CHAPTER 1

INTRODUCTION

Secondary metallurgy is the focal point of the development of steel technology. The production of high quality steel would be inconceivable without secondary metallurgy. The term "secondary metallurgy" denotes all metallurgical treatments from the time of tapping in the melting unit to the start of casting. In the past the main objectives like reduction of carbon content, hydrogen content or sulfur content were in the foreground of considerations, today the tasks are more complex and attention must be paid to the behavior of other elements too, such as phosphorus, silicon, nitrogen, aluminium, etc., depending on the type of steel. The term "Ultra clean steel" is commonly used for steels containing less than 100 ppm of C + O + S + N + P [1]. The limits of lowering the trace element contents are associated with the technologically available vacuum levels.

First, the vacuum processes were applied in the 1950s and had been primarily used for reducing carbon and hydrogen contents in the steel. Later, more and more facilities have been developed for mixing and homogenizing, heating, oxidizing refining at reduced CO-partial pressure, injection of solid

materials, deep desulfurization and inclusion modification [2]. During that time the steelmaker developed the processes to find out the combination, how to obtain the different characteristics of decarburization, desulfurization, degassing (N, H). The VOD unit (Vacuum Oxygen Decarburization) is a suitable high efficient facility for decarburization, desulfurization and degassing. Therefore, the production of clean steel can be easily performed in such a unit.

In the mature secondary metallurgical technologies, the production of high quality steel can be performed. The combination of the units EAF-LHF-VOD (Electric Arc Furnace - Ladle Heating Furnace - Vacuum Oxygen Decarburization) for steel production is very common in the steel industry [3-5]. The development especially for VOD is influenced by the requirement for very low tramp elements. The main advantages of VOD over the others are high decarburization and degassing efficiency. Values of less than 40 ppm carbon, 10 ppm sulfur, 40 ppm nitrogen and 1 ppm hydrogen can be adjusted in the VOD unit. To achieve these values, the techniques like oxygen blowing and vacuum operation must be carefully controlled. Furthermore the pick up of the tramp elements after the VOD operation must be minimized.

There are several optimal conditions for secondary metallurgical treatments which are summarized in Table 1.1 [6-11].

The goal of this work is the development of possible secondary metallurgical treatment of the steel with the ladle heating furnace (LHF) and vacuum oxygen decarburization unit (VOD). The realization of high quality steel for the Compact Strip Plant (CSP) at Nakornthai Strip Mill (NSM) is essential for production of high quality hot strip.

NSM will operate with two ladle heating furnaces and two tank degassing systems. The crude steel from the electric arc furnace (EAF) will be produced from scrap and direct reduced iron (DRI). The scrap as well as the DRI might be the reason for a high amount of undesired elements, which have to be removed in the secondary metallurgical step. This work deals with possible secondary treatments of crude steel from EAF in the LHF and VOD to produce special quality steels that will be produced by NSM in the future.

Table 1.1 The optimal conditions for secondary metallurgical treatments

Metallurgical treatments	**Optimal conditions**
Dephosphorization	lime saturated slag, strong metal/slag agitation, oxidizing condition, low temperature treatment
Decarburization	oxidizing condition, high oxygen potential, vacuum condition
Desulfurization	lime saturated ladle slag, strong reducing condition, high temperature treatment, strong metal/slag agitation
Dehydrogenization	vacuum condition
Denitrogenization	vacuum condition, low surface active elements (e.g. S,O), low initial nitrogen content
Oxide cleanness	cleanness stirring, avoidance of over intensive agitation
Inclusion modification	calcium treatment