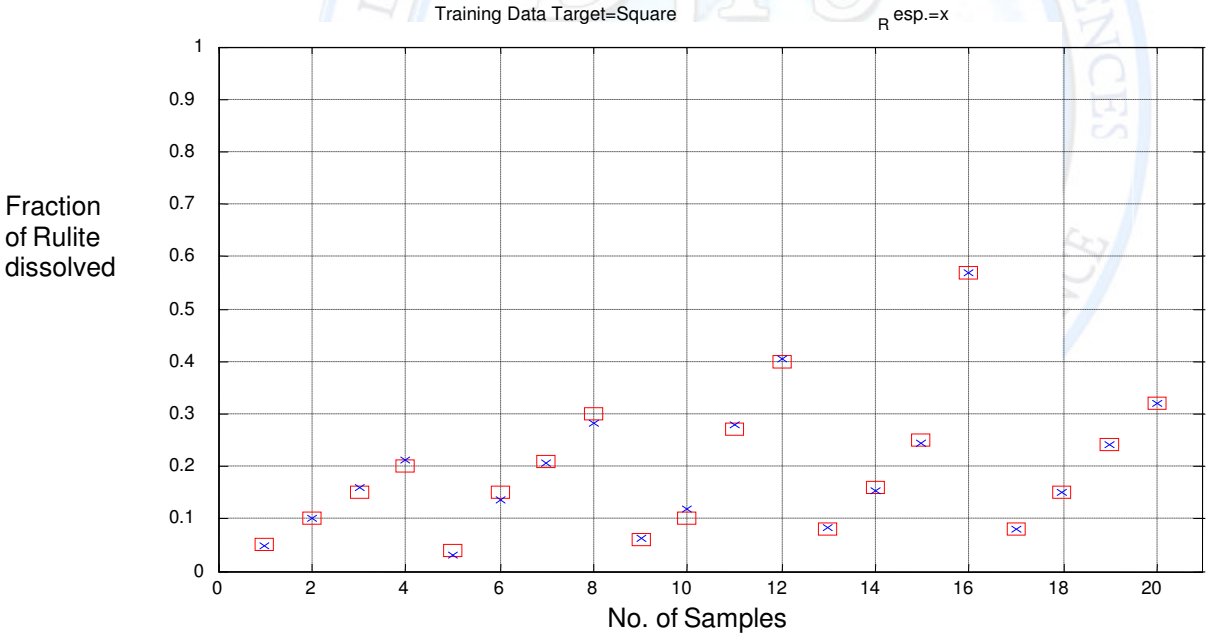

Fig .No.4 comparison of the estimation of ANN with experimental results .

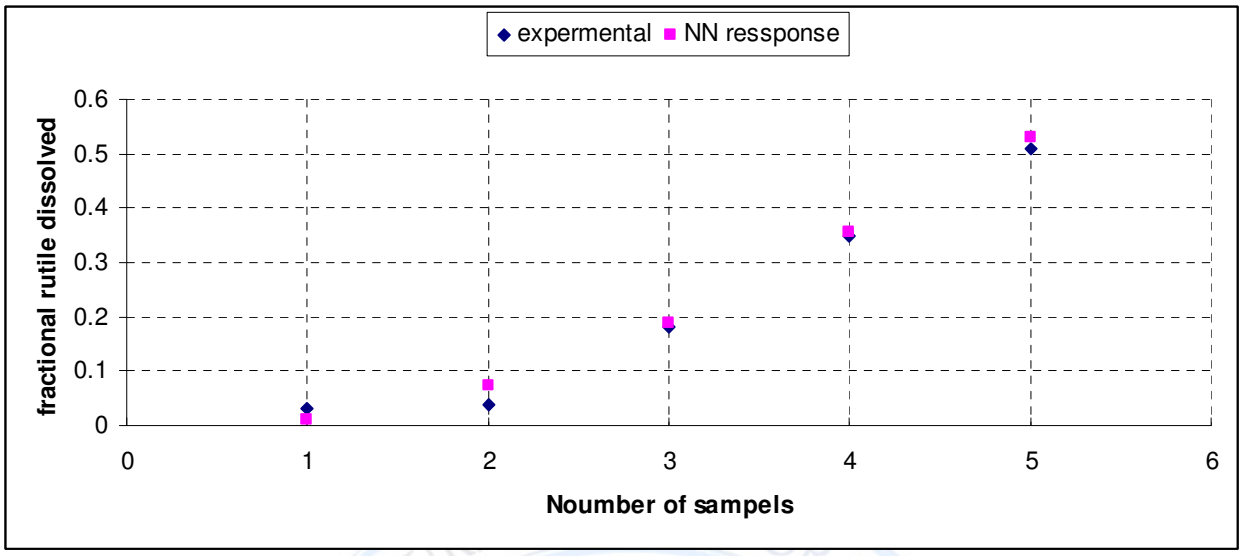

Fig .No.5. Explain test pattern after training comparison of the estimation of the ANN and experimental data

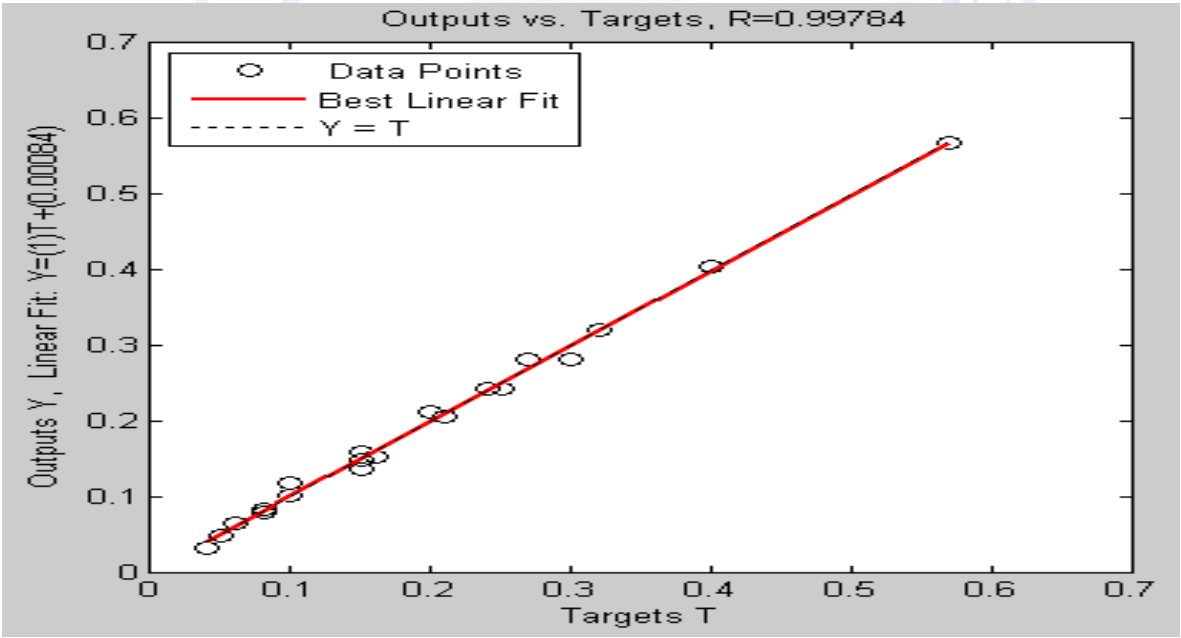

Fig .No.6. Best fit line between the experimental data and ANN for training network.

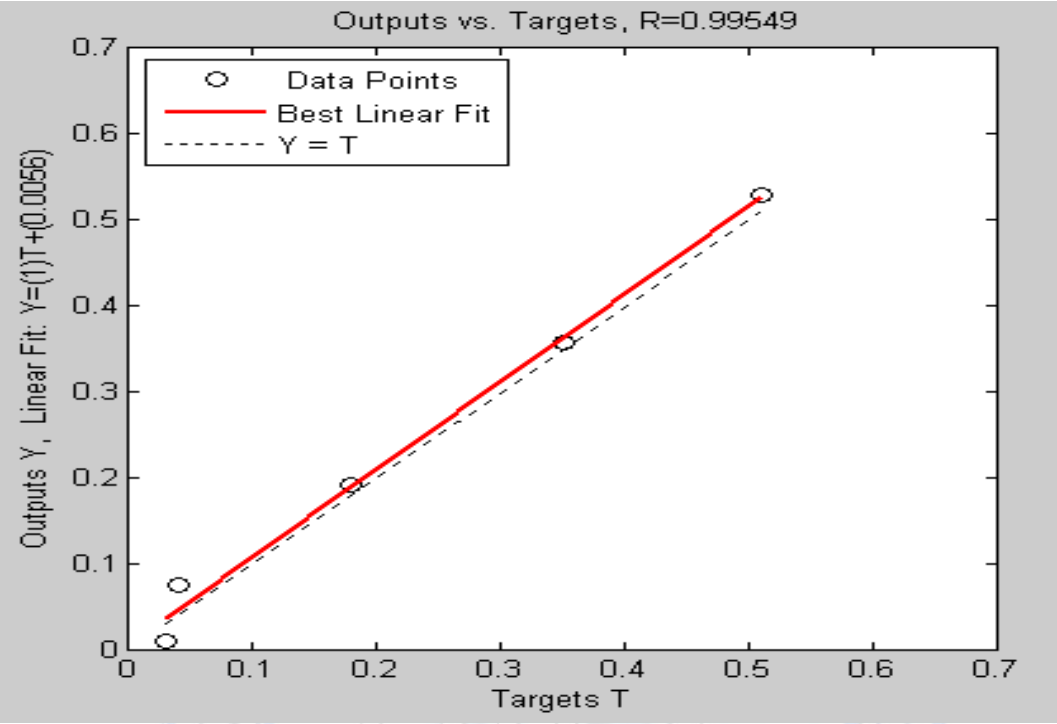

Fig .No.7. Best fit line for training samples.

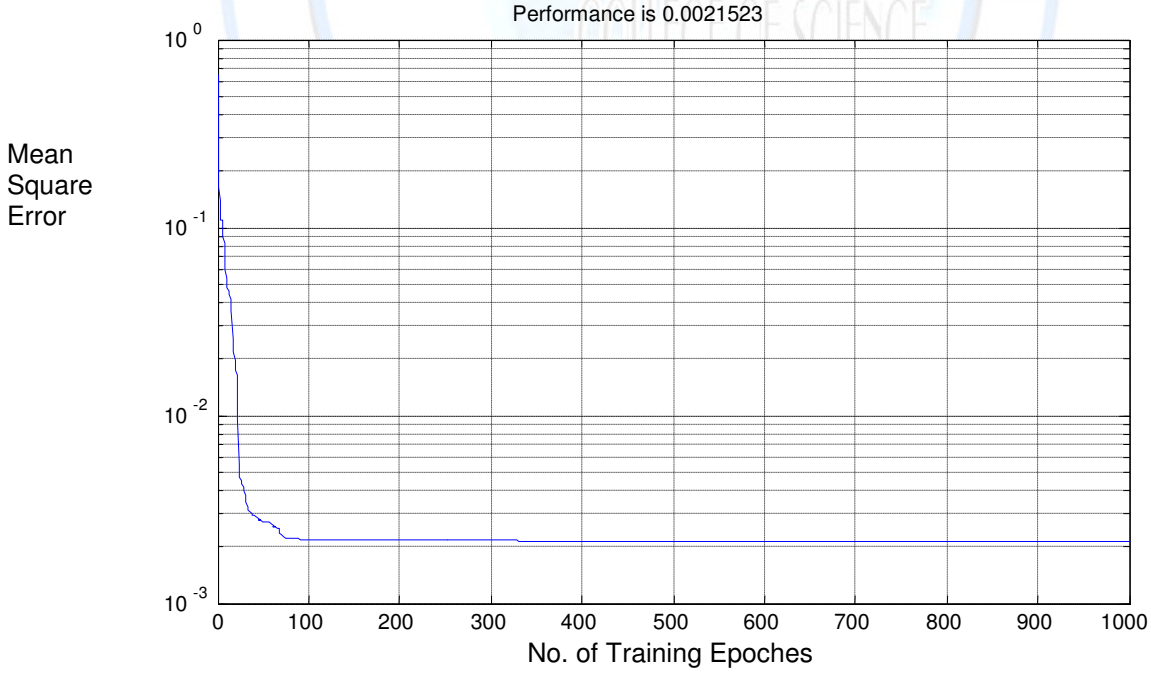

Fig .No.8 The training error in net work process.

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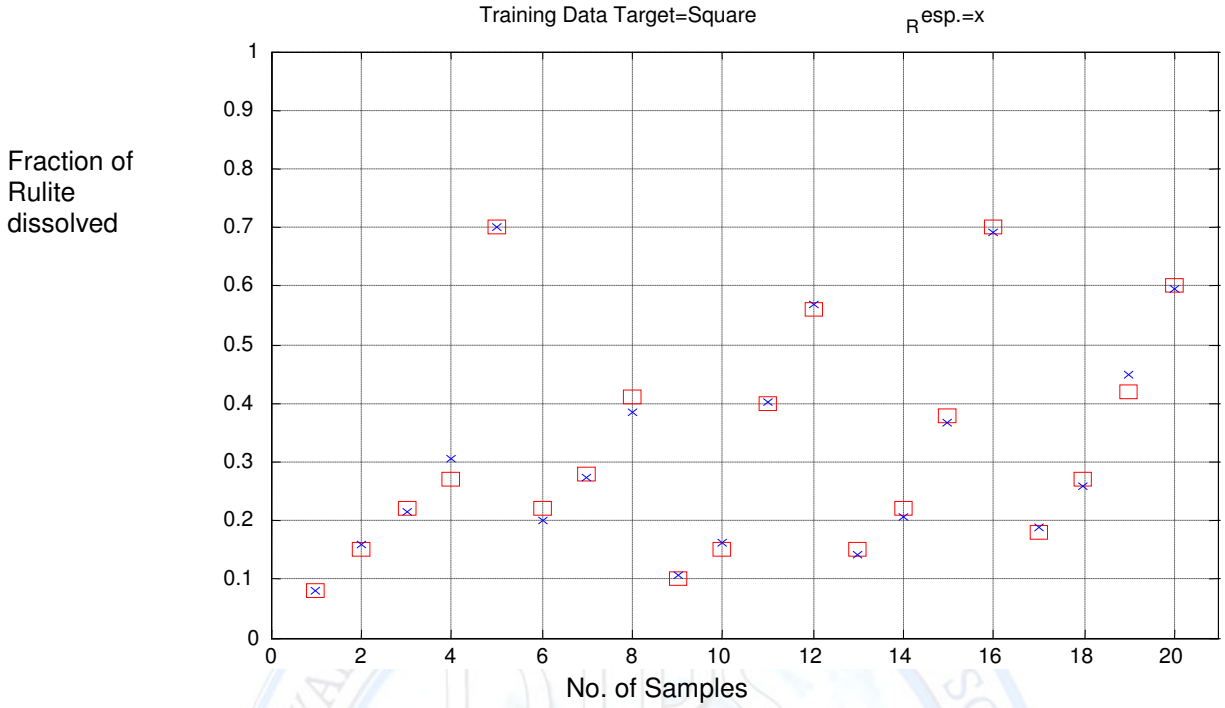

Fig .No.9 comparison of the estimation of ANN with experimental results.

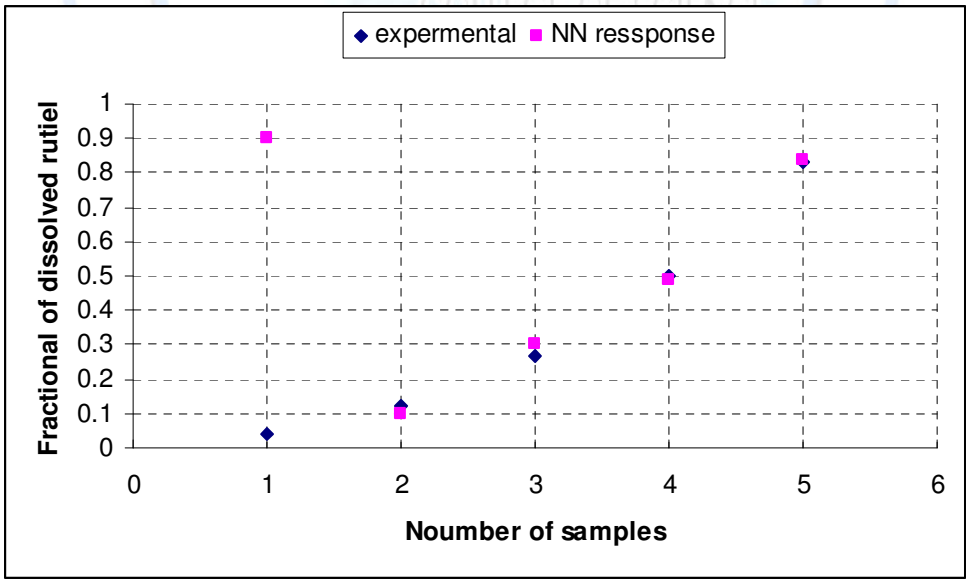

Fig .No.10. Explain test pattern after training comparison of the estimation of the ANN and experimental data

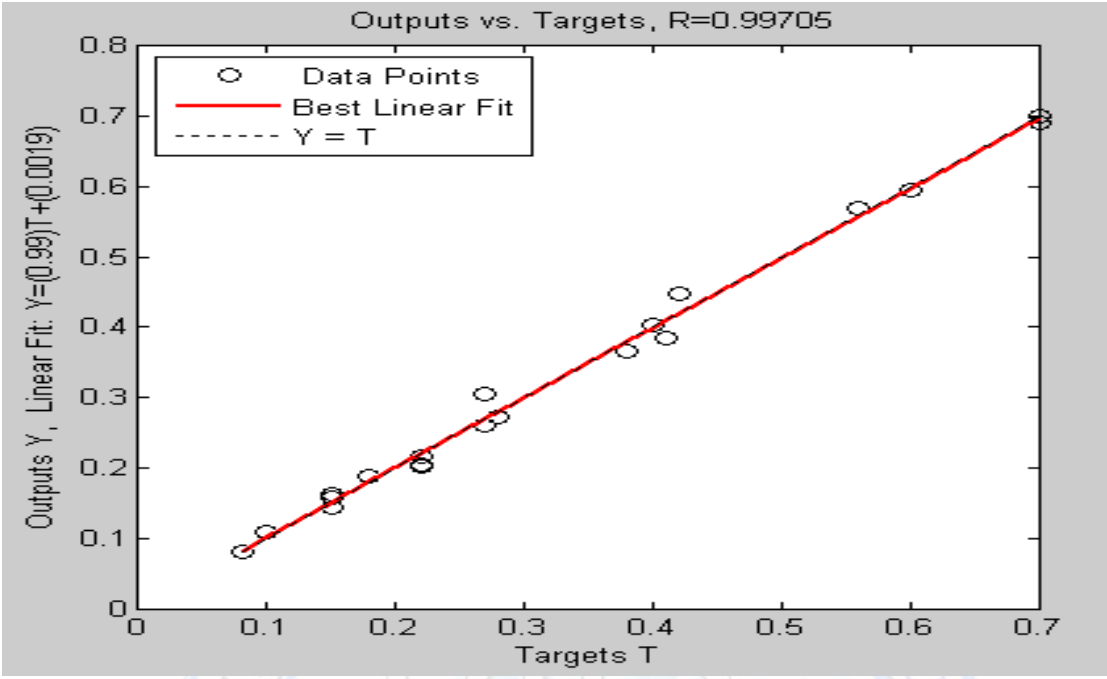

Fig .No.11. Best fit line between the experimental data and ANN for training network.

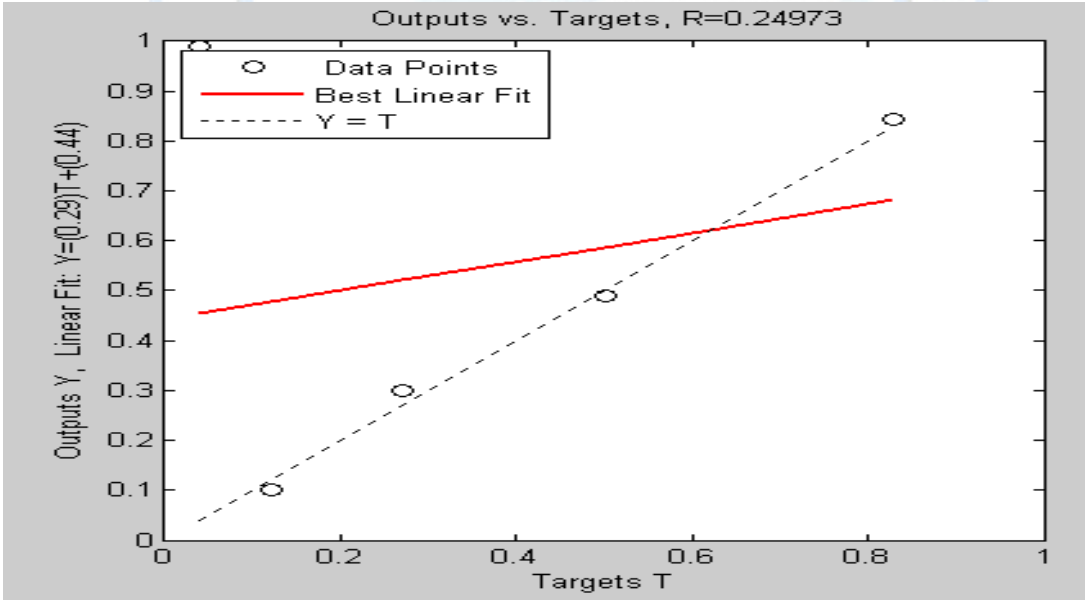

Fig .No.12. Best fit line for training samples