CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

During the last few decades, the usage of stainless steel materials have increased due to its excellent corrosion resistance, wide range of strength levels, good formability, and an aesthetically pleasing appearance. Even though many new materials have developed in recent decades stainless steel still remains as one of the most important and potential materials. The duplex stainless steel (DSS) alloys offer two important advantages over austenitic stainless steel (ASS) alloys, namely improved chloride stress corrosion cracking resistance and higher mechanical properties. It is apparent that a balance of ferrite and austenite phase in a microstructure made it realistic for applications which demand better corrosion resistance and improved mechanical properties. DSS and super ASS have almost similar properties, which is achieved with overall lower alloy content in DSS. This makes the DSS cost effective for many applications. DSSs are extensively used in many industrial sectors like chemical and petrochemical, off-shore, desalination, oil and gas industry, pollution control equipment, chemical tankers, pressure vessels, storage tanks, machinery in the pulp and paper industry, marine industry and also in civil engineering applications (Davis 1996, Bouchair et al 2008, Cigada et al 1990, Cunat & Jean 2000, HeNian 2001, Machado et al 2006, Olsson & Snis 2007, Sai et al 2001).
1.2 NEED FOR THE STUDY

Stainless steels are difficult to machine material due to its high toughness, low thermal conductivity, high degree of work hardening rate and tendency to the built up edge (BUE) formation (Paro et al 2001b). Machining difficulties increase when DSS and high strength stainless steels are to be machined. Machinability is often compared to the pitting corrosion resistance equivalent (PRE) value representing the alloying content of the stainless steels. Modern DSS grades are difficult to machine due to their higher austenite and nitrogen contents (Gunn 1997, Paro et al 2001b). Among the various production techniques such as Argon oxygen decarburization (AOD), vacuum oxygen decarburization (VOD), vacuum induction melting (VIM), vacuum arc remelting (VAR), electron beam melting (EBM) etc, one common limitation existing is that it has to be processed in controlled atmospheric conditions with specialized equipment which is highly expensive. Conventional induction melting can be opted as a better choice to overcome the above stated limitations when supported by proper alloy design and process control. DSS castings like valves, tubes and containers are being produced using conventional induction furnace. The casting products require further machining operations such as turning, drilling, milling etc. Currently the manufacturing industries are facing difficulties in machining of DSS components. The present research work provides a solution to overcome the present limitations with machining of DSS.

1.3 OBJECTIVES OF THE PRESENT RESEARCH WORK

The following are the main objectives of the present research work:

1. To find out the influence of cutting parameters such as cutting speed and feed rate on output parameters like surface
roughness, cutting force and tool wear in turning and milling operations.

2. To optimize the cutting parameters for minimizing the surface roughness, cutting force and tool wear during the turning and milling operations under dry and wet cutting conditions using Taguchi method.

3. To compare the performance of 5A and 4A grade DSS under dry and wet cutting conditions with respect to surface roughness, cutting force and tool wear.

4. To develop a mathematical model for predicting the surface roughness in terms of cutting parameters during milling operation using RSM.

1.4 ORGANIZATION OF THE THESIS

The rest of the thesis is organized into four chapters. A brief outline of the forthcoming chapters is given below.

Chapter 2 provides a detailed summary of the literature review undertaken for this research. It explains the various types of stainless steels, Taguchi method and response surface methodology (RSM) used in this work.

Chapter 3 provides the experimental work of turning and milling operations. The details of work piece material, machines, tool holder, cutter, tool inserts, measuring instruments, cutting parameters and their levels, experimental layout used in the experiments are reported.
Chapter 4 explains the results of surface roughness, cutting force and tool wear of ASTM 995 grade 5A and 4A DSS alloys in turning and milling operations under dry and wet cutting conditions using Taguchi method. It also discusses the optimization of cutting parameters to minimize the surface roughness, cutting force and tool wear in turning and milling operations. The effects of cutting parameters on the responses are also discussed. It also presents the results of prediction of surface roughness in milling operation using RSM.

Chapter 5 provides the conclusion of this research work and scope for future work.