FrontRunner

Special [Round-table talk]

Ricoh and Tokyo Steel Score an Industry "First"

Pushing Back the Frontiers of 100% Recycled Steel in a Bid to Save the Planet

Ricoh announced the adoption of electric furnace steel sheets (*1) jointly developed with Tokyo Steel Manuf acturing Co., Ltd. (Tokyo Steel) for the structural part of multifunction printers (MFPs) in March 2012. These electric furnace steel comprises 100% recycled steel scraps as raw material, which are normally used for construction materials. This is the first time they have been adopted for office machines. To use these electric furnace steel sheets for MFPs, mechanical properties (surface characteristics, formability, workability, etc.) must conform to those of regular steel sheets from blast furnaces. With this background of pioneering challenges, we talked to people from both companies about how they overcame difficulties and achieved use in MFPs.

*1 Electric furnace steel sheet: Scrap steel is dissolved in an electric furnace and, after quality governing, refining, and casting, is made into slabs. These slabs are rolled and cooled to become a hoop steel (coil). They then go through a secondary process of annealing and coating, and finish as a sheet steel.

PROFILE

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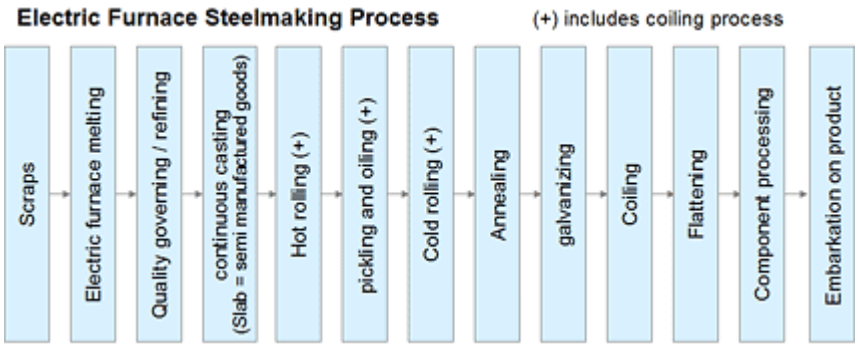
01. Two parties, collaborating on common goals with an open mind

Both companies brought complementary strengths to the table. Tokyo Steel, deploying the resource cyclic-type business of iron-and-steel resources, and Ricoh, promoting "environmental management" to preserve the environment while creating profit on the other. It all started in the autumn of 2009.



Sakakitani (Ricoh/R): While investigating ecological leading-edge technology, we looked at electric furnace steel as an environment-friendly material. We contacted Tokyo Steel, a unique sheet steel vendor with high technical capabilities in the industry.

Ito (Tokyo Steel/TS): It was the first time for us to manufacture steel sheets for office machines. We were a little tense in the beginning, knowing we must meet tough expectations.

Electric furnace steel sheets are mainly used for construction materials, and their application for industrial products remains limited. The limitation results from issues with workability and moldability, but the material excels in toughness and corrosion resistance. Beyond that, the requirements for surface finish are fundamentally different between construction materials, whose surface is not visible, and industrial products, whose surface appearance must be good.

Yagi (TS): The first thing that worried me was the talk about the plating processing method (*2) being different. Although the steel sheets for MFPs were electrogalvanized in thin film, our standard products were only hot dip galvanized in thick film.

Yoshito Yagi
Joined the company in 1986, extensive experience working in various plants. Played an active role in metal rolling field.

Ito (TS): Chromate-free (*3) production was also a hurdle for us, although it was nothing special for office machines. Corrosion resistance is the first priority for construction materials, so our trial for chromate free processing might run behind. I thought we might have a hard time as so much of this was new.

*2 Plating processing method: Electrogalvanization bonds zinc to the steel sheet surface using the electrolyzation method. On the other hand, hot-dip galvanization dips a steel sheet in zinc liquid, and further controls plating thickness by air blast. The former fits thin filmed applications and the latter fits thick filmed materials.

*3 Chromate free: Although chromate is used to enrich corrosion resistance of the undercoat agent (oxide film material) or plating of steel materials, the use of hexavalent chromate is restricted because of its adverse effect on the environment. Ricoh stopped using it in 2000.

Although Ricoh understood the technical difference between blast and electric furnace steel sheets, they also insisted on the need to reduce environmental impact, even tracing back to the level of the raw materials, deciding that adopting electric furnace steel sheets was worth a try. Steel sheets account for about 50% of all MFPs. Because most resins are already being recycled, if we can adopt electric furnace steel material, which is also a recycled product, to replace conventional steel sheets, our campaign to reduce environmental impact will enjoy a great boost.

Hirota (R): Although I knew of the technical issues and approaches to some extent, I was prepared to spend about two to three years making things run smoothly.

Ito (R): We presented the detailed evaluation criteria to achieve equivalent specifications with blast furnace steel sheets. We believed that the sheets could not be used on our products unless the criteria were fulfilled.

Ito (TS): There were more than 40 main items specified. Moreover, there were detailed descriptions not only of material characteristics but also of the solvent to be used. I saw many terms for the first time and I often had to say "I will take it home for the technical department to study in detail. (grin)

Ricoh was able to go into much detail because it had accumulated abundant information through materials development. The morale of Tokyo Steel also increased. Usually, even if the targeted values (goal) are set out by supply destinations, it is rare that the evaluation criteria (process) are disclosed along the way.

Yagi (TS): The original idea was that it would take several years, but progress was unexpectedly fast; I think this happened because of Ricoh's open mindedness.

02. Large barrier impossible to overcome with technology alone

As soon as joint development started, we immediately faced a white-knuckle problem. The steel sheets for MFPs are processed with molds for casting into the required shape. If workability is low, they cannot be used for MFPs.

When the first sample was pressed, it cracked. Ricoh's technical experts were not smiling. Believing that the problem was with workability, we dared to challenge adoption of the electric furnace steel sheets, to meet our ecology goals. The project was launched after showing the concept to and obtaining understanding from upper management, and asking cooperation from related departments, including design.

Hirota (R): My first concern was that electric furnace steel sheets might be judged unusable.

The main problem was with the hardness of the base material. The steel scraps used as the raw material for electric furnace steel contain various inclusions, which contribute to the hardness of the material. Material hardness is "the selling point" of electric furnace steel sheets. With blast furnace steel sheet, components are added to enrich hardness. Although Tokyo Steel brought in samples softened as much as possible for use in MFPs, they were far below Ricoh's requirements. Ricoh was at a loss, and Tokyo Steel were also scratching their heads. In cases where the workability required by Ricoh could not be fulfilled, even if adopted, adoption would only be limited. If quantity cannot be produced, it is no longer welcome from management's viewpoint. This weighed heavily on Tokyo Steel staff.

Ito (TS): There is a special persistency at Tokyo Steel as an electric furnace steel manuacturer. That is, we accept the rate of steel scraps on the market as is. About 80% of the steel scraps are obsolete scraps containing many extra substances; 20% are scraps with high purity. If we use high-class materials only, we might be able to meet the equivalent quality of blast furnaces, but the cost becomes impractical. It is the forte and raison d'etre of our company to create high quality steel sheets from common waste.

Gaku Ito
Joined the company in 1994. Having worked exclusively in the sales division, he became the first section chief of the newly established "Steel Sheet Development Section" in 2011.

Just when it seemed impossible, we saw a ray of light. We found a way to improve workability if we used the degassing system at the Tahara Plant, which was about to start operations. The process consisted of removing a gas component at the molten steel stage. Introduction of this system was a first in the electric furnace industry.

Yagi (TS): We knew that we had to control nitrogen as one of the conditions for raising workability, so we immediately began testing. Finally, we were able to hold the content down to the same level as blast furnace steel sheets.

Sakakitani (R): I had already heard about the establishment of the Tahara Plant. Hearing that the new plant held the key to improving workability, I wanted to see it in full operation.

Workability does not reach the desired value merely by degassing. We also had to optimize the temperature and roll force in the continuous annealing process (*4). The process for creating new annealing conditions was developed at the Okayama Plant, where a continuous annealing line is available.

*4 Continuous annealing process: Annealing adjusts the hardness of a steel sheet. Continuous annealing is the method of uncoiling hoop steel (coil), to pass inside the annealing furnace.

Ito (R): As for workability, we asked that the condition to use the mold for mass-production currently in use with the blast furnace steel sheets remain as is. That's because, if we have to manufacture a dedicated mold for electric furnace steel sheets, cost will increase.

Kenichiro Ito
Joined Ricoh in 2009 after working for an automobile manufacturer. Took charge of overseas production of pressed components, and development of press related technologies.

Yagi (TS): We had the actual results of manufacturing steel sheets for automobiles, but because the specifications requested by Ricoh were so exacting, our challenge was significant; we finally had to thoroughly investigate the crystal grain diameter.

At the Okayama Plant, the challenge was to reduce coat thickness of the hot-dip galvanization, which was another big concern. One approach was to shorten liquid-immersion time; another was to develop a new method to wring excess plating. Because hot-dip galvanization is done during the continuous annealing process, the whole process must be optimized to shorten liquid-immersion time. Overall process conditions had to be reexamined nearly from scratch and efforts moved forward together with the above-mentioned improvements in workability. The same applied to wring excess plating. The coat layer of plating is controlled by wringing excess plating with air injection after liquid immersion. Because we had almost no experience of reducing coat thickness, the optimum direction and quantity of injection had to be found through trial and error. With this improvement in the continuous annealing process, the high target of "electric furnace steel sheets excellent in workability" was reachable.

Hirota (R): The issues with material or surface treatment can be solved by technology. But it is difficult to break through restrictions with the equipment, like the continuous annealing process. I appreciate how successful Tokyo Steel was in achieving this.

Yagi (TS): For our technical challenge, there were portions more strongly supported by Ricoh. However, since manufacturing is our area of responsibility, I felt a strong responsibility here. If we could meet our goals, we could improve our technological know-how. It was all down to us.

The plating thickness we achieved is an overwhelming thinness as hot-dip galvanization. It became much less than the lower limit stipulated by JIS (Japanese Industrial Standards).

03. Establishing a new evaluation method as an extra benefit

Along with the plating, Tokyo Steel was deeply concerned about chromate-free processing. They had little experience in coating the chemical film of resin systems to substitute chromate (as mentioned above). Moreover, although a thick film is advantageous for resisting corrosion, conductivity then worsens. Conductivity is an absolute requirement to prevent electromagnetic interference (EMI (*5)). For that purpose, an MFP needs thin film processing. The antinomic requests on corrosion resistance and EMI were put to Tokyo Steel's technical experts, who were relatively inexperienced in chromate-free coating.

*5 Prevention of Electromagnetic interference: Conductive substances are used for the housing of an electronic device to prevent electromagnetic rays from causing malfunctions. Electromagnetic rays decline in proportion to the amount of conductivity (or magnetic permeability) of the material.

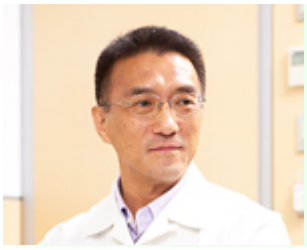
Yagi (TS): We were indifferent to EMI until then, so we were stuck without any solutions at hand. Ricoh advised us to try a dull finish. We tried it and it worked.

A dull finish is a method of making the steel sheet surface pearskin finished, with minute unevenness, and is generally used in steel sheets for MFPs. By producing a dull finish, we were able to hold conductivity at the salient part and keep corrosion resistance concave. This was also a first trial for Tokyo Steel.

On the other hand, Ricoh also had an issue with EMI. They had continued measuring conductivity of the provided steel sheets, trying to determine whether or not a more precise or simple method was possible. The measurement method till then required time and effort; verifying the test result was difficult.

Ito (R): We examined lots of things; we identified a measurement method with higher sensitivity than before. This method enabled us to clearly measure the influence of different coat thicknesses or surface finishes, which had previously been difficult.

Hirota (R): Discovery of this new evaluation technique is extremely meaningful for Ricoh. It was one of the big gains obtained through development of these electric furnace steel sheets.



Hiroshi Hirota
Joined Ricoh in 1975. After working with press related technologies, assumed his present post in 2007. Mainly works on cost reduction activities for components.

Yagi (TS): Better evaluation was also good for us. Being able to quickly evaluate the chromate-free coat allowed us to develop even better solvents.

There was an episode of note in our approach to chromate-free processing. With the initial sample, the corrosion resistance was satisfactory but EMI became an issue. After Ricoh received the second sample and corrosion resistance was tested for confirmation, immediately after forecasting there were mostly no problems. But slight rust was found on the surface.

Ito (R): I couldn't believe my eyes. I actually wondered if too much salt had been used in the spray test. It was on the same day that we were to meet Tokyo Steel and we had already sent them an OK the day before. I didn't know how to start the meeting. (grin)

After repeated prototyping and evaluation, it was not until April, 2011 that an electric furnace steel sheet which

fulfilled most of the requirements for MFPs was made. Ricoh decided to try it out it on MFPs, which were in mass production trials. This was done in a little less than a year after being disappointed by the first sample—much less than the two to three years forecast at the start.

Sakakitani (R): Although a portion did not meet the original target, we decided to start with the usable parts first. I felt that the image of electric furnace steel must be enhanced in our company as soon as possible, as I wanted to contribute to reducing environmental impact.

Masatoshi Sakakitani
Joined Ricoh in 1994. After working on design of facsimiles and inkjet MFPs, he moved to his current post in 2009. Mainly works with electric furnace steel sheets and assists the recycling center.

Yagi (TS): Ricoh wisely chose to allot an adoption area and the portions corresponding to the target achievement by degrees, not trying to do everything at once. The gradual targeted values given to us were very helpful, as we faced many issues spanning the material to the solvent. That's why, I think, we were able to reach the point of adoption in about a year.

Ito (R): Our assignment was to master the use of electric furnace steel. Tokyo Steel had a policy of harnessing components, such as the copper contained in steel scraps, wherever possible. The process for improving quality consistent with this policy is very interesting and I found it challenging and worth doing.

Adoption of the electric furnace steel in MFPs has gained the attention of the industry and has been widely reported in newspapers and technical magazines. The first device in which it was used, Aficio MP 9002/7502/6002, was released in summer, 2012. However, this is just a start. (Release dates differ by region.)

Hirota (R): Although there some issues remain, such as deep drawability into more complicated shapes, spot weldability, and others, new issues await us, such as the need to reduce thickness further. I think it is necessary, from now on, to focus on the further reduction of thickness, while enhancing workability. This is needed for electric furnace steel to extend their share in the field of office machines, including MFPs, maintaining interchangeability with blast furnace steel sheets. I hope you can understand that this request came up precisely because we felt that electric furnace steel furnace sheets had potential. They have come to fruition through joint development.

Ito (TS): The debate surrounding electric furnace steel revolved around price. In such circumstances, Ricoh based its evaluations on finding an environment-friendly material, which gave us this opportunity for joint development. We of course believed our engineers could overcome technical barriers, but the question was whether we could meet Ricoh's product development and delivery schedule. It was uncharted territory and the task ended up involving two plants, and many nerve wracking hours. In the end, united by the basic concept of building an environment-friendly material, we were able to push on through.

We can say both companies were brought together for a profound reason and acquired much through this joint development beyond products or technologies.

COMMENT

Gaku Ito:
I am proud that we pushed back the frontiers of the electric furnace steel field, with the development of steel sheets for MFPs. I expect that, thanks to our success, prejudice against electric furnace steel will diminish. I expect to take our collaboration on recycling even further.

Yoshito Yagi:
I am grateful that Ricoh disclosed the details of the evaluation criteria, which enabled us to improve our technical capabilities. However, I recognize that there is still some way to go before we can fulfill Ricoh's requirements 100%, and increase the adoption rate.

Kenichiro Ito:
Although there were many issues to be solved beyond technical aspects, embarkation on a mass-production model was achieved, thanks to cooperation beyond anything we could have imagined. I would like to enhance interchangeability further with blast furnace steel sheets, strengthening the relationship, and to expand the use of these materials to the satisfaction of our partners here and around the world.

Masatoshi Sakakitani:
It was my first job after transferring from the design department. I am proud to have been able to successfully contribute to resource circulation. After this, in addition to conquering technical backlog issues, new issues, such as materials procurement overseas, will appear. There is much more to be done, and no end to the fun.

Hiroshi Hirota:
Although I had so far concentrated on investigating the functional aspects of steel sheets, I was able to work on the environmental theme as well this time. As an engineer, I am glad to be able to contribute to society.

(May, 2012)