CHAPTER 1

INTRODUCTION

1.1 GENERAL

As a result of the increasing demand for environmental friendly materials and the desire to reduce the cost of traditional fibres (i.e., carbon, glass and aramid) reinforced petroleum-based composites, new bio-composites have been developed. Researchers have begun to focus attention on natural fibre composites (i.e., bio-composites), which are composed of natural or synthetic resins, reinforced with natural fibres.

Some of the natural fibres are low-density material yielding relatively lightweight composites with high specific properties. These fibres also offer significant cost advantages and ease of processing along with being a highly renewable resource, in turn reducing the dependency on foreign and domestic petroleum oil.

The recent advances in the use of natural fibres (e.g., flax, jute, hemp, straw, switch grass, kenaf, coir and bamboo) in composites have been reviewed by several authors (Kandachar and Brouwer 2002, Katharine Conrad 2008).

In this chapter, the general introduction, need of this study, scope of this research work, objectives and organization of the thesis are discussed.
Over the decade, composites of polymers reinforced with natural fibres have received ever increasing attention, from various industries. Natural fibre composite materials have been utilized in sports products such as surf boards and snowboards as well as in the furniture industry as structural material because of their quality of endurance and durability in combination with low density. In addition, natural fibre composites have been adopted by the automotive industry where lower weight can increase transport capacity and decrease fuel consumption. In fact, many of the automotive manufacturers aim to largely replace glass fibre composites with recyclable or biodegradable natural fibre composites.

Natural fibres have already accepted a record of success as reinforcing material in automotive parts. Natural fibres like jute, flax, hemp coir and sisal are good reinforcement in thermosets and thermoplastic matrices and are being used in automotive applications, construction as well as in packaging industries with few drawbacks (Mohanty et al 2000).

A composite containing at least one constituent (e.g., matrix or reinforcement) that is derived from readily renewable resources may be considered a bio-composite (Bullions et al 2004).

Generally, four main reasons are mentioned which make the application of natural fibres attractive: (1) specific properties (2) price (3) health advantages and (4) recyclability.

The volume and number of applications of composite materials have grown steadily, penetrating and conquering new markets relentlessly. Modern composite materials constitute a significant proportion of the engineered materials’ market ranging from everyday products to sophisticated
niche applications. While composites have already proven their worth as a weight-saving materials, the current challenge is to make them cost effective. The efforts to produce economically attractive composite components have resulted in several innovative manufacturing techniques, currently being used in the composites industry.

Berghezan (1966) defines composite as a compound material which differs from alloys by the fact that the individual components retain their characteristics but are so incorporated into the composite as to take advantage only of their attributes and not of their short comings, in order to obtain enhanced materials.

The advantages of composites over their conventional counterparts are their ability to meet diverse design requirements with significant weight savings as well as strength-to-weight ratio. Some advantages of composite materials over conventional ones are as follows (Berghezan 1966):

- Composites are 30% - 40% lighter than aluminium structures designed for the same functional requirements. (Berghezan 1966)
- Composites are less noisy while in operation and provide lower vibration transmission than metals.
- Composites are more versatile than metals and can be tailored to meet performance needs and complex design requirements.
- Long life offers excellent fatigue, impact, environmental resistance and reduce maintenance.
- Composites exhibit excellent corrosion resistance and fire retardancy.
• Improved appearance with smooth surfaces and readily incorporable integral decorative melamine are other characteristics of composites.

1.2 NEED FOR THE PRESENT STUDY

Around 24 billion chickens are killed every year across the world which discards four billion pounds of poultry feather, according to press reports (2009). This mammoth size of discarded feather, apart from polluting the soil or air, causes various human ailments including chlorosis, mycoplasmosis and fowl cholera arising from feather waste.

Chicken feathers possess unique properties like low relative density and good thermal and acoustic insulating properties. (Griffith 2002). They could be used advantageously in a number of applications, which would serve as alternatives to feather meal and feather disposal. In addition, technologies for processing chicken feathers into fibrous (feather fibre) and particulate (quill) fractions have been developed and patented (Griffith 2002, Gassner III 1998). Although a number of commercial applications have been investigated, market mechanisms have failed to produce alternative high volume consumers of the processed materials.

Composite building materials containing chicken feather materials are high volume applications which could potentially consume all of the chicken feathers produced annually and raise their market value. Based upon processing costs and the price of similar fibres, it has been estimated that feather fibre could yield a profit of $1000/ton (McGovern 2000).

In order to successfully develop applications for chicken feathers in the area of composite materials, the physical, chemical, mechanical properties and structure of chicken feather fibre (CFF) must first be understood.
Jute is a suitable natural fibre for use as reinforcement in composite because of its low cost, renewable nature and much a lower energy requirement for processing. Jute is a strong, coarse and rigid fibre with very low extensibility which makes it suitable to act as reinforcing material in the composite. Jute is cheaper and process friendly (Ganguly and Samajpati 1996).

Thermoplastic matrices are increasingly being used in preference to thermosets for industrially fabricated natural fibre composites mainly because their composites are easier to recycle and faster to process than thermosets’ composites. Thermoplastic polymers to be used as matrices for natural fibre composites must meet several requirements including having a low melting temperature and low density, as well as being cheap and recyclable. The processing temperatures of natural fibre composites are limited below 200\(^{0}\)C to avoid fibre degradation, and so the first criterion for selecting a suitable composite matrix is that it melts below 200\(^{0}\)C. However, lower temperature processing also reduces processing costs and is more environmental friendly.

The most commonly used thermoplastic resins are Polyethylene (PE), Polypropylene (PP) and polyvinylchloride (PVC). PP is one of the cheapest materials and has excellent toughness and impact strength, but the lowest in service temperature (Joseph et al 2002). PP, high-density polyethylene (HDPE), low density polyethylene (LDPE) and PVC have suitably low melting temperatures. PP and LDPE have the lowest densities and are therefore the most suitable ones in this respect.

The increased interest in using natural fibres as reinforcement in composite manufacturing to substitute conventional synthetic fibres has become one of the main concerns to study the potential of using CFF as reinforcement for composite. The development of natural fibre composites has been a great support towards the development of technical applications
for renewable resources. Hence this research work aims at using CFF and jute fibre to produce compression moulding composite board and to analyse its mechanical properties. Further, to analyse the composite board for its acoustic property.

1.3 OBJECTIVES

The objectives of the study are as follows:

1. To characterize the CFF for its physical, chemical, thermal, morphological properties and amino acid content.
2. To manufacture a compression moulding composite board of CFF, jute fibre and its blends reinforced with polypropylene matrix.
3. To investigate the mechanical properties of composites such as tensile strength, impact strength and flexural strength.
4. To provide relationships between process variables on composites mechanical properties and to optimize the process conditions.
5. To evaluate the acoustic property of composites.

1.4 SCOPE OF THE PRESENT STUDY

The present study was undertaken to exploit two natural materials, CFF and jute fibre, to manufacture natural fibre reinforced composite board with thermoplastic polypropylene matrix. Use of these natural CFFs is expected to reduce the land pollution. Very limited research has been carried out on the utilization of CFF into composites. There is a lack of logical studies with these byproducts to understand the effect of process variables during composite manufacturing on mechanical and sound absorption
properties of composites. These two properties must satisfy performance standard before being considered for applications, may be in the automotive sector which needs light weight, cost effective and crashworthiness parts.

CFF called barbs are removed from the rachis (quill) of decontaminated and cleaned feathers with the help of surgical blade. The average length of CFF is about 30mm. The morphological properties of CFF shows that the fibre has honeycomb structure (refer Chapter IV). Because of this structure, it contains more micro voids which are one of the useful factors to utilize this fibre for acoustic purpose. In order to normalize the effect of size of reinforcing materials on composite properties the jute fibres were cut into 30mm length as like the length of CFF to compare the mechanical properties of composites under similar processing conditions. The effect of temperature, pressure and time on tensile, impact and flexural strength properties of composites has been investigated. The effect of CFF and its hybrid composites on sound dampening has also been studied with the results derived from the impedance tube method.

1.5 ORGANIZATION OF THE THESIS

Chapter 2 consists of a literature review of natural fibres, CFF, jute fibre, comparison and applications of natural fibres, matrices for composites, hybrid composites, influential factors of bio-composites, compression moulding, acoustic characteristics, performance of sound absorbing materials and summary.

Chapter 3 describes the materials and methods used for preparing the composite samples required for the study. Further, the testing procedures adopted for the analysis are also described.
Chapter 4 contains the research results and a discussion of CFF properties. The following chapters deal with the effect of processing parameters for its mechanical properties.

Chapter 5 reveals the result and discussion of tensile strength of composite samples.

Chapter 6 holds the result and discussion of impact strength of composite samples.

Chapter 7 deals with the result and discussion of flexural strength of composite samples.

Chapter 8 presents the result and discussion of acoustic property of the composite samples.

Chapter 9 presents the summary of the entire study, the various findings drawn and recommendations for future work.