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Implementation of Linear Algebra in Balanced Equation

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***Abstract:** In this paper we study describes a procedure applying Gaussian elimination method in matrix algebra to balance chemical reaction equation. In this method it is possible to balance any chemical reaction with given reactants and products finally the result satisfies the law of conservation of mater and confirms that there is no contradiction to the existing ways of balancing chemical equation to the existing ways of balancing chemical equation.*
***Keywords:** Balanced equation, Simultaneous liner and conservation of matter.*

I. INTRODUCTION

Chemical equation play a main roll in theoretical as well as industrial chemistry. A chemical equation is the symbolic representation of a chemical reaction in the form of symbols and formulae, where in the reactant entities are given on the left hand side and the product entities on the right hand side. The balancing of chemical equation can be made much easier especially for those who find it difficult, by moving the procedure towards the algorithmic and away from the heuristic. Early on in your chemistry studies you will have ample opportunity to balance equation. This is a fundamental skill in chemistry, as you might have noticed from the short reading into chemistry. Balancing equation means writing chemical equation such that the amount of stuff you start with in the reaction equals the amount of stuff you end up with as a product. Balancing chemical equation by inspection is often believed to be a trial and error process and therefore it can be used only for simple chemical reactions. But still it has limitations. If some simple chemical reaction which cannot be balanced is given to balance it by using trial and error method then it becomes very difficult to conclude that such type of reactions do not happen physically. Here we are presenting the Gauss elimination method of balancing chemical equation using which we can easily determine whether the given chemical reaction exists or does not exists. Some authors are balance chemical equation some different methods.

II. MATHEMATICAL MODELING OF CHEMICAL REACTION

Here we look how a chemical reaction is represented as a system of simultaneous linear equations.
Consider the following unbalanced chemical Reaction $HClO_4+P_4O_{10} \rightarrow H_3PO_4+Cl_2O_7$
In this reaction there are four compounds H: Hydrogen, Cl: Chlorine, P: Phosphorus, O: Oxygen
In This Problem of balancing chemical Equation is nothing but the finding the coefficient numbers for both reactants and product.
So we represent above Chemical Reaction into the mathematical from as follows. Suppose the required coefficient numbers are x_1, x_2, x_3, and x_4 such that $x_1HClO_4+ x_2P_4O_{10} \rightarrow x_3H_3PO_4+ x_4CL_2O_7$
Corresponding to four Compounds we have the four simultaneous linear Equation as below
H : $x_1=3x_3$, Cl : $x_1=2x_4$, P : $4x_2=x_3$, O : $4x_1+10x_2=4x_3+7x_4$
That is $x_1-3x_3= 0$, $x_1-2x_4= 0$, $4x_2-x_3=0$, $4x_1-10x_2-4x_3-7x_4= 0$
More Precisely $x_1+0x_2-3x_3+0x_4= 0$, $x_1+0x_2+0x_3-2x_4= 0$, $0x_1+4x_2-x_3+0x_4= 0$ and
$4x_1+10x_2-4x_3-7x_4= 0$ This is a homogeneous system of four linear equation in four unknowns.

A. Gauss-Elimination Method

Now to solve the above homogeneous system of four linear equations we use the gauss elimination method. Consider the matrix equation AX=0, where

$$A = \begin{pmatrix} 1 & 0 & -3 & 0 \\ 1 & 0 & 0 & -2 \\ 0 & 4 & -1 & 0 \\ 4 & 10 & -4 & -7 \end{pmatrix} \quad X = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} \quad O = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

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Now obtain we can obtain the echelon form of a matrix *A* as below.

$$\begin{pmatrix} 1 & 0 & -3 & 0 \\ 1 & 0 & 3 & -2 \\ 0 & 4 & -1 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

Converting into equations we get x_1-3x_3=0, $3x_3$-2x_4=0, $4x_2$-x_3=0
Let us take x_1=3, therefore we obtain x_1=3, x_2=1/4, x_3=1, x_4=3/2
Thus we get the balanced equation as $3HClO_4 + 1/4P_4O_{10} \rightarrow H_3PO_4 + 3/2Cl_2O_7$
Multiplying by 4 ,we obtain $12HClO_4 + P_4O_{10} \rightarrow 4H_3PO_4 + 6Cl_2O_7$

III. DISCUSSION

In a balanced equation, coefficients specify the number of molecules (or formula units) of each element involved the coefficients must satisfy Dalton's (conservation of mass)
Requirement that atoms are not created or destroyed in a chemical reaction. There is no fixed procedure for balancing an equation. Although a trial – and-error approach is generally used in classroom, a systematic algebraic approach is a principal of possibility that often works. This procedure seems to substantially facilitate the balancing of equations that, traditionally, have been considered difficult for many students. It is interesting that the more difficult the equation, the greater this facilitation appears to be. This procedure allows average students and below average students to experience ready success in balancing, thus avoiding a traditional source of frustration and failure which might contribute to there losing interest in chemistry. One interesting serendipity of this procedure is how quickly it turns able pre-matrix students into extremely fast and accurate balancers of chemical equations.
The immediate importance of the procedure lies in the fact that it can remove the heuristic wall of haphazard inspection, replacing it with a near algorithmic procedure that virtually assures balancing success for average students and below average students. Also, it gives able students and unusual facility. A significant, but less immediate, advantage is the preparation the procedure could offer for future matrix techniques.

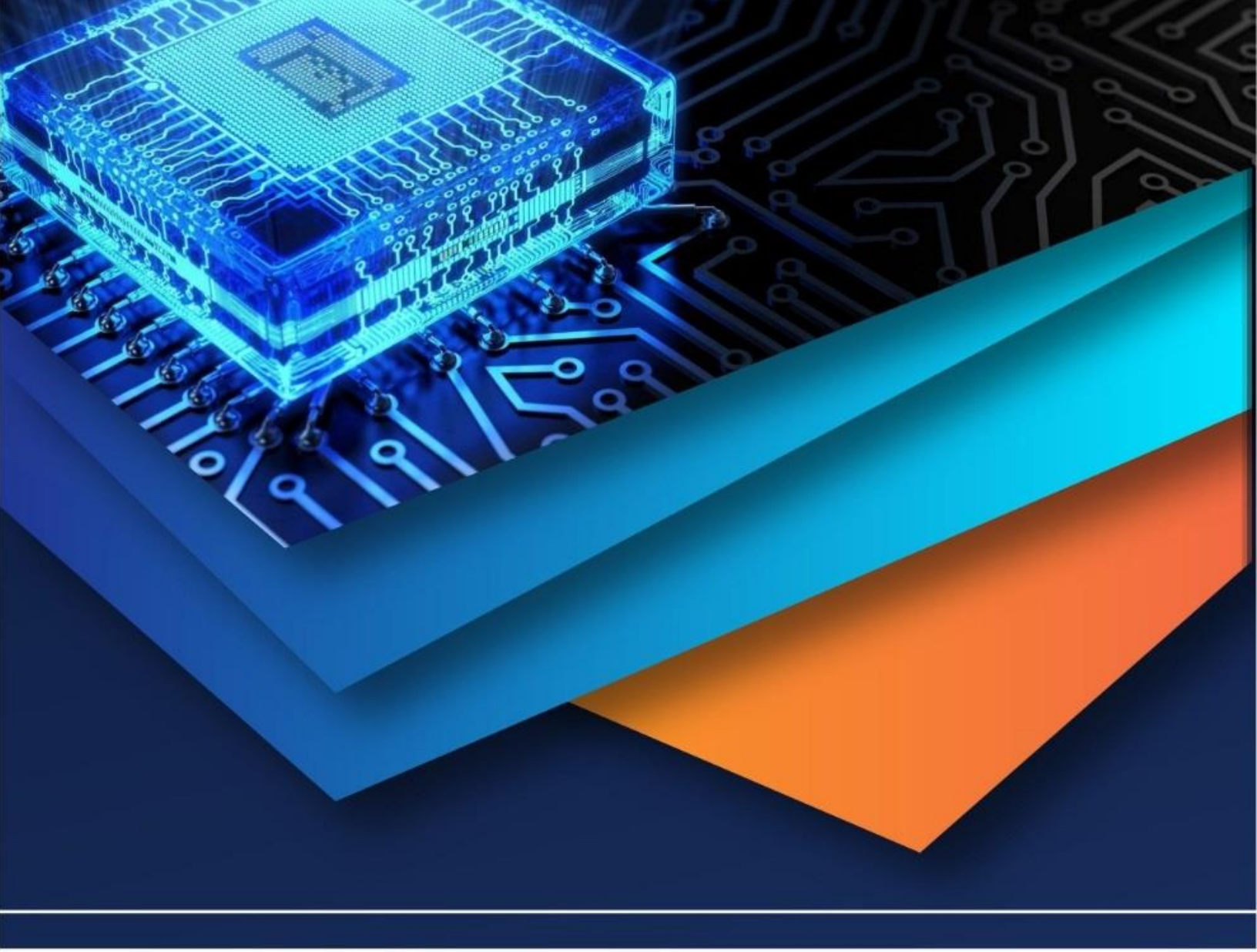
IV. CONCLUSION

Balancing chemical reaction is not chemistry, but it is just algebra. Using the method given in this paper of balancing chemical equation one can correctly write formula and show how a balanced chemical &must have the same number and types of atoms on each side of the arrow. It can be easily verified whether the given chemical equation physically occurs (or) not. In other words, the mathematical method given here is applicable for all possible cases in balancing chemical equations.

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