CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

Traditionally components that require high hardness as functional requirement are machined in the soft state, heat treated to the required hardness and then finish ground to the final dimensions. This long process cycle can be avoided if the components with the required hardness can be directly machined to the final dimensions. In the recent years, the concept of hard machining has gained considerable importance in metal cutting. Direct machining of hardened steel components leads to reduction in machining time and promotes better quality (Koenig et al., 1993; Sheehy, 1997). But hard machining involves very large quantities of cutting fluid. The most comprehensive early work on cutting fluids was reported by Taylor in the early 1900's (Taylor, 1907). Since Taylor, cutting fluids have changed dramatically, for better performance as well as health and safety reasons. With the advent of new standards regarding the environment, health and safety, some of the ingredients in many cutting fluids used earlier were identified as problematic. These components contributed to a variety of illnesses and environmental hazards and therefore had to be eliminated from continued use. These health effects include skin diseases, acute respiratory illnesses, and cancers. The primary routes of exposure of cutting fluids are dermal and by inhalation. The dermal exposures occur from splashing and handling of parts coated with the cutting fluid. The inhalation exposures occur when workers breathe air contaminated with cutting fluid mist. This mist is generated by the machining process, from splashing, and from the application of fluid to spinning parts and tools (Amir et al., 2005).

The most common way of applying cutting fluids in machining process is flood application in which the machining area is flooded with an abundant quantity of cutting fluid. Use of very large quantities of cutting fluid involves expenses associated with procurement, storage and disposal. According to a survey conducted by the European Automobile Industry, the cost incurred on cutting fluids comprises nearly 20% of the total manufacturing cost (Brockhoff and Walter, 1998).

Recent awareness on environmental aspects puts lot of stress on minimizing the use of cutting fluid. Storage and disposal of cutting fluid has to comply with environment
regulations as well. For example, the Permissible Exposure Level (PEL) for metalworking fluid aerosol concentration is 5 mg/m³ as per the Occupational Safety and Health Administration (OSHA) of United States (Aronson, 1995) and is likely to be reduced to 0.5 mg/m³ (Marano et al., 1997). According to the National Institute for Occupational Safety and Health (NIOSH) of the United States (NIOSH, 1998), the oil mist level in U.S. automotive parts manufacturing facilities has been estimated to be generally of the order of 20-90 mg/m³ with the use of traditional flood cooling and lubrication (Bennett and Bennett, 1998). It is important to find some ways to manufacture products using more sustainable methods and processes, which could minimize the use of cutting fluids in the machining operation and provide a healthy and safe working environment. Consequently, elimination on the use of cutting fluids, if possible, can be a significant economic incentive (Dhar et al., 2006a). The ideal way of performing manufacturing processes in this regard is by dry machining (Klocke and Eisenblatter, 1997), which will completely eliminate the use of cutting fluids but it requires ultra hard cutting tools and extremely rigid machine tools and cannot be easily implemented on the shop floor (Leo et al., 2010). However, cutting fluids have their own advantages and positive effects which can not be exploited in dry machining. Machining with minimal cutting fluid application, is a more realistic approach in this regard which is an intermediary stage between conventional flood application and dry machining (Varadarajan et al., 2002a). In this method, extremely small quantities of cutting fluid is used and for all practical purposes it resembles dry machining. The present work aims at developing a minimal fluid application scheme for surface milling of AISI4340 steel of 45 HRC.

1.2 SCOPE OF THE PRESENT WORK

The present work consists of developing a fluid application system that can deliver a proprietary cutting fluid in the form of a high velocity pulsed jet at critical zones during surface milling of AISI4340 steel with the hardness of 45 HRC using coated carbide tools, optimizing its performance and comparing it with hard dry milling and milling with conventional flood cooling in terms of surface roughness, flank wear and cutting force.
1.3 RESEARCH PLAN

- Literature review
- Selection of work and tool material
- Development of fluid application system
- Preliminary experiments
- Studies on the influence of cutting parameters
- Studies on the influence of cutting fluid composition and number of jets used
- Study on the influence of fluid jet configuration
- Optimization of fluid application parameters using Response Surface Methodology
- Performance comparison of optimized hard milling with minimal fluid application with conventional wet milling and dry milling
- Role of semisolid lubricant as a performance enhancer
- Simulation of surface milling of hardened AISI4340 steel with minimal fluid application using Artificial Neural Network
- Summary and Conclusions