



Infrared Welding

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Process description

1. Introduction

For welding by means of infrared technology short-wave (0,78-2 μm) as well as medium-wave (2-4 μm) infrared radiation of the spectrum can be used. This depends particularly on the radiation absorption capacity of the respective polymer material.

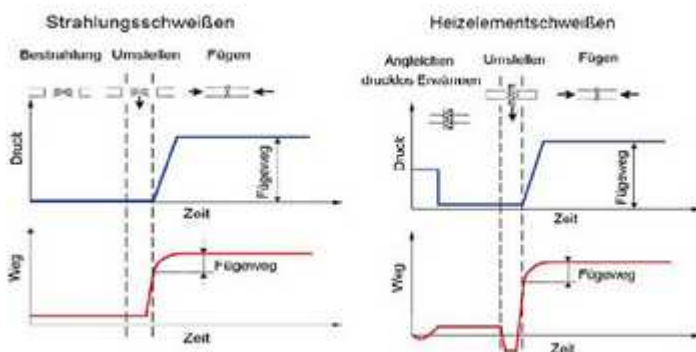
The more precisely the radiator is adapted to the absorption capacity of the polymer material, the higher is the degree of efficiency, that means the conversion into warmth. Short waves are absorbed in deeper layers of the material, whereas medium waves heat it up more at the surface.

Additives like carbon black lead to absorption of the largest part of energy at the surface. Since in most cases short-waves have a higher capacity (Watt/cm radiator length) and medium-wave metal-foil radiators are absorbed at the surface, the material surface can be impaired thermally. The parameters, capacity, radiation time and distance must be adjusted and optimized accordingly.

The nearer the radiation source is positioned at the spot to be heated up and the better the ray is focussed, the faster the material will be heated up.

2. Process

The welding process is very similar to that of hot plate welding (please see picture).



(Process picture)

Also the infrared process consists of two stages, in which the heating-up phase is separated from the actual welding process.

There is no matching phase like it is in hot plate welding.



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In a first step the parts to be welded are moved at a certain distance to the radiator. The distance depends on the part geometry, the material and its absorption property as well as on the wave length of the radiator (short-wave radiator at larger distance than medium-wave radiators). The distance to medium-wave radiators is often in the range of 3-5 mm, in short-wave radiators it is rather between 10 – 20 mm. Depending on the application both of them can have advantages and disadvantages.

Since the distance to the radiator has a significant influence on the melting result and must be adjusted a lot, infrared welding machines are mostly fitted with a servomotor. Moreover, the radiator units must be moved quickly, but smoothly. Any knocks onto the radiator units must be avoided!

After having been heated the radiator unit is moved out of the melting area. Depending on the material this should be carried out as quickly as possible. The higher the melting point of the material, the shorter the change-over time should be.

The following welding process is based on the same principle as the hot plate welding process. KLN machines are able to weld depending either on power or travel.

3. Advantages of infrared heating up:

- contactless (no adhesion)
- well controllable
- high melting depth can be achieved
- may be integrated in existing hot plate and vibration machines
- the use of masks gives a good focus on the welding joint
- 3D contours can be realised in the medium- and short-wave range, but no any contour can be realised. All thermoplastics can be melted; depending on the radiator the pigmentation has an influence on the melting characteristics.
- after heating up the total height of weld ribs remains available for welding
- no lint formation during the welding process

4. Infrared radiator units (IR)

In the KLN machine program there are short-wave glass tube radiators, short-wave contour radiators and medium-wave metal foil radiators.

The metal foil radiators are embedded in a ceramic isolating against electrical and thermal influence.

The ceramic is milled following the contour of the part acc. to CAD data. Metal foil radiators are manufactured by KLN.



4.1 Short-wave radiators

- short-wave radiation (2200 °C at the metal filament)
- 3D contours can be represented, however, manufacturing is expensive (formed in graphite mold)
- by referring masks a bat-wing radiator can be focussed on narrow areas (expensive for 3D contours)
- quick reaction time (1-2 sec.), thus it can be controlled and regulated in the heating-up phase
- suitable for pre-heating in vibration welding (reduced lint formation)
- suitable for melding the welding surfaces (analogous to hot plate welding)
- performance curve is adapted to the individual material



4.2 Bat-wing radiator

- short and medium-wave radiators (900-2400 °C at the metal filament)
- suitable for large surfaces
- by special masks it can be adapted to the respective welding contour
- high energy consumption
- only flat parts can be welded
- can be used as standard radiator
- suitable for pre-heating in vibration welding (reduced lint formation)
- suitable for melding the welding surfaces (analogous to hot plate welding)
- bat-wing radiator can be used for the whole range of parts



4.3 Metal foil radiator

- medium-wave radiator (approx. 800°C at the metal filament), ceramic welding nest needed
- 3D contour can be represented (ceramic nest)
- cheap radiator due to in-house production
- short heating-up time
- required distance to the welding surface approx. 3mm; exact contour needed
- suitable for pre-heating in vibration welding (reduced lint formation)
- suitable for melding the welding surfaces (analogous to hot plate welding)
- energy introduction independent from color or pigmentation of the material



5. KLN infrared welding machine technology

KLN uses the infrared heating technology as a good alternative to melt thermoplastics.

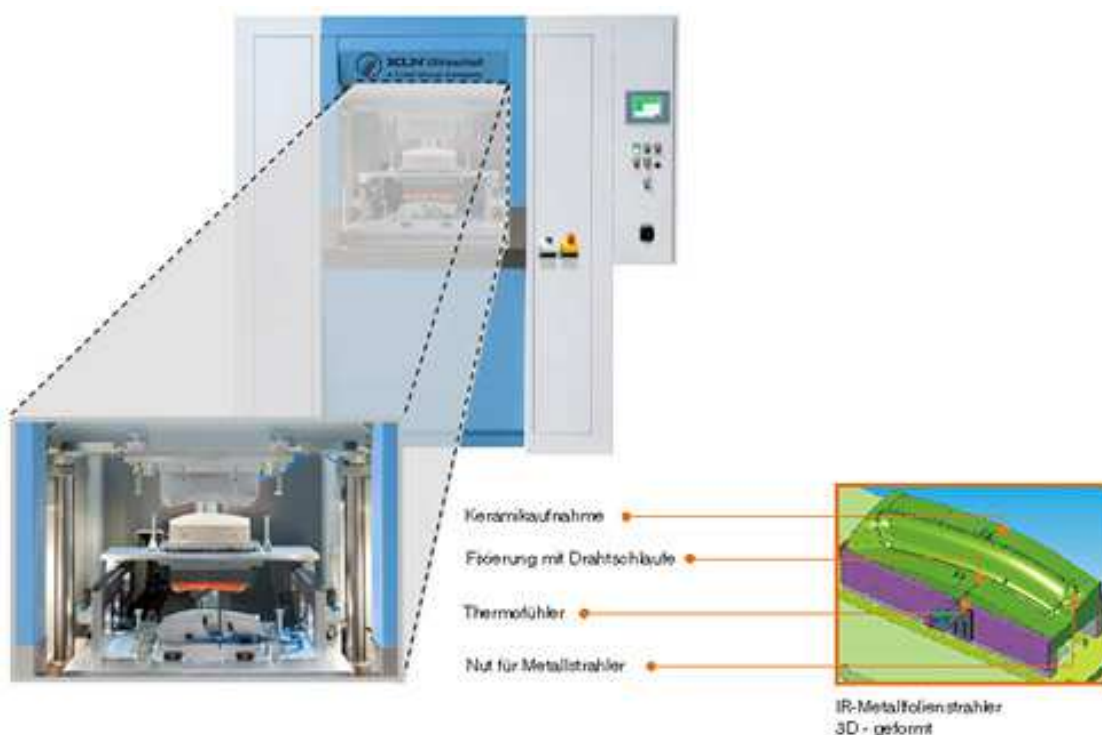
In the last few years KLN has enlarged their hot plate welding machine program „TOOLMASTER“ and their vibration welding machine program “LVW” by the infrared welding program.



5.1 Vibration welding machines with integrated pre-heating

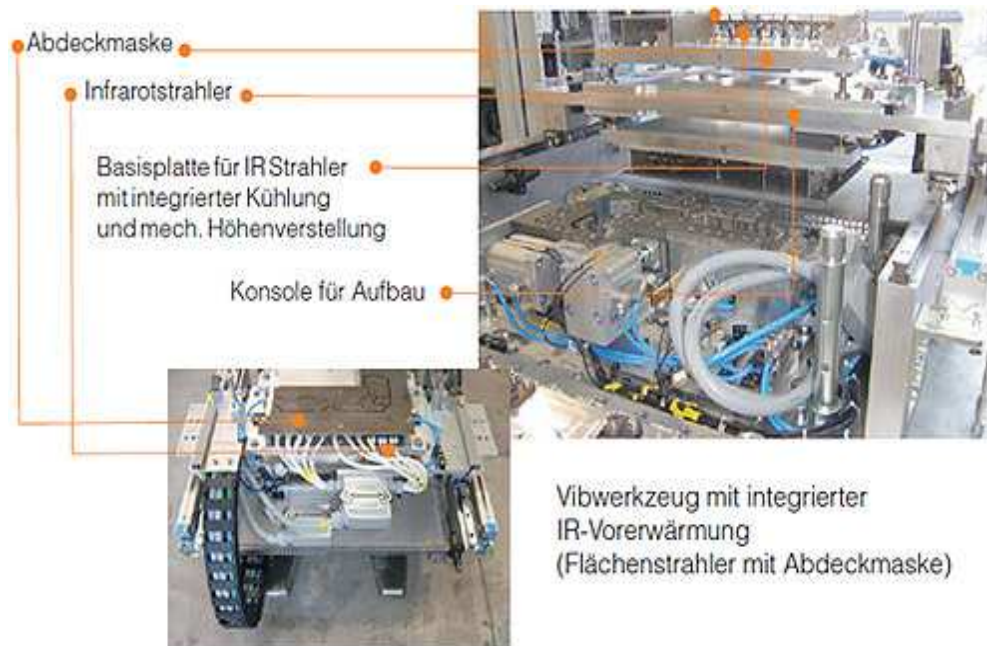
KLN offers the possibility to integrate in all machines or tools the infrared technology. This minimises abrasion during the solid matter friction phase by means of pre-heating with short- or medium-wave radiation.

- Vibration welding tool with infrared metal foil radiator in LVW 2032.
- Radiator unit with two each individually controllable metalfoil radiators approx. 300 mm
- Quick change-over time < 3 s in order to avoid cooling of the welding joint





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The picture shows a vibration tool for welding a part (material PA 6.6) of the car engine compartment.

The actual infrared radiator unit is integrated in the vibration tool and is located on the lower tool together with an actuator unit.

Prior to the vibration process the IR unit is moved at a certain distance between the parts to be welded. The distance to the upper tool is set by the lifting table position of the vibration welder.

For this reason and to guarantee a fast and exact travel movement KLN vibration welder can optionally be fitted with a servomotor-driven lifting table.

Movement speeds of up to 0,5 mm/s can be achieved. This makes possible very short change-over times from pre-heating up to start of vibration.

As a standard these machines are equipped with 8 IR control circuits.



5.1.1 The LVW program



In all vibration welders infrared pre-heating units can be integrated.
Then these machines can be used as „pure“ vibration welders or with integrated infrared pre-heating.

Infrared pre-heating reduces lint formation up to 90%, as the friction phase only starts after melting.

Also it is possible to weld somewhat more complex geometries (like welding against an inclined surface).



5.2 Hot plate welding machines – infrared machines

The KLN machine program of „pure“ IR welding is based on the hot plate machine program „TOOLMASTER“.



All standard machines of the series TOOLMASTER can be fitted with the infrared technology.

Machines for infrared heating should be equipped with servomotor drives in order to guarantee simple, quick and exact positioning.

- High acceleration of the slides for the parts fixture and also for the hot plates
- Precise speed regulation depending on travel by servo technology
- Regulated braking of all travel motions
- Precise speed regulation depending on travel, in various steps of the melting and welding phase. The required parameters can be set at the TP.
- Exchangeable hot plates
- PLC control Siemens S7 with Siemens TP
- Welding either depending on travel or power
- Control of the process parameters
- Option: Control of the energy introduced by an IR camera



6. Summary

KLN will be pleased to develop special solutions for your technical requirements.

For example KLN developed a 3-station rotary table machine for embedding of filter paper in a plastic housing.

Here the challenge was to integrate water-cooled fixtures, a leak test in the machine and automatic unloading of the parts.

One of the most common IR applications is the welding of instrument panels.

Also for this KLN developed a wide variety of machine concepts, like a combination of IR technology, ultrasonic welding or ultrasonic riveting.

Since KLN has all plastic welding technologies in the product range, it is possible to develop an individual solution for you.

For further information please have a look at our homepage www.kln.de

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