Vandana Publications
IJEMR

Volume-5, Issue-3, June-2015
International Journal of Engineering and Management Research
Page Number: 784-788

Product Trial and Development of Section Rolling Mill

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ABSTRACT

The paper is about the "Product Trial And Development of SECTION ROLING MILL". The paper describes about the hot rolling process of different sections which are rolled in a "SECTION ROLLING MIL". Different sections rolling process and different steel grades rolling are described in the paper.

Keywords— ROLLING PROCESS, Scope of study, Methodology, Technical Considerations.

I. INTRODUCTION

Rolling is a metal forming process in which hot metal is passed through rolls in order to get a desired shape and size. There are two types of rolling process – flat rolling(sheet rolling) and profile rolling(section rolling).

In section rolling, the final product is round rod, angle, unequal angle, channel, flat, square, RCS etc .The billet of different cross sections such as 170*170,200*200,250*250,300*300 sizes are rolled. This is the process of plastic deformation of metal by passing it through the rolls and the metal is at the recrystalisation Rolling is the most widely used method of forming / shaping metals, which provides high production, higher productivity and close control of final product than other forming processes. This is the process which is most important one in the steel sector.

II. TYPES OF STAINLESS STEEL

Steel types are Austenitic, Ferritic, Martensitic, Austenitic-Ferritic (Duplex) stainless steel grades while supplying special grade stainless steel of Precipitation hardening, Cold heading & Electrode quality.

SRM is a section rolling mill having different sections such as ROUND, HEXAGON, ANGLE, SQUARE, FLAT ,CHANNEL of different sizes. The plant has various equipment as Furnace, Stand, Shear, Loppers, Lubrication Units, PLC, AC Drives, DC Drives and control and supervision system etc.

One of the most important in hot rolling process is hot rolling practice is heating the billet from the room temperature to the recrystallization temperature. At that higher temperature the steel is transformed in to single austenite phase from the dual phases of perlite and cementite at room temperature. At lower or higher carbon percentage, this phase change temperature increases and therefore, the temperature to which the steel is heated for hot rolling is increased accordingly. However, in practice steel is actually heated to a temperature of about 500 Cto 1000 C above the phase change temperature. This increase in temperature is because steel besides having varying percentage of carbon and iron also contain other alloying elements which affect the phase changing temperature.
Hot rolling takes place in a number of steps and drafting / reduction is given in every stage. The ultimate draft is at a temperature above the recrystalisation temperature. Material is heated to a much higher temperature than the recrystalisation temperature. Therefore, the ultimate temperature to which the work piece depends on the amount of total draft, the number of steps where the drafting is provided and the composition of the steel stock. Billets are heated to the rollable temperature in a reheating furnace. This is the starting point of the hot rolling mill practice.

III. REHEATING FURNACE

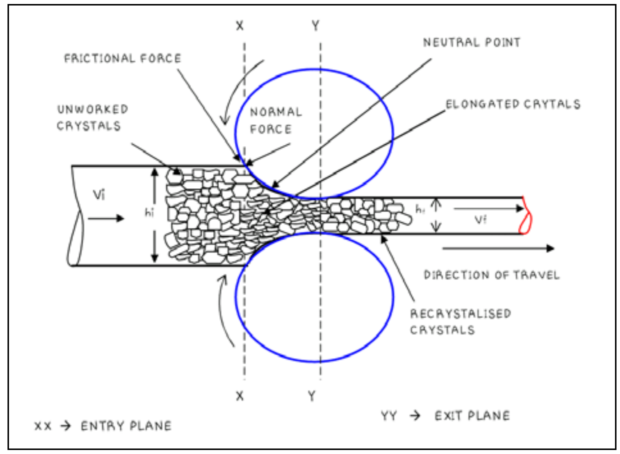
1. Billets are heated to make them soft and thus suitable for rolling.
2.Furnace has three parts: walls, roof and hearth. Furnace is lined with several layers of refractory bricks. It is insulated by glass wool. The initial heating zone of the furnace has temperature of about 1000 C. This zone is lined with low alumina refractory bricks. Soaking zone has temperature in excess of 1200 to 1300 C.

3. High Alumina refractory bricks are suitable for this zone.

Reheating is a continuous process where the billet is charged at input of the furnace and heated. The hot billet (in the rollable temperature) come out from the front, i.e., the discharged end of the reheating furnace and then proceed in the direction of rolling. Heat energy is transferred from the burner flame to the cold billet then it is discharged from the out side door. This exchange of heat energy takes place by means of conduction, convection and radiation. The rollable temperature of the hot billet ranges between 980C. Thus the temperature inside the furnace is still higher. There are many types of reheating furnaces such as pusher type,moving rake type etc…

IV. RECRYSTALLIZATION

1. The distinction between hot and cold rolling depends on the processing temperature with respect to the recrystallization temperature of material.
2. Rolling is classified according to the temperature of the metal rolled. If the temperature of the metal stock is above its recrystallization temperature then the process is termed as hot rolling, whereas if the temperature of stock is below its recrystallization temperature the process is known as cold rolling. Hot rolling is conducted by raising the temperature of the steel to its upper critical temperature to its austenitic phase, i.e., above the recrystallisation temperature. Then controlled load is applied which forms the material to the desired profile and specification.
3. While the material is rolled, its temperature is monitored to make sure it remains above the
recrystallization temperature. To maintain a safety factor, the finishing temperature is usually 500 C to 100° C above the recrystallization temperature. If the temperature does drop below this critical level, then it is not termed as hot rolling
4. The austenite grains get deformed / elongated in the rolling direction. However, these elongated grains start recrystallising as soon as these come out from the deformation zone.



Hot Rolling & Recrystallisation

V. SCALE FORMATION & ITS EFFECT

a. The formation of scale is influenced by the temperature , the composition of the steel input, the furnace atmosphere (whether excess air or not), i.e., whether excess oxygen is available or not and the time of residence of the stock in the furnace. More time spent inside the furnace at a high temperature and oxidising atmosphere leads to thicker scales and thus more metal loss. Formation of scale means loss of valuable steel metal.
c. Improved control of the furnace atmosphere enables a lower and more stable oxygen content inside the furnace and hence reduction of metal loss through scale formation. Now a days reheating furnace are controlled by full automation which leads less fuel consumption and scale formation.
d. However, a very thin scale is purposely formed on the outer surface of the stock to prevent dissipation heat from the hot steel. Scale forms an insulating material cover resulting in very low heat conductivity. After preheating steel slabs or blooms the rough material is descaled, but growth of secondary scale, a function of time starts immediately. To remove the scale from the surface a descaler is used in which water at high pressure through the nozzle are sprayed to descale the surface.

VI. METAL BURNING

1. Another undesirable feature influencing metal loss to a great extent is burning of metal.
2. This is caused by excessive heating resulting in burning / melting of the input stock, which leads to metal loss.
3. This happens largely when the material is kept for a long time in the furnace.
4. The input steel on occasions is degraded because of excessive oxidation of carbon and other alloying elements in steel.

3. The higher the coefficient of friction, higher is the resistance to lengthwise flow and more is the spread.
4. Spread is the most difficult and complex of all the parameters in rolling to understand.
5. The quantum of spread can never be worked out analytically. Neither any formula nor any method of computation is available to quantify spread.

VII. FORCES IN ROLLING

Pressure during Rolling

The distribution of roll pressure along the arc of contact shows that:
1. The pressure rises to a maximum at the neutral point and then falls off.
2. The pressure distribution does not come to a sharp peak at the neutral point, which indicates that the neutral point is not really a line on the roll surface but an area.
3. The area under the curve is proportional to the rolling load.
4. The area in shade represents the force required to overcome frictional forces between the roll and the stock.
5. The area under the dashed line AB represents the force required to deform the metal in plane homogeneous compression.

The main variables in rolling are :

- The working roll diameter – with higher diameter of the working rolls, greater drafting is possible.
- The contact length, i.e., the biting angle is decreased by decreasing the roll radius. Lesser the biting angle, lesser is the reduction.
- The deformation resistance of the metal is influenced by metallurgy, temperature and strain rate.
- The friction between the rolls and the work piece – greater the friction higher is the drafting possible.

Friction & its Effect

Quality of Rolled Product

The strength and the hardness of the material are a function of the chemical composition and the rate of cooling after hot rolling.

The higher is the carbon and other alloying elements higher are the strength and more is the hardness. The hardness of hot rolling is generally lower than that of cold rolling and the required deformation energy is lesser as well.

Increase of cooling rate increases hardness and strength. Hot rolled metals generally have little directionality in their mechanical properties and deformation induced residual stresses. However, in certain instances non-metallic inclusions will impart some directionality and work pieces less than 20 mm thick often have some directional properties. Non-uniformed cooling induces a lot of residual stresses, which usually occurs in shapes that have a non-uniform cross-section, such as beams, channels and rails.

It takes some time to reach what are considered stable conditions in rolling schedules. Longer stoppage times upset the applecart.

Physical Metallurgy of Hot Rolling

Hot rolling, due to recrystallization, reduces the average grain size of a metal while maintaining an equiaxed microstructure where as cold rolling will produce a hardened microstructure with unidirectional grains. As the rolling process breaks up the grains, they recrystallize maintaining an equiaxed structure and preventing the metal from hardening. Hot rolled material typically does not require annealing and the high temperature prevents residual stress from accumulating in the material resulting better in better quality.

Since the crystal structures are formed after the metal is worked, this process does not itself affect its micro structural properties.

- Mechanical Properties of Rolled Steel is a function of:
- Chemistry of metal.
- Reheat temperature.
- Rate of temperature decrease during deformation.
- Rate of deformation.
- Rate of deformation.
- Total reduction.
- Recovery time.
- Recrystallisation time.
- Subsequent rate of cooling after deformation.
- Scope of study
- Our aim is to slowly and steadily develop the different grades and sections of the various profiles for which the SRM plant is set for, it would take time to develop all the sections with different grades. Mainly the grades are :

 ISSN (ONLINE): 2250-0758, ISSN (PRINT): 2394-6962

STANDARD COLOUR CODES FOR THE PLANTS

Grade		Common Colours	
1.4541/321	WHITE	White	
1.4305 / 303 / BS 303S31	YELLOW		
1. 4307/ 304L / BS 304S11/304LER	BROWN		
1.4021 / 420 / BS 420S29	RED		
1.4016/ 430LER/ 430/ 430 L	SKY BLUE+ORANGE		
1.4104/430F	SKY BLUE+ PINK		
1.4057 / 431 / BS 431S29	PINK		
1.4571 / 316Ti /BS 320S31	PURPLE		
1.4404/316L/316LER/316LMo	GREEN		
1.4401 / 316 /BS 316S31/1.4436	BLACK		
1.4301 / 304 /304H / 304N/BS 304S31	NAVY BLUE		
1.4005 / 416	RED+ YELLOW		
1.4006 / 410 / BS 410S21/403	RED+WHITE		White
1.4122	RED+PURPLE		
304HC / 304CHQ/304LCu	RED+NAVY BLUE		
316L CU / 316L CHQ	RED+GREEN		
MS	BLACK+RED		
1.4542 / 630 / 17 - 4PH	BLACK+ WHITE		White
1.4845/310 / 310S /310ER	BLACK + NAVY BLUE		
317/317L	BLACK+PURPLE		
308/308L/308LER	BLACK+YELLOW		
1.4429/316LN	GRAY		
1.4462/F-51	GREEN+ ORANGE		
1.4310 / 302	GREEN+YELLOW		
1.4828/309/309S/309 LMo/309 LER/309LSi	GREEN+BLACK		
302 HQ / 302 CHQ	GREEN+PURPLE		
347 / 347H	GREEN+BROWN		
304M	YELLOW+ NAVY BLUE		
305	YELLOW+PURPLE		
201	YELLOW +WHITE		White
204Cu	WHITE+ BROWN	White	
202	YELLOW+ BROWN		
1.4370/307	NAVY BLUE+BROWN		
1.4306	GRAY+WHITE		White

Methodology

VIII. AREA OF DEVELOPMENT AND MODIFICATION

Round section from (70mm to 214mm)

In round section from 70mm to 214mm, we were facing the problem of standardization of recipe, calibration of lineal and stand gap so we made a standard SOP and followed it. The recipe of 105mm round is as follows:

NO OF PASSES	GROOVE POSITION	ROLL GAP	INITIAL ANGLE	ROTATION ANGLE
1.	2020	77	0	180
2.	1991	33	90	0
3.	1741	117	180	90
4.	1716	76	90	0
5.	2011	15	180	90
6.	1530	58	180	90
7.	1740	11	90	0
8.	1343	33	0	90
9.	1140	14.5	135	45
10.	936	13	135	90
11.	726	12	180	45
12.	265	6.7	0	90

TECHNICAL CONSIDERATIONS

Key words:

Material tracking; minimum tension control; speed cascade and loop control

Material Tracking

Material tracking function is used to control the material head cut and tail cut ,other process such as induction temperature control ,water on off sequence, bar laying etc.

Speed cascade control is the most important part of the control system for modern profile mills. Since the distance between the stands is short and the rolling speed is fast, the control system must have high accuracy, good stability, fast speed regulation and self-adaption.

Signal Source and Reliability Processing

The following signal sources are used, depending on different rolling areas:

- Hot metal detector (HMD), which is the most commonly used sensor in the mill line.
- Loop scanner, which is used in automatic loop control.
- Stand threading signal, which is generated from the peak torque detector in the AC/DC drive unit.

IX. BASIC CONCEPT AND BASIC PRINCIPLE OF MATERIAL TRACKING

The basic method of material tracking is to calculate the integral of the material speed reference over time. The HMD, loop scanner, threading signal, cutting signal are used to start and update the tracking function.

X. CONCLUSION

At last it can be concluded that rolling is a forming process in which different sections are rolled at different condition and different rolling parameters .There are several sections of Rounds, Hex, Angles, Channel, Flats, RCS, Squares, Unequal Angles Etc. It will take a long time to develop the most effective rolling process for all these and many more to come in future.

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