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Productivity and Quality Improvement through Setting Parameters in Hot Rolling Mill

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Abstract— *Rolling is a forming operation where plastic deformation of a work piece is achieved by compressing it under application of force between two rotating rolls in the mill.*

The present paper aims at studying parameters which affects the quality of products in hot rolling mill and optimizing one of them. Generally, it is seen that most of the rolling mills work on the principle of experience and mutual settlements. There are no fixed, live and calculated arrangements of process or processes. However, rolling mills are one of the most productive and sensitive areas of industry where slow process or any breakdown in production line is not acceptable, even if the company have to go for costly machines or any costly environment. But in order to have higher production various parameters are considered which directly or indirectly (both quantitative and qualitative aspects of the process) contribute to increase in productivity.

Keywords- : Plastic Deformation, Compression, Quality, Productivity, Optimization

1. INTRODUCTION

Rolling is a metal working operation whereby plastic deformation is imparted to a work piece by two rotating rolls. It is widely used when large surface area is to be generated. It carries two distinct advantages of the forming operation; firstly, it is economical manufacturing process as there is insignificant loss of metal in it, and secondly, a part of energy is utilized for improving strength of the product by strain hardening. On the basis of temperature of deformation, rolling process can be divided as hot and cold rolling. In simple terms, when the rolling temperature exceeds the re-crystallization temperature of the metal work piece, it is called hot rolling. In cold rolling, deformation is imparted to the feedstock below its re-crystallization temperature. Whereas cold rolling is employed primarily to roll flat products like cold rolled strips and sheets, hot rolling may be used for rolling of both the flat and shape products.

Hot rolling mills are normally two-high reversing mills with 0.6-1.4 m diameter rolls (designated by size). The objective is to breakdown the cast ingot into blooms or slabs for subsequent finishing into bars, plate or sheet. In hot-rolling steel, the slabs are heated initially at 1100 - 1300^{o}C. The temperature in the last finishing stand varies from 700 -900^{o}C But should be above the upper critical temperature to produce uniform equiaxed ferrite grains.

Steel re-rolling is one of the most important segments of the steel industry, as it constitutes an unavoidable link in the total supply chain of iron and steel. **(1)** The secondary steel production constitutes approximately 57% of the total steel production in India. It mainly takes place in steel re-rolling mills (SRRM) that usually are family-run small and medium enterprises (SMEs) with 75% of units in the small scale. According to comprehensive Survey on “Steel Rerolling Industry”, carried out by the Organization of Development Commissioner of Iron & Steel (DCI&S), the SRRM sector is comprised of 1,200(working) re-rolling mills. The SRRM sector grew with almost 5% annually during 1966-1996 and with 6% annually during 1997-2002. With no major large steel plant additions planned in the near future, the share of secondary is expected to grow in the near future, also because the sector has some competitive edge due to flexibility in production for meeting low-tonnage requirements in various grades, shapes and sizes to serve niche markets.

2. WORKING PROCESS

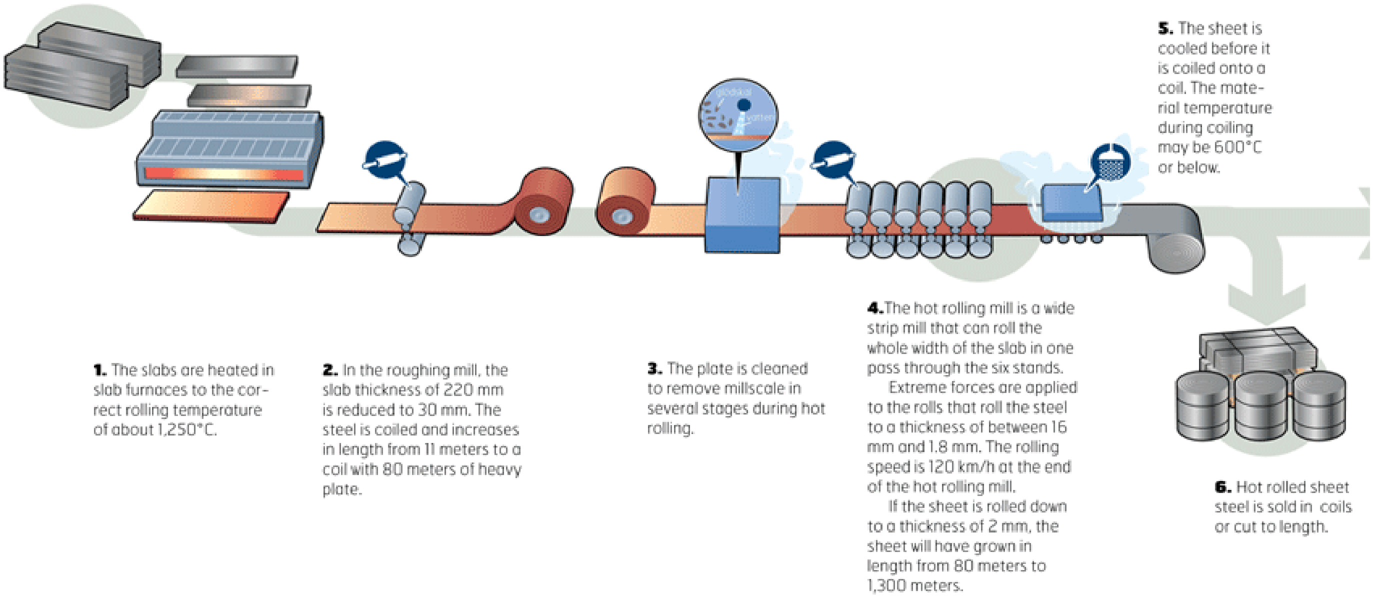
The primary function of the Hot Strip Mill is to reheat semi-finished steel slabs of steel nearly to their melting point.

1. REHEATING 2. DESCALING
3. ROUGHING 4. EDGING
5. DESCALING 6. CROPPING
7. FINISHING 8. COILING
9. COIL HANDELING

3. DISCUSSION

This research paper in brief discusses about the hot rolling mill, how the process works in actual practice and the various technical and environmental parameters affecting the process, leading to some defects in final product and its quality.

Hot ingot from the furnace i.e. at recrystallization temp (above 1700^{0}F) is taken out which is further passed through various stands of different sizes. The number of stands are selected according the shape of final product. Rollers of different diameters and geometries between the stands mold the hot billet into desired output. The time required to get one complete final product is calculated and on the basis of that a complete lot is made. The size of the final product depends upon order given to the manufacturers as per demand or by ordering company.



3.1 ANALYSIS: It has been seen that initial setting parameters like:

1. DRAFT- it is the reduction in thickness of raw material by a small amount when work is pressed between two rolls.

2. In addition to thickness reduction, rolling usually increases work width called as SPREADING.

3. SPEED: let us assume that V is the roller velocity, V_0 and V_f are the entering and exiting velocities of the work resp. also Vr is the surface speed of the rolls. As the raw hot product passes over the rolls there is increase in its velocity from the entering value. The velocity of the hot product is highest at the exit from the roll gap.

4. SLIP FACTOR: Consider that metal is moving from left to right so at one point along contact length the velocity of the strip is same as that of the roll. To the left of this point, the roll moves faster than the strip; to the right of this point, the strip moves faster than the roll. Amount of slip between the rolls and the work is needed to be measured

5. ROLL FORCE: The rolls apply pressure on the flat strip in order to reduce its thickness, resulting in a roll force, F. In practice, the arc of contact is very small compared with the roll radius, so we can assume that the roll force is perpendicular to the strip without causing significant error in calculations.

The more we study the more we get into the depth of project. These are only few parameters whereas several different parameters are also studied and applied before getting final product as an output.

Rolling Mills are with complete setup of Testing and Quality Department. Engineers here test the products and take a note of the parameters that was initially considered before actual output to be within limits and under safety Consideration. One of the final product from lot in selected to inspect the defects includes strength, hardness, roughness, etc. The product is further checked for quality purposes in the Quality & Assurance department.

With certain quality improvement methods the defects existing in the product are carried out to achieve its desired Abilities. The defects such as improper shape, straightness, etc. comes into the picture due to the breakdown of the plant which includes power cut off, breakage of the mechanical parts, etc. The productivity of any organization gives its best results when minimum resources (man, machine, material, money, management) maximum output in many ways.

Operational Research deals with the study of products, processes, time for completion of one product, number of operations, time consuming operations, working environment, infrastructure and many more.

The project mainly focus on different operations involved, time required in completion of each operation, pointing the process taking maximum time, selection of method used to minimize processing time, number of rolling stands, quality assurance and quality testing, etc. depending upon the above results obtained the work starts with selecting any one parameter while keeping others constant optimizing the process and applying it to improve and enhance the productivity of an organization.

4. PARAMETERS AFFECTING QUALITY

There are certain parameters that affects the Quality of the product which further affects the Productivity. Chemical Composition is the primary parameter, the improper range of chemical composition may lead to defects in final product. Improper roll gap causes various defects in the hot product. It is difficult to maintain a uniform gap between the rolls since the rolls deflect under the load required to deform the steel piece.

The deflection causes the steel piece to be thinner on the edges and thicker in the middle. Excess temperature may lead to change in properties of the hot product which can results into cracking and tearing. Roll Force should be maintained properly change in roll force will impact in final product. Mill spring is a defect in which the rolled sheet is thicker than the required thickness because, the rolls have got deflected by high rolling forces. Internal stresses are also responsible for defects, due to the internal stress pattern caused by the non-uniform transversal compressive action of the rolls and the uneven geometrical properties of the steel being fed for the rolling. The speed of the billet when it passes through the different stands affects the quality of final product. Billet dimensions should be fixed as per the requirements otherwise it will be responsible for the defects which results in larger scrap value.

Excess convexity may lead to edge cracks in roll. It is found that the middle portion of the piece gets more elongated. So, the edges are found to be uneven in thickness. Flow of material may change the dimension of the final output. Another defect called alligatoring (series of cracks grouped together in one area) occurs due to non-homogeneous flow of material.

5. LITERATURE REVIEW

Pearson (2) observed that, the effects of bending and thermal expansion on the work roll gaps, and the strip tension between two mill stands, results in a non-uniform distribution of the internal stress over the width of the strip. That can cause either latent or manifest shape, depending on the magnitude of applied tension and the thickness of the strip. Both latent and manifest bad shape are unacceptable for users of strip because they present problems in the subsequent manufacturing processes.

Wilms et.al (4) found out that, the fine tuning of the roll profiles is nearly always carried out empirically, because there is no such mathematical model available for rolling process. If a new program is introduced it will not always a straight forward task to find suitable sets of work roll profiles.

J.C. Herman et.al (5) talked about the desired properties which the ideal lubricant should have so as to control the thermal expansion of the unloaded rolls during rolling and subsequent cooling the deformed billet and to use full lubrication in all stands in order to avoid the uneven surface of the rolls.

6. FUTURE SCOPE

Even though the hot rolling is limited to only desired output, but still number of variations are possible that are needed to be corrected. The establishment of the plant is simply done by the investment and serving of the people, hardly having any technical knowledge, it's completely an experienced dependent process. The complete working of mill is on the basis of experience, which incorporates proper running of mill and the wage distribution to the workers. The main focus is on quality of product and productivity, then simply running of mill. Hot rolling plants are known for their quality and precise work output at minimum investment. While working on the project we found out that "If proper engineering and technical aspects are adopted for the settlement of a hot rolling plant, then that would help to increase the productivity and can contribute to nations GDP".

7. CONCLUSION

In this paper we have analyzed the potential for the improvement of rolling process parameters that can be realized in the long term. The developments described above point to the peculiarities of rolling processes and their consequences.

This rolling process needs the human activities to be conducted in a manner of fundamental task, the rolling process is then applied as a formal method for repeatedly making such judgments in new situations. The effect of groove collar taper angle showed that the lowest collar taper angle of 22 degrees gave lowest load, with desired groove filling. The load is higher for collar angle up to 45 degrees, hence higher groove depth is obtained, which provides better strain penetration with lower mill load.

The proposed study can critically explore the relevance by assessing the objectives against problem to be solved and to analyze current scenario of rolling industry in Central India and explore all possible areas of rolling Process. The assessment of the relationship between input and output can improve the efficiency and can facilitate the identification of input and output parameters for best possible rolling system

Reviewing the effectiveness as reflected in the relationship between the result (outcomes) and the purpose of the proposed work.i.e.to discover how rolling industries in Central India can benefit by implementing the popular continuous improvement methodology Lean Six Sigma. The benefits preserved from the emerged work can contribute to enhance quality of various parameters and in sustaining quality management programs.

8. REFRENCES

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