Chapter 1

Introduction

1.1 Background

Coal is the most widely used energy source for power generation in many countries including India. It is an essential input for steel production as well. It also plays a very important role as a cooking fuel in many rural and sub-urban parts of India. To fulfill the demand of energy and other curial requirement, it still comes under the basic fuel category. Coal is excavated from the earth surface. India has a long history of domestic and commercial coal mining. Mines are designed to reach the coal seams either through underground mining method or opencast method. The selection of the appropriate method depends on the technical feasibility and economic viability. In the past, coal was being extracted mostly through underground mining methods. To enhance the overall production as well as to increase the safety of miners, opencast mining has grown at a phenomenal rate in terms of improvement in technological research and innovation across the globe including India, since last two decades or so. Though opencast mining technology yields high rate of production than its counterpart, at the same time, it imparts more pollution to the environment in terms of land, air and water pollution. Opencast mining generates environmental pollution mainly by deteriorating air quality in respect of particulate and gaseous pollutants. A huge amount of airborne dust is generated from various operational units of opencast mining like drilling, blasting, loading, vehicle movement on haul road, transportation, crushing of waste rocks, bulldozing, and stockpiling [1]. Out of these, dust

emission from transportation of coal/overburden through vehicle over the haul road is more critical than the other activities. Haul truck, loader dumpers, excavator etc. ply over the haul road. Vehicles running over the haul road generate massive amount of fugitive dust which directly or indirectly contribute to air pollution.

The research done by the United States Environmental Protection Agency (US EPA) indicates that 78% to 97% of total dust emission in a coal mine is due to haul road transportation system [2]. If such a huge amount of dust emission remains unabated, then huge quantity of toxic particles, pollutants and other tiny particulate matters will emerge into the atmosphere creating health issues. Also, dense concentration of dust particles will weaken the visibility of operators, and thereby, increasing the haul road accidents. According to SIMRAC report, 74% of accidents are associated with haul trucks movement in South Africa [3]. Dust not only creates health issues on human being, it also inflicts severe impact on animals, plants and infrastructure. Beside this, high dust concentration will cause negative effect on the efficiency and productivity of the mine workers.

Spraying of water is the most convenient method for controlling dust dispersion. Hence, it is most widely adopted. But due to high evaporation rate during summer season, especially in India, it works effectively only for a very short period of time. Therefore, other than water spraying, chemical based dust suppression control method is gaining popularity for its longer effective duration and improvement of haul road surface condition [4]. Dust suppressants like calcium chloride, magnesium chloride, petroleum emulsions, ligno-sulphonates, tall-oil derivatives and bitumen emulsions have been applied for controlling the haul road dust generation. Keeping in view of the environmental concerns, development of multi-functional, high effective, biodegradable and environment-friendly chemical dust suppressants have

become an active research area of late**.** Biodegradable polymer with hydrophilic nature, allowing them to be chemically and physically modified into a good water absorbing materials are being favoured. Several researchers have developed dust suppressing agents consisting of carboxymethyl cellulose (CMC), guargum based polysaccharides, tributylol, propylene glycol, acrylate etc. which are suitable particularly for road application, building construction sites, material yards, and other outdoor dusty area [5, 6]. Still no systematic study has been reported to reduce the haul road dust emission by enhancing the moisture retention efficiency of haul road through environment-friendly and biodegradable polymers as dust suppressants.

1.2 Research Objectives

Purpose of the research:

The primary aim of this research is to develop chemical dust suppressing polymers that will enable to hold moisture for long duration when sprayed over the surface of haul road to control dust generation. Also, such developed polymers should have biodegradability property so that there is no negative effect on the environment due to its application.

Specific objectives of the research are:

1. Literature review of dust generation from haul road, characterization of dust, impact of dust, existing dust control methods, and to identify the research gap in haul road dust suppression technology.
2. Synthesis of eight numbers of biodegradable polymers and their characterization, namely,

(i) Polyacrylamide (PAM),

(ii) Hydrolyzed Polyacrylamide (H-PAM),

(iii) Amylopectin-grafted-Polyacrylamide (AP-g-PAM),

(iv) Hydrolyzed-Amylopectin-grafted-Polyacrylamide (H-AP-g-PAM),

(v) Guargum-grafted-Polyacrylamide (GG-g-PAM),

(vi) Hydrolyzed-Guargum-grafted-Polyacrylamide (H-GG-g-PAM),

(vii) Poly (2-acrylamido-2-methyl-1-propanesulfonic) acid-co-Polyacrylamide (PAMPS-co-PAM), and

(viii) Hydrolyzed poly(2-acrylamido-2-methyl-1-propanesulfonic) acid-co-Polyacrylamide (H-PAMPS-co-PAM)

3. Evaluation of moisture retention efficiency of haul road dust in the laboratory with the application of polymer solutions and compare it against application of water-alone system.
4. Estimation of dust emission rate from haul road.
5. Identification of best performing synthesized polymer.

1.3 Scope and Methodology

Work Plan:

To execute and achieve the above objectives, a consolidated work plan has been prepared and followed. The overall objectives of this work are to study of water-soluble polymeric material as a dust suppressant, applied over the surface of haul road of opencast coal mines. In other words, it is aimed to optimize the control of dust emission from haul road of opencast coal mines

by the application of water-soluble polymeric materials. The objectives stated in the above section, have been achieved carrying out the following studies.

Flow chart of the methodology:

The aim and objectives of the study were achieved by following a step-by-step approach as depicted in Figure 1.1.

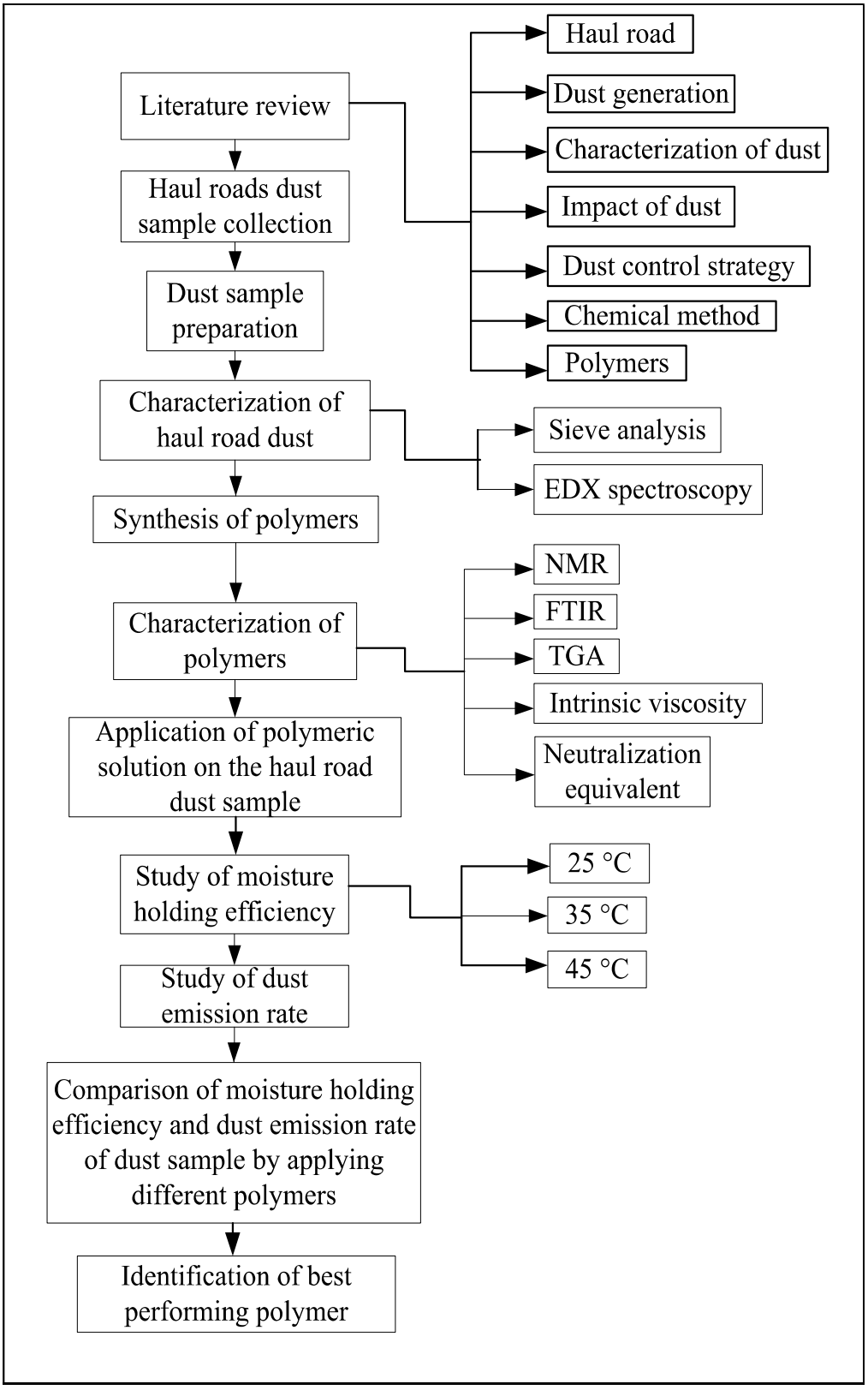

Figure 1.1 Flow chart of methodology

1.4 Organization of Thesis

The thesis is organized in six chapters which are briefly outlined as follows:

Chapter 1: The first chapter gives an overall introduction which provides the research background, statement of the problem, research objectives, scope, and the work plan. It also includes the thesis overview in organization of thesis sections.

Chapter 2: The second chapter gives a comprehensive review of the literature related to mine haul road transportation system vis-a-via fugitive dust. It covers dust generation from haul road, dust characterization and impact of dust. Further it includes literature on haul road dust control technologies, chemical methods and dust suppressants, comparison of the dust suppressants and their environmental aspects. It also reviews the literature related to polyacrylamide, amylopectin, guar gum and poly (2-acrylamido-2-methyl-1-propanesulfonic acid), and their applications, polymerization techniques, initiator, and the roles of these polymers in dust suppression.

Chapter 3: Materials and Methodology come under chapter three. It includes salient features of the study mine area, haul road dust collection, characterization of dust sample, chemicals and other materials, polymerization process of all the eight laboratory synthesized polymers [as listed in Ch. 1.2 under the heading 'Specific objectives of the research'] and their characterization.

Chapter 4: The characterization of haul road dust and polymers are dealt in chapter four. Detailed analysis and discussion of characterization of dust sample by size distribution and EDX analysis are presented. Detailed analysis and discussion of characterization of polymers by ^{1}H-

NMR, FTIR, TGA, intrinsic viscosity, molecular weight and neutralization equivalent are also presented in this chapter.

Chapter 5: In this chapter, the basic chemistry behind the moisture holding ability of polymers are discussed.

Chapter 6: The results and discussion parts of moisture holding ability and dust suppression efficiency of the polymers are dealt in this chapter five. On the basis of moisture content of dust, estimation of dust emission rate from haul road has been done using established empirical equation.

Chapter 7: Chapter six focuses on the conclusions of the whole research investigation. In this section it also elaborates the future work and recommendations on the area of current research.

After completion of all the chapters, references and bibliographies of all the quotations and citations come up with IEEE reference style, i.e. authors' name and publication date. Publication details out of the research work are mentioned at the end.