

# PROVIDING PRIVACY PROTECTION FOR SENSITIVE LABELS IN SOCIAL NETWORKS

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## ABSTRACT

As everyone needs privacy while uploading or sharing social network data which helps in social science research and in the business analysis. Hence, this paper is motivated by the recognition of the need for a finer grain and more personalized privacy in data publication of social networks. To gain privacy we propose a privacy protection scheme that not only prevents the disclosure of identity of users but also the disclosure of selected features in users' profiles. An individual user can select which features of his/her profiles he/she wishes to hide. The social networks are modelled as graphs in which users are nodes and features are labels. Labels are denoted either as sensitive or as non-sensitive. We treat node labels both as background knowledge an adversary may possess, and as sensitive information which has to be protected. We provide privacy protection algorithms which allow that graph data to be published in such a way such that an adversary who possesses information about a node's neighbourhood cannot safely infer its identity and its sensitive labels. To this aim, the algorithms transform the original graph into a graph in which nodes are sufficiently indistinguishable.

**Keywords:** Social Networks; Privacy Protection Scheme; Sensitive Labels; Data Mining

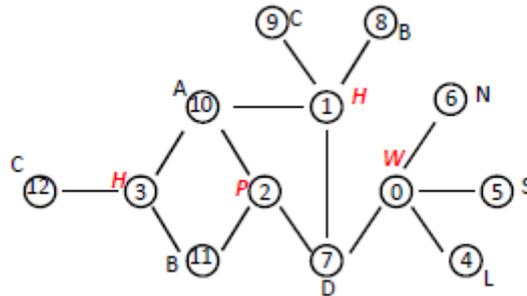
## I. INTRODUCTION

Social network data which can be published of particular individual should always wants to gain its privacy. Means sensitive information of users/individuals among the social networks should be protected. The main challenge is to plan correct methods to publish social network data in a form that provides utility without compromising privacy. Previous research has proposed various privacy models with the corresponding protection mechanisms that prevent both accidental private information leakage and attacks by malicious adversaries. These early privacy models are mostly concerned with identity and link disclosure. The social networks are modelled as graphs in which users are nodes and social connections are edges.

Users entrust social networks such as Facebook, LinkedIn, etc., with a wealth of personal information such as their age, address, current location or political orientation. We treat these details and messages as features in the user's profile. We propose a privacy protection scheme that not only prevents the disclosure of identity of users but also the disclosure of selected features in users' profiles. An individual user can select which features of his/her profile he/she wishes to hide.

The social networks are modelled as graphs in which users are nodes and features are labels. Labels are considered either as sensitive or as non-sensitive. Figure1 is a labelled graph representing a small subset of such a social network. Each node in the graph represents a user, and the edge between two nodes represents the fact

that the two persons are friends. Labels presented to the nodes show the locations of users. Each letter represents a city name as a label for each node. Some individuals do not mind their address being known by the others, but some do, for various reasons. In such case, the privacy of their labels should be protected at data release. Therefore the locations are either sensitive (labels are in red italic in Figure 1) or non-sensitive.



**Fig.1. Example of the Labelled Graph Representing a Social Network**

The privacy issue arises from the disclosure of sensitive labels. One might suggest that such labels should be simply deleted. Still, such a solution would present an incomplete view of the network and may hide interesting statistical information that does not threaten privacy. A more sophisticated approach consists in releasing information about sensitive labels, while ensuring that the identities of users are protected from privacy threats. We consider such threats as neighbourhood attack, in which an adversary finds out sensitive information based on prior knowledge of the number of neighbours of a target node and the labels of these neighbours. In the example, if an adversary knows that a user has three friends and that these friends are in A (Alexandria), B (Berlin) and C (Copenhagen), respectively, then he/ she can guess that the user is in H (Helsinki).

We present privacy protection algorithms that allow the data to be published in a way such that an adversary cannot safely infer the identity and sensitive labels of users. We consider the case in which the adversary possesses both structural knowledge and label information.

The algorithms that we propose transform the original graph into a graph in which any node with a sensitive label is indistinguishable from at least  $l-1$  other nodes. The probability to infer that any node has a certain sensitive label (we call such nodes sensitive nodes) is no larger than  $1/l$ . For this purpose we design  $l$ -diversity-like model, where we treat node labels as both part of an adversary's background knowledge and as sensitive information that has to be protected.

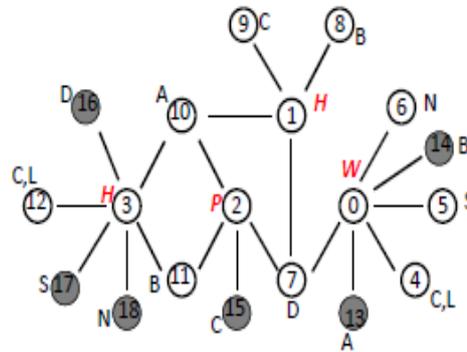
The algorithms are designed to provide privacy protection while losing as little information and while preserving as much utility as possible.

## II. BACKGROUND

**Problem Definition:** We model a network as  $G(V, E, L^s, L, \Gamma)$ , where  $V$  is a set of nodes,  $E$  is a set of edges,  $L^s$  is a set of sensitive labels, and  $L$  is a set of non-sensitive labels.  $\Gamma$  maps nodes to their labels,  $\Gamma: V \rightarrow L^s \cup L$ . Then we propose a privacy model,  $l$ -sensitive-label-diversity; in this model, we treat node labels both as part of an adversary's background knowledge, and as sensitive information that has to be protected. These concepts are clarified by the following definitions:

**Definition 1.** The neighborhood information of node  $v$  comprises the degree of  $v$  and the labels of  $v$ 's neighbors.

**Definition 2.** (L-sensitive-label-diversity) For each node  $v$  that associates with a sensitive label, there must be at least  $l-1$  other nodes with the same neighborhood information, but attached with different sensitive labels.



**Fig.2. Privacy- Attaining Network Example**

In example 1, nodes 0, 1, 2, and 3 have sensitive labels. The neighborhood information of node 0 includes its degree, which is 4, and the labels on nodes 4, 5, 6, and 7, which are L, S, N, and D, respectively. For node 2, the neighborhood information includes degree 3 and the labels on nodes 7, 10, and 11, which are D, A, and B. The graph in Figure 2 satisfies 2-sensitive-label-diversity; that is because, in this graph, nodes 0 and 3 are indistinguishable, having six neighbors with label A, B, {C,L}, D, S, N separately; likewise, nodes 1 and 2 are indistinguishable, as they both have four neighbors with labels A, B, C, D separately.

### III. RELATED WORK

The first necessary anonymization technique in both the contexts of micro and network data involves in removing identification. This technique has quickly been recognized as failing to protect privacy. For microdata, Sweeney et al. propose k-anonymity [17] to circumvent possible identity disclosure in naively anonymized microdata. l-diversity is proposed in [13] in order to further prevent attribute disclosure. Similarly for network data, Backstrom et al., in [2], show that naive anonymization is insufficient as the structure of the released graph may reveal the identity of the individuals corresponding to the nodes. Hay et al. [9] emphasize this problem and quantify the risk of re-identification by adversaries with external information that is formalized into structural queries (node refinement queries, subgraph knowledge queries). Recognizing the problem, several works [5, 11, 18, 20, 22, 24, 27, 8, 4, 6] propose techniques that can be applied to the naive anonymized graph, further modifying the graph in order to provide certain privacy guarantee. Some works are based on graph models other than simple graph [12, 7, 10, and 3].

To our knowledge, Zhou and Pei [25, 26] and Yuan et al. [23] were the first to consider modelling social networks as labelled graphs, similarly to what we consider in this paper. To prevent re-identification attacks by adversaries with immediate neighborhood structural knowledge, Zhou and Pei [25] propose a method that groups nodes and anonymizes the neighbourhood of nodes in the same group by generalizing node labels and adding edges. They enforce a k-anonymity privacy constraint on the graph, each node of which is guaranteed to have the same immediate neighborhood structure with other  $k-1$  nodes. In [26], they improve the privacy guarantee provided by k-anonymity with the idea of  $\tilde{l}$ -diversity, to protect labels on nodes as well. Yuan et al. [23] try to be more practical by considering users' different privacy concerns. They divide privacy requirements into three levels, and suggest methods to generalize labels and modify structure corresponding to every privacy

demand. Nevertheless, neither Zhou and Pei, nor Yuan et al. consider labels as a part of the background knowledge. However, in case adversaries hold label information, the methods of [25, 26, and 23] cannot achieve the same privacy guarantee. Moreover, as with the context of microdata, a graph that satisfies a k-anonymity privacy guarantee may still leak sensitive information regarding its labels [13].

#### **IV. SCOPE OF THE PROJECT**

The objectives of this project are as follows:

- The main objective of the algorithm that we propose is to make suitable grouping of nodes, and appropriate modification of neighbours' labels of nodes of each group to satisfy the *l*-sensitive-label-diversity requirement.
- It helps to investigate the protection of private label information in social network data publication.
- It experiments on both real and synthetic data sets confirm the effectiveness, efficiency and scalability of that approach in maintaining critical graph properties while providing a comprehensible privacy guarantee.
- We can publish the Non-sensitive data to every-one in social Network.
- We can post sensitive data to particular people and in the same way we can post non-sensitive data to everyone like ads or job posts.

#### **V. CONCLUSION**

In this paper we have investigated the protection of private label information in social network data publication. We consider graphs with rich label information, which are categorized to be either sensitive or non-sensitive. We assume that adversaries possess prior knowledge about a node's degree and the labels of its neighbors, and can use that to infer the sensitive labels of targets. We suggested a model for attaining privacy while publishing the data, in which node labels are both part of adversaries' background knowledge and sensitive information that has to be protected. We accompany our model with algorithms that transform a network graph before publication, so as to limit adversaries' confidence about sensitive label data.

#### **VI. ACKNOWLEDGMENT**

I consider it is a privilege to express my gratitude and respect to all those who guiding me in the progress of my paper.

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## **BIOGRAPHY**

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# OPTIMIZED AND INTEGRATED TECHNIQUE FOR NETWORK LOAD BALANCING WITH NOSQL SYSTEMS

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## ABSTRACT

*An integrated technique is proposed for handling social network interactions using Hadoop, which deals with huge computations as well as data analysis and Cassandra database's replication strategy for fault tolerance in distributed Environment , which in turn helps in data analytics. Hypergraph is used as an input to Mapreduce programming model of Hadoop, which reduce the write frequencies across the partitions. Honeygot technique is used as an early-warning and advanced security surveillance tool for data security against the attackers. Finally moving this setup to cloud infrastructure would render good performance.*

***Keywords: Cassandra File System (CFS), Hadoop (Map Reduce Programming Model), Hypergraph, Honeygot, L7 Load Balancer. Reverse Proxy Server***

## I. INTRODUCTION

The data around the world is growing day by day. The 80 percent of the world data is been generated from the last 4-5 years. The data from the social networks in the forms of tweets , messages , pictures and videos is the major contribution to this acceleration of the data. This acceleration of growth of data has led to many technologies around the world to manage and analyze in better way. In other words the loads of data generated from social networks has led to Big data analysis , Hadoop [1][2] technology , Data partitioning algorithms, Load balancing schemes and replication strategies for the availability of the data.

Load balancing is a means to distribute tasks over different resources. Load balancing has many kinds namely, Network Load balancing link Load balancing [10] [14] and server Load balancing are among the most common forms. It splits the users across different servers. Load balancer, it follows some etiquettes to accomplish its task. First, it will ensure that the servers are free. Then it contacts the server and if the response is positive, it will adds it in the available list. Load balancer may use the technique called round-robin where the servers are used in queue fashion. Since online social networks gained much more popularity when compared to email , Load balancing plays a vital role in managing social network data.

Earlier we used to work with Relational databases to manage and store the data. Down the lane, there occurred the challenge to manage the unstructured data which is not handled by the RDBMS which was purely schema dependent. This opens up the door for NoSQL [3] systems, which use data partitioning and replication to achieve scalability and availability.

The term “NoSQL” [5] is now getting popularity across the globe. It is targeted towards improvements over the relational databases. The databases categorized under NoSQL system, have variety of good characteristics, but most does not support strict transactions and strict relational model that are essential part of the relational design. The ACID (Atomic-Consistent –Independent –Durable) transactions of the relational model make it virtually impossible to scale across data centers while maintaining high availability, and the fixed schemas defined by the relational model are often inappropriate in today’s world of unstructured and rapidly mutating data.

NoSQL (key/value, document, column, graph) brings together a wide variety of technologies under one roof. NoSQL databases can broadly be categorized into four main types, Key-Value databases, Document databases, Column family stores, Graph databases. key/value databases emerged by the inspiration of amazon’s dynamo and distributed hash tables and they are designed to handle massive load . HBase (column)[4] is based on google’s big table. HBase supports automotive rebalancing or re-partitioning and it is highly distributed. Cassandra taken the features from both dynamo and big table. Cassandra supports fast reads/writes Query processing in social networks[7] plays vital role in performance of a server. It covers ,server load imbalance, the total number of I/O operations, and the number of servers processing a query.

In this paper, the work proposes a selective partitioning and replication method for data distribution in social networks by utilizing the Hadoop and Cassandra[8]. As a supportive input to this work, a novel Hypergraph[6] model to represent the social network interactions among multiple users and HoneyPot [12] [13] technique to avoid attacks to personal data.

## II. PROPOSED TECHNIQUE

Hadoop File System (**HDFS**) got emergence in the market due to usage of its commodity hardware thereby providing cost-effective storage for applications and it is mainly used for large scale computations and calculations. While Cassandra File System (**CFS**) has capability to run Analytics on the data it has received and It is fault tolerant in distributed Environment. So merging the capabilities of both HDFS with Cassandra CFS would let us perform both Analysis and Analytics on the data from line-of-business application. Using the **Hypergraph** technique before replicating the data will reduce the Write overhead of the newsfeed. The L7 load balancer called reverse proxy server is used, which makes a load balancing decision based on the content of the message. Integrating **HoneyPot** technique with proposed system to avoid attackers to gain access to personal files and videos.

### 2.1 Algorithm

**Input:** Social Network User Interactions and Registration Details:

**Output :** Data processed & replicated with the help of HDFS and CFS [11]. Handles multiuser operations and Chooses less loaded partition for new user registration

#### 2.1.1 Register User to Less Loaded Partition

```
for i=1 to n // Number of users.  
    Useri ← Reg. details[i]  
    P = (p1 + p2 + p3 + ... + pn) // P is a partition has sum of records in each Partition.  
    X = P/n  
    If (X == p1 && X == p2 && ... X == p3)
```

```

    RandomPartiotion();
Else
    For i=1 to Pn          //Consider Partition p1,p2,...pn
        X[i] ←Count [records (Pi)]    // x – is a array stores count(records) of each
partition.
        SORT the elements of array – x[ ]    // Use Treemap(Data structure ) for automatic
sorting.
    End for.
    
```

### 2.1.2 Algorithm: Data Handling

- Construct **Hypergraph** Users and their interactions with each other.  
 HyperGraph H(V,E) ← User Interactions.
- Give Hypergraph as Input to **MapReduce** technique (Hadoop).  
 MR ← H(V,E)
- **Reduce** method reads from CFS. **Map** method writes to CFS.
- Integrate **Honeypot** technique to this system so that it avoids attackers to corrupt data.

### 2.1.3 Alogorithm: Manipulate/Download file

```

i ← User
for j=1 to n //all files of user i (1to n)
    if permission(Filej) == 1 //permission granted from useri
        Delete/Edit/Download the Filej j++;
    
```

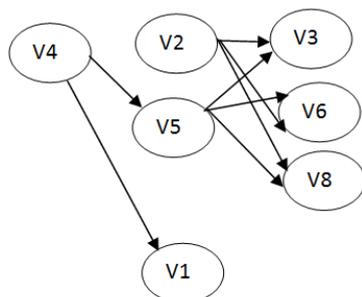
## III. APPLICATION OF HYPERGRAPH:

As before stated , Hypergraph[9]is taken as an input to MapReduce Programming model, in turn MapReduce model communicates with Cassandra database CFS. Hypergraph can be analysed by the following example: Directed Hypergraph is used and the edges are called Hyperedges. Here an edge can connect to any number of vertices unlike in graph where it is restricted to only two vertices.

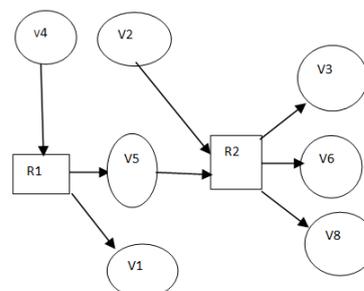
Say R1 and R2 are Replicators. We have ,

R1: V4→V1+V5

R2: V2+V5→ V3+V6+V8



Fig(1)- Graph



Fig(2)- Hypergraph

As shown in the Fig(1) , a normal Graph Vertex V2 and V5 sends requests/data file to {V3,V6,V8} through point to point link. In Fig(2), the Hypergraph shows usage of Replicator (R1,R2) which takes input from sender and replicates to respective people in that partition, thereby reducing the write frequency.

### 3.1 Input\_Format

Src\_Graph\_id<tab>Source\_vertices<tab>Destination\_vertices<tab>Dest.Graph\_id

Consider Group1 {V2,V4}, Group2 {V1,V5}, Group3 {V3,V6,V8}

Grp1<tab>V4<tab>V1<tab>Grp2

Grp1<tab>V4<tab>V5<tab>Grp2

Grp1<tab>V2<tab>V3<tab>Grp3

Grp1<tab>V2<tab>V6<tab>Grp3

Grp1<tab>V2<tab>V8<tab>Grp3

Grp2<tab>V5<tab>V3<tab>Grp3

Grp2<tab>V5<tab>V6<tab>Grp3

Grp2<tab>V5<tab>V8<tab>Grp3

### 3.2 Sample\_Output

Source\_Group\_id<tab>Source\_vertives<tab><Replicator\_id>

Grp1<tab>V4<tab>R3

Grp1<tab>V2<tab>R2

Grp2<tab>V5<tab>R2

## VI. CONCLUSION

The proposed technique uses both the qualities of Hadoop and Cassandra to perform both data analysis and analytics. Hypergraph is been used to handle multi way relations in social networks and given as a input for MapReduce. In turn, MapReduce is made to communicate with Cassandra database called CFS , which is highly fault tolerant in distributed environment. Finally the work suggest to integrate the Honeypot technology to this system to avoid attackers from corrupting the stored data. Moving this setup to cloud will render good performance.

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# RESEARCH CHALLENGES IN AD-HOC SOCIAL NETWORK (ASN)

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## ABSTRACT

Today mobile social networking is gaining high attention. Most of the mobile devices are equipped with ad-hoc mode of communication like Bluetooth, WI-FI, or cellular radio. Ad-hoc mode of communication can be used to build an ad-hoc Social network (ASN) between mobile users. ASN is used to form a small network between nearby users having same interest. In this paper, work done for implementation of ASN is described along with various research challenges and issues of ASN.

**Keywords:** Ad-Hoc Social Network, Profile Matching, GPS, Tuple Space, Routing, Semantic Similarity

## I. INTRODUCTION

These days social networking is becoming very popular among people of every age group. It has also gained tremendous popularity on mobile devices to communicate with people. But, online social networking has some limitations. In online social networking, centralized infrastructure is prerequisite. If for some reason, website is blocked, then social network will not be available [1]. Secondly, the location of user is not considered in online social networking. Thirdly, it suggests friends on the basis of user's profile and ignores the dynamic interest of user. To connect with new people, usually all the users publish their complete profile for others to search. However, users profile may contain some sensitive or personal information that they do not want to make public [2].

There is a need of network-on-move to connect with people of same interest who are in physical proximity of him/her. ASN is a social network which uses ad-hoc mode of communication to develop relations with different people who are in proximity. ASN has its advantages over online social network, since it is decentralized and uses infrastructure-less network. It helps user to connect with nearby users who matches their interest at any instant of time. For example, user has different browsing pattern at different location meaning at office search terms are different and when at home or some location for holidays key terms are different. ASN is used as anytime anywhere social network.

ASN can be used to send text messages, photos, videos, or any other file to nearby user with similar interest. Nearby users can be found by wireless mobile protocols like Bluetooth, or GPS (Global Positioning System)

## II. RELATED WORK

Sarigol [3] presented AdSocial, a Software and middleware platform for social networking using ad hoc networks. It has been deployed on Nokia N810 internet tablets. AdSocial targets small scale networks such as

friends playing game on train, to make social connection with people in a institution or conference or share documents and photos in office. AdSocial uses data piggybacking mechanism and share data using ad hoc routing protocols without any modification. Using AdSocial, buddies can chat, play games, can do video conferencing etc. Here buddies are the users in proximity which are detected by AdSocial. Users can retrieve profile of a nearby buddy which contains Session Initiation protocol (SIP) address and interest along with some basic information. AdSocial is implemented on a regular web browser (e.g. Firefox) that connects to lighttpd web server to redirect the call to AdSocial via FastCGI interface. To locate a buddy and to determine the address of buddy's webserver, AdSocial uses MAND(Mobile ad hoc network dictionary), a distributed dictionary service for ad hoc networks.

Sarigol [4] proposed a distributed tuple space for social networking on mobile phones. They presented an approach for storing and sharing the underlying network as the common memory space in which nodes can store and lookup key/ value pairs. A tuple consists of six fields. Key is tuple identifier and value is its content. Owner identifies the node generating the tuple. Version specifies replacement schema among tuples with the same key. Scope tells the number of hops and lifetime field specifies for how long a tuple is stored locally at a node.

```
Tuple-presence = {  
  Key= "adsocial-presence"  
  Value="15.10.5.2.80:/Patrick/busy"  
  Version= 32  
  Owner= "15.10.5.2"  
  Scope= 4  
  Lifetime= 30  
}
```

Authors uniquely identified the tuple by pair <key, version>. Tuple space can perform tuple insertion, deletion and lookup of tuples. Insertion of tuple is done by *put(table)* operation. *Get(query)* and *scan(query)* operations are used for lookup of tuples stored in network. Deletion of tuple is done either when lifetime is expired or by incrementing the update of same tuple. Authors implemented buddy presence using tuple space that allows users to view all buddies with specific interest. Buddy's presence status and interest are periodically updated in network. Such an application may be used in a conference venue to allow people to set up discussion group.

Chayant[5] proposed optimized based approach for community identification in dynamic social networks. They assumed social networks as the graphs where a vertex represents individuals and an edge represents social interactions. They also assumed that time is discrete and in each time step, social interaction is in the form of several complete subgraphs of individuals. Authors showed that problem of inferring community structure in dynamic networks is NP hard and thus presented heuristic algorithms ( e.g. greedy heuristic, Bipartite heuristic) to find the near optimal solution.

Seada [6] considered social network as the killer app for wireless ad hoc networks. They proposed proximity local networks using existing device base and wireless interfaces like WI-FI and Bluetooth. They also considered ad hoc network technology as the best way to provide proximity factor for following reasons:

- i. Without any infrastructure, users can connect other peers in the same range.
- ii. Users can detect and verify the proximity of their peers and can find their approximate location.

- iii. Avoiding centralized approach for crowded locations, distributed approach is likely to offer viable alternatives.

They proposed several components required in ad hoc network that can support social network application like joining a social network by detecting physical neighbors that are part of same network, locating friends with same interests in proximity, finding locations using GPS, providing proper authentication and encryption of messages transmitted between two friends and lastly to allow nodes to form a social network without the need for internet access.

Lee and Hong [7] proposed an algorithm to create a user profile and infer user's interest in real-time. The data is extracted from the URLs which are accessed by users. The mobile web browser stores the browsing history to analyze user's interest. Authors presented a hierarchical model to infer user's interest from web pages. A node hierarchical mode consists of a keyword and a value. Keyword is the extracted word from URL and value is its interest level. Authors recorded the keyword and corresponding values. If extracted word from URL exists in hierarchical model, then its interest level is increased else it is added in hierarchical model and interest level is initialized. To build a ad hoc social network, a mobile device A broadcasts a neighbor discovery message with its own profile. Mobile device B on receiving this message calculates similarity between two profiles. If similarity is high then B sends its profile to A and forms a virtual link between two else it discards the neighbor discovery message. Using virtual link, the mobile devices can interact with each other in transmission range.

Aneja and Gambhir [8] presented a geo social profile matching algorithm that constructs user profiles dynamically based on their interests. They considered GPS location of users to create user's profile. GPS location of users is stored in data structure list. Each GPS Location has a corresponding hierarchical structure where extracted keywords from URL are stored. Current GPS location of users is compared with the GPS location stored in data structure list. If GPS location is found, then corresponding hierarchical structure is extracted. Keywords are compared with all children nodes of this hierarchical structure. If it is found then its interest level is increased else it is added to the structure and its interest level is initialized. If GPS location is not present, then a new tree with root node as that GPS location is added in forest along with its corresponding hierarchical structure.

Kaisa[9] designed a software called MobiClique for mobile social networking for windows phone that uses store-carry-forward technique. It does not rely on any infrastructure or on a centralized server. It creates a virtual world between users based on their proximity, interest level and social compatibility. In order to connect with other users Mobi Clique uses three steps:

- i. Neighborhood discovery
- ii. User identification
- iii. Data exchange

Neighborhood discovery is done by radio technology being used like Bluetooth or wifi. After discovery, in user identification phase, the user exchange their full profiles which are stored by MobiClique along with other contact statistics. In data exchange phase, users exchange messages which are stored on the device and can be forwarded to other devices in the proximity. MobiClique can be used to address both to the group of users or to a specific user. Messages stored on a device can be removed when TTL(time to live) expires. This exchange of messages between multiple hops in infrastructure-less environment creates a temporal communication network as in pocket switched network(PSN). Along with mobile social networking and asynchronous messages,

MobiClique can also be used for epidemic newsgroups whereby multiple disconnected users can share their specific interest.

Li[2] proposed FindU, the first distributed privacy preserving personal profile matching in mobile social networks. In FindU, users can find best matching profile from group of users. For privacy purpose only minimal information about participant users is exchanged. FindU is secure under HBC (honest but curious) mode and prevents active attacks.

Aneja and Gambhir[1] presented various research issues in ASN. The authors presented the need of optimized routing protocols for better and efficient results of ASN and to provide stable path between users. They also presented the issue of privacy and security in ASN to prevent intermediate nodes from knowing about other user's friend. They focused on prioritizing data packets to make ASN reliable and feasible.

### **III. RESEARCH CHALLENGES IN ASN**

- Current research on ASN is focused on similarity matching by extracting keywords from URLs or browsing history of user and finding similarity based on those keywords. They do not determine if keyword being matched within a profile or different profile is synonymous. E.g. one user may search for club and other user may search for disco. Thus there is a need of semantic similarity..
- Privacy of user is another issue in ASN. Authentication of users is difficult since ad hoc social network is not based on pre knowledge of other users. Encryption technique is required to send messages over a network.
- Ad hoc social network as per now works on routing protocols of ad hoc networks. They need to be optimized for ASN to include prioritizing of messages. Network is dynamic and thus topology can be changed at any instant of time. So, routing protocols must be designed so that a stable path can be maintained for message passing.
- In ASN, friend suggestions are shown on the basis of proximity and dynamic interest of users. There must be some similarity aspect on the basis of which it can be predicted that which profile is better to build a social network. Therefore, a profile matching algorithm is needed

### **IV. CONCLUSION**

In this paper we discussed the research issues in ASN. Profile matching in ASN with several security parameters is a serious issue. In this paper only the survey on various profile matching schemes and security is presented.

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# A STUDY ON STRESS MANAGEMENT AMONG THE EMPLOYEES OF BANKS

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## **ABSTRACT**

*The productivity of the work force is the most decisive factor as far as the success of an organization is concerned. The productivity in turn is dependent on the psychosocial well being of the employees. The banking organization, have been facing greater challenges in terms of technological revolution, service diversification and global banking. Stress is unavoidable on the part of the employees as the systems, procedures; techniques are getting complicated with the use of advance technology. Every employee cannot cope with such rapid changes taking place in the jobs. This will lead to arising of stress among employees. Stress can affect one's health, work performance, social life and the relationship with family members. The stressors and its consequences are to be understood at individual and organizational level. An attempt has been made through this research paper to know the reasons of stress among the bank employees and the ways used by employees to cope with the stress generated at workplace The aim of this paper is to provide insight that will help the reader further improve his/her management competencies in managing stress in the workplace.*

**Keywords:** *Stress Management, Employees, Yoga & Meditation.*

## **I. INTRODUCTION**

Stress is a natural human response to its environment. Stress has become significant due to dynamic social factor and changing needs of life styles. Stress is man's adaptive reaction to an outward situation which would lead to physical, mental and behavioral changes., In fact, moderate levels of stress are considered essential motivators. However, high levels of stress have the capacity to greatly impact physical and emotional health, not all stresses are destructive in nature. Appropriate amount of stress can actually trigger passion for work, tap latent abilities and even ignite inspirations. Stress can make a person productive and constructive, when it is identified and well managed.<sup>[1]</sup>

## **II. OBJECTIVES**

1. To study the causes of stress among employees.
2. To know the level of stress on employees.
3. To study the effects of stress on the health of employees.
4. To analyze the importance of interventional strategies to manage stress among bank employees.
5. To study effectiveness of stress management programme organized by the banks.

### III. RESEARCH METHODOLOGY

Both primary and secondary method is used to collect information. The sample size is 50. It was collected from the employees of various bank situated in Hissar. Data was collected through self-structured questionnaire. Books, internet web sites, journals etc were used as a source of secondary data.<sup>[2]</sup> Percentage Analysis method was used to analyze and interpret results and achieves research objectives.

#### 3.1 Workplace Stress

Workplace stress is the harmful physical and emotional response that occurs when there is a poor match between job demands and the capabilities, resources, or needs of the worker.

### IV. FINDINGS

Most of the employees fear with the fact that they lack quality in their work. This puts stress on them. It is found that maximum number of employees in banks remains in stress. 50% employees feel that they are overloaded with work. 42% employees feel tensed due to their non-achievement of their target of work. 36% employees accepted that they will obey the order of their boss by sacrificing their important domestic function. It indicates fear and stress among employees. 37% employees feel stress due to their family related problems. It means such employees feel greater level of stress as compared to other employees. Half of the employees accepted that there is conflict among the employees<sup>[3]</sup>. It is a concern for top management. Only 44% employees feel that strategies used by banks to manage stress of employees are effective. Majority of the employees try to find solution to relieve them from stress. 47% employees use YOGA or other ways to relieve them from stress. In spite of stress, majority of the employees balance in their social life.

**Causes and Consequences of Workplace Stress Table**

Causes	Consequences of distress
1) Work related stressors: ⊏ Inter-personal stressors ⊏ Role related stressors ⊏ Task control stressors ⊏ Organizational-physical environment stressors	1) Physiological ⊏ Heart diseases ⊏ Ulcers ⊏ High blood pressure ⊏ Head aches ⊏ Sleep disturbances ⊏ Increased illness ⊏ Certain cancers ⊏ Back pain
2) Non-work stressors: ⊏ Time-based ⊏ Strain based ⊏ Role based conflict	2) Psychological: ⊏ Job Dis-satisfaction ⊏ Low commitment ⊏ Exhaustion ⊏ Depression ⊏ Moodiness ⊏ Burnout

3) Individual Differences : ⌋ Personal health ⌋ Knowledge-skill ⌋ Coping skills ⌋ Resilience work holism.	3) Behavioral : ⌋ Low job performance ⌋ More accidents ⌋ Faulty decisions ⌋ Higher absenteeism ⌋ Workplace aggression ⌋ Turnover/Absenteeism
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#### 4.1 Stress Management

Stress management is the need of the hour. However hard we try to go beyond a stress situation, life seems to find new ways of stressing us. Stressors, if not escapable, are fairly manageable. Effective management of job stress can only be achieved under two conditions. First, the individual worker must be able to recognize stressors and understand their consequences and second, organizations must develop stress prevention, as well as stress reduction techniques<sup>[4]</sup>. Stress Management is important for both individual and from the point of view of the organization. It is generally assumed that there are two basic approaches to cope with stress i.e. individual oriented approach and organizational oriented approach<sup>[5]</sup>.

#### 4.2 Individual Oriented Strategies for Coping with Stress

- Solo-Active - Reading, Writing, Photography, Art, Playing a musical instrument, Collection of different things, Running, Hobbies, Vacations.
- Group- Activities: - Sports, Games, Eating out, Vacations.
- Solo-Passive/Group-Passive: - Television, Movies, Shows & Theatre, Listening to music, Concepts, opera, Sporting events, Vacations.
- Yoga & Meditation: - it is helpful in overcoming the stress

#### 4.3 The Organizational Oriented Strategies for Coping with Stress

- **Flex time.** Allowing workers to start or end the workday earlier or later can reduce work/life stress, especially for working parents. Flex time can also reduce the stress of commuting in rush hour traffic.
- **Job sharing.** This allows at least two people trained to perform each job, enabling each employee to have time off without losing productivity.
- **Work from home.** Working from home results in higher morale and job satisfaction and lower employee stress and turnover, The prime reason is that working at home provides employees more control over how they do their work, Working at home also helps workers better manage work/family demands.
- **Longer lunch hours.** Extending the lunch hour may help discourage snacking and fast food. Adequate time may also encourage time for calming or other stress-reduction activities such as walking.
- **Healthcare advocacy.** Offering an expert who can personally address healthcare issues, such as helping to resolve medical bills and interacting with insurance and providers, can help employees reduce worry and stay focused on their job<sup>[6]</sup>.
- **EAPs (Employee Assistance Programs)** EAPs are typically offered by the HR department as part of the employer's health insurance plan to assess and address personal issues that affect employee performance and productivity. Issues can range from substance abuse to family problems, and EAPs often include

counseling benefits. EAPs for substance abuse can reduce workers' compensation claims, employer healthcare costs, and absenteeism<sup>[7]</sup>.

- **Stress management programs** Conducting stress management programs at organizational level, with the objective of creating awareness about stress and making employees to learn stress management techniques.
- **Physical activities planned in job design** The body can release stress, better through physical exertion, as physicians were suggesting, indulging any kind of physical activity is recommended while job design.

#### **IV. CONCLUSION**

Stress can make an individual productive and constructive when it is identified and well managed. In times of great stress or adversity, it's always best to keep busy, to plow anger and energy into something positive. Positive attitude and meditation will be helpful for coping the stress. Stress can be minimized if companies take the right steps. Stress-free employees perform better, work harder, feel happier and have a long term commitment to the organization as compared to their counterparts. Having broader perspective of life will definitely change the perception of stress. Let us hope that we will be successful in making distress into eu-stress for our healthy lifestyle as well as organizational well being.

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# SYNTHESIS, CHARACTERIZATION AND BIOLOGICAL ACTIVITY OF MACROCYCLIC METAL COMPLEXES DERIVED FROM DIHYDRAZIDE AND DIKETONE

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## ABSTRACT

A new macrocyclic ligand was synthesized by refluxing malonic dihydrazide and 5-chloroisatin in methanolic medium and formulated as:  $C_{11}H_8N_5O_2Cl$ . A series of complexes were synthesized by template condensation of 5-chloroisatin and malonic dihydrazide in methanolic medium in the presence of trivalent chromium, iron salts and may be represented by formula:  $[M(C_{11}H_8N_5O_2Cl)X]X_2$ , where  $M = Cr(III), Fe(III)$  and  $X = Cl^-, NO_3^-, CH_3COO^-$ . The ligand and complexes were characterized with the help of various physico-chemical techniques like IR, elemental analyses, electronic spectra, conductance and magnetic susceptibilities. On the basis of these studies, a five-coordinate square-pyramidal geometry, in which two nitrogens and two carbonyl oxygen atoms are suitably placed for coordination toward the metal ion, has been proposed for all the complexes. Ligand and complexes were also screened for their *in vitro* antimicrobial activities against bacterial strain *Bacillus cereus* (MTCC 1272), *Salmonella typhi* (MTCC 733), *Escherichia coli* (MTCC 739) and *Staphylococcus aureus* (MTCC 1144). Minimum inhibitory concentration shown by ligand and complexes was compared with MIC shown by standard antibiotic drugs. Some of the complexes showed good antibacterial activity.

**Key Words:** *Bacillus Cereus* (MTCC 1272), *Escherichia Coli* (MTCC 739), *5-Chloroisatin*, *Malonic Dihydrazide*, *Salmonella Typhi* (MTCC 733), *Staphylococcus Aureus* (MTCC 1144)

## I. INTRODUCTION

Metal complexes play an essential role in agriculture, pharmaceutical and industrial chemistry. The use of metal complexes as therapeutic agents for the treatment of different diseases have been extensively studied. As they generally have different mechanism of activity from the organic compounds, the development of metal complexes provides an alternative route of novel drug. Presently, there is a growing interest in the design and synthesis of macrocyclic compound are increasing, due to their resemblance with many natural macrocycles like metalloproteins, porphyrins and cobalamines [1-4]. Transition metal macrocyclic complexes have received a great attention because of their biological activities, including antiviral, antcarcinogenic, antifertile, antibacterial and antifungal. Macrocyclic metal complexes of lanthanide *e.g.*,  $Gd^{3+}$  are used as magnetic resonance imaging (MRI) contrast agents [5-10]. A number of nitrogen donor macrocyclic derivatives have long been used in analytical, industrial and medical applications [11]. In the present paper, we report the synthesis and

characterization of macrocyclic ligand prepared derived from 5-chloroisatin and malonic dihydrazide and its complexes with trivalent chromium and iron. The synthesised complexes have been characterized by IR, elemental analyses, electronic spectra, conductance and magnetic susceptibilities. The ligand and its complexes were screened for their in vitro antimicrobial activities against bacterial strain *Bacillus cereus* (MTCC 1272), *Salmonella typhi* (MTCC 733), *Escherichia coli* (MTCC 739) and *Staphylococcus aureus* (MTCC 1144).

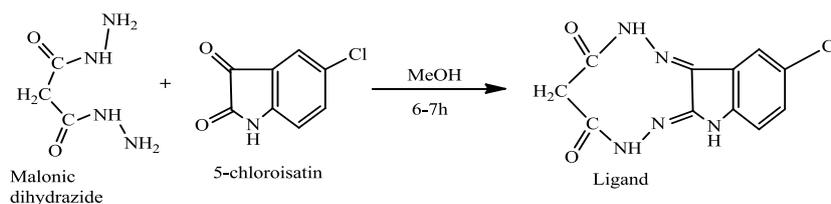
## II. EXPERIMENTAL

### 2.1 Materials

All the chemicals used were of AR grade. Malonic dihydrazide and 5-chloroisatin was purchased from Sigma-Aldrich, metal salts and other chemicals were purchased from HPLC, Himedia and used as received.

### 2.2 Synthesis of Ligand

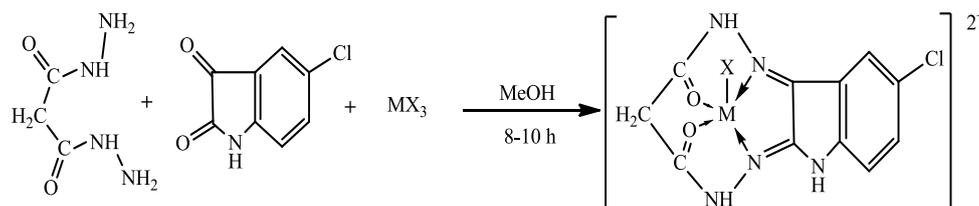
To a hot and well stirred methanolic solution of 5-chloroisatin (10 mmol), malonic dihydrazide (10 mmol) was added. The resulting solution was refluxed for about 6-7 hours. The mixture was concentrated to half of its volume and kept for overnight cooling dark coloured precipitate was obtained. The ligand was filtered and washed with methanol, acetone, diethyl ether and dried. The yield was ~70 %. The ligand was found soluble in DMF and DMSO, but insoluble in common organic solvents and water. The syntheses of the ligand may be represented by the following scheme:



Scheme – I: Synthesis of ligand

### 2.3 Synthesis of Metal Complexes

All the metal complexes were synthesized by template synthesis. To a hot stirring methanolic solution (50 cm<sup>3</sup>) of malonic dihydrazide (10 mmol), metal (Chromium(III) and Iron(III)) salt (10 mmol) dissolved in minimum quantity of methanol (20 cm<sup>3</sup>) was added. The resulting solution was refluxed for 0.5 h. After that 5-chloroisatin (10 mmol) dissolved in 20 cm<sup>3</sup> methanol added in the refluxing mixture and refluxing was continued for 8-10 h. The mixture was concentrated to half of its volume and kept in dessicator for overnight cooling. The dark coloured precipitate was filtered, washed with methanol, acetone, diethyl ether and dried in vacuum; Yield ~ 55 %. All the complexes were found soluble in DMF and DMSO, but were insoluble in common organic solvents and water. They were thermally stable up to ~ 230 -260 °C and then decomposed. The template syntheses of the complexes may be represented by the following scheme:



Where M = Cr(III) and Fe(III), X = Cl<sup>-</sup>, NO<sub>3</sub><sup>-</sup>, CH<sub>3</sub>COO<sup>-</sup>.

## Scheme –II: Synthesis of Metal Complexes

### III. ANALYTICAL AND PHYSICAL MEASUREMENTS

The microanalyses of C, H and N were carried out at Sophisticated Analytical Instrument Facility. The metal contents were determined by standard EDTA methods. Electronic spectra (DMSO) were recorded on PerkinElmer LAMBDA 25 spectrophotometer. The magnetic susceptibility measurements of the complexes were carried out by Gouy balance. The IR spectra were recorded on Thermo Scientific NicolettiS50 FT-IR Spectrometer in the range 4000-400  $\text{cm}^{-1}$  using ATR. The conductivity was measured on digital conductivity meter (Hach,).

### VI. RESULTS AND DISCUSSION

The analytical data of ligand and trivalent macrocyclic complexes derived from malonic dihydrazide and 5-chloroisatin and the complexes formulated as:  $\text{C}_{11}\text{H}_8\text{N}_5\text{O}_2\text{Cl}$ , and  $[\text{M}(\text{C}_{11}\text{H}_8\text{N}_5\text{O}_2\text{Cl})\text{X}]\text{X}_2$ , where  $\text{M} = \text{Cr}(\text{III}), \text{Fe}(\text{III})$  and  $\text{X} = \text{Cl}^-, \text{NO}_3^-, \text{CH}_3\text{COO}^-$ . Ligand and all the macrocyclic complexes are dark coloured solids and are soluble in dimethyl formamide and dimethyl sulphoxide. The anions test for trivalent metal ion complexes is positive before and after decomposing the complexes, indicating their presence inside as well as outside the coordination sphere. The higher values of molar conductance in dimethylsulphoxide indicate them to be 1:2 electrolytic in nature ( $140\text{-}150 \text{ ohm}^{-1}\text{cm}^2 \text{ mol}^{-1}$ ) [12]. All compounds give satisfactory elemental analyses results as shown in the Table-1. All complexes were decomposed over 250 °C indicating their thermal stability.

#### 4.1 Elemental Analysis

**Table-1: Colour and Analytical Data of the Ligand and its Metal Complexes**

Analytical data of trivalent chromium and iron complexes derived from malonic dihydrazide and 5-chloroisatin.								
Found (Calcd.) %								
S.N.	Complexes	M	C	H	N	Cl	Colour	m.w.
1	$\text{C}_{11}\text{H}_8\text{N}_5\text{O}_2\text{Cl}$	-	47.49 (47.58)	2.88 (2.90)	25.17 (25.22)	12.70 (12.76)	Light yellow	277.66
1	$[\text{Cr}(\text{C}_{11}\text{H}_8\text{N}_5\text{O}_2\text{Cl})\text{Cl}]\text{Cl}_2$	11.88 (11.92)	30.29 (30.30)	1.81 (1.84)	16.01 (16.06)	32.48 (32.52)	Brown	436.02
2	$[\text{Cr}(\text{C}_{11}\text{H}_8\text{N}_5\text{O}_2\text{Cl})(\text{NO}_3)](\text{NO}_3)_2$	10.02 (10.08)	25.59 (25.62)	1.54 (1.56)	21.67 (21.72)	6.81 (6.87)	Brown	515.67
3	$[\text{Cr}(\text{C}_{11}\text{H}_8\text{N}_5\text{O}_2\text{Cl})(\text{OAc})](\text{OAc})_2$	10.23 (10.25)	40.21 (40.28)	3.35 (3.38)	13.78 (13.81)	6.87 (6.99)	Light Brown	506.79
4	$[\text{Fe}(\text{C}_{11}\text{H}_8\text{N}_5\text{O}_2\text{Cl})\text{Cl}]\text{Cl}_2$	12.64 (12.69)	30.00 (30.03)	1.82 (1.83)	15.90 (15.92)	32.21 (32.23)	Yellow	439.87
5	$[\text{Fe}(\text{C}_{11}\text{H}_8\text{N}_5\text{O}_2\text{Cl})(\text{NO}_3)](\text{NO}_3)_2$	10.68 (10.74)	25.40 (25.43)	1.48 (1.55)	21.47 (21.56)	6.79 (6.82)	Orange	519.52

#### 4.2 Infrared Spectroscopy

In the IR spectrum of malonic dihydrazide, a pair of bands corresponding to  $\nu(\text{NH}_2)$  was present at  $\sim 3275$  and  $3215 \text{ cm}^{-1}$ , but absent in the IR spectra of ligand and all the complexes [13]. However, a single broad medium

band at  $\sim 3455\text{-}3365\text{cm}^{-1}$  was observed in the spectra of ligand and all the complexes, which may be assigned to  $\nu$  (NH) stretching vibrations [14,15]. A strong peak at  $\sim 1660\text{ cm}^{-1}$  in the IR spectrum of malonic dihydrazide and ligand is assigned to the  $\nu$  C=O group of the CONH moiety. This peak is shifted to lower frequencies  $\sim 1620\text{-}1640\text{ cm}^{-1}$  in the spectra of all the complexes [16,17], suggesting the coordination of the oxygen of the carbonyl group with the metal. Further, no strong absorption band observed at  $1735\text{ cm}^{-1}$  indicating the absence of  $\nu$  (C=O) group of 5-chloroisatin. This indicates the condensation of carbonyl groups of 5-chloroisatin and amino groups of malonic dihydrazide might have taken place. These results provide strong evidence for the formation of macrocyclic frame [18-21]. A strong absorption band in the region  $1590\text{-}1610\text{ cm}^{-1}$  may be due to the C=N group. The lower values of  $\nu$  (C=N) may be explained on the basis of drift of lone pair density of azomethine nitrogen towards metal atom [19-21]. The presence of single medium intensity band in the region  $\sim 3255\text{ cm}^{-1}$  in the 5-chloroisatin complexes may be assigned due to  $\nu$  (N-H) stretching [22]. The bands present in the range  $3010\text{-}3055\text{ cm}^{-1}$  may be assigned due to  $\nu$  (C-H) stretching vibrations of aromatic moiety of 5-chloroisatin [13, 23]. The various absorption bands in the region  $1400\text{-}1590\text{ cm}^{-1}$  may be assigned due to  $\nu$  (C=C) aromatic stretching vibrations of the aromatic ring of 5-chloroisatin moiety [13, 23]. The bands present in the range  $1350\text{-}1000\text{ cm}^{-1}$  are assigned due to  $\nu$  (C-N) vibration.

The IR spectra of the nitrate complexes display three (N–O) stretching bands at  $\sim 1410\text{-}1455\text{ cm}^{-1}$  ( $\nu_5$ ),  $\sim 1305\text{-}1315\text{cm}^{-1}$  ( $\nu_1$ ) and  $\sim 1015\text{-}1030\text{ cm}^{-1}$  ( $\nu_2$ ). The separation of the two highest frequency bands ( $\nu_5 - \nu_1$ ) suggest that both the nitrate groups are coordinated in a unidentate manner [24, 25]. The acetate complexes showed two bands at  $\sim 1630\text{-}1640\text{ cm}^{-1}$  ( $\nu_1$ ) and  $\sim 1380\text{-}1390\text{ cm}^{-1}$  ( $\nu_2$ ). These indicate that the acetate group is coordinated in a unidentate manner [26]. The far IR spectra show bands in the region  $\sim 420\text{-}450\text{ cm}^{-1}$ . Corresponding to  $\nu$  (M–N) vibrations in all the complexes [27-29]. The presence of a band in all the complexes in the  $\sim 420\text{-}450\text{ cm}^{-1}$  region originate from (M–N) azomethine vibration modes and support the coordination of azomethine nitrogen with the metal [30].

### 4.3 Magnetic Measurements and Electronic Spectra

#### 4.3.1 Chromium Complexes

Magnetic moment of chromium complexes were found in the range of 4.25-4.50 BM at room temperature which is close to the predicted values for three unpaired electrons in the metal ion [31]. The electronic spectra of chromium (III) complexes show bands at 9030-9310, 13045-13335, 17460-18320, 27435-27830 and 34815  $\text{cm}^{-1}$ . However, these spectral bands cannot be interpreted in terms of four- or six- coordinated environment around the metal atom. In turn, the spectral bands are consistent with that of five-coordinated chromium (III) complexes, whose structure have been confirmed with the help of X-ray measurements [32]. Thus keeping in view, the analytical data and electrolytic nature of these complexes, a five coordinated square pyramidal geometry may be assigned for these complexes. Thus, assuming the symmetry  $C_{4v}$  for these complexes [33], the various spectral bands may be assigned as:  ${}^4B_1 \rightarrow {}^4E^a$ ,  ${}^4B_1 \rightarrow {}^4B_2$ ,  ${}^4B_1 \rightarrow {}^4A_2$  and  ${}^4B_1 \rightarrow {}^4E^b$ .

#### 4.3.2 Iron complexes

The magnetic moment of iron complexes lie in the range 5.85-5.90 BM corresponding to the five unpaired electrons and is close to predicted high spin values for these metal ions [31]. The electronic spectra of iron (III) complexes show various bands at 9835-9960, 15530-15570, 27625-27730  $\text{cm}^{-1}$  and are consistent with the range of spectral bands reported for five coordinate square pyramidal iron(III) complexes [34]. Assuming  $C_{4v}$  symmetry for these complexes, the various bands can be assigned as:  $d_{xy} \rightarrow d_{xz}$ ,  $d_{yz}$  and  $d_{xy} \rightarrow d_z^2$ . Any attempt

to make accurate assignment is difficult due to interactions of the metal-ligand  $\pi$ -bond systems lifting the degeneracy of the  $d_{xz}$  and  $d_{yz}$  pair.

## V. IN VITRO ANTIBACTERIAL ACTIVITY

All synthesized macrocyclic complexes were tested for in vitro antibacterial activity against some bacterial strains using spot-on-lawn on Muller Hinton Agar.

### 5.1 Test Pathogens

Four test pathogenic bacterial strains viz *Bacillus cereus* (MTCC 1272), *Salmonella typhi* (MTCC 733), *Escherichia coli* (MTCC 739) and *Staphylococcus aureus* (MTCC 1144) were considered for determination of MIC (Minimum Inhibitory Concentration) of selected complexes.

### 5.2 Culture Conditions

The test pathogens were subcultured aerobically using Brain Heart Infusion Agar (HiMedia, Mumbai, India) at 37°C/24 hrs. Working cultures were stored at 4°C in Brain Heart Infusion (BHI) broth (HiMedia, Mumbai, India), while stock cultures were maintained at -70°C in BHI broth containing 15% (v/v) glycerol (Qualigens, Mumbai, India). Organism was grown overnight in 10 ml BHI broth, centrifuged at 5,000g for 10 min and the pellet was suspended in 10 ml of phosphate buffer saline (PBS, pH 7.2). Optical density at 545 nm (OD-545) was adjusted to obtain  $10^8$  cfu/ml followed by plating serial dilution onto plate count agar (HiMedia, Mumbai, India).

### 5.3 Determination of Minimum Inhibitory Concentration

The minimum inhibitory concentration (MIC) is the lowest concentration of the antimicrobial agent that prevents the development of viable growth after overnight incubation. Antimicrobial activity of the compounds was evaluated using spot-on-lawn on Muller Hinton Agar (MHA, HiMedia, Mumbai, India). Soft agar was prepared by adding 0.75% agar in Muller Hinton Broth (HiMedia, Mumbai, India). Soft agar was inoculated with 1% of  $10^8$  Cfu/ml of the test pathogen and 10 ml was overlaid on MHA. From 1000X solution of compound (1mg/ml of DMSO) 1, 2, 4, 8, 16, 32, 64 and 128X solutions were prepared. Dilutions of standard antibiotics (Linezolid and Cefaclor) were also prepared in the same manner. 5 $\mu$ l of the appropriate dilution was spotted on the soft agar and incubated at 37°C for 24 hrs. Zone of inhibition of compounds were considered after subtraction of inhibition zone of DMSO. Negative control (with no compound) was also observed.

### 5.4 Biological Results and discussion

The MIC (minimum inhibitory concentration) shown by the complexes against these bacterial strains was compared with MIC shown by standard antibiotics Linezolid and Cefaclor (Table-2 & Fig-1 ). Complex 1 registered a MIC of 4  $\mu$ g/ml against bacterial strain *Staphylococcus aureus* (MTCC 1144), which is equal to MIC shown by standard antibiotic Linezolid against the same bacterial strain. Complex 5 registered a MIC of 8  $\mu$ g/ml, againsts bacterial strain *Bacillus cereus* (MTCC 1272), which is equal to MIC shown by standard antibiotic Cefaclor against the same bacterial strain. Further complex 5 and 2 showed a minimum inhibitory concentration of 32  $\mu$ g/ml against bacterial strain *Salmonella typhi* (MTCC 733), which is equal to MIC shown by standard antibiotic Linezolid against the same bacterial strain. Complex 4 showed a MIC of 8  $\mu$ g/ml againsts

bacterial strain *Escherichia coli* (MTCC 739), which is equal to MIC shown by standard antibiotic Cefaclor against the same bacterial strain. Among the series under test for determination of MIC, complex 5 was found most potent complex. However, complex 3 showed poor antibacterial activity or no activity against all bacterial strains among the whole series (Table-2 & Fig.-1).

**Table-2 : Antibacterial Screening Data of Ligand and its Cr(III) and Fe(III) Complexes**

S.No.	Complexes	MIC ( $\mu\text{g/mL}$ )			
		a	b	c	d
1	$\text{C}_{11}\text{H}_8\text{N}_5\text{O}_2\text{Cl}$	>128	>128	>128	>128
2	$[\text{Cr}(\text{C}_{11}\text{H}_8\text{N}_5\text{O}_2\text{Cl})\text{Cl}]\text{Cl}_2$	32	4	64	>128
3	$[\text{Cr}(\text{C}_{11}\text{H}_8\text{N}_5\text{O}_2\text{Cl})(\text{NO}_3)](\text{NO}_3)_2$	>128	64	>128	32
4	$[\text{Cr}(\text{C}_{11}\text{H}_8\text{N}_5\text{O}_2\text{Cl})(\text{OAc})](\text{OAc})_2$	-	-	64	>128
5	$[\text{Fe}(\text{C}_{11}\text{H}_8\text{N}_5\text{O}_2\text{Cl})\text{Cl}]\text{Cl}_2$	32	32	8	64
6	$[\text{Fe}(\text{C}_{11}\text{H}_8\text{N}_5\text{O}_2\text{Cl})(\text{NO}_3)](\text{NO}_3)_2$	8	64	64	32
	Cefaclor	8	2	8	16
	Linazolid	4	4	16	32

(-) No activity

a - *Bacillus cereus* (MTCC 1272)

b - *Staphylococcus aureus* (MTCC 1144)

c - *Escherichia coli* (MTCC 739)

d - *Salmonella typhi* (MTCC 733)

Cefaclor and Linezolid are standard antibiotics.

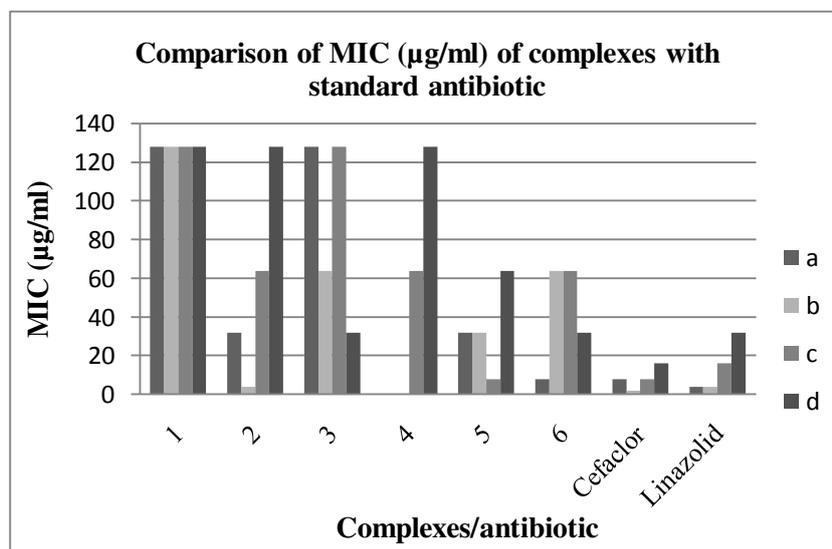
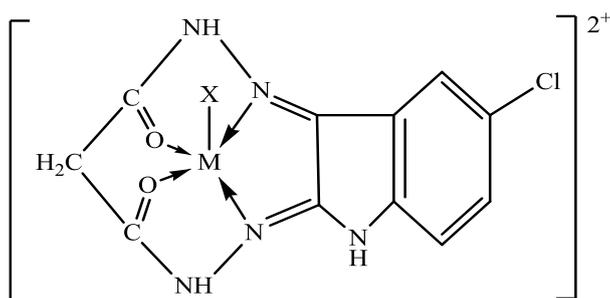


Fig. - 1

## VI. CONCLUSION

Based on various physicochemical studies like elemental analysis, conductivity measurements, magnetic measurements, electronic and IR spectral studies, a five-coordinate square-pyramidal geometry, in which two nitrogens and two carbonyl oxygen atoms are suitably placed for coordination toward the metal ion may be

proposed for all of trivalent metal complexes as shown in Fig. 2 . The synthesized compounds have antibacterial activity against the bacterial strain *Bacillus cereus* (MTCC 1272), *Salmonella typhi* (MTCC 733), *Escherichia coli* (MTCC 739) and *Staphylococcus aureus* (MTCC 1144). Unlike the ligand, the complexes showed that significant antibacterial activity. The series under test for determination of MIC, complex 5 showed good antibacterial activity against four bacteria. It has been suggested that chelation/coordination reduces the polarity of metal ions mainly because of partial sharing of its positive charge with donor group within the whole chelate ring system [35] and increases the lipophilic nature of central metal atom, which in turn favours its permeation through the lipid layers of membrane more effectively. In addition to this many other factors such as solubility, dipole moment and conductivity may be possible reasons for the antibacterial activities of metal complexes [36].



Where M = Cr(III) and Fe(III),  
X = Cl<sup>-</sup>, NO<sub>3</sub><sup>-</sup>, CH<sub>3</sub>COO<sup>-</sup>.

**Fig. 2**

### Abbreviations

MIC: Minimum inhibitory concentration

MTCC: Microbial type culture collection

MHA: Muller Hinton Agar

CFU: Colony forming unit

B.M.: Bohr Magnetron

DMF: N,N-dimethylformamide

DMSO: Dimethylsulphoxide

BHI: Brain heart infusion

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# A REPORT ON THE PROKARYOTIC BIO-LOAD SCALE AND OCCURRENCE OF *mecA*<sup>+</sup> MRSA ON FOMITES FROM RESTAURANTS

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## ABSTRACT

This work was carried with the objectives to calculate the bacterial count on the fomites of restaurants and to screen the fomite surfaces for the presence of *mecA* positive Methicillin Resistant *Staphylococcus aureus* (MRSA) strains. Two fomite surfaces that include eating table surfaces and hand washbasin surfaces of eight restaurants from educational institutions and commercial restaurants were screened to scale the bacterial counts. Colony counts were done using the dip slide technique. The results revealed that the tested eateries at the educational institutions harboured more bacterial colonies on the eating table surfaces than the hand washbasin surfaces. The reverse results of more bacterial colonies in the hand washbasin and less bacterial count on the eating table surface were observed in case of the fomites from commercial restaurants. Screening for the presence of Methicillin Resistant *Staphylococcus aureus* (MRSA) revealed that all the test fomite surfaces harboured MRSA. Multiplex PCR study showed that 37.5% of the isolated MRSA strains harboured *mecA* gene. Double disc diffusion test revealed that 25% of the MRSA isolates showed inducible Clindamycin resistance. The results highlight the existence of clinically significant pathogenic *Staphylococcus aureus* strains in the frequently accessible fomite surfaces of restaurants which could be a reservoir and portal for the establishment and dissemination of Community Acquired Methicillin Resistant *Staphylococcus aureus* infections.

**Key Words:** Fomites, *mecA*, MRSA, Inducible Clindamycin Resistance, PCR.

## I. INTRODUCTION

Fomites – defined as inanimate objects that act as carriers of pathogenic microbes play a vital role in the establishment and dissemination of community acquired infections. Mostly fomite surfaces are colonized by secondary pathogens that are commensals on the skin of frequenting persons. Amongst the vast array of such pathogens, *Staphylococcus aureus* – a Gram Positive skin commensal and an opportunistic pathogen is a clinically significant organism. Methicillin was introduced in 1959 to treat infections caused by penicillin-resistant *Staphylococcus aureus*. In 1961 there were reports from the United Kingdom of *S. aureus* isolates that had acquired resistance to methicillin (Methicillin-Resistant *S. aureus*, MRSA). Since then MRSA isolates were isolated in many countries. MRSA is now a problem in hospitals worldwide and is increasingly recovered from nursing homes and the community. The methicillin resistance gene (*mecA*) encodes a methicillin-resistant penicillin-binding protein that is not present in susceptible strains and is believed to have been acquired from a distantly related species (4). *mecA* is carried on a mobile genetic element, the Staphylococcal cassette

chromosome *mec* (*SCCmec*) [1]. Methicillin Resistant *Staphylococcus aureus* is an established nosocomial pathogen worldwide but more recently has emerged as a highly virulent organism in the community. Community Acquired Methicillin Resistant *Staphylococcus aureus* (CA-MRSA) infection is defined as illness compatible with Staphylococcal disease in a patient residing in the community and isolation of the organism from clinically relevant site [2]. CA-MRSA strains are transmissible from fomites to skin with transmissibility for many weeks after contamination [3].

In contrast to health care-associated MRSA (HA-MRSA), CA-MRSA is often susceptible to trimethoprim-sulfamethoxazole, clindamycin, doxycycline or minocycline, and Fluoroquinolones, although susceptibility to these agents may vary by geographic area. Given that the majority of reported CA-MRSA infections are skin and soft-tissue infections, Clindamycin represents an attractive option for several reasons. First, clindamycin comes in both intravenous and oral formulations (with 90% oral bioavailability). Second, the drug distributes well into skin and skin structures, and unlike  $\beta$ -lactams, it is not impeded by a high bacterial burden at the infection site. Clindamycin is also less costly than some of the newer agents that might be considered for these infections. Finally, clindamycin may be able to inhibit production of certain toxins and virulence factors in Staphylococci. One of the major concerns with regard to the use of Clindamycin for CA-MRSA infection is the possible presence of inducible resistance to Clindamycin. The Erythromycin-Clindamycin D-zone test or the Double Disc diffusion test can separate strains that have the genetic potential to become resistant to Clindamycin during therapy from strains that are fully susceptible to Clindamycin [4].

## II. MATERIALS AND METHODS

### 2.1 Calculation of Bacterial Bio-Load On Restaurant Fomite Surfaces

A total of eight restaurants that included 4 canteens from 2 educational institutions and 4 commercial restaurants in Madurai- Tamil Nadu were selected for the study. The fomite surfaces used in the study were the eating table surface and the hand washbasin sinks of each restaurants. Sampling of the surfaces were done using Hidip slides (HiMedia). The two sides of the dipslide were pressed against the test surfaces for 5seconds according to the manufacturer's instructions. Results after incubation were read using the manual's reference chart [5].

### 2.2 Isolation and Identification of MRSA from the Fomite Surfaces

Detection of *mecA* gene appears to most accurately detect methicillin resistance in *Staphylococcus aureus*. It is known that many strains of methicillin resistant *Staphylococcus aureus* also demonstrate expression of Oxacillin resistance. As a result laboratory methods have been developed to enhance the expression of resistance in Staphylococci, including the supplementation of media with NaCl. The use of Oxacillin containing 6 $\mu$ gms of oxacillin per ml of the medium, as recommended by NCCLS, has been very useful for identifying Methicillin Resistant *Staphylococcus aureus* [6].

Sterile swabs in test tubes containing Nutrient broth (HiMedia) with 6 $\mu$ gms/ml Oxacillin and 4% NaCl were used to swab the fomite surfaces. The swabs were then incubated in the tubes for 48hrs. After the period of incubation, an aliquot of 100 $\mu$ ls were quadrant streak inoculated in Mannitol Salt Agar plates (HiMedia). The plates were incubated at 37 $^{\circ}$ c for 24hrs. The golden yellow colonies were Gram stained. The isolates were then identified by tube coagulase test. Coagulase test was done by adding 0.2ml of broth culture to 0.5ml of plasma in a tube. It was mixed gently and incubated for 24hrs [7]. The isolates were subcultured in nutrient agar slants as MRSA isolates 1-16.

### 2.3 Multiplex PCR for *mecA* Gene Detection

All the isolated MRSA strains were subject to *mecA* gene detection by multiplex PCR study. The procedure was based on a modification by Unal *et al.*, (1992) [8] and this was used as the Gold Standard for all isolates. The oligonucleotides used were *mecA* F primer 1282 (5'- AAAATCGATGGTAAAGGTTGGC-3') AND *mecA* R primer 1793 (5'- AGTTCCTGCAGTACCGGATTTGC – 3'), which gives a PCR product of 533bp [9].

### 2.4 Detection of Inducible Clindamycin Resistance

All the MRSA isolates were screened for the expression of inducible Clindamycin resistance (D Test) by placing a Clindamycin (2µgms) and Erythromycin (5µgms) disc adjacently with the disc centres 5-10mm apart on sterile Muller-Hinton Agar (HiMedia) plates swabbed with the test MRSA isolates [10].

## III DISCUSSION

Analysis of the bacterial bioload scale on the test fomite surfaces revealed that the eating table surfaces of restaurants from educational institutions had a mean bacterial count of 10<sup>5</sup>CFUs/cm<sup>2</sup>, whereas the hand washbasin sinks had a mean bacterial load of 10<sup>2</sup>CFUs/cm<sup>2</sup>. Screening of the same fomite surfaces from commercial restaurants showed that the eating table surfaces had a mean bacterial load of 10<sup>2</sup>CFUs/cm<sup>2</sup>, while the hand wash basin sinks were colonized by a mean 10<sup>5</sup>CFUs/cm<sup>2</sup>. (Table-I)

An interesting feature in the study is that the eating table surface from educational institutions harboured comparatively higher bacterial counts than the washbasin surface. But the reverse result of lesser count on the eating table surface than the washbasin sink were observed in case of commercial restaurants.

Screening of the fomite surfaces for the presence of MRSA revealed that all the screened fomite surfaces harboured Methicillin Resistant *Staphylococcus aureus*. This finding highlights the definitive existence of a very clinically significant nosocomial pathogen in varying degrees of concentration at the most frequently contactable surfaces at the eateries (Table-II).

Molecular analysis of the isolated MRSA strains for the presence of *mecA* gene showed that an average of 37.5% of the isolates were only *mecA*<sup>+</sup>. This could had been possible either by the fact that the rest of the isolates would have had exhibited an alternative protocol of methicillin resistance or were *mecA*<sup>-</sup> due to mutated alterations in the gene [11].

Analysis of the MRSA isolates by D test confirmed that 25% of the isolates had inducible Clindamycin resistance (Table-II). Interestingly, all the *mecA* positive MRSA isolates and isolates that exhibited positive D test were from the fomites of commercial restaurants only and that no inducible Clindamycin resistant MRSA strains or *mecA*<sup>+</sup> strains were detectable on the fomites from educational institutions despite our low test samples. This could perhaps be attributed to the type of frequenters to the restaurant and their personal hygiene.

## IV. CONCLUSION

The study confirms the existence of varying degrees of microbial load and the presence of Methicillin Resistant *Staphylococcus aureus* on the fomite surfaces of eateries. Presence of such a clinically potential pathogen confirms that commercial fomites serve as reservoirs for various pathogenic bacteria that are potent to initiate community acquired infections.

**Table I: Bioload Count of the Test Fomite Surfaces**

Restaurant	Fomite Location	CFUs/cm <sup>2</sup>
College-I Canteen-I	Eating Table Surface	10 <sup>6</sup>
	Wash Basin Sink	10 <sup>2</sup>
College-I Canteen-II	Eating Table Surface	10 <sup>5</sup>
	Wash Basin Sink	10 <sup>3</sup>
College-II Canteen-I	Eating Table Surface	10 <sup>5</sup>
	Wash Basin Sink	10 <sup>3</sup>
College-II Canteen-II	Eating Table Surface	10 <sup>5</sup>
	Wash Basin Sink	10 <sup>2</sup>
Commercial Restaurant-I	Eating Table Surface	10 <sup>3</sup>
	Wash Basin Sink	10 <sup>6</sup>
Commercial Restaurant-II	Eating Table Surface	10 <sup>3</sup>
	Wash Basin Sink	10 <sup>6</sup>
Commercial Restaurant-III	Eating Table Surface	10 <sup>3</sup>
	Wash Basin Sink	10 <sup>5</sup>
Commercial Restaurant-IV	Eating Table Surface	10 <sup>2</sup>
	Wash Basin Sink	10 <sup>4</sup>

**Table II: Source, Biochemical, Molecular and Clinical Characteristics of The Isolated MRSA Strains**

Restaurant	Fomite	MRSA Isolate	Coagulase	<i>mecA</i>	D Test
College-I Canteen-I	Eating Table Surface	1	+	-	-
	Wash Basin Sink	2	+	-	-
College-I Canteen-II	Eating Table Surface	3	+	-	-
	Wash Basin Sink	4	+	-	-
College-II Canteen-I	Eating Table Surface	5	+	-	-
	Wash Basin Sink	6	+	-	-
College-II Canteen-II	Eating Table Surface	7	+	-	-
	Wash Basin Sink	8	+	-	-
Commercial Restaurant-I	Eating Table Surface	9	+	+	-
	Wash Basin Sink	10	+	+	+
Commercial Restaurant-II	Eating Table Surface	11	+	-	-
	Wash Basin Sink	12	+	+	+
	Eating Table Surface	13	+	-	-

Commercial Restaurant-III	Wash Basin Sink	14	+	+	+
Commercial Restaurant-IV	Eating Table Surface	15	+	+	-
	Wash Basin Sink	16	+	+	+

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# STUDY OF BUSINESS RISK MODEL IN CLOUD COMPUTING

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## ABSTRACT

Cloud computing is a hopeful technology for development of large-scale, on-demand, flexible computing infrastructures. The trend of adopting this technology by the businesses automatically introduced new risk on top of existing risk. Study of cloud business Risk purpose is to guide IT managers and decision makers regarding what to look for and things to consider when making a business decision about cloud. The Business Risks Framework reviews and illustrates the five most important business factors mentioned here. The simulations and process provided here are small illustrations about how to evaluate cloud availability and costs. The qualitative aspect of this research is to assist IT managers in coping with the uncertainties of IT transformation and the business decision of adopting cloud technology.

**Keywords:** Cloud Computing, Cloud Security, Cloud Security Risk Model

## I. INTRODUCTION

Cloud computing is currently one the most valued IT innovations. The research focuses on helping IT managers in their ongoing risk tradeoff efforts, which must always balance the demands of the business, constant regulatory changes that must be met, and escalating security threats. As cloud computing becomes more pervasive, many corporations are considering moving mission-critical workloads to cloud computing offerings. However, hesitation and barriers to adoption persist due to concerns about security, compliance, and business risks, as well as the lack of a functional model to rationalize and quantify IT risks in cloud computing services. The purpose of this research is to bring clarity and to create a better understanding of the security, business, and compliance risks associated with cloud computing, and to align perceived risks with actual risks. The goal of this research is to create a model that can guide IT professionals in the understanding of security, compliance, and business risks associated with cloud offerings, and tradeoffs that could mitigate these risks. Most IT companies planning to the cloud computing prototype. we have seen a rapid evolution of a cloud computing security discipline, with ongoing efforts to handle with the individual requirements and capabilities regarding privacy and security issue. Clouds have created new surfaces for attacks.

## II. SECURITY CONCERN

Some security concerns are listed and discussed below:

### 2.1 Cost Factor

Cost is one of the main factors that experts agreed on its positive effect for lowering business risks. The experts seemed to have faith on the significant benefits that the cloud model brings to businesses. They highlighted

their own experiences building clouds for innovative model associated with cloud computing. As discussed earlier, this cloud model reduces the need for large capital investment, reduces operational cost, and provides payment flexibility since pay only for what you consume. The skills and training required to maintain cloud VMs is significantly lower than the expertise and necessary to support traditional IT. This point has been supported not only by the experts consulted but in many other sources also. The flexibility of payment based on paying for usage is evident simply by visiting any of the cloud provider websites like Amazon, cloudsigma, Gigenet, and Rackspace. But all clouds providers are different, there is no standard unit of measurement for VMs. Some clouds like RackSpace and GoGrid use RAM as the basic unit of measurement, while others use CPU units and others have invented their own unit of measurement. there is so much confusion about cloud costs and which cloud to use. First, we discuss how to estimate cloud cost. The fastest way is to use the cost estimate tool from cloud provider. After that you probably want to compare prices with other cloud services to ensure you are getting the best price. there are many open source cloud calculators already available. the research findings were not surprising, but instead very consistent with expectations of workloads with variable or “bursty” demand pattern. The “bursty” pattern can be a collection of unpredictable peaks that result, for example, from flash crowds responding to an advertising campaign, or a special sales offer on eCommerce website, or any activity on a social networking site. The “bursty” pattern can also be created by predictable peaks caused by differences in demands due to time-offday, day-of-the-week, or cyclical patterns like tax season. we can see that predictable peaks for time-of-day variations like those experienced by banks usually have a peak-to-average ratio (PAR) of about two or three. When a burst in traffic comes we can quickly deploy as many VMs as we need to support the volume. The advantage of the cloud is not just the low cost per VM, but the automation scripts that enable “bursty” workloads to quickly deploy, in a matter of minutes, thousands of VMs to handle very high volumes.

some of the key cost advantages of cloud over traditional IT are-

### **2.1.1 Power**

The cost of electricity is becoming a significant cost of running a data center. This is why new cloud data centers are located in areas where the cost of electricity is lower, and where it can utilize water sources or air to minimize cooling costs. Because of their large consumption of power, clouds are able to negotiate wholesale block prices for electricity at much lower cost than smaller. most cloud data centers operate with minimal lighting. Some clouds use mega data center providers turn their lights off.

### **2.1.2 Operations and Labor Cost**

Cloud providers have the advantage that data centers are heavily automated and one operator is able to handle thousands of computers. Contrast this with traditional IT, where one system administrator is usually responsible for 150 servers or perhaps less, and we can easily recognize a significant advantage for cloud environments. The combination of high automation and substantial number of servers per operator in clouds results in significantly lower costs for labor and operations.

### **2.1.3 Buying Power**

When it comes to buying power the big cloud providers have tremendous Influence. For example, the top clouds (Google, Apple, Amazon, Microsoft, eBay) consumed five percent of the entire worldwide x86 spending in 2010. With this kind of buying power, discounts are significant. Some suppliers provide parts at minimum profit margins because the volumes are very high.

#### **2.1.4 Commoditized Hardware**

Another aspect that provides great advantage to cloud providers is that most clouds are built with “white boxes.” The term white box means the computer is assembled with parts provided by independent vendors. The cloud provider becomes the assembler of the final computer, which is built from parts representing the lowest possible cost of hardware.

#### **2.1.5 High Utilization**

Clouds have the advantage of being able to choose from many workloads to maintain their systems at high capacity. where lack of virtualization, no multitenancy, and a small number of instances works against optimizing workloads to maintain high utilization. Automation and virtualization technology facilitates the move of VMs to aggregate complementary workloads, which maximizes the usage of IT resources.

### **2.2 Efficiency**

The main motivation to move to a cloud is to save money on capital expenditure and operational expenses, but a very close second reason is to support faster deployment of nmm,./applications and improve the overall agility of the enterprise. Lead times to create a data center can be very long. They include the lead times to obtain capital approval, purchase hardware, configure systems, and deploy a solution. The quality assurance verification tests for a data center can range from several weeks to several months. The scalability of clouds because of their natural elasticity is one of the aspects that mitigate cloud risks associated with efficiency, availability, and cost. Standardization and automation create enormous efficiencies for clouds through substantial reduction in configuration options, limited software images supported, and automatic movement of VMs to optimize the cloud IT resources. There are some disadvantages to standardization and automation. As, standardization limits the number of operating systems and software levels available in the cloud, resulting in a dramatic reduction on the diversity of VMs. This lack of diversity helps facilitate the penetration of viruses and other malicious software across the cloud. Automation reduces cost and complexity if done correctly, but if a mistake is made on the automation script, it can cause an incredible number of problems. Automation mistakes can spread quickly, perhaps affecting the entire cloud pod before being contained. Clouds are very efficient at performing automation workflows, and automation is a known culprit in creating IT “storms” in the clouds.

### **2.3 Control Factor**

One of the disadvantages mentioned by CIOs and CTOs during the interview process for this research was the lack of transparency that cloud providers maintain regarding operations procedures. A good mitigation for this lack of transparency is a detailed set of requirements, expectations, and assurances described in SLA contracts with the cloud provider. Contracts can protect users by providing penalties when loss of income is caused by lack of service, but this doesn't mitigate possible lock-in risks. IT professionals are accustomed to controlling their IT resources, and it takes some time to get accustomed to new management processes and tools to manage IT resources at the VM level (IaaS), or platform level (PaaS), instead of at the physical level. After IT managers get new cloud processes in place that generate good availability at lower cost, many experts have observed that most of the resistance and concern about diminished IT control quickly fades.

### **2.4 Availability Factors**

cloud environments, which behave very differently. Failures in the cloud are easy to recover from within a couple of minutes because of automatic scripts and instantiation of VMs. Events that are catastrophic in a

traditional data center are an everyday occurrence in the cloud environment, but with no tangible significance to the user. This is a paradox because failures are more common in clouds. Services offered by cloud providers to automate the recovery process help reduce the recovery time to only a couple of minutes. But why do clouds have more failures than traditional IT? These failures are the result of massive amounts of systems and storage running at 95 percent utilization in mega data centers. Clouds provide the illusion of “always available,” despite the constant failure of systems, because of the large redundancy and automation they possess. Automation enables very fast recovery, which helps minimize the amount of time the system is down. A review of the availability equations listed below helps illustrate that the shorter the recovery time the better the availability, and that the more redundancy a system has the better its availability. In addition to recovery automation, a recovery strategy should also be created when moving workloads to the cloud. No cloud system is immune to a possible catastrophic event, and a disaster recovery plan is of key importance, whether a business uses clouds or traditional IT. In the case of the cloud, it is recommended that a different cloud provider be used, or at a minimum, ensure that the disaster recovery configuration is in a separate location, with different network providers and substantial redundancy. Another unique aspect of cloud computing is its ability to sustain significant denial of service (DoS) attacks. This ability is the result of the cloud’s elasticity and the ample resources from which more capacity can be drawn. This capacity can be used to maintain the services until the source of the attack can be shut down. However, this capability requires automation. If cloud users don’t invest in the automation and allocation of additional resources, the few standard allocated VMs can certainly tip over with the excess demand created by a DoS attack. Cloud users are not immune to DoS attacks, but instead have more resources available to them to defend against an attack. Cloud providers are using significant technology to enable early detection of DoS perpetrated on their customers. They are monitoring outliers on service requests and communicating to customers to address the attacks as well as possible. Availability is one of the factors that affect the reputation of a business. The general perspective of is that IT availability is one of the factors under the control of IT managers that can make a great impact on preserving and enhancing the reputation of a business. If availability is of great importance, the IT budget is not significant, and the solution doesn’t use confidential data that requires strict regulatory compliance, hosting the solution in the cloud could provide some significant advantages over traditional IT.

## **2.5 Legal Complexity**

From a legal perspective there are many issues with cloud contracts. These issues include unclear and restrictive laws, frequent trans-border operations, and lack of precedents to guide litigation. Most standard cloud contracts are based on “as is” warranties, which means the service is provided with no promises of any kind. There is no guarantee that the cloud service will be appropriate or that it will meet the customer’s expectations. Not all cloud providers offer SLAs, and those that specify assurances are usually based on limited obligation and availability. This is measured by the cloud portal uptime, instead of by the customer’s service reliability and actual performance. Also, lack of standards is a problem for cloud contracts because there is no unified way to offer cloud services and there are no standardized benchmarks to help quantify the quality of service. Trans-border data flows are COMMON when data is resident in multiple countries and cloud service and customer are located in different countries. Data flow that crosses a country’s borders is subject to the jurisdiction of multiple countries, and can create costly litigation fees because of unclear and contradictory law. Trans-border data flow has many potential legal issues that can arise because of inappropriate handling of data, disparities between IT

regulations depending on country, and ambiguity about obligations. IT managers should fully negotiate cloud contracts to ensure the agreements satisfy the needs of the business and avoid ambiguity about roles, responsibilities, and processes. The process of negotiating a contract should include specifications about the location of the data at all times, security and performance assurances, and country jurisdiction and litigation processing in the event of a dispute.

### **III. SOLUTION FOR CLOUD BUSINESS RISK MODEL**

As we discussed earlier Cloud BUSINESS risk model is based on- (1) cost (2)Efficiency (3)Control (4) Availability (5) legal complexity.

This solution strategy can assist IT managers in coping with the uncertainties of IT transformation and the business decision of adopting cloud technology.

#### **3.1 Solution for Cost**

a) Create long term strategy- Move to a cloud should instead be viewed as a long-term business transformation. A long-term plan can help identify workloads that are expensive for the corporation to maintain in-house, and cause them to evaluate a lower-cost alternative. A plan can help prioritize the workloads that are best suited for clouds, and accelerate that transformation. This plan should perform a deep analysis on the security and cost tradeoffs when making the decision to move workloads to a cloud.

b) Estimate cloud migration cost – Moving a workload to a cloud can be a great opportunity to lower capital expenditure (capex) and operating expense (opex). However, not all workloads move easily to a distributed and virtualized environment. Some modifications might be necessary to achieve a successful cloud

c) Calculate current cost- Before moving to any cloud it is important to know the cost of your current traditional IT. Analyze which applications; services are the main cost drivers.

d) Compare cloud providers- Before committing to a cloud provider make sure to compare prices across many clouds because the price differences between clouds are significant. Since clouds tend to optimize their configurations by different workloads, types of VMs, and network configurations, every cloud service is different.

e) Automate – To achieve the lowest possible cost in clouds, you need to make sure to automate your workloads to use the optimal amount of VMs for your workloads, and remove VMs you are not going to need. Keeping VMs running unnecessarily is a waste of money in clouds, because you pay for what you use.

#### **3.2 Solutions for Efficiency**

a) Optimize your cloud solution – There are many cloud management tools that are able to monitor and optimize workloads hosted on virtual environments, and that can greatly facilitate the management of VMs. Cloud elasticity is fantastic at providing the capacity necessary on demand, but keep in mind that the requests for additional resources should be managed to optimize your business and not necessarily the IT service.

b) Use the right tool for your workload - Each cloud solutions has different IT requirements and it is important to use the right tool for the job. Many cloud solutions use new programming languages like Python, PHP, and Ruby on Rails. These types of programming and scripting languages require management and development tools designed to be used with them, and extensions that facilitate the usage of cloud APIs and services

- c) Create a Disaster Recovery Plan – It is out of your control to prevent “cloud storms,” and since sooner or later there will be some type of unfortunate mistake that could affect your solutions, it is best to prepare for a disaster. A disaster recovery plan should include data centers from multiple cloud providers. However, if a single cloud provider is used, a minimum Configuration should include two data centers in different locations, with significant network redundancy, including at least two different network suppliers. Clouds provide good availability, but still can’t be assured 100 percent, and business solutions running on clouds still need a disaster recovery plan.
- d) Patch Often – To mitigate the lack of diversity of operating systems and middleware versions and types, it is recommended that users and cloud providers follow a process to continuously update software to the latest level. Stay informed. On vulnerability reports and make sure your cloud provider uses the latest operating system versions and patches.
- e) Reconfigure and redesign for the clouds – Moving workloads “as is” sometimes is not the most effective way to utilize cloud resources. For a workload to achieve the maximum economic benefit and scale horizontally automatically, it needs to be redesigned with cloud scaling in mind. Workloads need to be adjusted to interface with the cloud APIs and web services to automatically instantiate VMs. When required, delete unnecessary resources to avoid needless charges, and achieve an effective load balance across VMs. Without effective configuration and adoption of the cloud provider APIs and services for optimization, solutions won’t run as efficiently as possible.

### **3.3 Solution for Control**

- a) Demand Transparency – you must know how your data and workloads will be managed. To mitigate this concern, request inspection of the Physical data center facility, and audit the IT processes associated with your workloads before signing a long-term contract with the cloud provider.
- b) Create Isolation Layer – Avoid cloud lock-in by keeping customization related to cloud APIs and automation scripts encapsulated in a few modules to facilitate movement to other clouds if necessary.
- c) Educate IT Managers about Cloud Benefits – If IT managers understand the reasons and business benefits for moving to the cloud, less pushback and resistance can be expected from IT personnel.
- d) Control by the Numbers – The control points on IaaS and PaaS moves from the physical layer to the VM layer. Appropriate cloud tools should be utilized to ensure cloud services are optimized. The more data you collect, the better analysis you can make and more control you can exert on the utilization of the VMs.
- e) Create Clear Contractual Agreements – If you plan to run a considerable amount of work in the cloud, it is advisable to create a contract or SLA stating your expectations and requirements. Don’t accept the standard contract you get on the web when you first register with a credit card. Those contracts are written for the benefit of cloud providers, and usually include indemnification clauses.

### **3.4 Solution for Availability**

#### **3.4.1 Automate Recovery Process**

To benefit from higher availability in the clouds an investment must be made in automating the recovery process. Moving a workload to a cloud without investing in automating the recovery process would not provide any availability benefits, and could in some instances provide inferior availability.

#### **3.4.2 Monitor for Outliers**

Be proactive in defending against DoS attacks. If request loads are substantially higher than expected, consult your cloud provider to validate network activity and the origin of possible attacks. Cloud providers constantly

monitor the network volumes for possible DoS attacks and can help block attacks coming from external servers, or within the same cloud.

### **3.4.3 Create a Disaster Recovery Plan**

Clouds don't protect against catastrophic events and it is necessary to build a solid disaster recovery plan using data centers in different locations, with plenty of redundancy.

### **3.4.4 Calculate Availability**

It is important to understand the current availability as well as the possible future availability with new IT configurations. Before moving to the cloud constructs a realistic view about the current probability of system failure and overall availability. When moving to the cloud, include in the SLAs the availability expected, and dedicate a budget to automate the recovery process. After the service is in the cloud, test the Availability by stressing the service. Simulate a DoS attack to ensure the solution will work correctly when an actual DoS attack happens.

## **3.5 Solution for Legal Complexity**

### **3.5.1 Negotiate Contracts**

The standard cloud contract won't likely satisfy enterprise needs. It is recommended that contracts be fully negotiated to add the assurances, desired operational processes, and the specific country that has jurisdiction in case of a dispute.

### **3.5.2 Avoid Ambiguity**

Define concepts carefully, in a way that can be measured or quantified consistently to avoid ambiguities and misconceptions. Since there are no standard benchmarks and precedents to help describe important concepts.

### **3.5.3 Cyber Forensic Support**

For court proceedings it is important to have evidence to prove our innocence or to demonstrate wrongdoing by an attacker. However, without support by the cloud provider, and the enablement of cyber forensics on the cloud services, the user might end up with insufficient evidence. Lack of support for cyber forensics is one of the key risk factors listed under the compliance framework.

### **3.5.6 Specify Roles and Responsibilities**

Cloud systems consist of multiple layers of services, some created by the cloud provider and others provided by external vendors. Most clouds have a rich ecosystem of vendors to ensure delivery of services. To guarantee the quality expected, a mitigation strategy is to negotiate directly with the vendor providing the subservices.

### **3.5.7 Follow Best Practices for IT Contracts**

Because of a lack of benchmarks and precedents, cloud contracts should be more specific about the expected results and services provided. However, IT contracts best practices should be followed to avoid common pitfalls. Because the expected trend is for prices to drop until further maturity of the cloud market, most enterprises should set flexible contract agreements that enable them to take advantage of falling prices, but also to protect themselves against unexpected price hikes.

## **IV. CONCLUSION AND FUTURE WORK**

Cloud computing is the future of IT industries It helps the industries to get efficient use of their IT Hardware and Software resources at low cost. This paper discuss about the cloud business risk Challenges. this research illustrated the way financial benefits of the cloud can fluctuate depending on the kind of workloads. In the case

of “bursty” workloads, the potential financial benefits could be significant, since substantial reduction in IT cost can be achieved by utilizing the lowest possible configuration and dynamically provisioning VMs to support demand peaks. New cloud compliance risks related to cyber forensics, data segmentation, and data remnants are a few of the many new risks associated with clouds, and described under the Cloud Compliance Risks. Since the pace of technology is very fast in the area of cloud computing, it would be interesting to do an evaluation of cloud risks in several years to show how risk vectors, identified by this research, have changed with new technologies.

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# RANKING OF MULTIFACETED CRITERIA FOR THE VARIOUS H<sub>2</sub>S REMOVAL TECHNOLOGIES FROM BIOGAS USING ANALYTIC HIERARCHY PROCESS

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## ABSTRACT

Biogas, a clean and renewable form of energy could very well substitute for nonrenewal sources of energy. Biogas is a mixture of mainly methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>) with small amounts of sulfuric component (H<sub>2</sub>S). The chemical energy contained in biogas is converted into heat or electricity through combustion. In both cases biogas quality is the key factor in terms of methane content and purity. The Hydrogen sulfide is typically the most problematic contaminant because it is toxic and corrosive to most equipment. Removing H<sub>2</sub>S as soon as possible is recommended to protect downstream equipment, increase safety, and enable possible utilization of more efficient technologies. Packed Tower Absorption (Water Scrubbing), Chemical Reaction with Iron oxide (& its Derivatives), Chemical reaction with Zinc Oxide, Chemical Reaction with Lime, Iron Chelation Method, Adsorption on Carbon Molecular Sieves are the main available Technologies for the removal of H<sub>2</sub>S from Biogas.

Each type of Technologies has its merits and demerits. In order to selecting the most appropriate Technology among them are very important to gain the optimal benefit. To deal with such complex decision making problems, The Analytic Hierarchy Process (AHP) a Multi criteria Decision Model introduced by Thomas Saaty, is an effective tool. In this research, ranking of multifaceted criteria like Technology Maturity, Technology Availability, Initial Investment Cost, Operation Cost, Process Efficiency and Process Emissions is done by using AHP (Super Decision Software) for the prioritization of H<sub>2</sub>S Removal Technology from Biogas.

**Key Words:**, Biogas, H<sub>2</sub>S Removal Technologies, Analytical Hierarchical Process, Multifaceted criteria, Super Decision Software

## I. INTRODUCTION

Energy is vital for development and this means that if India is to move to a higher growth route than is now feasible, it must ensure the reliable availability of energy. The present energy scenario in India is not reasonable. The Energy supply position existing in the country is characterized by persistent shortages and unreliability and also high prices for industrial consumers. There is also anxiety about the position regarding fossil fuels. India depends to the extent of about seventy percent on imported fuel, and this obviously raises question about energy

security. These concerns have been worse by recent movements in international oil prices. Electricity is produced domestically but its supply depends upon the availability of coal, use of hydro power sources and the scope for expanding nuclear power, and there are restraint affecting each source. Vibrant functioning society needs energy as its lifeline and the quantum of its use indicates the quality of life being experienced by its members. There is a great disparity in the energy use amongst different regions of the world and even for countries like India where the rural areas are bereft of the benefits of energy and where obtaining food and shelter is a daily challenge. India needs to bridge this divide as soon as possible and this is of paramount importance for any growth which should include all sections of society [1].

India needs to realize the vast potential of renewable energy and need to step up effort for attaining the goal by 2020 i.e. 20% reduction in GHG, 11% reduction in consumption of energy by bringing about attitudinal changes, 20% share of renewable energy and 20% conservation of energy from the year 2011 till 2020. These targets are attainable and not only provide cleaner energy but also open a new field for providing employment opportunities to millions of people who are unemployed. This thrust then needs to be maintained so that India attains a target of having 70% renewable energy uses by 2050 [2].

There are many types of renewable resources like- wind energy, solar energy, geothermal energy, fuel cell, ocean energy, and biomass. Although these are pollution free but have some limitation like limited sites in India and also lack of appropriate technology for extraction of energy from these sources. India is second largest country of the world and the economy is based on agriculture. In India agriculture profession creates lots of residue and animal excreta are also available in adequate quantity. If these are not handled properly, this may create environmental pollution and also human health. Hence from above explanation this clear that India has large scope of biomass. In India energy crises and environmental problem can be solved by the help of biomass. Biogas is produced by the anaerobic digestion or fermentation of biodegradable materials. Biogas is a renewable energy source and can replace fossil fuel. Anaerobic digestion is often the only possibility of producing biogas from manure. By definition, anaerobic digestion is a microbiological process during which organic matter is decomposed into biogas and microbial biomass in the absence of air. There has been growing interest in biogas which is bio-energy source resulting from the conversion of natural biomass. Biogas consists mainly of methane ( $\text{CH}_4$ ) and carbon dioxide ( $\text{CO}_2$ ), with smaller amounts of water vapor and trace amounts of hydrogen sulfide ( $\text{H}_2\text{S}$ ), and other impurities. Various degrees of gas processing are necessary depending on the desired gas consumption process. Hydrogen sulfide is typically the most challenging contaminant because it is toxic and corrosive to most equipment. Additionally, combustion of  $\text{H}_2\text{S}$  leads to sulfur dioxide emissions, which have harmful environmental effects. Removing  $\text{H}_2\text{S}$  as soon as possible is recommended to protect downstream equipment, increase safety, and enable possible utilization of more efficient technologies such as micro turbines and fuel cells [3].

Most biogas purification methods are derived from conventional gas separation technologies and many of them have been successfully applied for natural gas purification. Commonly used technologies are Packed Tower Absorption (Water Scrubbing), Chemical Reaction with Iron oxide (& its Derivatives), Chemical reaction with Zinc Oxide, Chemical Reaction with Lime, Iron Chelation Method, Adsorption on Carbon Molecular Sieves.

Each type of  $\text{H}_2\text{S}$  removal from Biogas technology has its merits and demerits, so that selecting the most appropriate removal Technology among them is very important to gain the best possible option. The Analytic

Hierarchy Process (AHP) a MCDM model introduced by Thomas Saaty, is a useful tool for dealing with such complex decision making.

The principles and philosophy of the theory of this multi criteria decision making technique were explained giving background information of the type of measurement utilized, its properties and applications (Saaty 1990). It is becoming quite popular in research due to the fact that its utility outweighs other rating methods (Eddi and Hang 2001). The AHP methodology has been accepted by the international scientific community as a robust and flexible multi-criteria decision-making tool for dealing with complex decision problems (Elkarmi and Mustafa 1993). The potency of the AHP approach is based on breaking the complex decision problem in a logical manner into many small but related sub-problems in the form of levels of a hierarchy. The hierarchical structure of the AHP model permits decision- makers to compare the different prioritization criteria and alternatives more effectively. The AHP may involve group discussion and dynamic adjustments to finally arrive to a consensus [4, 5].

In the present study, an attempt has been made to arrive at the ranking of multifaceted criteria like Technology Maturity (Technical Aspects Only), Technology Availability (In India), Initial Investment Cost, Operation Cost, Process Efficiency and Process Emissions (Air, Water & Ground) using AHP (Super Decision Software) for the prioritization of most appropriate Removal Technology of H<sub>2</sub>S removal from Biogas in Indian context.

## **II. VARIOUS REMOVAL TECHNOLOGIES OF H<sub>2</sub>S FROM BIOGAS**

Removal of H<sub>2</sub>S from Biogas can be accomplished by using a number of different Technologies like Packed Tower Absorption (Water Scrubbing), Chemical Reaction with Iron oxide (& its Derivatives), Chemical reaction with Zinc Oxide, Chemical Reaction with Lime ,Iron Chelation Method, Adsorption on Carbon Molecular Sieves. Factors that influence the choice of removal process are: the type and quantity of biogas available, the ultimate application of energy, environmental norms and economic viability. The Brief discussion of H<sub>2</sub>S removal Technologies from Biogas is given below:

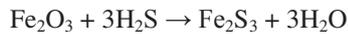
### **2.1 Packed Tower Absorption (Water Scrubbing)**

Pressurized water scrubbing (PWS) is the most commonly used method for the purification of biogas. It is fundamentally based on the principle that the solubility of CO<sub>2</sub> and H<sub>2</sub>S is higher in water as compared to CH<sub>4</sub>, thus separating both CO<sub>2</sub> and H<sub>2</sub>S simultaneously from biogas with a high efficiency is easy. To increase the absorption of CO<sub>2</sub> and H<sub>2</sub>S, Biogas is usually compressed to about 1000 kPa and a packing media which has a high surface area is used. Inside the scrubber, the flow of biogas keeps counter currently with respect to water flow that is sprayed from the top of scrubber, and the absorption primarily occurs on the surface of the packing media. Cleaned biogas can contain more than 96% CH<sub>4</sub> after drying. The liquid effluent contains a high concentration of CO<sub>2</sub> and a low concentration of methane. It is recycled in the flash tank where pressure is lowered to 200–400 kPa. Finally, water is regenerated in the stripper at near atmospheric pressure with air blown into the stripper. The advantages of this method include no need for chemicals and simultaneous removal of CO<sub>2</sub>, H<sub>2</sub>S, and other impurities which are soluble in water, e.g. Dust and Ammonia (NH<sub>3</sub>).The main challenge of this method is that its demand of water is very high [6-7]. H<sub>2</sub>S has a slightly higher solubility than CO<sub>2</sub>, but costs associated with selective removal of H<sub>2</sub>S using water scrubbing have not yet shown competitive with other

methods. Therefore, water scrubbing will probably only be considered for the simultaneous removal of both H<sub>2</sub>S and CO<sub>2</sub>.

## 2.2 Chemical Reaction with Iron oxide (& its Derivatives)

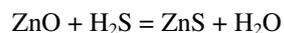
Iron-oxide impregnated wood-chips selectively adsorb H<sub>2</sub>S and mercaptans. The primary active ingredients are hydrated iron oxides (Fe<sub>2</sub>O<sub>3</sub>) of alpha and gamma crystalline structures. The mixed oxide, Fe<sub>3</sub>O<sub>4</sub> (Fe<sub>2</sub>O<sub>3</sub>.FeO), also contributes to the activity present. The chemical reactions involved are shown in the following equations



Like all gas-solid adsorption processes, iron-sponge-based H<sub>2</sub>S removal is operated in batch mode with separate regeneration, or with a small flow of air in the gas stream for continuous, at least partial, regeneration. The iron sponge can be operated in batch mode with separate regeneration, or with a small flow of air in the gas stream for continuous revivification. It is imperative to manage heat build-up in the sponge during regeneration to maintain activity and prevent combustion. Due to S<sup>0</sup> build-up and loss of hydration water, iron-sponge activity is reduced by about one third after each regeneration cycle. Therefore, regeneration is only practical once or twice before a new iron sponge is needed. While the benefits of the iron sponge also comprise simple and effective operation, there are critical drawbacks to this technology that have led to its decreased usage in recent years. The process is highly chemical-intensive; operating costs can be high; and a continuous stream of spent waste material is accumulated. Additionally, the change-out process is labor-intensive, and can be troublesome if heat is not dissipated during regeneration. Perhaps most importantly, the safe disposal of spent iron sponges has become problematic, and in some instances, spent media may be considered as hazardous waste requiring special disposal procedures. Land filling on site is still practiced, but has become riskier due to fear of the need for future remediation [8-9].

## 2.3 Chemical Reaction with Zinc Oxide

Zinc oxides are preferred for removal of trace amounts of hydrogen sulfide from gases at elevated temperatures due to their increased selectivity over iron oxide. Typically in the form of cylindrical extrudates 3-4 mm in diameter and 8-10 mm in length, zinc oxides are used in dry-box or fluidized-bed configurations. Hydrogen sulfide reacts with zinc oxide to form an insoluble zinc sulfide via Equation:



Zinc-oxide processes are available in several forms for operation at temperatures from about 200° C to 400° C. Maximum sulfur loading is typically in the range of 30-40 kg sulfur/100 kg sorbent for these processes. Formation of zinc sulfide is irreversible and zinc oxide is not very reactive with 24 organic sulfur compounds. If removal of mercaptans is also desired, catalytic hydro desulfurization to convert these compounds to the more reactive hydrogen sulfide is needed first [10].

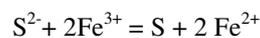
## 2.4 Chemical Reaction with Lime

Maizirwan Mel et. al (2014) used Aqueous solution of Ca (OH)<sub>2</sub> as chemical solvent to demonstrate its ability and effectiveness in absorbing CO<sub>2</sub> and H<sub>2</sub>S from biogas. Different operating parameters which include concentration of limewater solution and flow rate of biogas were used. Methane (CH<sub>4</sub>) composition after treatment was also studied as removal of impurities is interrelated to CH<sub>4</sub> enhancement. The concentrations of limewater were varied, as well as the biogas flow rates. Experiments done reveal the highest CO<sub>2</sub> removal

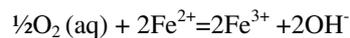
efficiency can be achieved with 14% concentration of limewater solution and the highest absorption capacity was achieved with 1.0 l/min of biogas flow rate. Increment is about 21.2% from its original value. These results indicate that the highest performance of limewater solution as an absorber is when the concentration of the solvent used is at 14% with 1.0 l/min flow rate of biogas. H<sub>2</sub>S removal however was unable to be conducted due to its low concentration (ppm) in biogas mixtures, hence there is no significant changes in its concentration that are worth to be analyzed. Since in this technique H<sub>2</sub>S and CO<sub>2</sub> both are removed, in that case costs associated with selective removal of H<sub>2</sub>S using this technique has not yet shown competitive with other methods. Therefore, H<sub>2</sub>S removal from this technique will probably only be considered for the simultaneous removal of both H<sub>2</sub>S and CO<sub>2</sub>.

## 2.5 Iron Chelation Method

Horikawa et al. (2004) investigated chemical absorption of H<sub>2</sub>S in a Fe (III)-EDTA catalyst solution. In this process, H<sub>2</sub>S is dissolved in an aqueous solution and catalytically removed by a chelated iron according to the following reaction:



The sulfur produced is easily separated by sedimentation or filtration from the Fe-EDTA-solution. Regeneration of the aqueous Fe-EDTA-solution is done by oxygenation, followed by conversion of the pseudo-catalyst into its active form Fe<sup>3+</sup>:



Due to the regeneration the Fe-EDTA-solution can be retained entirely and a large consumption of chemicals is avoided. The process can be carried out at ambient temperature and is very specific in removing H<sub>2</sub>S: the volumes of the other biogas components CH<sub>4</sub> and CO<sub>2</sub> remain nearly constant. Moreover, a removal of 90-100% can be obtained for biogas containing 2.2% H<sub>2</sub>S at a gas flow of 1 dm<sup>3</sup> min<sup>-1</sup>, the catalytic solution flowing at 83.6 cm<sup>3</sup> min<sup>-1</sup> and an inlet biogas pressure of 220 kPa . At lower catalytic solution flow, lower absorption efficiency is obtained. At lower inlet H<sub>2</sub>S concentration higher absorption efficiency is obtained. Therefore, the total removal of H<sub>2</sub>S depends on the use of the adequate ratio of gas to liquid flow rates.

## 2.6 Adsorption on Carbon Molecular Sieves

Granular activated carbon (GAC) is a preferred method for removal of volatile organic compounds from industrial gas streams. Heating carbon-containing materials to drive off volatile components forms GAC's, which have a highly porous adsorptive surface. Utilization of GAC's for removal of H<sub>2</sub>S has been limited to removing small amounts. If H<sub>2</sub>S is the selected contaminant to be removed, GAC's impregnated with alkaline or oxide coatings are utilized. Catalytic-impregnated, impregnated carbons and non-impregnated carbons (virgin) are the three basic types of activated carbon. Catalytic-impregnated AC is manufactured by treatment with urea or some other chemical containing nitrogen (i.e. NH<sub>3</sub>). These chemicals react with the surface sites on AC particles and add nitrogen functionalities. Catalytic carbons are said to be water-regenerable. Whereas Impregnated AC is those to which a solid or liquid chemical has been mixed with carbon substrate before, during, or after activation. The main chemicals serving as impregnates are sodium bicarbonate (NaHCO<sub>3</sub>), sodium carbonate (Na<sub>2</sub>CO<sub>3</sub>), sodium hydroxide (NaOH), potassium hydroxide (KOH), potassium iodide (KI), and potassium permanganate (KMnO<sub>4</sub>). Mixtures of these chemicals are sometimes used. A typical H<sub>2</sub>S loading capacity for caustic, impregnated carbons is 0.15 g/g of AC. Strong base-impregnated carbons are considered

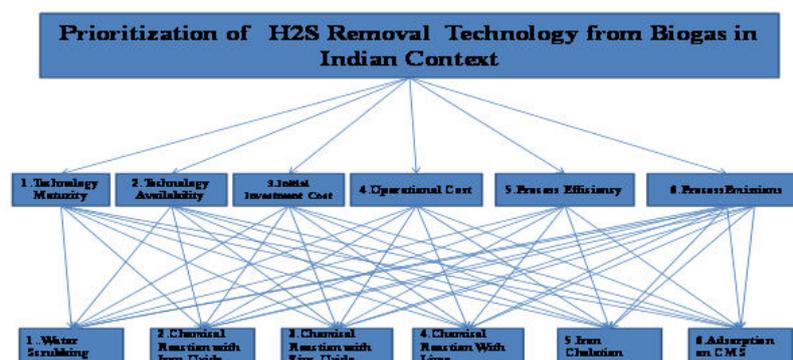
regenerable by re-application of the strong base. Such regenerations are rather cumbersome for small scale applications and can lead to the spent adsorbent being classified as hazardous, including the treatment area. While non-impregnated AC employed for H<sub>2</sub>S removal has H<sub>2</sub>S-loading capacities around 0.02 g/g of AC [12].

### III. RESEARCH METHODOLOGY

The *Analytic Hierarchy Process* (AHP), introduced by Thomas Saaty, is an effective tool for dealing with complex decision making, and may assist the decision maker to set priorities and make the finest decision. By reducing complex decisions to a series of pairwise comparisons, and then produce the results, the AHP helps to capture both subjective and objective aspects of a decision. As well the AHP include a helpful technique for checking the consistency of the decision maker's assessment, thus reducing the prejudice in the decision making process. The AHP considers a set of assessment criteria, and a set of alternative options among which the best decision is to be made. It is significant to note that, since some of the criteria could be different, it is not true in general that the best option is the one which optimizes each single criterion, to a certain extent the one which achieves the most suitable trade-off among the different criteria. The AHP make a weight for each evaluation criterion according to the decision maker's pairwise comparisons of the criteria. The superior the weight, the more significant the corresponding criterion. Subsequently, for a fixed criterion, the AHP allocate a score to each option according to the decision maker's pairwise comparisons of the options based on that criterion. The superior the score, the better the performance of the option with respect to the considered criterion. Finally, the AHP merge the criteria weights and the alternative scores, thus determining a inclusive score for each option, and a consequential ranking. The inclusive score for a given option is a weighted sum of the scores it obtained with respect to all the criteria.

The AHP is a very flexible and influential tool because the scores, and as a result the final ranking, are obtained on the basis of the pairwise relative assessment of both the criteria and the options provided by the user. The calculation made by the AHP are always guided by the decision maker's experience, and the AHP can thus be considered as a tool that is able to interpret the assessment (both qualitative and quantitative) made by the decision maker into a multicriteria ranking [14].

The Selection and ranking of multifaceted criteria for the Prioritization of H<sub>2</sub>S removal Techniques from Biogas in Indian Context is very crucial step of this process. Various criteria like Total Availability of Biomass, Conversion Technology, Process efficiency, Cost of Biomass Resources, Capital Cost Involved and Emission Released are selected from the literature review and discussion with experts from different sectors that are related to the problem improves the effectiveness and correctness of the decision. The alternatives will be pairwise compared with respect to the criterion for preference as shown in Fig. 1 given below.

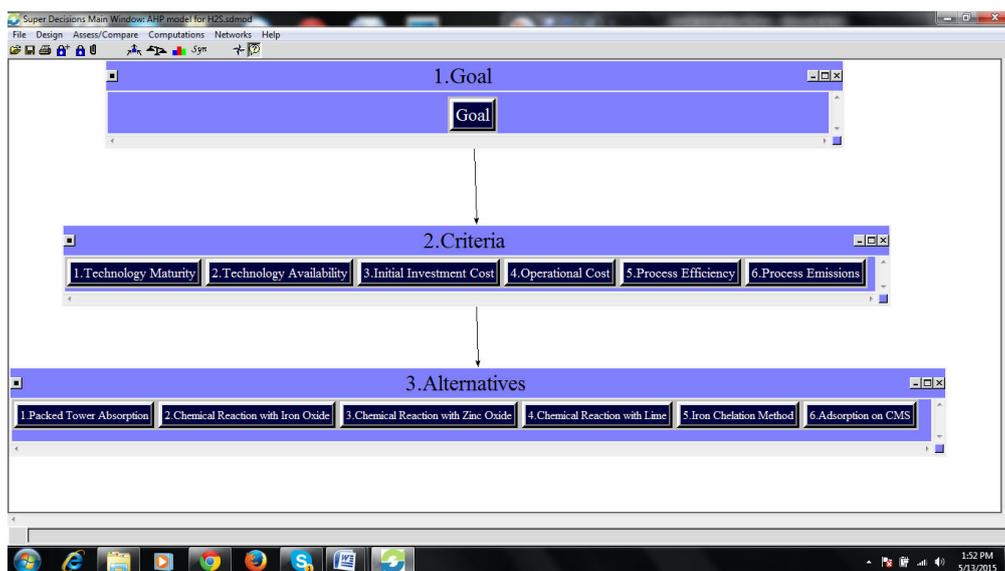


**Fig 1: The Hierarchy of H<sub>2</sub>S Removal Technologies from Biogas**

In this research SuperDecisions software designed by William J. Adams is used for the implementation for decision making. In this software a decision model is made up of clusters, nodes and links. Clusters are groupings of nodes which are logically related factors of the decision. Connections are made among nodes to establish comparison groups and when nodes are connected links automatically appear between their clusters. In a hierarchy the links go only downward: from the goal node to the criterion nodes and from each Criterion node to the alternative nodes. Priorities for the criteria are obtained by calculating the principal eigenvector of the above matrix. A short computational way to obtain this vector is to raise the matrix to powers. Fast convergence is obtained by successively squaring the matrix. The row sums are calculated and normalized. The computation is stopped when the difference between these sums in two consecutive calculations of the power is smaller than a prescribed value.

The priorities of an AHP pairwise comparison matrix are obtained by solving for the principal eigenvector of the matrix. The mathematical equation for the principal eigenvector  $w$  and principal eigenvalue  $\lambda_{max}$  of a matrix  $A$  is given below. It says that if a matrix  $A$  times a vector  $w$  equals a constant ( $\lambda_{max}$  is a constant) times the same vector, that vector is an eigenvector of the matrix. Matrices have had more than one eigenvector; the principal eigenvector which is associated with the principal eigenvalue  $\lambda_{max}$  (that is, the largest eigenvalue) of  $A$  is the solution vector used for an AHP pairwise comparison matrix.  $Aw = \lambda_{max} w$ . The *SuperDecisions* software uses a special algorithm to remember and display additional priorities in the Limit supermatrix that appeared in successive powers of the matrix and give useful information. The final overall priorities for the alternatives, in raw unnormalized form, appear in the column beneath the goal. The priorities for the criteria in the goal column, when normalized, are the original priorities derived by pairwise comparison. The weighted supermatrix is raised to powers until it converges to the limit supermatrix which contains the final results, the priorities for the alternatives, as well as the overall priorities for all the other elements in the model. It happens that the weighted supermatrix is the same as the unweighted supermatrix for an AHP hierarchy, so raise the matrix above to powers [15, 16]. Below is a screenshot of the Biomass Alternatives hierarchy as it appears in the software in Fig.

2



**Fig 2: The Hierarchy of Links in Super Decision Software**

The pairwise comparison judgments are made using the Fundamental Scale of the AHP and the judgments are arranged in the pairwise comparison matrix. The pairwise comparison judgments used in the AHP pairwise comparison matrix are defined as shown in the Fundamental Scale of the AHP given by Thomas Satty below in Table 1.

**Table .1: The Fundamental Scale of the AHP**

Intensity of importance	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong importance	An activity is favored very strongly over another
9	Absolute importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2,4,6,8	Used to express intermediate values	
Decimals	1.1, 1.2, 1.3, ...1.9	For comparing elements that are very close

The numbers in the cells in an AHP matrix, by convention, indicate the dominance of the row element over the column element; a cell is named by its position (Row, Column) with the row element first then the column element. Only the judgments in the unshaded area need to be made and entered because the inverse of a judgment automatically entered in its transpose cell. The diagonal elements are always 1, because an element equals itself in importance. If the number of elements is  $n$  the number of judgments is  $n(n-1)/2$  to do the complete set of judgments as shown in Table-2.

**Table 2: Matrix showing Pairwise Comparison of Criteria with respect to Goal**

Goal	1.Technology Maturity	2.Technology Availability	3.Intial Investment Cost	4.Operation Cost	5.Process Efficiency	6.Process Emissions
1.Technology Maturity	1	3	4	5	4	7
2.Technology Availability		1	3	4	3	6
3.Intial Investment Cost			1	2	4	5
4.Operation Cost				1	3	4

5.Process Efficiency					1	2
6.Process Emissions						1

Table 3 represents the complete pair-wise comparisons between the different parameters considered for ranking the overall priorities of H<sub>2</sub>S removal Technologies. The values of the respective criteria are entered in 6x6 matrix.

**Table 3: Matrix showing Complete Pairwise Comparison of Criteria with respect to Goal**

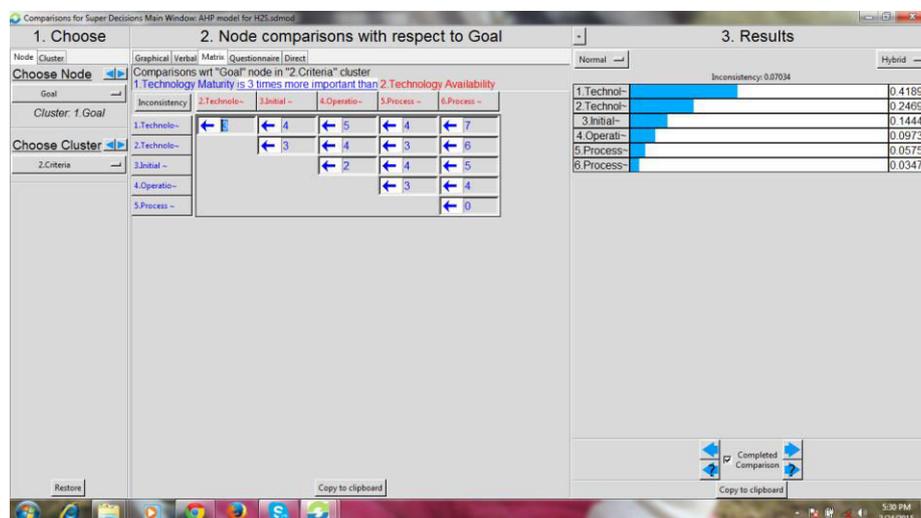
	1.C1	2.C2	3.C3	4.C4	5.C5	6.C6	
1.C1		1	3	4	5	4	7
2.C2	0.333		1	3	4	3	6
3.C3	0.25	0.333		1	2	4	5
4.C4	0.2	0.25	0.5		1	3	4
5.C5	0.25	0.333	0.25	0.333		1	0
6.C6	0.142	0.166	0.2	0.25	0		1

#### IV. RESULTS AND DISCUSSION

Six types of multifaceted criteria Technology Maturity (Technical Aspects Only), Technology Availability (In India), Initial Investment Cost, Operation Cost, Process Efficiency and Process Emissions (Air, Water & Ground) have been evaluated to determine the most appropriate one for the prioritization of most appropriate Technology for H<sub>2</sub>S removal from Biogas in Indian Perspective . A selection methodology based on AHP (Super Decision Software) is proposed. This methodology involves a procedure for the aggregation of expert opinion using the six selection criteria that are appropriate for India.

Experts involved in the assessment found that the Technology Maturity is the most important criteria having the priority of 0.4189 followed by the priorities of Technology Availability and Initial Investment Cost as 0.2469 and 0.1444 respectively. While other criteria Operation Cost, Process Efficiency and Process Emissions have lower scores 0.0973, 0.0575 and 0.0347 respectively.

The Results above mentioned is shown below in Fig.3, the screenshot from super decision software.



**Fig.3: The screenshot from super decision software**

The results of the above decision can also be shown as below in Table 4.

**Table 4: Priorities of Different Criteria**

Inconsistency	0.07034	
Name	Normalized	Idealized
1. Technology Maturity	0.418933375	1
2. Technology Availability	0.246977191	0.589538112
3. Initial Investment Cost	0.144443978	0.344789855
4. Operation Cost	0.097330098	0.232328347
5. Process Efficiency	0.057575502	0.137433553
6. Process Emissions	0.034739856	0.082924537

It is very clear from the above results that the criteria related to **Technology Maturity and Technology Availability** are more important than any other criteria. The benefit of the proposed model is that it increases the effectiveness of the decision by allowing participation of different experts. Since decisions made in the energy sector affect all society and sectors, these decisions should not be made by the initiative of individual or through one sector.

## V. CONCLUSION

Biogas is preferred over fossil fuels sources as it is much cheaper and environmentally friendly. Gases in biogas can be combusted or oxidized with oxygen. However, before the biogas could be supplied for energy application, it needs to be cleaned and purified as there is the presence of entities like CO<sub>2</sub> and H<sub>2</sub>S which can affect the calorific value, quality, quantity and also the performance of the whole system for biogas production. Hydrogen sulfide can significantly damage mechanical and electrical equipment used for process control, energy generation, and heat recovery. The combustion of hydrogen sulfide results in the release of sulfur dioxide, which is a problematic environmental gas emission. Its removal is essential for end use of Biogas.

It was found that there are sufficient removal Technologies are available but each option has its own limitations. The Analytic Hierarchy Process (AHP) a MCDM model is an useful tool for dealing with such complex decision making. In this study an overview of various Removal Technologies of H<sub>2</sub>S from Biogas is presented and Ranking of Criteria for prioritizing various Removal Technologies of H<sub>2</sub>S from Biogas has been done. An AHP (Super Decision Software) model is developed to meet out the purpose.

From the Research, it can be concluded that the experts involved in the assessment found that in the criteria related to Technology Maturity, Technology Availability and Initial Investment Cost are more important than any other criteria. The results of this study can be useful to develop a comprehensive sustainable Energy model for a developing country like India. It should be noted that the model's application is country-specific, since the strategic criteria depend on the country's specific Biogas energy characteristics. The method used and the results obtained from this study can be used in the further research.

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# EXPERIMENTAL ANALYSIS ON DE-LAMINATION IN DRILLING GFRP COMPOSITE MATERIAL

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## ABSTRACT

Glass fibre reinforced plastic composite materials are increased application in aeronautical, automobile and structural applications. Most of fibre reinforced composite material parts are processed to a near net shape, machining is often like finishing, trimming, drilling, grinding, etc. Among the several research processes, drilling of composite materials causes several damage modes, such as: de-lamination, fibre-pull out, edge chipping, uncut fibres, surface roughness and dimensional errors and others. During machining, the reduction of tool wear is an important aspect. The objective of this study is was an optimization technique has been developed to predict the de-lamination on the machining of GFRP composites using Taguchi method in order to study the main and interaction effects of machining parameters, viz., feed rate and spindle speed. Drilling test was carried out on E- glass fibre composites using uncoated and diamond coated HSS twist drill bits with same tool geometry.

**Keywords:** GFRP composites, De-lamination, L9 orthogonal array, Taguchi approach, Diamond coated HSS twist drill.

## I. INTRODUCTION

Fiberglass is an immensely versatile material due to its light weight, inherent strength, weather-resistant finish and variety of surface textures. The development of fiber-reinforced plastic for commercial use was extensively researched in the 1930s. It was of particular interest to the aviation industry. A means of mass production of glass strands was accidentally discovered in 1932 when a researcher at Owens-Illinois directed a jet of compressed air at a stream of molten glass and produced fibers.

In aerospace industry, more and more composite laminates are primarily used in structural components instead of metal alloys allowing for weight reduction. GFRP composite laminates are used in fairings, storage room doors, landing gear doors, and passenger compartments. CFRP composite laminates are often used in wing boxes, horizontal stabilizers, vertical stabilizers, and wing panels.

In automobile, glass fiber reinforced plastics (GFRP's) are the most commonly used in mechanical joints in pieces and structures in industry. However, the mechanical joints require good surface quality holes for bolts and rivets.

J Babu, Tom Sunny studied about the de-lamination of composite materials by conducting drilling experiments using Taguchi's L25, 5-level orthogonal array and Analysis of variance (ANOVA) was used to analyze the data

obtained from the experiments and finally determine the optimal drilling parameters in drilling GFRP composite materials using Four Fluted End Mill.

Vinod Kumar Vankanti, Venkateswarlu Ganta mentioned the optimize process parameters namely, cutting speed, feed, point angle and chisel edge width in drilling of glass fiber reinforced polymer (GFRP) composites. In this work, experiments were carried out as per the Taguchi experimental design and an L9 orthogonal array was used to study the influence of various combinations of process parameters on hole quality. Analysis of variance (ANOVA) test was conducted to determine the significance of each process parameter on drilling [8].

Desh Bandhu, Sandeep Singh Sangwan and Mukesh Verma aims to present a literature survey on the drilling of composite materials, more specifically on drilling of carbon fiber reinforced plastics. Aspects such as tool materials and geometry, machining parameters and their influence on the thrust force and torque are investigated [2].

Zhenchao Qi, Kaifu Zhang, Yuan Li, Shunuan Liu, Hui Cheng The aim of this paper is to study about de-lamination during drilling metal-FRP (Fiber Reinforced Polymer Composite) stacks, with the effect of the metal part taken into account [10].

Turgay K1vak, Gurcan Samtas, Adem Cicek focuses on the optimization of drilling parameters using the Taguchi technique to obtain minimum surface roughness (Ra) and thrust force (Ff). A number of drilling experiments were conducted using the L16 orthogonal array on a CNC vertical machining centre. The experiments were performed on AISI 316 stainless steel blocks using uncoated and coated M35 HSS twist drills under dry cutting conditions [7].

K. Palanikumar conducted experiments on GFRP composites using Brad & Spur drill and optimized drilling parameters by using two input variables with four levels and concluded that low feed rate and high spindle speeds are beneficial to reduce de-lamination [5].

T.V. Rajamurugan, K. Shanmugam, K. Palanikumar In the present study the experiments are carried out using end mill (Carbide) to find the optimum drilling parameters using Taguchi's L25 orthogonal array. To develop empirical relationships between the drilling parameters such as fiber orientation angle, tool feed rate, rotational speed and tool diameter with respect to de-lamination in drilling of GFR-polyester composites. The empirical relationship has been developed by using response surface methodology [8].

## **II. TECHNIQUES OF DE-LAMINATION**

Among the several research processes, drilling of composite materials causes several damage modes, such as: de-lamination, fiber-pull out, swelling, edge chipping, uncut fibres, surface roughness and dimensional errors and others. De-lamination is considered as the major concern.

### **2.1 Peel up de-lamination**

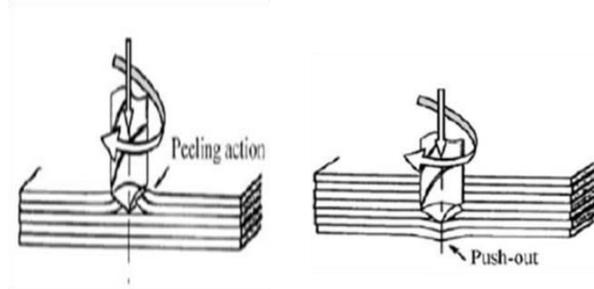
Peel-up is caused by the cutting force pushing the abraded and cut materials to the flute surface.

The cutting edge of the drill will first abrade the laminate initially. It then, by moving forward, tends to pull the abraded material away along the flute.

Before material is machined completely it spirals are up. This action introduces a peeling force upwards to separate the upper laminas from the uncut portion held by the downward acting thrust force.

## 2.2 Push Down De-Lamination

The laminar under the drill thus tend to be drawn away from the inter-laminar bond around the hole. At the end of the drill, the uncut thickness becomes smaller and the resistance to deformation decreases. In particular point, the loading exceeds the inter-laminar bond strength and de-lamination occurs.



**Fig. 1 Peel-Up and Push Down De-Lamination**

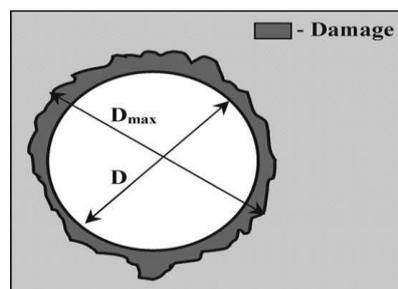
## 2.3 De-Lamination Factor ( $F_d$ )

The factor used to determine the extent of de-lamination is called de-lamination factor.

$$F_d = D_{\max}/D$$

$D_{\max}$  - The maximum diameter created due to de-lamination around the hole.

$D$  - The hole or drill diameter.



**Fig. 2 De-Lamination**

## III. MATERIALS & EXPERIMENTAL PROCEDURE

Four layered UD-GFRP specimens of 5mm thickness were prepared using the hand lay-up process. The reinforcement was in the form of unidirectional E-glass fiber mat and the matrix was epoxy, araldite Ly 556 with hardener HY (anhydride hardener). A gel coat was applied on the mould prior to the lay-up process to facilitate easy removal of the laminate. Specimens were cured at room temperature for 24 hr in ambient conditions.



**Fig.3 E-Glass Fibre**

From this experiment, the analysis is mostly depending on the tool (drill bit) selection. The uncoated and diamond coated HSS twist drill bits with 5mm diameter are used in the experiments to drilling the GFRP composite materials.



**Fig.4 Uncoated HSS twist bit**



**Fig.5 Diamond coated HSS twist bit**

The experimental set-up is shown in fig.6. Drilling experiments are conducted on computer numerically controlled CNC vertical milling machine. Tool maker microscope is used to measure the maximum diameter due to de-lamination around the hole.



**Fig.6 Experimental Setup**

Traditional experimental design methods are too complicate and difficult to use. Additionally, these methods require a large number of experiments, when the number of process parameters increases. In order to minimize the number of tests required, Taguchi experimental design method is a powerful tool for designing high quality system was developed by Taguchi.



**Fig.7 View Of Entrance Side Of Drilled Holes For Different Cutting Parameters By Both drills**

The experimental design was according to an L9 array based on Taguchi method, while using the Taguchi orthogonal array would markedly reduce the number of experiments. Using Analysis of Variance (ANOVA), the effect of input parameters on de-lamination factor is studied

**TABLE I L9 ORTHOGONAL ARRAY**

Experiment no	Feed rate	Spindle speed
1	1	1
2	1	2
3	1	3
4	2	1
5	2	2
6	2	3
7	3	1
8	3	2
9	3	3

#### IV ANALYSIS OF RESULTS AND DISCUSSION

A drilling test was conducted to evaluate the effect of cutting parameters on the damage at work piece. The damage around the work piece was measured using a toolmaker micros scope.

After measuring the maximum diameter  $D_{max}$  in the damage around each hole, the de-lamination factor is determined by utilizing equation as mentioned in the section II for both drills. Table IV illustrates the influence of cutting parameters on the de-lamination factor.

From the table 2 it was observed that the de-lamination factor was vary with feed rate and spindle speed for both uncoated and diamond coated HSS twist drill.

**TABLE 2 L9 ORTHOGONAL ARRAY AND EXPERIMENTAL RESULTS**

Test no	Spindle speed	Feed rate	De-lamination factor	
			Uncoated	Diamond coated
1	2000	25	1.064	1.056
2	2000	30	1.084	1.052
3	2000	35	1.162	1.066
4	2400	25	1.106	1.060
5	2400	30	1.090	1.049
6	2400	35	1.092	1.062
7	2800	25	1.150	1.041
8	2800	30	1.128	1.062
9	2800	35	1.126	1.087

The highest value of de-lamination factor was observed from the table 2 is 1.162 for uncoated and 1.087 for diamond coated drill bit. The lowest value of de-lamination factor was 1.064 for uncoated and 1.041 for diamond coated drill bit.

There are three categories of quality characteristics in the analysis of the S/N ratio, i.e. the lower the better, the higher the better, and the nominal the better.

Here, I prefer

Lower-the-better

This is usually the chosen S/N ratio for all undesirable characteristics like defects for which the ideal value is zero. Also, when an ideal value is finite and its maximum or minimum value. The generic form of S/N ratio then becomes,

$$n = -10 \text{Log}_{10} [\text{mean of sum of squares of \{measured - ideal\}}]$$

**TABLE 3 S/N Response Table For Delamination Factor (Uncoated)**

Test number	Feed rate	Spindle speed	De-lamination factor	S/N ratio
1	25	2000	1.064	23.8764
2	30	2000	1.084	21.5144
3	35	2000	1.162	15.8097
4	25	2400	1.106	19.4939
5	30	2400	1.090	20.9151
6	35	2400	1.092	20.7242
7	25	2800	1.150	16.4782
8	30	2800	1.128	17.8558
9	35	2800	1.126	17.9926

From the above table we can clearly see that the de-lamination factor is indirectly proportional to the S/N ratio. It also varies with the varying feed rates and spindle speeds. For smaller de-lamination factor we get the higher S/N ratio for both the drill bits.

The highest value of S/N ratio is 23.8764 for uncoated and 27.7443 for diamond coated drill bit. The lowest value of S/N ratio was 15.8097 for uncoated and 23.6091 for diamond coated drill bit.

From the table 3 the lowest de-lamination factor occurs at the feed rate 25 mm/min and spindle speed 2000 rpm for drilling E-glass fiber by uncoated HSS twist drill bit.

**TABLE 4 S/N Response Table For Delamination Factor (diamond coated)**

st number	Feed rate	Spindle speed	De-lamination factor	S/N ratio
1	25	2000	1.056	25.0368
2	30	2000	1.052	25.6799
3	35	2000	1.066	23.6091
4	25	2400	1.060	24.4370

5	30	2400	1.049	26.1961
6	35	2400	1.062	24.1522
7	25	2800	1.041	27.7443
8	30	2800	1.062	24.1522
9	35	2800	1.087	27.2096

From the table 4 the lowest de-lamination factor occurs at the feed rate 25 mm/min and spindle speed 2800 rpm for drilling E-glass fiber by diamond coated HSS twist drill bit.

After finding the de-lamination factor and S/N ratio, the mean values are predicted and the graphs are plotted between the de-lamination factor and varying parameters like feed rate and spindle speed for both drills called main effects for means shown in fig 6 and 7.

At the same time the graphs plotted between the de-lamination factor, feed rate and spindle speed called interaction effects for means for both uncoated and diamond coated HSS twist drill bits shown in fig 8 and 9.

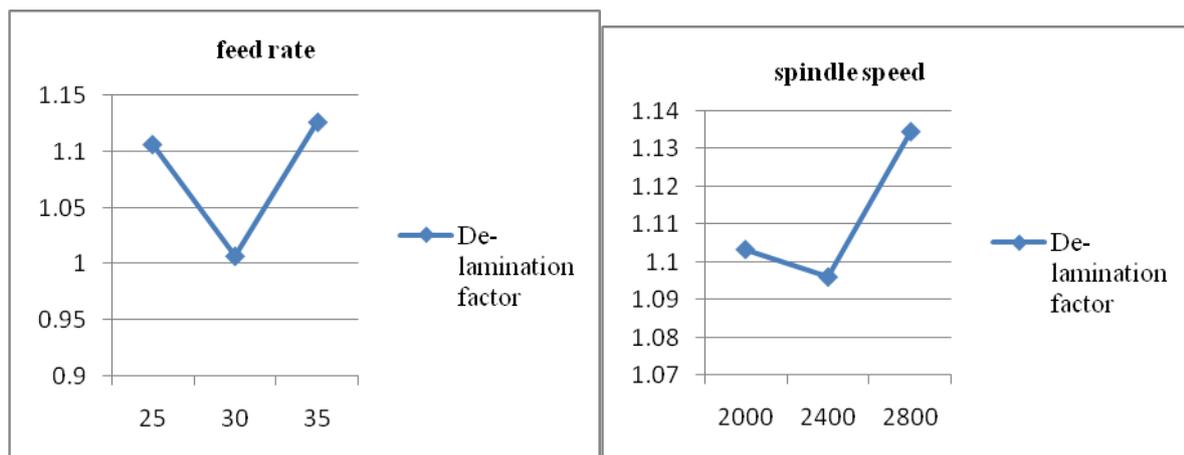


Fig.6 Main effects for means (uncoated)

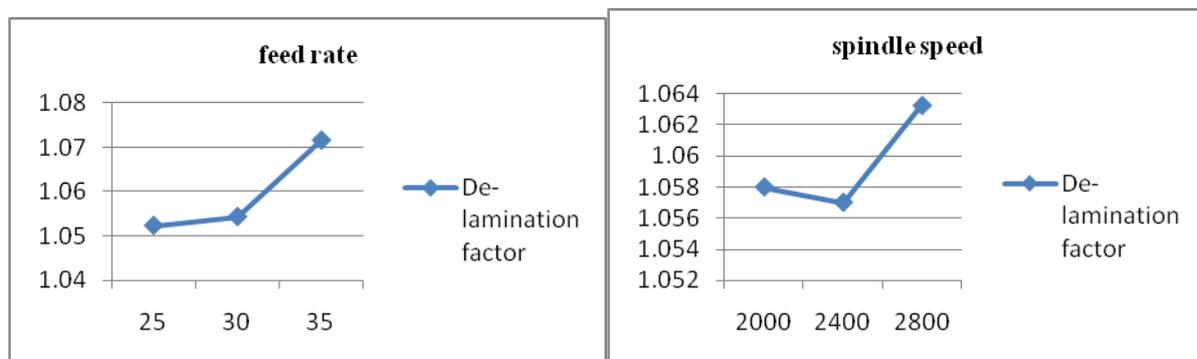
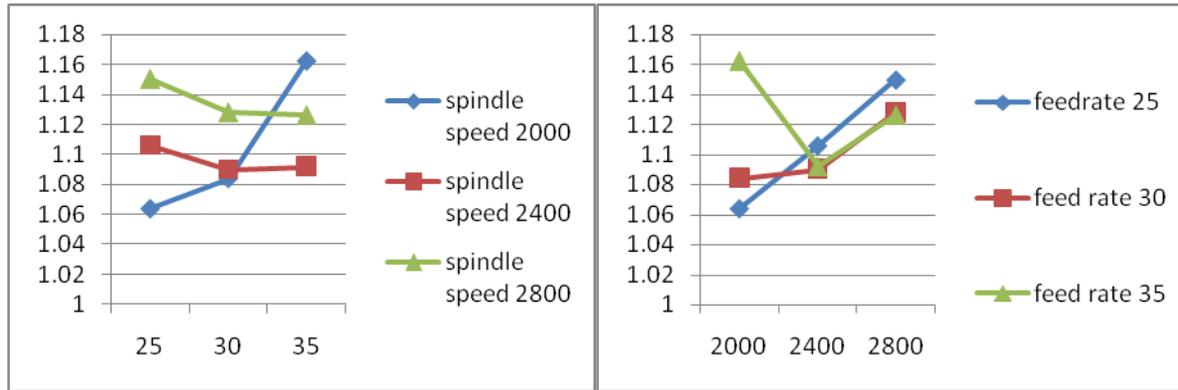
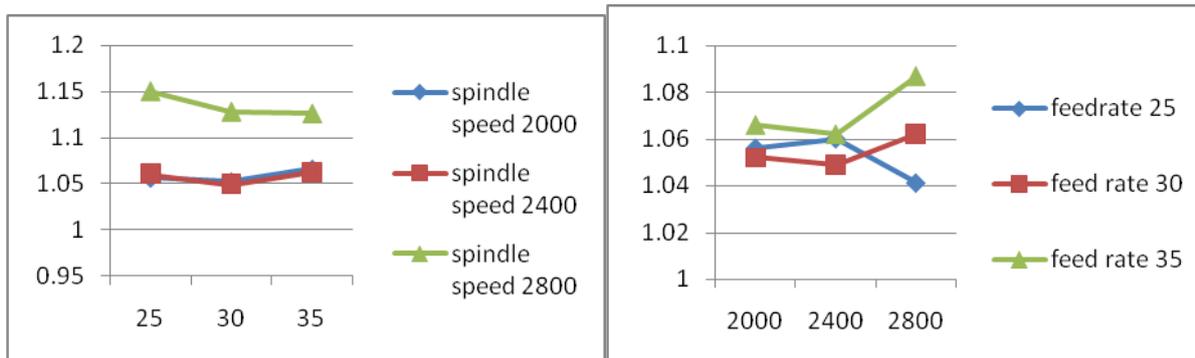


Fig7. Main effects for means (diamond coated)



**Fig.8 Interaction effects for means (uncoated)**



**Fig.9 Interaction effects for means (Diamond coated)**

From the graphs it is seen that the spindle speed decreased from 2800rpm to 2400rpm, the de-lamination factor decreases for uncoated drill bit. And also the feed rate decreased from 35mm/min to 30mm/min, the de-lamination factor decreases for diamond coated drill bit.

**Table 5 Analysis of Variance For Means (uncoated)**

source	DF	Seq SS	Adj MS	F	P
Feed rate	2	0.00112	0.00056	0.467	0.627
Spindle speed	2	0.00253	0.00127	1.065	0.426
Residual error	4	0.00475	0.00119		
total	8	0.00840			

**Table 6 Response Table for Means (uncoated)**

Level	Speed	feed
1	1.1033	1.1066
2	1.0960	1.1006
3	1.1346	1.1266
Delta	0.0386	0.0260
rank	1	2

From the table 6 for uncoated HSS twist drill, the delta value for spindle speed is higher compared to the value of feed rate. The rank for spindle speed is 1 and that the feed rate is 2. Thus from the table 5 (F value larger).It is clear that the spindle speed is mainly affecting the de-lamination factor compared to feed rate.

**Table 7 Analysis of Variance For Means (diamond coated)**

source	DF	Seq SS	Adj MS	F	P
Feed rate	2	0.00069	0.000334	2.32	0.214
Spindle speed	2	0.00007	0.000034	0.23	0.802
Residual error	4	0.00058	0.000146		
total	8				

**Table 8 Response Table for Means (diamond coated)**

Level	Speed	feed
1	1.0580	1.0523
2	1.0570	1.0543
3	1.0633	1.0716
Delta	0.0063	0.0193
rank	2	1

From the table 8 for diamond coated HSS twist drill, the delta value for feed rate is higher compared to the value of spindle speed. The rank for feed rate is 1 and that the spindle speed is 2. Thus from the table 7 (F value larger).It is clear that the feed rate is mainly affecting the de-lamination factor compared to feed rate.

## **V. CONCLUSION**

The optimization of cutting process parameters namely speed and feed rate in drilling glass fiber reinforced polymer (GFRP) composites using the application of Taguchi and ANOVA analysis the conclusion drawn from this work are as follows:

The optimum process parameters in the drilling of GFRP composites are

- Uncoated drill bit - Speed of 2000 rpm, feed rate at 25 mm/min for the de-lamination are found to be optimum parameters.
- Diamond coated drill bit- Speed of 2800 rpm, feed rate 25 mm/min and for the de-lamination are found to be optimum parameters.
- The ANOVA results reveal that's that spindle speed is most significant influencing on the de-lamination factor for the uncoated drill bit.
- Speed is the most significant influencing on the de-lamination factor for the diamond coated drill bit.

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# A REVIEW OF ULTRAWIDE BAND ANTENNAS WITH AND WITHOUT BAND NOTCHED CHARACTERISTICS

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## ABSTRACT

Mobile & wireless communication technologies are rapidly growing industrial markets from last two decades. The future of communication system is to provide voice, image & data at high speed anytime, anywhere in the world. These communication devices need proper antenna to fulfill the requirements of wide band & multiband. The difficulty is that the advancement of the antenna design is required with increase in the operating frequency. The problem for the required antenna arises with increasing number of operating frequency bands and miniaturizing. In order to transmit and receive more information large bandwidths are required and bandwidth enhancement is currently a popular topic of research. This is achieved by the introduction of UWB range with the specific bandwidth of 7.5GHz. The studies and research for UWB antenna is of much attention these days due to its high data rate capability. Basic key requirements for antenna to operate in UWB range are capability of operating over an ultra wide bandwidth allocated by the FCC, group delay for UWB antenna must be in 10ns range, radiation pattern should be omni-directional, compact in size, planar, cheap and low profile,  $VSWR \leq 2$  across the whole band of operation so as to maintain good matching and efficient operation and constant gain. The focus of this paper is to study and analyse the types of UWB band antennas available and previously designed, which are physically compact, planar profile, sufficient impedance bandwidth, stable and near omnidirectional radiation pattern along with different method of notching the frequency bandwidths for filtering purpose.

**Keywords:** Ultra-Wide Band , Band-Notched & Multi-Band Antenna, Slot Antenna, Bandwidth Enhancement

## I. INTRODUCTION

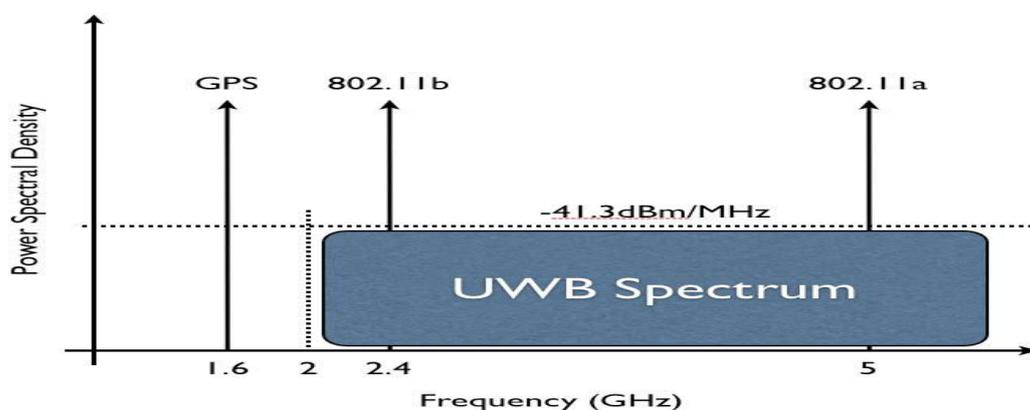
The increasing demand for wireless communication systems spurs on the need for antennas capable of operating at a wide frequency band. Owing to their attractive merits such as simple structure, pure polarization and omnidirectional radiation pattern, the conventional monopole and its variants have been widely used in wireless communications. Wireless multimedia systems are receiving increasing research and application interests. But improvements are still required to provide higher data-rate links, for instance, the transmission of video signals. Therefore, ultra-wideband (UWB) communication systems are currently under investigation and the design of a compact wideband antenna to overcome the narrow bandwidth limitation of microstrip antennas.

The Federal Communication Commission (FCC)'s allocation of the frequency band 3.1–10.6 GHz [1] for commercial use has a sparked attention on ultra wideband (UWB) antenna technology in the industry and academia. [2] [3].

After recognizing the potential advantages of UWB, the FCC developed a report to allow UWB as a communications and imaging technology. A UWB definition was designed as a signal with a fractional bandwidth greater than 0.2 or which engaged more than 500 MHz of spectrum. The fractional bandwidth [1] is defined as

$$2 * \frac{(f_H - f_L)}{(f_H + f_L)}$$

Where  $f_H$  and  $f_L$  are the upper and lower frequencies respectively measured at -10 dB below the peak value. The comparison of different wireless systems is shown in figure1.



**Figure 1: Comparison of Different Wireless Communication Systems in the Frequency Domain [1]**

### 1.1 Advantages of UWB

1. **Power Consumption:** The Federal Communications Commission power requirement for UWB systems is -41.3dBm/MHz (75nW/MHz). It uses 1/1000 of the power required for equivalent conventional transmission methods.
2. **High Security:** Because of their low average transmission power, Systems offering UWB communication have an inherent immunity to detection and interception. The time modulation of exceedingly narrow pulses adds security to UWB transmissions.
3. **Resistance to Interference:** UWB signals are therefore relatively resistant to intentional and unintentional jamming.
4. **High Performance in Multipath Channels:** It reduces Multipath Fading.
5. **Strong Penetration Ability:** UWB signals penetrate through the walls and make through the wall communication possible.

The key requirements for UWB antennas that should be considered are :

1. The bandwidth specified by the FCC is 7.5GHz ( 3.1 to 10.6 GHz).
2. Secondly group delay for UWB antenna must be in 10ns range.
3. Radiation Pattern should be Omni-directional with constant gain
4. Antenna should be compact in size, planar, cheap and low profile.

5. VSWR should be less than two (2) across the whole band of operation so as to maintain good matching and efficient operation.[4]

## II. LITERATURE REVIEW

As we know the several design methods and structures have been reported. UWB antenna designs with filtering property or band notch characteristics have been proposed not only to mitigate the potential interferences but also to remove the requirement of an extra band stop filter in the system.

**Mike W. K. Lee et.al. (2015)** proposed a wideband dual-polarized two-layer patch antenna using the 4-C shaped slot structure and T-shaped probe feeding. The novelty of the antenna is that a T-square stub feed is providing an extra resonance which is increasing the bandwidth. The antenna is miniaturized to size but with excellent port isolation. The T-probes used to feed the 4-C slot-cut patches widen the bandwidth. [5]

**Yingsong Li et.al. (2014)** presented multi-function circular wide-slot configurable UWB antenna which can be used as a dual band-notched UWB antenna, a single band notched UWB antenna, a UWB antenna, or even as a multi-band antenna. The frequency band-notched characteristics is achieved by using a stepped impedance resonator (SIR) and an arc-shaped parasitic element (ASPE), and the multi-function design is attained by the use of four switches. [6]

**QiangWang & Yan Zhang (2014)** presented UWB band notched antenna for the Frequency bands of 3.3–3.7GHz (Wimax) and 5.15–5.35GHz (WLAN) and in 7.25–7.75GHz (X Band Satellite Communication). They Introduced modified ground with two fillets and three steps to produce smooth transition from one resonant Frequency to another. two arc shaped slots were etched in the radiation patch which notched bands of 3.3–3.7 GHz and 5.15–5.35 GHz. A U-shaped slot in the ground plane generated the third notched band in 7.25–7.75GHz for the X-band satellite communication systems. [7]

**Sai K. Venkata et. al.(2014)** proposed an UWB Band Notched antenna by etching two round shape slots in radiating patch the at WiMax band (3.3-3.7 GHz) and WLAN band (5.15-5.875 GHz). They introduced a pair of rotated V-shape slot are etched on the ground plane to realize notch band at X-band downlink satellite communication band (7.1-7.76 GHz). [8]

**M. N. Shakib et.al.(2014)** proposed a compact planar Tuning Fork-shaped notched UWB antenna for 5.28–6.97GHz (WiMAX, WLAN, and C-band).. The bandwidth of the proposed antenna is increased by using rectangular radiating patch and an arc shaped strip in between radiating patch and feed line. [9]

**Ronghua Shi et.al. (2014)** presented a novel dual band notched UWB antenna. The band rejection is achieved by an arc H-shaped slot on the radiating patch. By varying the parameters of these slots band notched at 3.3–3.6 GHz for WiMAX and 5.1–5.9 GHz for WLAN is achieved. [10]

Tzu-Chun Tang & Ken-Huang Lin (2014) proposed a dual band notched UWB antenna. In the presented antenna the radiation patch is connected to conduction strip on the other side of patch with avia hole which is providing a coupling path as well as dual band rejection at WiMAX (3.4–3.7 GHz) and WLAN (5.15–5.35 and 5.725–5.825 GHz) frequency bands. [11]

**M. Ojaroudi et al. (2013)** proposed a small, printed UWB monopole antenna with dual notch band characteristics at 5.2-5.8 GHz (WLAN), 3.5-5.5 GHz (WiMAX) , and 4-GHz C-bands. A n inverted fork-shaped slit etched out on the ground plane which provides and an additional resonance which provides a wide impedance bandwidth. Dual

notch band characteristics, were achieved using a coupled inverted U-ring strip in the radiating patch. [12]

**M. Moghadasi et al. (2013)** proposed a small dual-band coplanar waveguide (CPW)-fed antenna. The proposed antenna is a rectangular patch that is surrounded by upper and lower ground-plane sections that are interconnected by a high-impedance microstrip line. [13]

**A. H. Shah et al. (2013)** presented A Tri-band G-shaped Microstrip Monopole antenna. The proposed antenna is fed with CPW waveguide and the parameters have been optimized to obtain the resonant modes at 2.4 GHz, 4.2 GHz, and 6.07 GHz as the centre frequencies of the said three frequency bands. [14]

**Zheng Guo et.al.(2013)** proposed methods of bandwidth enhancement in UWB Antennas. The original antenna covers the frequency range of 1.73GHz –11 GHz i.e. bandwidth of 9.27 GHz. By cutting two new slots on the ground plane, bandwidth is expanded to 9.33 GHz (1.67–11 GHz) and by the use of conventional mushroom-type electromagnetic band-gap enhances the bandwidth to 9.47 GHz (1.53–11 GHz) with the extra GPS covered. [15]

**Mubarak Sani Ellis et.al. (2013)** presented a small band-notched wing shaped monopole ultrawideband (UWB) antenna covering 5–15 GHz with a notched band of 6.7–7.1GHz which is achieved by attaching a strip to the hollow center of a wing-shaped monopole. [16]

**Fuguo Zhu et.al. (2013) proposed**, four novel coplanar waveguide (CPW)-fed consisting of half-circle shaped patch with an open rectangular slot and a half-circle shaped ground plane. The proposed designs can reject the frequency bands in 3.3–3.6 GHz, 5.15–5.35 GHz or 5.725–5.825 GHz without using an additional band-stop filter. [17]

**Jian-Feng Li et.al. (2013)** proposed compact dual band-notched ultra-wideband (UWB) multiple-input multiple-output (MIMO) antenna at 5.15 to 5.85 GHz and 3.30–3.70 GHz with high isolation. The two protruded ground parts are connected by a compact metal strip to reduce the mutual coupling for the band of 3.0–4.0 GHz. and the measured results show a bandwidth with ranged from 3.0 to 11.0 GHz excluding the two rejected bands. [18]

**H. F. Abutarboush et al (2012)** proposed a U-slot tri-band monopole antenna on a low- cost paper substrate using inkjet-printed technology. The U- shaped slot is designed to enhance the bandwidth and to achieve tri-band operating resonant modes at 1.57, 3.2, and 5 GHz with measured impedance bandwidths of 3.21%, 28.1%, and 36%, respectively. [19]

**Ali Foudazi et.al.(2012)** presented small-size planar UWB antenna with extended frequency band covering GPS/GSM/WLAN i.e. frequency bands of 1.3 GHz, 1.8 GHz and 2.4 GHz . The proposed antenna is a microstrip-fed multi-band planar diamond-shaped patch monopole antenna that covers the ultrawideband (UWB) i.e. from 3.1-10.6 GHz. Several narrow strips, acting as resonance paths, are integrated with the antenna gives the multiband design. It is also shown that by removing the centre part of the antenna, without distorting the UWB behavior, quarter-wavelength strips are added to the notched region. [20]

**S.Theepak & Sachendra Sinha (2012)** proposed dual band notched UWB monopole with Coplanar wave Guide (CPW) feed. The presented antenna covers the entire UWB range of 3.1 GHz to 10.6 GHz with notched band at 5.2GHz and 5.8 GHz. This double band notching technique has been introduced by reducing the mutual coupling between the notch filter in the patch and in the ground plane antenna by combining two traditional techniques. [21]

**Seyed Ramin Emadian et.al. (2012)** proposed a single-layer printed circle like slot antenna with dual band notch characteristics for ultrawideband (UWB) applications. The presented antenna consists of a circle-like slot, a trident-shaped feed line, and two nested C-shaped stubs. By using such a feed line, much wider impedance bandwidth is obtained. Two frequency band-notches of 5.1–6.2GHz (WLAN) and 3–3.8 GHz (WiMAX) are achieved by inserting a pair of nested C-shaped stubs on the back surface of the substrate. [22]

**Bing Li et.al. (2012)** proposed a dual band switched antenna that for the WLAN frequency bands (2.4–2.485, 5.15–5.35, and 5.725–5.825 GHz) and with the band-notched characteristics i.e. the stop band for the frequency band of 5.15 to 5.825 GHz. The presented antenna is composed of a rectangular ring slot, four switches, a coplanar waveguide (CPW) feeding line, a T-shaped stub, and two inverted S-shaped slots. [23]

**M. Koohestani et al. (2011)** presented a microstrip-fed planar monopole antenna for ultra-wideband (UWB) systems. The antenna structure consists of a dome-topped, bowl-shaped patch and a truncated ground plane structure. The ground plane is tapered and has a notch below the feed-line in the vicinity of the patch. [24].

**S. Jing et al. (2011)** presented dual-band E-shaped monopole antenna for 2.4 and 5.2GHz bands. Dual band characteristics are obtained by adding two L-shaped stubs to a traditional monopole antenna. The feed to the antenna is done by coplanar waveguide. [25]

**J. H. Yoon et al. (2011)** proposed dual-band planar monopole antenna which effectively covers both the 2.4GHz and 5.2/5.8 GHz bands. The designed antenna consists of two branches, an asymmetric ground plane, a rectangular projection strip, and a rectangular slit in the ground plane. The rectangular projection strip and the rectangular slit in the ground plane were introduced to enhance the performance of the proposed antenna. [26].

**Zhi-An Zheng et.al. (2011)** proposed two band-notched UWB compact slot antenna. A Z-shaped slot and a split rectangle ring slot were etched nearby the slot radiator in the ground plane, respectively. Both of them can achieve a notched band in frequency range from 5.15–5.825 GHz, and the notched band can be adjusted easily by varying the width and length of the slot. [27]

**S.Lin et al. (2010)** proposed a new dual frequency microstrip antenna which has two operating modes. The presented antenna has two different length monopoles, out of which the larger monopole work for first resonant mode and shorter monopole for the second mode and by etching rectangular slot in larger monopole a broadband dual frequency operation was demonstrated and it cover the two frequency band 1.9 GHz to 2.2GHz and 2.2GHz to 2.8GHz.[28].

**L.Y. Cai et al. (2010)** presented a compact triple band antenna using two U-type slot antenna which are very effective in rejecting unwanted frequency in term of its selectivity. This antenna gives bidirectional pattern in the E-plane and omni directional radiation pattern in H-plane over the frequency range and relatively stable. This antenna offer excellent performance for Bluetooth, WiMAX and WLAN Frequency Bands [29].

**K. Fuqiang et al. (2010)** discussed on a triple-band microstrip antenna for WLAN application is made up of quarter wavelength resonating component operating at 2.5GHz and 4.8GHz with the bandwidth of about 500MHz and 2.63GHz covering the triple band of WLAN system. [30]

**B. Vedaprabhu et al. (2010)** proposed a patch antenna with two U-shaped slots to achieve dual band operation. The design of a microstrip patch antenna is done to operate for multiple wireless bands with frequency ranges of 1.7-2.2GHz, 2.4-2.5GHz, 5.15-5.35GHz, and 5.45-5.85GHz. [31]

**K. Dong et al. (2010)** proposed a compact dual-band planar monopole antenna for 2.4/5GHz . The two resonant Frequency modes of the presented antenna are associated with four slots which contribute to the upper resonant frequency and can reduce the size of the lower resonant length. [32]

**Wei Hu et.al.(2010)** proposed an dual band notched ultra-wideband antenna The antenna is based on the rectangle planar monopole structure By modifying the radiation patch to octagon and etching out two T - shaped slots from the octagonal patch, the dual band-notched characteristic is achieved around 3.5GHz and 5.8GHz. [33]

**L. Xie et.al.(2010)** presented a compact Ultrawideband (UWB) monopole antenna with a dual band-notched characteristic at 3.5GHz and 5.25GHz. by the use of two meandered slots with the impedance bandwidth is 8.5 GHz (2.5-11 GHz). [34]

### **III. CONCLUSION**

In this paper, we have reviewed multiple types of UWB antennas covering whole impedance bandwidth i.e. from 3.1 GHz to 10.6 GHz as well as we have also observed multiple techniques for band notch designs. In wireless communication technology UWB is growing rapidly due to its high data rate. We have also observed about the applications of the UWB its time domain analysis and practical applications. The Challenges of the feasible UWB antenna design include the UWB performances of the impedance matching and radiation stability, the compact impression of the antenna size, and the low manufacturing cost for customer electronics applications. UWB antennas show great potential with the rapid growth and developments of wireless communication technology that we will be witnessing tomorrow.

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