Lamination sheet, stack or assembly?

The requirements for advanced electric motors can be fulfilled solely by a holistic view.

Thomas Stäuble, SWD AG

Summary

This article talks about new principles in the production of electric motors. The focus is on the lamination stack instead of the lamination sheet. Today, often the requirements for the single sheet are specified in detail, but adapted to the guidelines of the punching shop. Finally, the properties of the lamination stack are of interest and this needs various considerations from design to production. So, new approaches are required in order to produce motors fulfilling the increasing requirements.

The construction and production of electric motors is facing its greatest development ever. Electro mobility is still a niche, but it is growing continuously. New concepts and constructions are being developed which evolve from simple motors towards recuperation functionality and even the replacement of a mechanical clutch by an electrical one. In the field of mechatronics, highly compact motors are required to replace the widely used combination of motor, gear and mechanics or to replace pneumatic solutions. New concepts will reduce size and maintenance. All applications have in common that motors have to be more efficient, delivery higher output power, torque, dynamics, reach a higher speed, a.s.o. Additionally, the automotive industry requires a highly efficient production setup to reduce raw material, production energy and to minimise quality costs. Finally, those requirements can be fulfilled by new motor concepts. This article talks about the development of the lamination stack production. The lamination stack, as an important active part in the motor, influences the electrical, magnetical und mechanical properties of the motors. Still, it is often considered rather unimportant which, is a mistake, because required improvements of the motor performance are given away easily.

Developments in production

The production of lamination stacks has already faced innovations and developments in the past. Before specialised stamping companies emerged, every motor builder produced the laminations itself by cutting, corroding or punching. As time evolved, punching companies have taken over this process step and the motor builders have received laminations. The stacking of the laminations in these days was done by riveting. Later on, welding and interlocking has evolved. The punching companies followed this trend and now provide these stacking technologies in their product portfolio.

Bonded lamination stacks

Nowadays, bonding of lamination stacks becomes more and more popular. The benefits of bonded lamination stacks are: high precision of the stack, high mechanical stiffness which facilitates easier handling and even machining of the stack (e.g. drilling a hole), insulation between the laminations and seldom short cuts, no cushioning, less liquids and oil absorption. Due to the new production processes, the lamination stacks fulfil the customer requirements better. In the end, not the properties of the single lamination, but the properties of the whole stack are of interest. In this meaning, the lamination is an ingredient and the stacking process is the recipe.
Holistic view on the stack

For the production of the lamination stacks, a very specialised know-how of the different stacking technologies is required. It starts from the lamination geometry which has to consider the punching process and the stacking technology, continues to the processing of the assembly and includes the logistics and supply chain. A holistic view is important to achieve the maximum possible and to carry motor technologies to the next level. At this point, a stacking specialist helps. Early taken into account, the specialist already gives important hints in the development process to simplify and facilitate the large series production. Subsequent tests and verifications bolster a robust and process capable serial production.

Afterwards, the specialist completes the value chain by providing lamination stacks which exactly fulfil the requirements. The stacks are produced in a production setup which ensures high quality and continuous supply with short lead times.

Better properties evolve better motors

The stack instead of the sheet is in the focus. The stacking technology can have the same influence on the motor performance as the selection of the lamination material. This too often unknown potential will bring the motor and production improvements ahead. The combination of the specialised know how in the field of the lamination, the stacking technologies and the process capable serial production will result in a competitive advantage of the motor, not only in a technical view, but also in a commercial view. An early and holistic view will reduce costs also due to better process setup, less scrap, less quality control, less storage a.s.o.

The company

SWD AG Stator- und Rotortechnik is an innovative medium-sized company in Switzerland. We are dedicated to the development and production of lamination stacks and support our customers with new technologies from prototypes up to series production.
We have been working with bonding varnish (Backlack) since 1998 and we have helped to develop the materials and processes. Today, we have a lot of experience regarding strength, processing and ageing. The advantages compared to other stacking technologies are widely accepted. We are working with major electric steel manufacturers to further improve bonding varnish. At the same time, we are developing the stacking processes to improve quality, reduce quality controls and lower costs.

One of our specialties is the production of small, precise stacks from 0.1-0.3 mm electrical steel with bonding varnish. We can do all from the strip layout until the manufactured and validated stack. This includes design and manufacturing of the stamping tool, production of the parts and quality control.

We have developed the bonding varnish process so far to be able to produce with highest quality and repeatability. This includes not only the exact stacking of the sheets, but also the control of the length of the stack and the tight bonding of the sheets without leakage of bonding varnish.

We are currently producing several series for motor manufacturers and automotive suppliers, with further projects in development stage.

The benefits of this technology are apparent.

- High mechanical strength of stacks and possibility to machine
- Laminates are insulated, seldom short cuts between sheets and therefore better magnetic properties
- High precision of stacks
- Interconnection all over the sheets, no cushioning and no absorption of liquids and oils
- Simpler stamping dies and therefore cheaper tooling

We would be proud to support you in developing and producing high quality stacks – contact us!

**SWD AG – your partner**

SWD AG – Stator and Rotor technology is an innovative medium-sized company in Switzerland. We are dedicated to the development and production of lamination stacks and support our customers with new technologies from prototypes up to series production.

SWD AG – Stator- und Rotortechnik
Kaisermatt 3
5026 Densbüren
Tel.: +41 (0) 62 867 92 18
www.swd-technology.com
info@swd-technology.com
Welded lamination stacks

We have studied the different welding technologies deeply and developed our own receipts to exactly control the geometry of the weld seam and the distortion of the stack. Additionally, we have developed the production machines for this purpose. Today, we master all important welding technologies. Our experience already sets in for the construction of the geometry of the notch for the weld seam and continuous for the development of the high quality, repeatable production process in order to avoid costly changes of the tooling.

For serial manufacturers we can construct and build completely automated welding machines. Another speciality is the welding of electrical sheet containing high rates of silicium.

Plasma welding

We have been using plasma welding for stacks of electrical steel since 2007. Developments of the electrodes lead to higher life time and quality. Our own machine controls the height of the stack and produces up to six welds simultaneously. The benefits are plain:

- Long lifetime
- Narrow ray focus and reduction of spatter
- Control of the process parameters
- Short process time and lowest distortion by using several torches

Laser welding

During the year 2009, we have developed a laser welding machine for stacks of electrical steel. Special lenses allow welding on both sides of the stack. The cross section of the weld seam can be controlled precisely and the bending of the stack can be controlled to stay in the tolerances. The benefits are:

- Higher welding speed
- Less distortion and higher strength
- Capability of deep welds
- Less prone to variation in material properties
- Capability to weld thicker insulations and thinner sheets
- Automated control of the weld seam geometry

TIG- resistance welding

We have been using traditional technologies like TIG and resistance welding since 1975. Through continued improvements of the machines and tools, we could improve quality and lifetime significantly. We are welding both ways, automatically and manually.

We would be proud to support you in developing and producing high quality stacks – contact us!

SWD AG – your partner

SWD AG – Stator and Rotor technology is an innovative medium-sized company in Switzerland. We are dedicated to the development and production of lamination stacks and support our customers with new technologies from prototypes up to series production.

SWD AG – Stator- und Rotortechnik
Kaisermatt 3
5026 Densbüren
Tel.: +41 (0) 62 867 92 18
www.swd-technology.com
info@swd-technology.com
Segmentation

Today, stator and rotor lamination stacks are often produced from different raw materials. Reason for that are different requirements regarding mechanical strength, magnetizability, permeability, a.s.o. Therefore, rotor and stator laminations are no longer punched from the same material and the inner diameter of the stator can't be used to stamp the rotor in a progressive tool. A solution to overcome this shortfall is segmentation. Segmentation allows to increase material usage heavily. The stator is no longer stamped as one piece, but divided into single stator teeth. The segments can then be placed on the raw material strip to maximise the material utilization, reducing scrap and thus raw material logistics.

Benefits of bonding varnish

There are a lot of different ways, how electric sheet can be interconnected in an effective way. One conventional technology is interlocking. This well-accepted and cost effective way has its known advantages and disadvantages. For segmented stators, bonding varnish should be considered as a reasonable alternative to interlocking, especially in regards to the presented production setup described in here. Bonding varnish will improve the motor in several ways:

- Better magnetic properties due to the segmentation and evenly insulated lamination sheet due to bonding varnish interconnection
- Mechanically highly precise stacks resulting in a narrow tolerance range of the stator diameter and narrow fit into the housing, thus enabling safe torque transmission over a wide temperature range
- High strength interconnection of the laminations resulting in a mechanically highly stable and robust stack which can be processed highly automated
- No cushioning, no liquid absorption, less vibrations and therefore less noise
- Higher iron filling factor due to the bonding varnish technology and higher copper filling factor achievable due to very robust stack which can be wound with copper tighter

Contact us!

From samples…

We are offering a complete service and the know-how required to transform the full stator into a segmented version for large series production. Together with you, we find the optimal geometry, build prototypes, do press fitting tests, temperature tests, manufacture samples and continue with the series production on our fully automatic production lines. Based on simple punching and bonding tools, we produce near-series samples. Additionally, we have developed procedures and equipment to do continuous tests during serial production.

…to serial production

SWD AG has developed a revolutionary approach to produce stator teeth with bonding varnish. All production steps from the raw material to the bonded stator segment are combined in one machine. All parameters are monitored and stored for later traceability. The whole system is built from modules, so it can easily be adapted to the production capacity required. Often, it is cost effective to start directly after the prototyping phase with this system and then increase the production capacity step by step.

We would be happy to support you in developing and producing high quality stator teeth – contact us!

SWD AG – your partner

SWD AG - Stator- und Rotortechnik is an innovative medium-sized company. We are dedicated to the development and production of lamination stacks and support our customers with new technologies from prototypes up to series production.

SWD AG – Stator- und Rotortechnik
Kaisermatt 3
5026 Densbüren
Tel.: +41 (0) 62 867 92 18
www.swd-technology.com
info@swd-technology.com