Application of semi-endless rolling technology in CSP production line

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Abstract: The technical problems and relating reasons of semi-endless rolling were introduced in this paper. Regarding the problems, we carried out a series of improvement towards these problems. The application of semi-endless rolling got a great success.

1. Introduction
The technology of thin slab continuous castings and rolling that new technology were coming forth constantly have passed through about twenty years development. Semi-endless rolling technology is the one key of the Secondary Generation production line. It has made considerable progress in practice, It initially has already realized the industrialization production, and been widely used for the production of ultra-thin hot rolling strip[1-8].

The CSP production line of Hunan Valin Lianyuan Iron &Steel adopts the technologies and partial main bodies of SMSD Corporation(German), TOSHIBA-GE Corporation and the BRICMONT Corporation. The line fetches in the Semi-endless rolling technology and related equipments to get steady production[9]. During debugging and trial production, we accomplish the breakthrough of rolling of long slab of 269m and the thickness of 0.78mm.

2. craft process of the Semi-endless rolling technology
The long slab get into the funnel furnace from the 1# caster, and cut by hydraulic shear when aim length(Fig. 1).
Then the long slab was heated to setup temperature, rolled in finish mill set. The rolled strip gets to the underground coiler in output tunnel, passing laminar cooling. When the coiler gets tensile force, the PLC system would divide the strip into two parts according to the aim weight by high speed fly shear. The strip tail of 1# coil would accelerating forward for loss of tensile, but the strip head of the back one holds rolling rate because of the tensile between F7 and fly shear, thus gets 1-2 metres space from 1# coil, getting into another coiler. The two coilers works in turn until the rolling period finish. When Semi-endless rolling, the mill could accomplish to vary specifications (thickness), that is to switch between different thickness in short time. For ultra-thin spec., we commonly use speed-change rolling. (low-speed strip threading and unthreading operation and high speed rolling).

3. The drawing of the Semi-endless rolling plan

Profited from the advanced manage experience of domestic and foreign steel enterprise, the CSP line of Liangang set up multi-level PLC and information management system(L1, L2, L3, L4). The system order was input from L4 and transfer to production plan delivered to L3, then working plan created in L3, and delivered to L2, insisting organizing production according to plan.

In the early days of debugging, we basically established work plan according to the model plan of Semi-endless rolling the expert provided us, which requests strict combination of two strands of casting speed, the length and number of single long slab. But in the actual production process, any working procedure wrong possibly would affect the whole plan. There are always such conditions that the ideal rolling opportunity without long slab plan or fit chance, inducing the caster “feels stifled”. So it’s urgent to increase the freedom of the plan.

Then the engineer amended the corresponding relations, allowed time advanced to the long slab work plan delivered by L3 or the combination of single slabs to long one, and endued them with coil number accordingly before Semi-endless rolling In the same way, if rolling plan is blocked, the system could divided the received long slab into single ones, also entrust corresponding coil number to carry on the rolling.

4. The distribution rule of Semi-endless rolling reduction

Compared with the computation of the distribution rule of single slab rolling, the one of Semi-endless rolling is mainly reflected on the difference that our system would conduct on every transition length and subcoils. Through the is processes are normally same, but our rolling time lasts more, the rolling parts, roll and the main drive system would specially changed. So, it’s important to confirm reasonable distribution rule.

When confirm a rule of reduction, the back frame should hold same load and reduce the variable between the setup data of the force coil and the back one’s as possible besides obeying the rule of “force bigger than back” to distribute load to reduce the of the back position frame. The aim thickness is 3.0mm, 2.8mm, 2.6mm(Fig.2).
We could get that the results of output thickness of simulation and the actual measurement is approximate, almost same while rolling the first coil. But the error went on increasing during the second rolling. When the third went, the error was significant although we had got ideal thickness control curve by AGC feedback system. But the rolling is unstable because of the increcent error, and the wave got bigger, the pile and exploit correlation exited between frames. The aim thickness is 1.0mm, 0.9mm, 0.8mm (Fig.3)

We could get that the results of output thickness of simulation and the actual measurement is approximate. And the model simulation results of second and the third ones is almost the same as measurement, that suggests The model hypothesis computation precision enhances greatly, and the rolling condition is extremely stable.

5. semi-endless rolling process tracks
semi-endless rolling process track strategy like chart 4 shows, S1, S2, S3, S4, S5 is changes the specification rolling starts the point, E1, E2, E3, E4, E5 is changes the specification rolling conclusion spot, C2, C3, C4, C5 is cut point, M1, M2, M3, M4, M5 is the steel coil track starts the point after changes the specification or cut point, LSC1, LSC2, LSC3, LSC4, LSC5, LSC6 is the permanent thickness control length. In the system, above each tracking point already may be in the long slab position, also may be after the rolling coil position.
semi-endless rolling setup computation mainly is calculates based on semi-endless rolling plan as well as the actual slab data semi-endless slab various systems tracking point changes when the specification rolling in the slab position as well as the optimization the rolling craft parameter. It altogether divides three times of computations, the first setup computation carries on when the slab enters furnace, plans the slab and the coil goal parameter carries on the computation; The second setup computation carries on when the slab all enters the furnace, goal parameter carries on the computation by the actual slab data and the coil; The third computation when leaves the furnace rolling for the slab, in second time calculates in the foundation heats up the data by the reality carries on the computation. Changed the specification the start and the conclusion points that it decides Transiting Section of length when changed specification. Changes the specification time is excessively long, the product transition section long, the customer accepts production with difficulty, the rolling process also is in the non-steady state; Changes the specification time is excessively short, when specially carries on the limit specification the rolling, The rolling mill process unit withstands the load is extremely big, extremely will be strict to the process unit control precision request. Therefore, the reasonable setup starts and the conclusion these two points distance is the model computation key.

Cut points the computation is the model acts according to the slab length automatic setup cut points of the position satisfies the goal coil heavy process. If in the actual and plan slab difference is too big, cut points through the automatic adjustment the position reduces some or certain coil weights, even cancels the coil.

When semi-endless rolling coil length receives the craft and the equipment parameter limit, the irrational coil length can affect the stable rolling, even the coil will take is unable smoothly to complete. The coil length computation, is synthesizes the consideration craft and under the equipment factor premise, the model acts according to the slab length setup the cut points position satisfies the goal coil weight process.

6. The strip shape and the straightness controls
When after semi-endless rolling stage, CVC on-line flees the roller arrived the limit, The rolling mill is unable rapidly through further to adjust flees the roller quantity control panel shape, Has big both sides, but this time roll bending strength already arrived the limit, was extremely easy to appear rolls over breaks and pulls.

In view of the above question, adopts increases the CVC roller is primitive crown, increases the following strip shape supposes the definite value, increases the rolling forces setup precision, the increase rolling forces setup computation number of times, and so on, enhances the board shape and the straightness control precision and the operation stability.

7. semi-endless rolling production practices
In the actual production process, and smoothly carries on semi-endless rolling for the maintenance production rhythm, after the general choice one caster production or roll change carries on semi-endless rolling production simulation, cuts number of times 1–3, simulation number of times 1–2,
after Simulates successfully, the long slab will carry on “1 cuts 2 ”trial rolls, coiler DC2 - DC1 transforms, Trial rolls over smoothly after, Starts to carry on the true significance semi-endless rolling, and gradually increases cuts times, realizes the single slab and semi-endless in turn rolling. Since table 1, table 2 separately for has gone into production semi-endless rolling statistical situation.

| Cuts the classification | Rolling times | notes |
|-------------------------|----------------|-------|
| 1 cuts 2                | 128            | 1. slab len |
| 1 cuts 3                | 42             | 2. |
| 1 cuts 4                | 14             | 3. gth 269m(Max.) |
| 1 cuts 5                | 8              | 2. product thickness 0.77mm(Min.) |
| 1 cuts 6                | 4              | 3. The thickness changes the specification 0.2mm(Max.) |
| 1 cuts 7                | 3              | |
| Total                   | 199            | |

Undergo the unceasing production practice, the liangang CSP production line technical personnel accumulated the rich semi-endless rolling experience, and through the craft optimization as well as the improvement control system, powerfully urged semi-endless rolling technology to be day by day mature.

8. Existence main question

The Scene measuring instrument is easy to receive the disturbance Causes strip to cut points Tracking Signal of the examination does not permit or has not examined, Appears high speed fly shear with the underground coiler misoperation or act causes cobble steel.

The high speed fly cutting edge one service life is short, cutting edge gap Adjusts difficulty, Connecting bolt of Main drive shaft connection is easy to become less crowded with the break.

Does not consider pulls the caster speed brings the influence, the long slab`s head, body and the tail part gradually shortens in the furnace time, is easy to create the tail part temperature is low, if the coal gas calorific value and pressure undulates is frequent, then guarantees in with difficulty the long slab entire length the temperature uniformity.

Two caster at the same time under the working condition carries on semi-endless rolling batch production, must synthesize the consideration casting slabs size, casting speed, the furnace cushion time, the product coiling weight and so on nimbly determines the long slab length, cut times, the long slab and the short slab combination, the production organization and the rhythm control difficulty is big. If once appears cobble steel or the equipment breakdown, is easy to create the caster stops the pouring.

9. Summary

In semi-endless rolling debugging and trial production period, the Liangang steel CSP production line met the very many crafts technology difficult problem. Through the optimized mathematical model, the craft parameter and the improvement production organization, carried on the massive experiments again, Deepened semi-endless rolling technology understanding, strengthened the production organization direction and the coordination ability, promoted the equipment maintenance and the management, semi-endless rolling technology is day by day mature, the extremely thin specification semi-endless rolling is specially successful, symbolizes the Liangang steel CSP production line semi-endless rolling technology application obtained a bigger success. But,
semi-endless rolling craft and the correlation equipment still had some problems, the production organization and the rhythm control awaits improvements, how fully displayed semi-endless rolling the superiority, caused semi-endless rolling to become the batch produces the thin specification product the conventional craft, Also needs further explores in the practice.

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