Press Hardening facility “hotPHASE” for automotive steel plate made by EBNER Industrieofenbau

1. Introduction

In recent years, in the automotive industry, in order to reduce the environmental burden, it is necessary to reduce the emission of carbon dioxide and NOx (nitrogen oxides), to improve the fuel economy performance to make it possible to travel longer distances with less fuel, and ensure the safety of drivers and passengers. And also an improvement of collision safety performance of car body, etc. are the theme of development for many automobile manufacturers.

In order to solve these problems at the same time, it goes without saying that development of an engine which an internal combustion engine, and at the same time a reviewing the material used for the chassis and the car body, and find the way how to reduce the weight of the car body in the manufacturing process of the car body, it is the biggest problem.

Among these problems, in order to ensure safety performance while reducing the weight of the car body, there are cases where these tasks can be dealt with by reviewing the manufacturing process of the car body.

“Hot press/hot stamping/Press hardening” is the technique which has been attracting the market attention. In the fair Thermotech 2017 we introduced the hot press technology of Austria EBNER Inc. which we have dealt as a domestic agency.

2. Improvement of collision safety performance and saving weight

As the material of improvement of collision safety performance and weight saving, High Strength Steel plate (490 to 790 MPa) · Ultra high strength steel plate (980 to 1470 MPa) · Mild steel plate (340 MPa) · Aluminum alloy plate (310 MPa) · Magnesium alloy (250 MPa) · CFRP: Carbon fiber reinforced plastic etc. has been used.

In terms of the density of the material, the steel material is 7.8 g / cm 3, which is not lightweight compared with aluminum and magnesium alloys, but for high strength steel sheets and ultra high steel sheets with high strength, it has the specific strength (per unit weight) than Aluminum, and it is classified as a lightweight material.

Because high strength steel sheets and ultra high steel sheets can be mass produced at low cost, and have strength with less emission of CO2, it is considered that the suitable material for improving collision safety and weight saving, at the same time, it can be said that it is the material considering the global environment.

On the other hand, high strength steel sheets and ultra high steel sheets has a force that tend to return to its original form when the press load is removed at the time of cold pressing

forming(spring back) and it may huge effect to the forming accuracy.
For the purpose of formability improvement and avoiding spring back, hot press technology is spreading in the automotive steel body sheet manufacturing process in overseas.

3. Hot press technology

The explanation for the affection and process of “hot press” are as follows. By heating the steel sheet for hot press which is not high /ultra high steel sheet up to approx. 400℃ in the furnace, the tensile strength decreases and tend to stretch, it becomes easier to press forming. Steel sheet which is heated more than 850 ℃ becomes Austenite structure. By quenching it, it transforms to Martensite structure and get high strength, this is the special quality of the steel sheet.

Hot press is the technique that does quenching and forming at the same time. The process of hot press is to punch the steel coil material to the press form called blank, convey it into the heating furnace, heated it to 930℃.

The heated blank is conveyed to press machine, being pressed for a few seconds to quench (Keep the bottom dead center). Processed blank is divided into 2 types. One is plating with Zin or aluminum silicon to prevent surface oxidation, another is without the plating.

After press process, the blank without plating is necessary to be machinery process called shot blast to surface oxide coating removal. The blank without plating need more process than blank with plating. The blank with plating itself is expensive because it doesn’t need the process of surface oxide coating removal. Also, strengthening by quenching at the same time, laser will be needed for trimming after press and drilling process, it makes the cost for after process more expensive.

To get the best effect of quenching blank, the time to convey from furnace to press machine is the key.

Transforming of blank into martensite require quenching it right after the hearing to 850℃ (austenizing). However, the temperature is going down rapidly because the thickness is very thin (1.6-1.75mm). So, the key is to shorten the time from the furnace to press.

4. About EBNER Industrieofenbau Inc.

EBNER Industrieofenbau Inc. is well known as an industrial furnace manufacturer which provides the cutting-edge technology. EBNER first established in the world the annealing technology which does heating treatment for metal products like steel, copper alloy under the circumstance of 100% H2 atmosphere. EBNER is located in Linz, Austria as their headquarter and the production base, where produces the bell type annealing furnace which is the main products of this H2 annealing technology, and other facilities for heat treatment for steel, copper alloy and aluminum. As their subsidiaries, production bases are in Ohio, USA and Shanghai, China. They

provide the facilities to the world.

EBNER is a private company owned by EBNER family. In spite of it, EBNER has got more than 200 patented technologies. In 2018, EBNER commemorates their 70th anniversary of its foundation. In the industrial furnace field, we can say EBNER is a pioneer.

The delivery reference for Japanese market is more than 200 plants to the steel, aluminum and copper alloy customers. We (K.Brasch) are one of the global expansion service bases where can be contacted by the customer 24hours.

As above, EBNER has been designing, developing and producing the heat treatment furnace for Steel material for automotive steel sheet, aluminum for aerospace, variety of copper alloy material for electronics since its foundation.

However, around 2009, a customer who was using the hot press furnace from the other company strongly requested EBNER to develop hot press furnace. Then, EBNER has started to develop and sell hot press furnace based on the experiences he has earned from the industrial furnace field with eliminating the problems of the other company's furnace.

5. General kind of facility and advantage, disadvantage

Automotive steel plate processing company called Tier1 has different ways to produce and implement heat treatment of the steel from each company. For example, to install the facility in limited space, batch type furnace with 2 stages or multi levels (more than 3 stage) is required. If you have large space, or need certain amount of production, roller hearth furnace is a choice.

In case of multi-level batch type furnace, the other stages can operate when one of the stages needs maintenance. This is an advantage of this type of furnace. On the other hand, it takes much time to convey the blank to press machine from the furnace exit, the productivity per hour (SPM) is lower relatively than roller hearth type furnace. Additionally, when the blank is pressed, the mechanical property, e.g. hardness, is stable because the temperature of blank is not uniform due to the time difference of the transportation between each stages.

In case of roller hearth type, it requires large space to install and doesn't have production backup function like batch type furnace. However, the distance between heating furnace exit table to press machine is short, and it makes possible to press the heat treated blank efficiently, the productivity per hour (SPM) is high.

6. Property of EBNER hot PHASE

a) Roller hearth type continuous furnace

The problem of the conventional roller hearth type hot press furnace is high frequency of replacement of hearth roller which transport the blank, bearing and insulation material, and the cost to do it. According to a customer using a furnace made by other company, they replaces

approx. 100 pcs of hearth roller, insulation material 2 times in a year.

The reason for the replacing hearth roller are 3 kinds as follows;

- Damage on the surface of blank, it is caused by sticking the plating of the blank on hearth roller.
- Blank cannot go straight, because the plating sticks on hearth roller and it makes surface bumpy.
- sticking the plating on hearth roller makes it broken, and fall into the furnace.
  (leads to damage to insulating material)

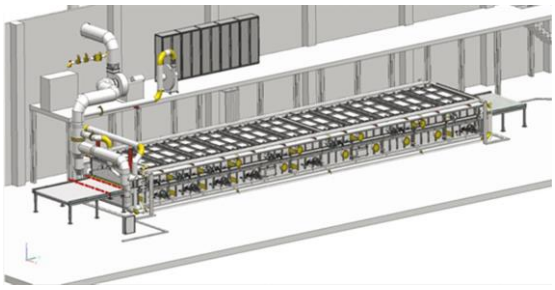
In any case, the production has to be stopped until the temperature goes down and replace the hearth roller by going inside of the furnace. We can imagine that the production loss to do the maintenance is also the problem. Also, if the frequency of falling the hearth roller into the furnace is higher, the damage to the insulation material is also higher. It leads to the replacement of insulating material in short term.

EBNER has developed roller hearth type hotPHASE furnace with high productivity by reducing the frequency of hearth roller replacement to 1/10 per year compared to the conventional one, by designing based on the experience earned as industrial furnace maker as follows.

1. Development of the hearth roller and the coating material
2. Structure to prevent the hearth roller falling into the furnace
3. Simplify the process of replacing hearth roller
4. Reduce the effect to the production during maintenance

There is no need to implement the replacement work for the insulation material any more by completely preventing the hearth roller falling into the furnace and drastically improvement of the thermal insulation performance. In addition to that, it is designed not to lose the energy. The material which rarely deform is used to the furnace and the furnace door where the blank is inserted/ejected. This make it possible to adjust finely how much the door is opened/closed.

The heating source which heats the blank up in the furnace can be gas, electric and hybrid. The customer can choose the one which is the most efficient utility.

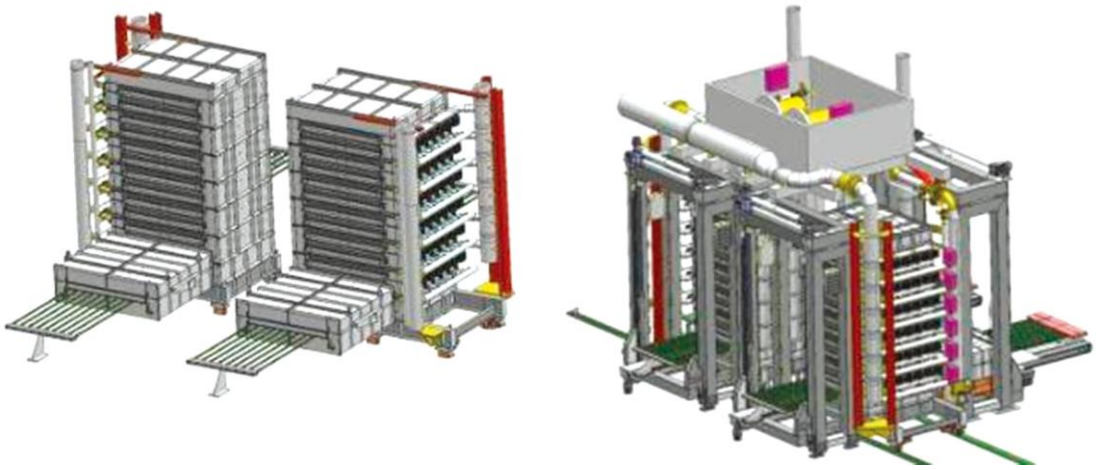


b) Butch type multi-stage furnace

There are the case of the company which is doing hot press but are not able to secure the space for the roller hearth type continuous furnace. In this case they do it with the batch type multi level furnace which is doing the heat treatment of the blank without surface plating (Except some

companies do the process with plating). The biggest problem of the multi level furnace is, as already explained, the mechanical property is not stable because of the time difference of transportation between each stages. EBNER developed the system which can set the stable conditions (distance, time) of transporting the heated blank to the press machine, and took it to the batch type multi stage furnace as a solution. This made it possible to keep the mechanical property of the blank stable after press.

In the case of blank with coating, atmosphere gas (mixture of N2 + CH4) is necessary to be included to prevent decarburizing and controlled in the furnace. When the gas control is used to the multi stage furnace, it is recommended that to use only for heat treatment of blank without coating because there are only few advantages from the aspect of the cost.



7. Centering system and atmosphere gas control system

The finger for centering on the furnace exit table is usually fixed, but EBNER designed it to be adjusted by operator freely depending on the shape of the blank. Also, EBNER made it standard function to lift the blank from the exit table. There is no need to go under the table when the maintenance.

EBNER, the company first established in the world the annealing technology under the circumstance of 100% H2 atmosphere, and his thought is also applied to the hot press furnace. The control of atmosphere gas (CH_4 + N_2) used when the blank without coating is heat treated is supervised by the device installed on the valve stand belong to the furnace, and the result is shown on the operator panel. At the same time, it is controlled to the set value. It makes sure that the safety of the exhaust of CH4, which is explosive, and safe operation.

Even if the kind of the steel or size (length, width, thickness) of the blank is changed, the operator is able to change the operation condition on the operator panel easily. Even the thickness of aluminum diffusion layer of the blank with coating is different between the specification of each automotive company, the auto calculation and control system is as an option to fit the operational

condition.

8. Tailor tempering technology

It was the usual way to change the blank temperature by cooling the dies temperature on the press machine when it is pressed to adjust the hardness, to change the hardness a part of the 1piece of blank. In this way, the stability of where the temperature of the dies gets cold is low, the mechanical property of pressed blank (e.g. hardness) is not even, at the same time, dies need to be replaced with high frequency because of the metallic fatigue.

EBNER developed patented technology which adjust the temperature of pressed blank in the furnace, not by adjusting the dies temperature. By that technology, no decreasing of the productivity, obtain the stable mechanical property of the blank and longer lifetime of the dies which is used to press.

9. Future perspective

In recent years, so many companies, not only automotive manufacturers or Japanese Tier1 which produce press parts, also Tier companies from overseas has been entering to Japanese market.

The circumstance of the press technology has been changing drastically. Comparing the market in Europe or the US, Japanese market has less kind of car made with the parts made by hot press technology excepting the luxury cars.

However, pressed parts made by hot press technology is unavoidable as far as trying to save

weight and improving collision safety performance. The important thing is to be flexible to specification changes which would be required from the automotive company not only by improve the SPM, also processing the press parts which have stable mechanical property.

It is true that EBNER hot PHASE facility is the later developed product in the hot press market, however, it has been providing user friendly facility with high durability and maintenance which is based on the R&D, improvement of the technology, experience and achievement as the industrial furnace manufacturer for 70 years.

In Japanese market, the company installing the hot press facility is increasing, and the delivery of hotPHASE is growing rapidly globally. The demand of the hot press facility is getting wide, most of the projects that had inquired also have the fact that EBNER has been received orders. Domestically, with the exhibition as turning point, the inquiry is growing, we will give the latest technology which the past problems has been cleared to the market hereafter.