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Top Doing More With Less

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Abstract.
A new technology for MLB pressing has been developed by MBT and industry partners, called TOP, Temperature Optimised Process. The goal was to reduce energy consumption and to improve product quality by quicker and more even heat distribution throughout the book. This was achieved by using new materials and direct electrical heating of the tools. Tools are made using a 3- ply-material having a core of Aluminium and both sides clad with Stainless Steel. This gives 90% of the heat conductivity of Al combined with the thermal expansion and surface hardness of rolled Stainless Steel. Each part of the tools is heated by a specially developed ultra thin heating element having a connection capacity of only 3 kW/h. Build in sensors allow each heating element to be controlled separately so that only the actually needed energy is supplied. Each opening can be controlled separately. A third heating element is placed in the middle of the book, thus actually creating 2 books in one allowing for up to 50 mm MLB material to be in each book / opening. All connections for energy and sensors built into the tool have their matching parts in the back of the press to have direct contact when putting the tool inside the press. Depending on the structure of the panels it takes 30 – 45 minutes from cold start to reach 200° C in book centre. Another important part of TOP is our patented Separator HTS 600. Having a thickness of only 0.5 mm HTS 600 has about 4 times better heat conductivity compared to Stainless Steel. Due to quick and even heat distribution no press pads are needed. Very tight thickness tolerances are achieved by even resin flow. Cooling is done by water circulation inside the top and bottom tool either under full pressure or controlled cooling/pressure ratio. This gives unequalled stability and extremely low shrink in X and Y axis. All above has been established by test runs with a number of German Customers and assistance by ISOLA Düren.

Introduction.
Energy consumption per panel produced always had a high influence on production cost. Recently this has become even more crucial because of the world wide energy shortage and subsequent dramatic cost increase. At the same time energy input per panel went up as demand for high TG materials requiring longer cycle times increased.

Our new technology is designed to serve both, the small and medium sized MLB maker concentrating on advanced technology and requiring high flexibility and also those producing the big volume like mobile phones etc.

The basic idea was: DOING MORE WITH LESS.

Presentation
Using state of the art pressing technology the ratio between “dead“ material to be heated and panels to be produced is extremely unfavourable as can be seen from Figure 1.

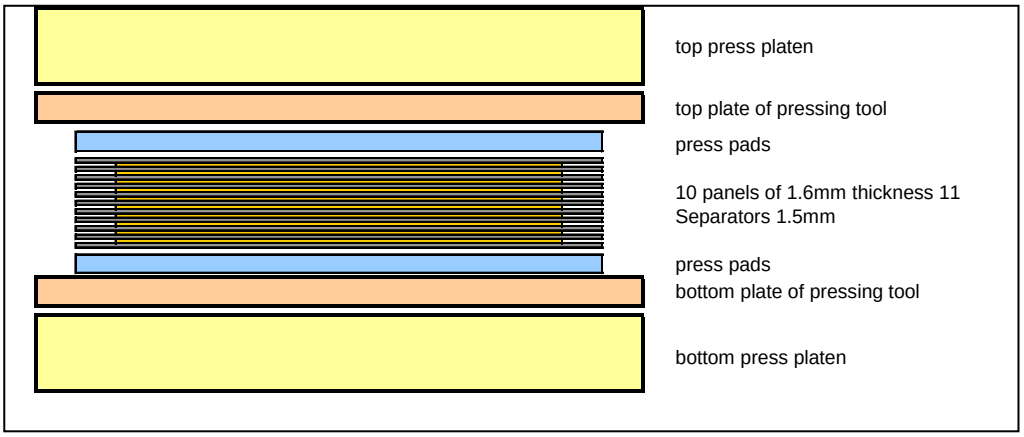

Figure 1: State of the Art Pressing Technology

Our TOP (Temperature Optimised Process) Technology has been developed to reduce energy consumption, improve quality by quicker and more even heat distribution in the book and at the same time increase flexibility and productivity.

These goals are achieved by using new materials with higher heat conductivity, direct electric heating of the tools and a vacuum press with new control possibilities.
A very important aspect is that each of these 3 components are complimentary to each other, forming an integrated technology and making sure that the advantages of each of them are fully maintained.

The following Figure 2 illustrates the difference between our tooling made of Swiss ply, our Separator HTS 600 and 2 standard steel grades.

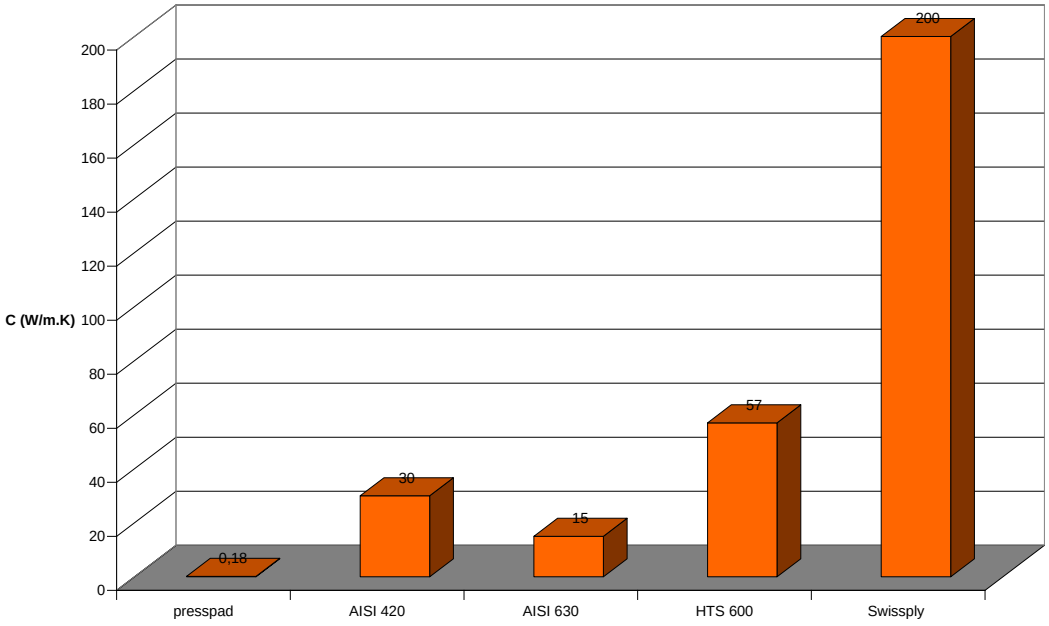

Figure 2: Heat Conductivity

Our tooling material is a 3 ply composite of Aluminium core, both sides clad with Stainless Steel (Figure 3). It thus combines 90 % of the thermal conductivity of Aluminium with the thermal expansion and the surface hardness of rolled Stainless Steel. The cladding process transforms these 3 layers into a bond that cannot be separated.

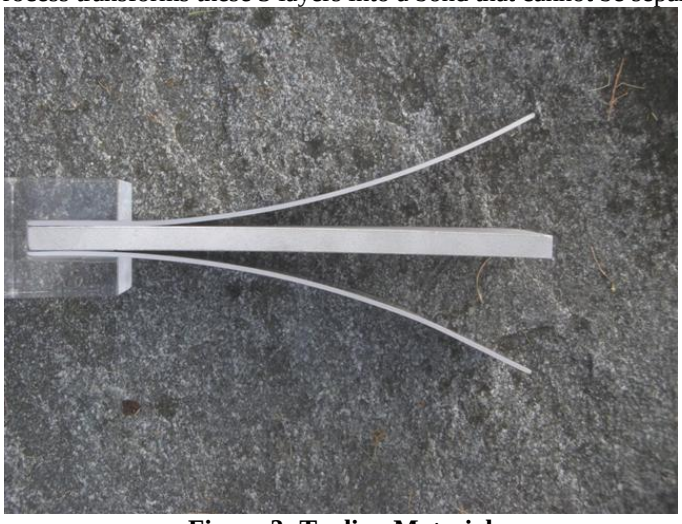

Figure 3: Tooling Material

The strong bond and the uniform heat distribution avoid warp and twist.

One set of tooling has 3 heated parts (Figure 4). Next to top and bottom an additional heated plate is placed in the middle of the book, thus actually creating 2 books in one and allowing for up to 50 mm MLB in each opening.

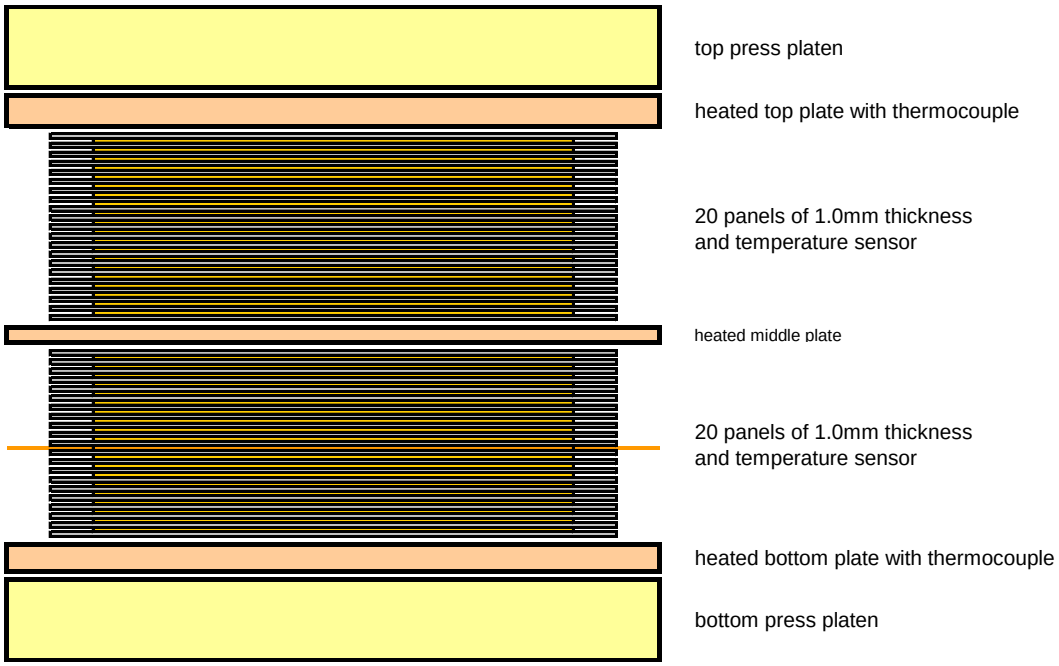

Figure 4: TOP Book

Top and bottom plate are made of 9 mm Aluminium core, both sides clad with 1 mm Stainless Steel. The heating element and the thermocouple are mounted to the clad material by a 4 mm pressure plate. The centre heating plate is 1.5 mm Aluminium and 0.4 mm Stainless Steel each side.
As in this case the heat shall be distributed in both directions the heating element and the thermocouple are placed between 2 plates of clad material.
Each part of the tool is heated by a special flat heating element (Figure 5) having a connection capacity of only 3 kW/h. The location of the heating wires guarantees absolute even and in combination with the high thermal conductivity of the composite material quick heat distribution covering the entire area and giving a very even resin flow.

Figure 5: Heating Element

Each heating element is controlled by its own build in thermocouple.

Additional thermocouples can be placed in the middle of each “part“ book.

When the pre set target temperature is reached in the heated plates the build in sensor reduces energy supply for theses elements to a level maintaining the temperature reached.

The following Figure 6 shows heating rates in a book of 24 panels TG 135, 1.6 mm thickness.

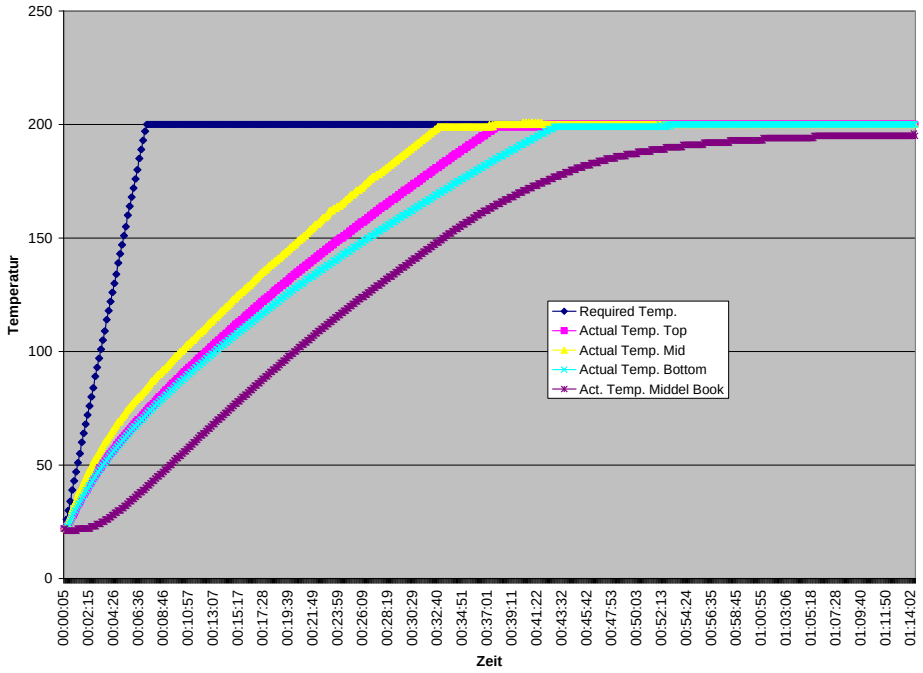

Figure 6 Heating Rates

All 3 heating elements were set at max. 200 ° C, control panel in book centre to min. 180 ° C.
When this is reached the energy supply is reduced to a level of about 15 % of the installed capacity maintaining the temperature for curing.
This brings us to a total energy consumption of about 7 kW for 24 panels.
The high thermal conductivity of the tooling and the separators allow for quick heat distribution in vertical direction. No press pads for heat buffer are needed.
All panels had min. TG 136 °, Delta TG max. 1.5 °.

Cooling is done by water circulation inside the top and bottom part of the tool using channels in the middle of the Aluminium layer (Figure 7) either under full pressure or controlled temperature / pressure reduction.
This gives unequalled stability and extremely low shrink in x and y axis.

Figure 7: Cooling Channels

A closed system with tank and heat exchanger is used.

All the above advantages of quick and even heat distribution and having up to 50 mm material in each opening require a new type separator combining higher heat conductivity with less thickness and extremely tight tolerances for thickness and flatness.

Heat conductivity of a separator is mainly influenced by the alloying elements of the steel used.

Ferritic and austenitic Stainless Steel grades have low thermal conductivity values because of their high contents of chromium and especially nickel.
Another important parameter is the heat capacity which is directly related to the volume and thickness of the separator.

In the book of 24 panels we had 31 separators.

The separator for TOP is our HTS 600.
It is made of low carbon, unalloyed steel with thickness of 0.5 mm.
It is rolled continuously and getting its hardness by controlled thickness reduction during rolling. Sophisticated equipment (Figure 8) and control mechanism allow us to guarantee a thickness tolerance of plus / minus 0.010 mm measured at any point of the sheet.

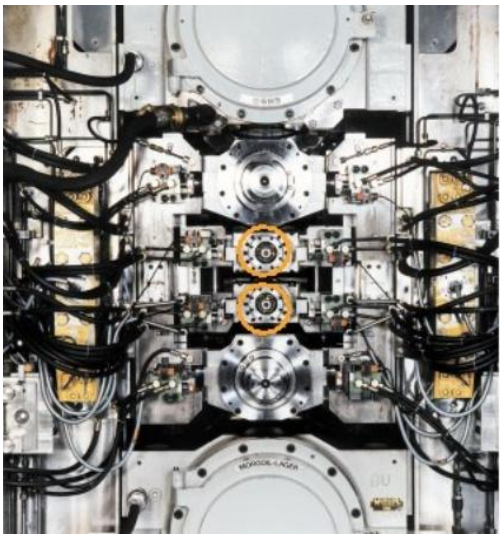

Figure 8: Rolling Equipment

For rust protection they are coated with a very thin layer of Chromium or other suitable metal.
A coating with our release agent avoids resin sticking especially in slots and allows very soft cleaning.

The high precision press is of course equipped with vacuum. In the standard version we provide 2 openings with daylight of 200 mm (Figure 9).
Depending on customers needs we can provide up to 6 openings.

The pressplaten are fully insulated to have about 95 % of the heat created in the tooling going into the book.
The control panel in combination with the thermocouples allows each opening to be heated separately.
The very compact design only requires a ground space of about 2 x 1 m plus about 1 x 2 m for the cooling system.
No special infrastructure is needed. Just a socket to plug in for power supply.

Figure 9: 2 Opening TOP Press

Summary

Our new technology offers following advantages:

- Low energy consumption, saving of up to 90 %
- High flexibility
- High productivity
- Improved quality because of quick and even horizontal and vertical heat distribution and permanent temperature control
- Avoids internal stresses
- No press pads necessary
- No extensive and expansive infrastructure
- Small space needed