Thermo Profil Scanner

A look into the emerging seam
The view through the arc into the heat signature

Local heat input is melting and is changing the structure of materials during brazing and welding processes.

The correct heat input and also the undisturbed heat distribution is an important attribute for the evaluation of welding seams.

The human eye cannot see heat radiation. The glare of the visible part of an arc is so intense, it will cover up any heat information.

Herefor technology is required that can capture the heat information in spite of:
- Massive glare of the arc
- Fumes and spatter contaminated environment permanently.

HKS is introducing a device that fulfills these requirements: ThermoProfilScanner (TPS)
Principle of operation ThermoProfilScanner

The Thermoprofilscanner is constantly capturing a thermo profile across the welding seam. Hereby it is able to fade out the visible light from the arc. A heat image of the welding seam is created by the continues movement of the welding torch.

Technical data:
- Work distance 15 to 120 mm
- Scan frequency < 400 Profiles/s allowing a resolution of better than 1 mm by speeds up to 20 m/min.
- Advanced design features allow **Indefinite operation very close to torch:**
  - Glass free design
  - Gas curtain
  - Anti spatter concept
  - Integrated water cooling
The view *into* the welding seam in creation

The thermo profile is captured *after solidification of the welding seam*, before it is cooled down. Depending on the application this happens 5 to 50 mm behind the torch.

brazing seam with offset  
affiliated heat image
New possibilities of seam control

**TPS =**

**Visual seam inspection**
Recognition of seam position

**Evaluation of metalurgic-thermal processes in the seam**
To recognize penetration faults and insufficient fusion along edges

The temperature profiles are processed in *real time*, width, position and symmetry e.t.c are analysed.

Welding inconsistencies compared to the OK-seam are recognized as deviations within the thermo profiles and will be flagged.

Attributes of the thermo profiles (width, position..) are taught the same way as other parameters, and can be monitored via thresholds or envelopes.
The ThermoProfilScanner as component for monitoring system WeldQAS

### WeldQAS

- **Production documentation**
  - Extensive representation and analysis functions

- **Welding process supervision**
  - Thresholds for warnings and faults

- **Recognize faults reject**
  - Automatic recognition of faulty part and rejection in serial production
  - Fault output for part marking, ejection and alarm

### Measurement weld-parameter

- **Current + Voltage**
- **Wire feed**
- **Gas flow**

### Measurement Heat field

- **ThermoProfilScanner**

**TPS**

**Sensors**
TPS advantages compared to other test methods

**Optical offline-method (after welding)**
(Automatic visualisation via laser triangulation)

**Principle:** Laser is projecting a cut line onto seam, a camera system with image processing unit is evaluating patterns.

**Eddy current method**

**Principle:** Is inducting eddy currents into base material and is processing disturbances in current flow.

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**In comparison: Use of TPS**

- **better fault detection** of
  - Pores
  - Penetration faults
  - Fusion faults below surface

- **substantially lower investment costs**

- **no tact time increase**

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**In comparison: Use of TPS**

- **better fault detection** with
  - Seam offset
  - Insufficient penetration
    (for example due to current deviation up to 50%)
  - Small holes
  - Unsymmetrical edge penetration

- **lower Investment costs**
1. Plasmatron brazing in car body production
2. MAG-welding of exhaust systems
3. Spiral tube production TIG
4. Longitudinal pipe manufacturing TIG/Plasma
5. Research
Example 1

Robot guided brazing of car bodies with Plasmatron
Example 1  Plasmatron brazing of car bodies

**Task**
Recognition of visible welding inconsistencies as fusion faults and pores larger than 1 mm.

**ThermoProfiScanner**
- Offset to the torch: 7 mm
- Scan frequency: 140 Hz
- Resolution: 0.9 mm
- Work distance: 130 mm
- Purging gas: 3 l/min
- Welding speed: up to 3 m/min
- No water cooling

The immediate fault recognition is prevention the part being used for the total body assembly. The resulting cost savings amount to 1000 EUR per detected fault.
Example 1  Plasmatron brazing of car bodies

Fault image:
large fusion fault

Right at the start, the seam is shifting towards the edge, than break up and fusion fault.
Example 1  Plasmatron brazing of car bodies

Fault image:
small fusion faults

- Fusion fault
  Caused by defective electrode
- Increasingly unstable seam progression towards the end of seam
Example 1  Plasmatron brazing of car bodies

Fault image:

No fusion during first 5 mm
### Task:

- Proof and recognition of visible welding inconsistencies during MAG-welding.
- Customer requested for a simpler and more robust handling as provided by an existing optical seam measuring system (after welding).
- Proof of visible burn through.

### ThermoProfilScanner

- Offset to the torch: **40 mm**
- Scan frequency: **100 Hz**
- Resolution: **0.9 mm**
- Work distance: **60 mm**
- Purging gas: **3 l/min**
- Welding speed: **60 cm/min**
- No water cooling
Example 2      MAG-welding exhaust systems

Fault image:
Multiple burn trough faults

Typical application for the TPS

- due the poor heat conductivity of the Cr-Ni-material, the burn trough happens app. 15 mm \textit{behind} the arc.

- it is not possible to detect such burn through effects within the welding current and voltage.
Example 2  MAG – welding exhaust systems

Fault image: geometric deviations and seam necking of 0.8 – 2 mm
Example 3  Spiral tube production TIG

Task

Recognition of visible and invisible welding inconsistencies as holes, pores larger than 1 mm, edge fusion faults and penetration fluctuations.

Recognition of “weldability” problems with supplied materials.

The existing eddy current detection system does not fulfill requirements.

ThermoProfiScanner

offset to the torch: 40 mm
scan frequency: 100 Hz
resolution: 0,9 mm
working distance: 20-60 mm
purging gas: 3 l/min
welding speed up to 3,5 m/min
water cooling via power source
Example 3  Spiral tube production

Work monitor with actual seam evaluation and heat signature

Captured are:
- Welding current,
- Voltage,
- Shield gas amount,
- Band position and speed

Heat signature of a 6 m tube

From the heat signature the following is calculated:
- Welding seam position
- Width of temperature zone
- Symmetry of heat field
- Cool down characteristic
Example 3   Spiral tube production

Special features for seam pipe welding

- Measurement of the running tube position and allocation welding faults to welding position
- Marking of faulty tube sections, when these reach marking position
- Data allocation after tube separation to one set of data for each tube including heat images
- Integrated network functionality

Graphic display of the last 25 tubes in tube monitor application
Example 3  Spiral tube production

Fault image: Burn trough

CrNi – Band 73*1,0 tube 32mm

Burn through is causing heat jam
One scan is equivalent to scan width of 0.62 mm.
Example 3  Spiral tube production

Fault image:
Uneven heat distribution

Steel band  86*1,5 – tube 38 mm

Uneven heat input and penetration fluctuations due to defective band material
(Seam appearance – fish scaling)
Example 3  Spiral tube production

Fault image: Seam offset / seam position

CrNi - Band 73*1,0 tube 32mm

Such seam offsets causing welding seam to fail when the tube is pressurized.
Task
Detection of visible and invisible welding irregularities as pores, insufficient side-fusion, defect root penetration and the detection of torch misalignments.

ThermoProfilScanner
offset to the torch: 20 mm
scan frequency: 100 Hz
resolution: 0,9 mm
working distance: 80 mm
purging gas: 3 l/min
welding speed up to 1,5 m/min
water cooling
Example 4 - Longitudinal pipe manufacturing
Plasma welding/TIG

Fault image: Torch is not in center line of the welding joint.
(Seam symmetry)

CrNi - pipe 20*3 mm

An off-center torch position is causing an asymmetric penetration. One fusion edge is melted more than another.

Optical hardly visible, but clearly visible in the heat signature.
Example 4 - Longitudinal pipe manufacturing
Plasma welding/TIG

Fault image: pores

CrNi - tube 20*3 mm

Hot cracks and pores are represented as „Hotspots“ in the heat image. Faults like these are causing a disturbance in the heat conduction and are therefore detectable.
These pipes are defective.
Example 4 - Longitudinal pipe manufacturing
Plasma welding/TIG

Fault image: asymmetric penetration due to a misaligned coil feed.

Optical not visible, here the thermo profile is becoming more and more asymmetric, because of wear and tear or insufficient lubrication on a roller set.

CrNi - tube 20*3 mm
Example 5  Research

Task
TPS as an instrument of the thermography and in welding research
fault image: root layer penetration, lack of side-fusion, holes (burn trough)

The TPS allows for the first time a thermographic evaluation of various welding seams.

With the THERMOPROFILSCANNER a simple and robust tool is now available for welding engineering and application research. It opens up totally new possibilities evaluating weldments during the welding process.
Thank you for your interest.

For further assistance please do not hesitate to contact us:

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