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ANALYSIS OF ROLLER SPEED AND ROLLER DIAMETER- A REVIEW

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ABSTRACT

This paper deals with the study of roller speed and roll diameter in different operations such as Twin Roll Casting (TRC), Hot Rolling, Cold rolling etc. The study includes effect on residual stress, rolling force, heat transfer, friction coefficient, strain rate, Vonmises stress, plastic strain, contact pressure etc. the effect of rolling speed and roll diameter is summarized with study carried by past researches.

Key words- Roller speed, Roll diameter, TRC, Hot rolling, Cold Rolling.

INTRODUCTION

Rolling process is one of the most popular techniques in the manufacturing industry. At least once in their production period metallic equipment is exposed for rolling and hence almost 80% of metallic equipment is exposed to rolling [1]. According to the complexity and geometry of rolling process can be divided into different categories [2]. But almost 40-60% of rolling production takes place by flat rolling as it is more popular one in industrial countries [1].

To sustain in the manufacturing market and increase the competitiveness, manufacturers develop low cost products and induce new technology with new mills to improve quality [4]. Therefore many scientists tried to improve quantity and quality of the products by optimizing parameters such as rolling speed, roll diameter etc. [1].

Rolling is processed in two conditions one is hot rolling and another cold rolling. Hot rolling is carried out to increase the workability of specimen and decrease the required energy [2]. Cold rolling is widely used in the electronic and instrument industries [5].

LITERATURE REVIEW

Rolling speed is an easily variable parameter it has great effect on microstructure, grain size, heat transfer, surface finishing of material, strength, hardness, flow stress, roll force, roll separating force etc. Effect of rolling speed is drastically depends on rolling process mills

being carried out for processing the material, processes such as Twin Roll Casting (TRC), Hot Rolling, Cold rolling etc.

Twin roll casting or the continuous casting is widely used process. It has several advantages such as low processing cost, low investment and operating cost but it has lower productivity and small range of alloys can be cast [6,7].

Sanjeev Das, N.S. Lim, J.B. Seol, H.W. Kim, C.G have published there research study about effect of speed in TWC, rolling speed has influence on heat transfer. Since there is less contact between roll and specimen in higher speed the less heat transfer occurs that gives rise to lesser hardness and strength because of poor curing of material. As the process takes place in high rolling speed little roughness occurs since there is low heat transfer material particles stick to roll surface. [8].

Sanjeev Das, N.S. Lim, J.B. Seol, H.W. Kim, C.G also studied behaviour of Al-Mg-Si. The microstructure elongates towards rolling direction in minimum rolling speed. As there is heat retain in work piece dynamic recrystallization takes place and with higher speed microstructure shows equi-axed grain structure. While high speed rolling heat is retained inside the material hence the grains grow without any directional load and also larger grain size [9].

Rolling speed directly controls the parameters such as the Strain rate, Flow stress, Roll force, Heat of Deformation and interface heat transfer coefficient. Hence the Rolling speed is one of the most important parameter during hot rolling [2].

A.K. Tieu, Z.Y. Jiang, C. Lu have published in there research paper about rolling speed in hot rolling under lubricated condition. Rolling force is depends on speed, increased speed gives larger force but decreased friction coefficient. Use of lubrication reduces roll separating force and also the friction coefficient [10].

Akira Azushima, Yoshifumi Nakata, Takahiro Toriumi also studied about effect of rolling speed on coefficient of friction. Roll surface is also major parameter to effect on work piece surface finishing; with smaller roll roughness friction coefficient is low at higher speed. Lubrication can lead to lower coefficient of friction [11].

Mahdi Bagheripoor, Hosein Bisadi have published in there research paper about temperature variation in material with different rolling speed. At high rolling speed there is less time contact between roll and material and hence heat is retained in material. Heat retained on surface and centre in material is different. Higher rolling speed leads to lower temperature gradient between surface and centre of work piece [2].

A.R. Shahania, S. Setayeshib, S.A. Nodamaiea, M.A. Asadic, S. Rezaiec carried out study about effect of rolling speed on rolling force. Rolling force has effect on strain rate that leads to hardness of material. Rolling force increases as the speed increases [1].

B. Wang, W. Hu, L.X. Kong and P. Hodgson carried out there study on cold rolling. Higher rolling speed leads to faster surface finish, also the decrease in residual stress and roll separating force in material [3].

K. Devarajan, K. Prakash Marimuthu and Dr.Ajith Ramesh studied about effect of rolling speed on rolling force. Roller force and residual stress decreases with increase in rolling speed. Authors also carried out study to analyse effect of roll diameter, higher roll diameter has higher surface contact to the material that leads to increase in rolling force. Increasing roll size leads to decrease in residual stress and after some increment stress becomes constant. [4].

Santosh Kumar, Prof.Bharat S Kodli Ramesh carried out study on reducing or minimising defects of hot rolling process. Larger roll diameter leads to decrease in vinmises stress; it gives roller capacity to take more loads. Plastic strain is always source of weakness and that can be avoided using higher diameter rolls, also reduces rigidity required by reducing contact pressure [12].

DISCUSSION AND CONCLUSION

Material property	Process	Parameter varied	Discussion	conclusion
Heat transfer	TRC	Rolling speed	At higher speed, Less heat transfer since there is less contact between roll and material	Poor curing of material leads to lesser hardness, strength and surface roughness of material.
microstructure	TRC	Rolling speed	Higher speed rolling process gives equi-axed microstructure	Low heat transfer leads dynamic recrystallization
Rolling force	Hot rolling	Rolling speed	Increase in force with increased speed. Force has effect on strain rate	Lubrication can be used to minimise force. Strain rate results in hardness of material.
Friction coefficient	Hot rolling	Rolling speed	Decrease in friction coefficient with increase in speed	Further friction coefficient can be minimised by using lubrication
Roll separating force	Cold rolling	Rolling speed	Decrease in roll separating force with increase in speed	-
Residual stress	Cold rolling	Rolling speed/ roll size	Lower residual stress with higher speed	Residual stress can be minimised by using higher rolling speed. And using

				larger sized rolls residual stresses can be constant after some increment
Plastic strain, Vonmises stress, Contact pressure	Hot rolling	Roll size	Higher roll diameter leads to decrease in plastic strain, Vonmises stress and contact pressure	Plastic strain is always source of weakness that can be reduced using higher sized rollers. Lower vonmises stress helps in roller capacity to take more rolling loads. Contact pressure will reduce rigidity required for the product.

Future scope is to analyse the roll diameter and rolling speed in hot rolling with different speed over different diameter. And most of simulations are done on ABAQUS software so new emerging, AFDEX tool [13] can be used to analyse the parameters.

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