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Process and Plant Technology

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STAHLEISEN COMMUNICATIONS

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Preface

This book contains contributions and references to the quality improvement, to the increase of the plant availability and the yield, to conserve resources during production as well as to automation, control and Metallurgical Plant concepts in the rolling of Hot Strip. The contributions are both published summaries of technical papers presented at international conferences and the published results of own papers and patents.

Focal point of the papers is the optimization of the geometric characteristics thickness, thickness profile and flatness of the hot strip by adapted process control and measuring techniques. Especially referred to [11.2] here are the investigations of the relationship between strip tracking and the wedge of the thickness profile. Measures for the production of straight and camber-free hot strip with a wedge-free thickness profile are the implementation of complex controllable side guides in the entry and exit of the roughing mill as well as the tilting of the hydraulic screw downs in the roughing and finishing mill. .A further focal point of the papers of the subject complex "hot strip geometry" is shown by the development of the Topometric Flatness Measuring System [11.3, 11.4].

The development and operational implementation of measuring systems for Online detection of temperature profile and coiling condition of hot strip down coilers as well as measures for the adjustment of homogeneous rolled strip temperatures and straight edge wrapped Coils are further subjects of this book [12.1, 14.1, 14.2]. Experience with these measuring systems formed the base for three further applications in the area of the exit roller table. These include (1) The production of hot strip with uniform temperature and therefore homogeneous mechanical properties with simultaneous resource conservation using width control of the water cooling quantity, (2) procedure for the optimization of the Coil form by pivoting of the coiler pinch roll and (3) procedures for the reduction of Coil breaks during the process of down coiling using a device to stretch level the hot strip.

The cost optimized production of hot strip increasingly forces the use of peripheral components in order to minimize rolled material losses during production in case of plant breakdowns or failures. In this context it is necessary to preserve the strips in the entry rolling process line so that they can be utilized at a later time in the rolling process when the failure is cleared. By utilizing a coil recovery furnace in hot strip mills it is possible in cases of downtimes to reuse a Coilbox strip by reheating it up to roll temperature and then integrating it into the rolling process again [7.5, 7.6].

The tool for the steel deformation - the rolls - is decisively for the quality of the finished product. In the chapter "Rolls in Hot Strip Mills" the advantages of rolls in general and also rolls made out of quick work hardening steels as opposed to conventional roll types such as High Chromium - and Indefinite Chill rolls with respect to reduced wear and improved surface quality of roll and rolled strip are described [10.2].

The subjects of this grouping has one thing in common: Adapted process control and measuring techniques can be used for the optimization of hot strip characteristics as well as reducing costs and conserve resources during the production of hot strip.

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1. Layout and design of Hot Strip Mills

1.1 Definition of the product hot strip and development of production

Hot strip is defined according DIN EN 10051 (Hot Wide Strip) and according the former DIN 10048 (Strip Steel) as a product with a rectangular cross section with a width much larger as its thickness. After the rolling and cooling process in the mill it is coiled up to a Hot Strip Coil. Hot Strip in rolling condition has slightly bulged edges. But it can be delivered as well with trimmed edges or as cut-to-length slit strip. Slight cold rolling of hot strip with a cross section change of less than 5% (Hot Strip Skin Passing) does not alter the allocation of the resulting finished product to the product group Hot Strip [1.1].

Hot rolled strip can be distinguished according its actual width into the two groups

- Hot Wide Strip with a width $\geq$ 600mm (DIN EN 10051) and
- Strip Steel or Narrow Strip with a width $<$ 600mm (DIN EN 10051 or former DIN 10048).

Strip steel can be delivered after decoiling the rolled coil as folded bundle or as rectangular bar.

Sheet is produced when cutting the rolled strip with a cross cut shear. This product is then named strip sheet.

Definition of Hot Strip is according specification of strip width, strip thickness, steel grade, and coil weight and batch size due to the standards DIN EN 10051 or DIN 10048.

Hot Wide Strip Mills cover a width range from 800mm minimum and 2,050mm maximum. The main part of production is in between 900mm and 1,500mm. The rolled strip thickness is in the range between 0.8mm and 25.4mm.

Hot strip customers prefer strip thicknesses in between 1.25mm and 20mm, at which the thickness range between 1.8mm and 5.0mm is the most application field. Thin and ultra-thin gage, pickled and skin passed hot strip with a strip thickness below 1.2mm could not dominate on the steel market against cold rolled strip material. Hot strip with a thickness of more than 20mm is as well less demanded on the market. Hot Wide Strip in the thickness range in between 10mm and 25mm is delivered as feedstock to pipe producers.

Further shearing lines up to 20mm strip thickness for cross cutting the rolled strip are erected. Very thick strip sheets, which are rolled with larger widths, could as well not dominate on the market. Therefore there is only small demand for Hot Strip Mills regarding this dimension range. The reason for this is the requested very small batch size which exceeds in only few cases the minimum size and weight of a rolled coil.

Hot Strip Mills supply to a large extent downstream operating cold rolling mill facilities. Therefore the hot rolled strip material has to fulfill certain demands regarding steel grade quality items. For production of strip steel sheet and tin plate material in cold rolling mills only soft unalloyed grades are used. For materials with a defined yield strength and yield stress construction steel grades are applied. These grades can be either cold rolled or further directly processed as hot strip or strip sheet. For welded pipe production unalloyed or low alloy hot rolled steel grades are used.

The necessity for material resistance against pressure increasing's during pipe transport applications and weight reduction in construction and automotive industry has influenced the development of weld able, micro alloyed less perlite microstructure steel grades and high strength steel grades such as DP- or CP- and Trip-steel grades. These steel grade groups can be rolled in Hot Strip Mills as well as electrical and stainless steel grades.

The coil weight in hot strip rolling is referred as absolute value in tons or as specific weight in kg/mm strip width. The specific coil weight varies between 7kg/mm and 25kg/mm depending on application purpose and rolling mill design. The minimum batch size of order weight is equal to the minimum coil weight of the Hot Strip Mill.

Development of hot strip production

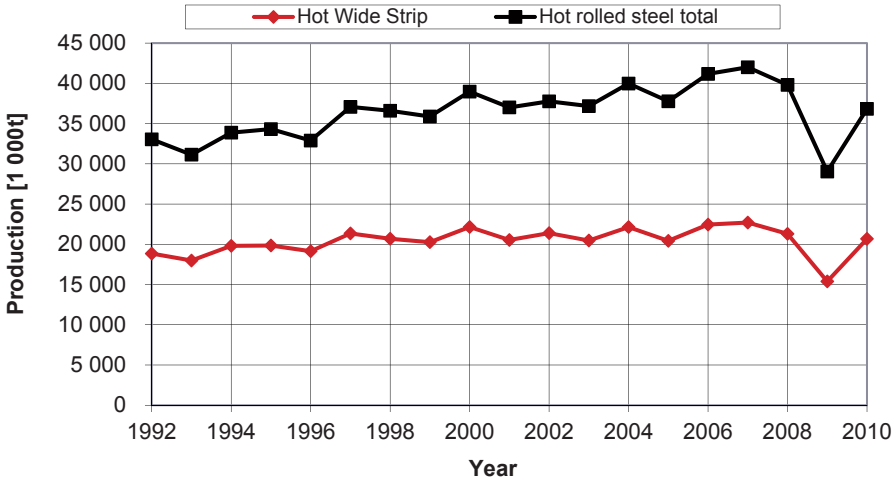

Fig. 1.1: Production of hot wide strip and hot rolled products in Germany (1992-2010).
Data source: Federal Statistical Office and own analysis

The production of Hot Wide Strip increases rapidly after World War II apart from some economic recessions in all industrial countries. This in correlation to the development of consuming goods and their industry which is related directly to the product Hot Wide Strip. In Germany 200,000 tons Hot Wide Strip were produced in Year 1954. In relation to the total hot rolled steel production this amount is less than 2%. In Year 1979 Hot Wide Strip production was 15.8 million tons. Related to the total hot rolled steel production this is a part of nearly 48%. Within the years 1992 and 2010 the part of Hot Wide Strip of total hot rolled production is in between 50% and 60% and remains almost constant in this time period, **fig. 1.1**. Total productions of Hot Wide Strip in Germany in Year 2009 are 15.38 million tons. The decrease of production in Year 2009 is a consequence of the general economic crisis which was caused by the breakdown of the building market and the following bankruptcy in the USA.