FERAN®
Aluminum clad steel for Power Plants' Direct Air Cooled Condensers (DACC)

Wickeder Westfalenstahl
Wickeder Group

Direct Air Cooled Condensers (DACC)

- DACC are used to regulate the efficiency of thermal energy of power plants

- DACC-systems are based on single tubes made of aluminum-clad steel

Photo: Power plant

Photo: Roof of the power plant

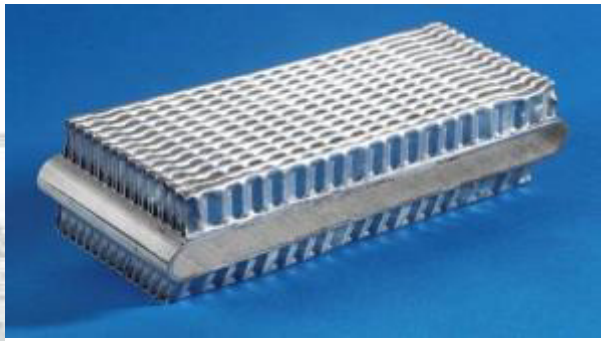
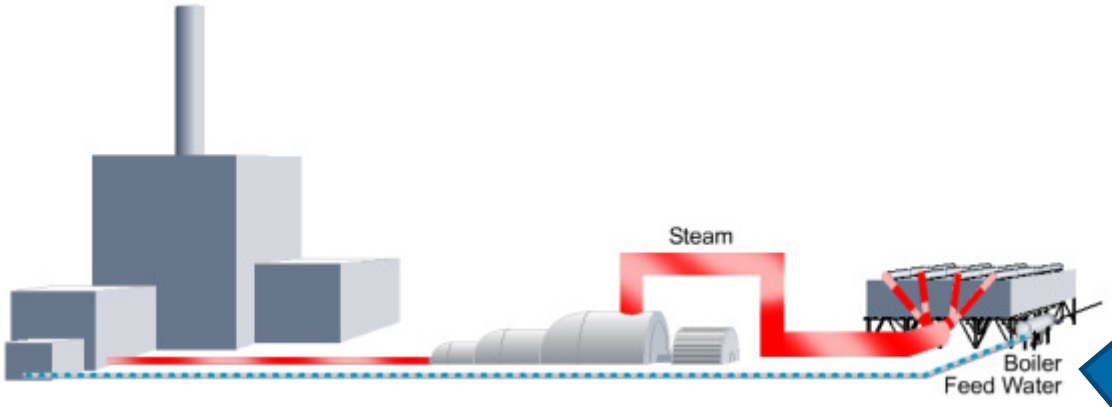


Photo: DACC with FERAN

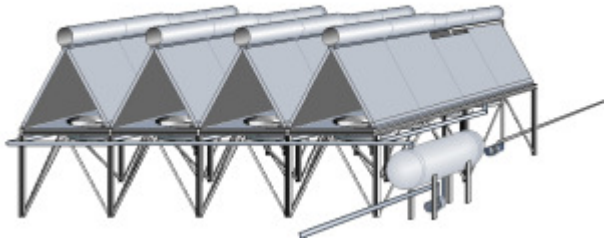
Source: GEA Energy Technology

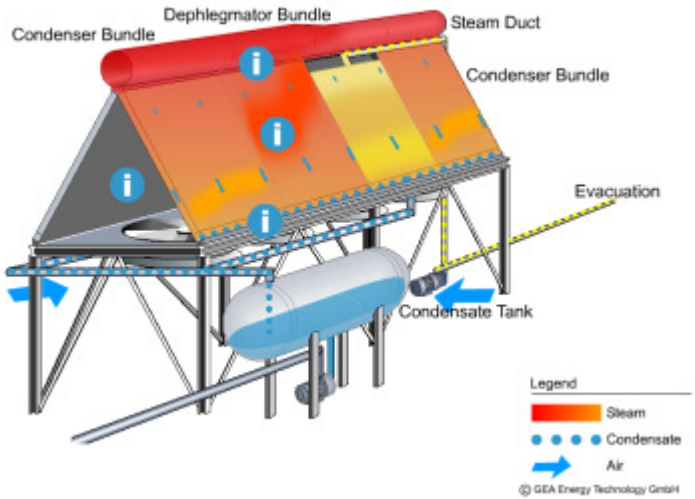
Wickeder Westfalenstahl
Wickeder Group

Direct Air Cooled Condensers (DACC)



Power Station | Steam Turbine | Air Cooled Condenser





Source: GEA Energy Technology

Wickeder Westfalenstahl
Wickeder Group

Why FERAN® for DACC?

Wickeder Westfalenstahl
Wickeder Group

Why FERAN® for DACC?

- FERAN® is the only **long term proven** material in the world for dry air cooling
- Maximum power plant efficiency over life time guaranteed through:
  - Corrosion resistance of integral Aluminum-Layer (> 50 µm)
  - Reliable heat transfer by stable bonding and brazing connections
  - Aluminum-free inner tube surface

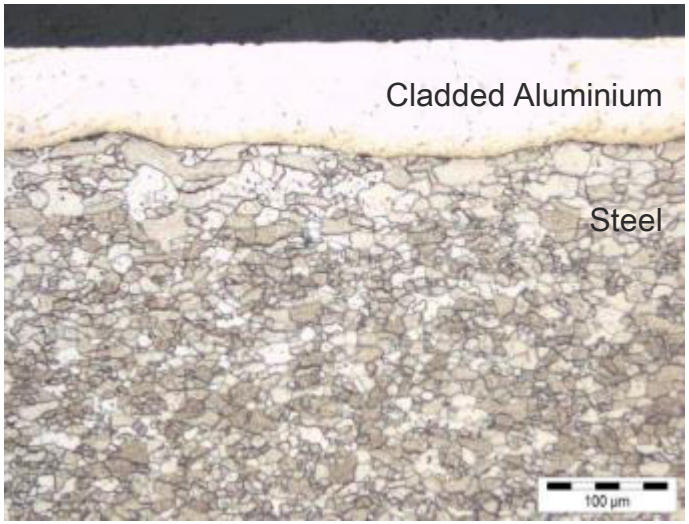
Why FERAN® for DACC?

- FERAN® is a one-side aluminum-clad steel
- Used to weld the single row tube in DACC-systems
- Aluminum-free edges guarantee a highly efficient welding process, achieved by edge free cladding
- The aluminum surface is ready for brazing
- The tubes are used to form tube bundles

Wickeder Westfalenstahl
Wickeder Group

Why FERAN® for DACC?

- No delaminating
- No brittle regions in the diffusion zone
- Tightest thickness tolerances within each production lot of several hundred of tons



Microsection of FERAN®

Wickeder Westfalenstahl
Wickeder Group

How to achieve the quality of FERAN®

- Right material selection for the combination of aluminum-steel
- Optimization of the production parameters for:
  - Heat treatment
  - Rolling
  - Surface preparation
  - Edge free cladding
- Consistency of production parameters over several hundred thousands tons of material
- Close cooperation between supplier and customers for welding and brazing
- Strong quality control of the **whole process**

Wickeder Westfalenstahl
Wickeder Group

Production & quality process of FERAN®

Certified supplier of hot-rolled strip

Certified supplier of aluminum foil

Cladding & Rolling	Heat Treatment	Temper rolling	Cutting	Packaging
• speed of the cladding process • control of the roll pressure • control of the tape tension • etc.	• control of the temperature of the oven • control of the temperature of the material • etc.	• speed of the temper rolling process • control of the stock gauge • control of the temper rolling grade etc.	• control of the strip width • etc	• control of the packaging • etc.

Wickeder Westfalenstahl
Wickeder Group

Why FERAN® from Wickeder Westfalenstahl?

- Wickeder Westfalenstahl has over 90 years production experience of Al-clad steel
- Wickeder Westfalenstahl has developed FERAN® in the mid-90‘s ➔ 100% reliability over 20 years of operation - no field failure ever reported
- Reference list includes more than 4.000 power plants worldwide with an installed capacity of more than 550,000 MW (=550 GW)

Wickeder Westfalenstahl
Wickeder Group

Why FERAN® from Wickeder Westfalenstahl?

- Best product
- Best process

➔ certified (by TÜV)


ZERTIFIKAT ◆ CERTIFICATE ◆ 認證證書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

CERTIFICATE

Industrie Service

The Certification Body of
TÜV SÜD Industrie Service GmbH
Plant Engineering

hereby confirms that

Wickeder Westfalenstahl
Wickeder Group

Wickeder Westfalenstahl GmbH
Hauptstraße 6
D-58739 Wickede (Ruhr)

has implemented and is running a quality control management system in compliance with TÜV SÜD Standard IS-P-003-1 for the manufacture of aluminum clad steel strip FERAN for air cooling condenser.
Production is monitored by TÜV SÜD.

This certificate is based on the certification report
TÜVIS-AT-14-sta-2053 dated 21.10.2014.

This certificate is valid until 31.12.2017
Certificate-Registration-No.: PC/564/01/265/02/14

Munich this 29th day of October 2014

Tobias Fleckenstein
Certification Body
Plant Engineering

Dr.-Ing. R. Kauer
Plant Engineering

TÜV®

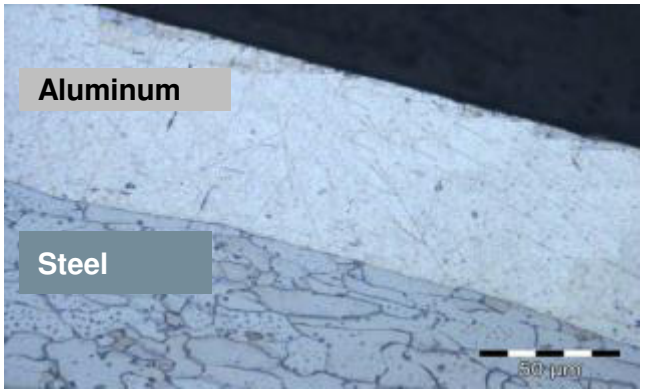
Wickeder Westfalenstahl
Wickeder Group

Material Selection

- Tight quality control of steel and aluminum is important
- Metallurgical specification of certain elements is very critical

FERAN®

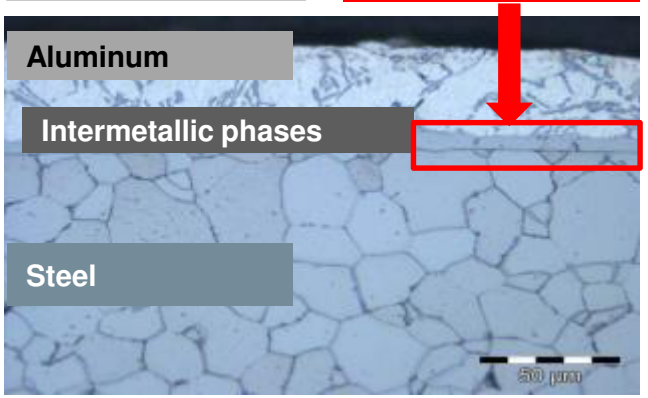
99,5% Al
< 1,0 % Si



Alternative Material

High % Si
> 90% Al

DANGER



	Layer thickness	
50-80 µm		appr. 25 µm-90 µm

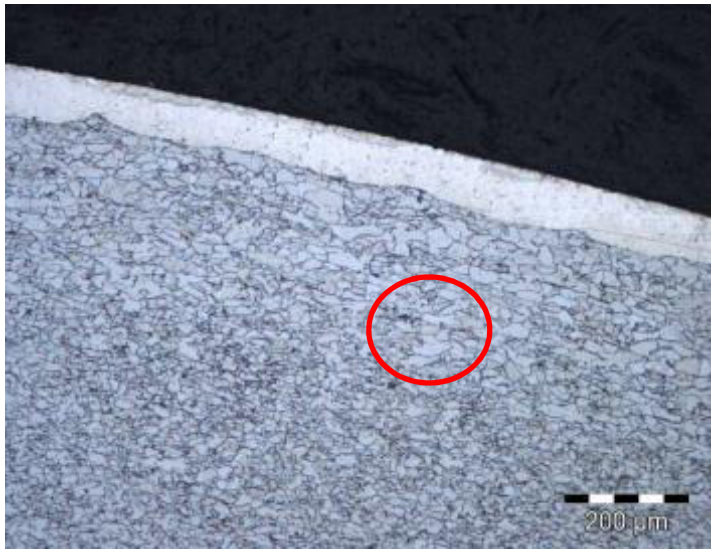
	Consistence	
No brittle Fe-Al-alloy at contact zone **virtually no Si-precipitations**		**Already, after the coil production an appr. 5 µm brittle Fe-Al-alloy shows up at the contact zone,** **heavy Si-precipitations in the Al-layer**

Wickeder Westfalenstahl
Wickeder Group

Rolling consistency and parameters

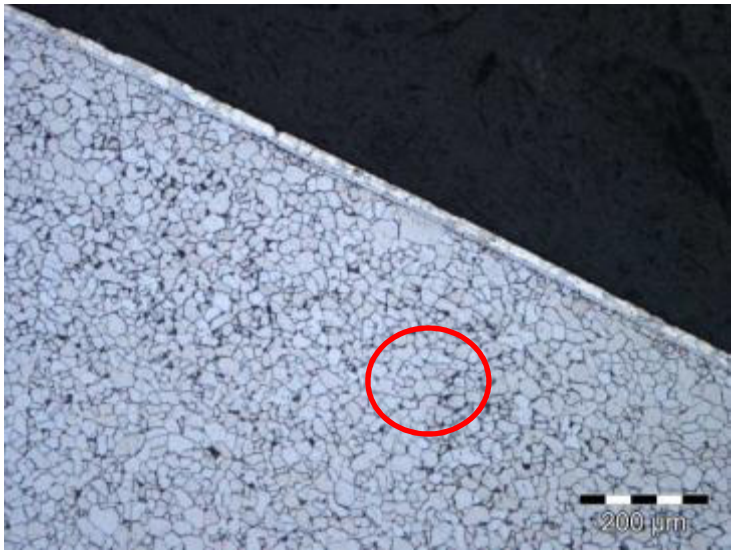
- Rolling parameters have been validated
- Wickeder Westfalenstahl´s material reaches a variation of +/- 0,01mm
- FERAN® reaches a defined and consisted grain size in the steel

FERAN®



Layer is thicker
better tolerances

Alternative Material



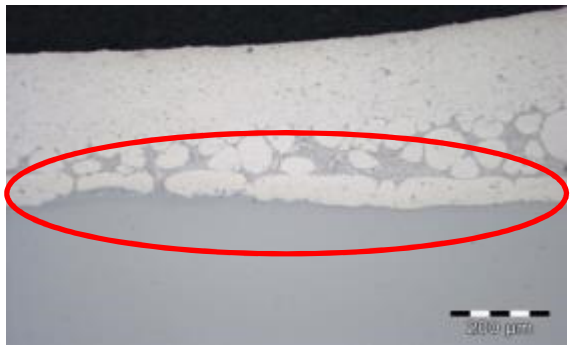
Layer is thinner
bad tolerances ➔
worst protection

Wickeder Westfalenstahl
Wickeder Group

Bahavior of the Al-layer during brazing process

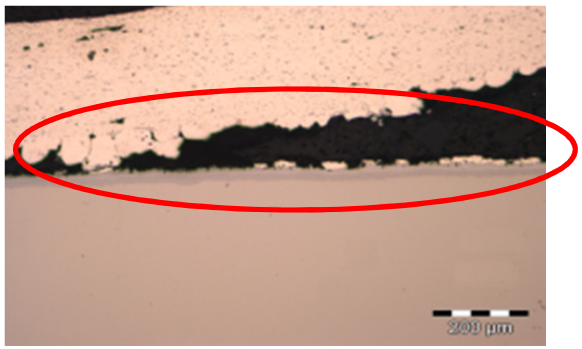
- FERAN® shows a very good Aluminum fin adhesion
- Alternative material shows only single spots adhesion

FERAN®



Good aluminum fin adhesion

Alternative Material



Only single spot adhesion

Wickeder Westfalenstahl
Wickeder Group

Corrosion test performed on tube samples

- Samples of tubes brazed with fins were tested by an salt spray test
- Operated through an independent institute (IGOS)

FERAN®

Appearance of FERAN® after 840 h salt spray test

Alternative material

Appearance of alternative material after 840 h salt spray test

Wickeder Westfalenstahl
Wickeder Group

Anti-Corrosion performance

Samples are tested by salt water spraying of strip with covered edges in a welded and bend condition. FERAN® shows no corrosion after 1.650 h, whereas the alternative material already shows heavy corrosion after 850 h

FERAN®

360h | 850 h | 1650 h

Alternative Material

Wickeder Westfalenstahl
Wickeder Group

Why FERAN® for DACC producers?

Immediate access to the raw materials / FERAN®-coils

- Wickeder Westfalenstahl has established a FERAN® stock in several warehouses to guarantee an immediate supply for the DACC-companies ➔ 500 t per week
- The stock volume enables to cover a continuous production of 8 weeks for the customers
- A continuous delivery system minimizes the needed stock at any time
- Disaster recovery program covers continuous supply

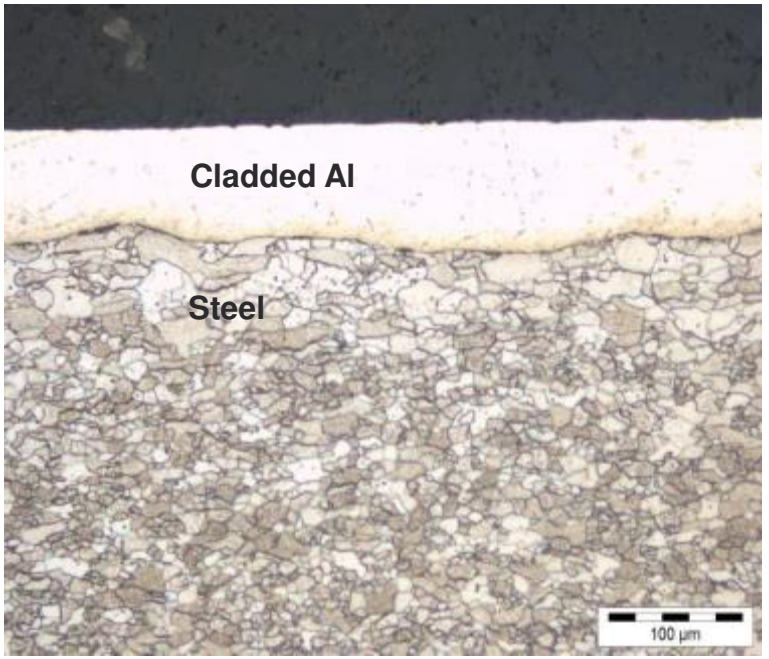
Wickeder Westfalenstahl
Wickeder Group

Why FERAN® for power plants?

Wickeder Westfalenstahl
Wickeder Group

FERAN®: Overview of the advantages

- FERAN® has a consistent and high quality
- Long life time of their products of more than 25 years in respect to corrosion resistance
- DACC-systems with FERAN® guarantee and have demonstrated an excellent yield of the power plant
- Optimized behavior during hot/cold periods
- The material is installed in DACC-systems in deserts, tropic and cold regions ➔ Resistance against sun, wind and storm



Structure of FERAN®

Wickeder Westfalenstahl
Wickeder Group

FERAN® for Power Plant Applications

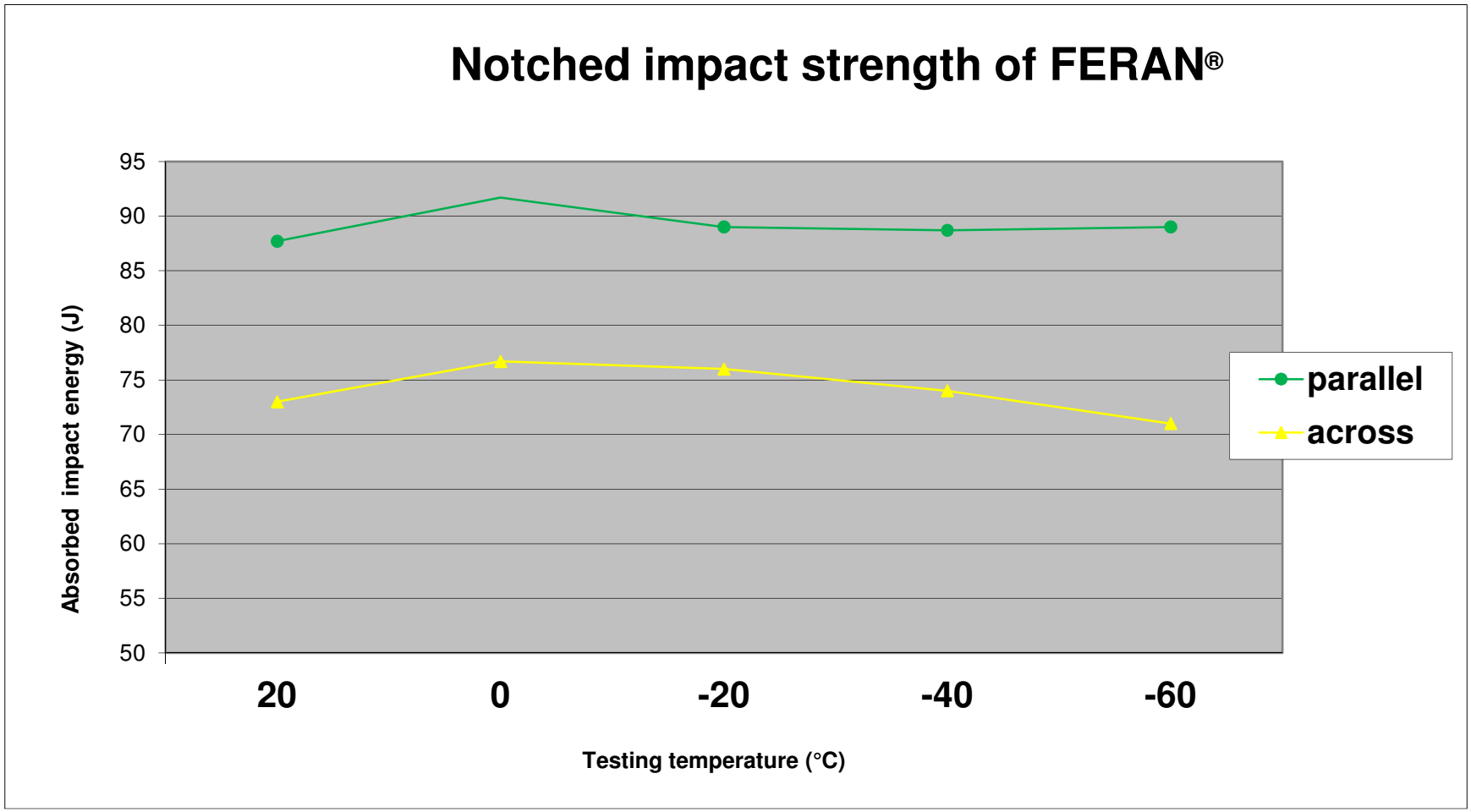
- FERAN® of Wickeder Westfalenstahl is especially developed and designed for Power Plant Applications in very hot and very cold regions in the world
- For evidence of the material toughness the Sharpy impact test was selected
- The test was done close to DIN EN 10045
- The graph shows that even at extreme temperatures up to -60°C or above 40°C there is no significant decrease of absorbed impact energy in comparison to other Al-cladded materials available.

Wickeder Westfalenstahl
Wickeder Group

Avoidance of quality problems and costs

Wickeder Westfalenstahl
Wickeder Group

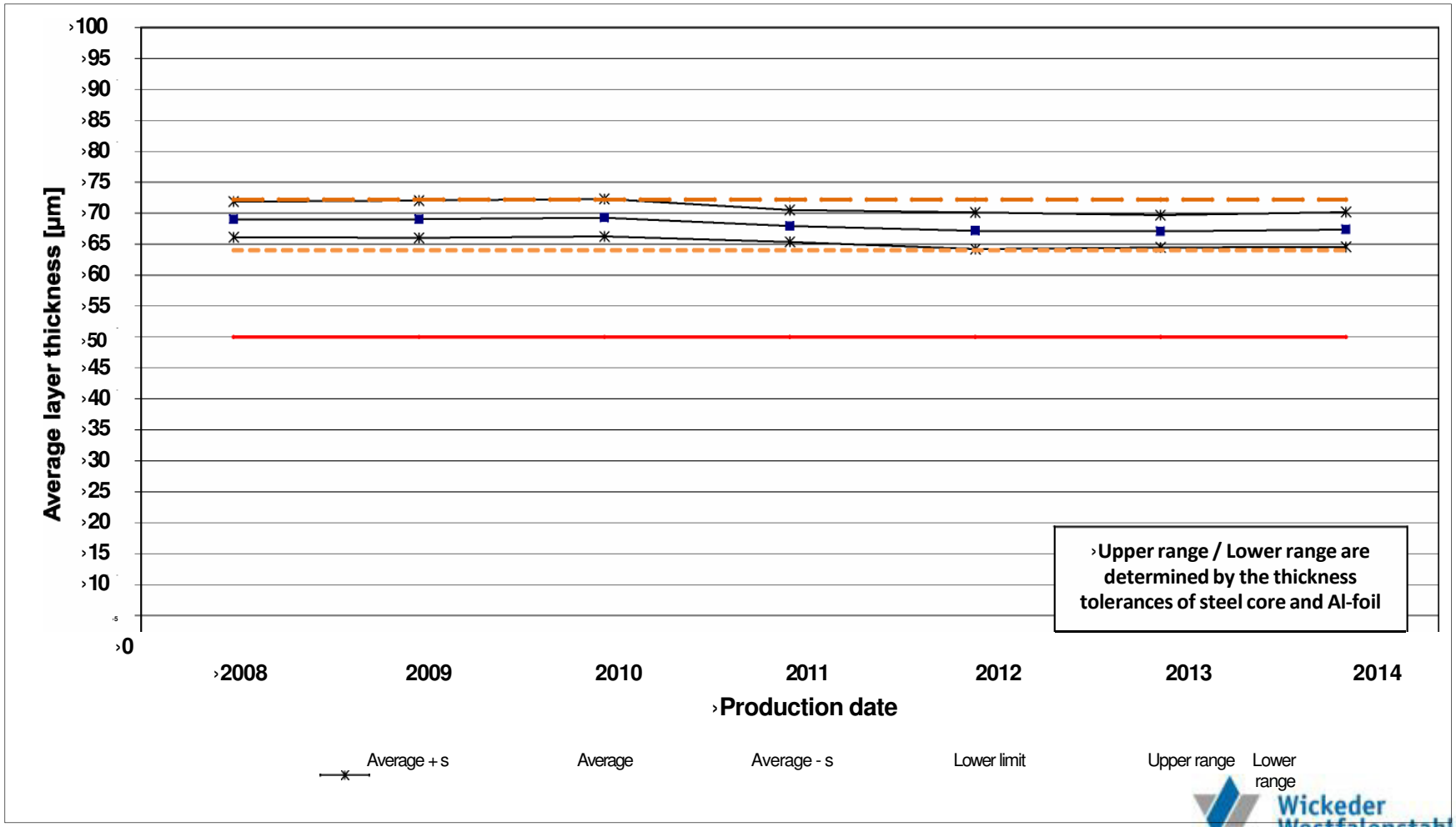
FERAN® for Power Plant Applications



Wickeder Westfalenstahl
Wickeder Group

Statistical Data (Al-Layer thickness)

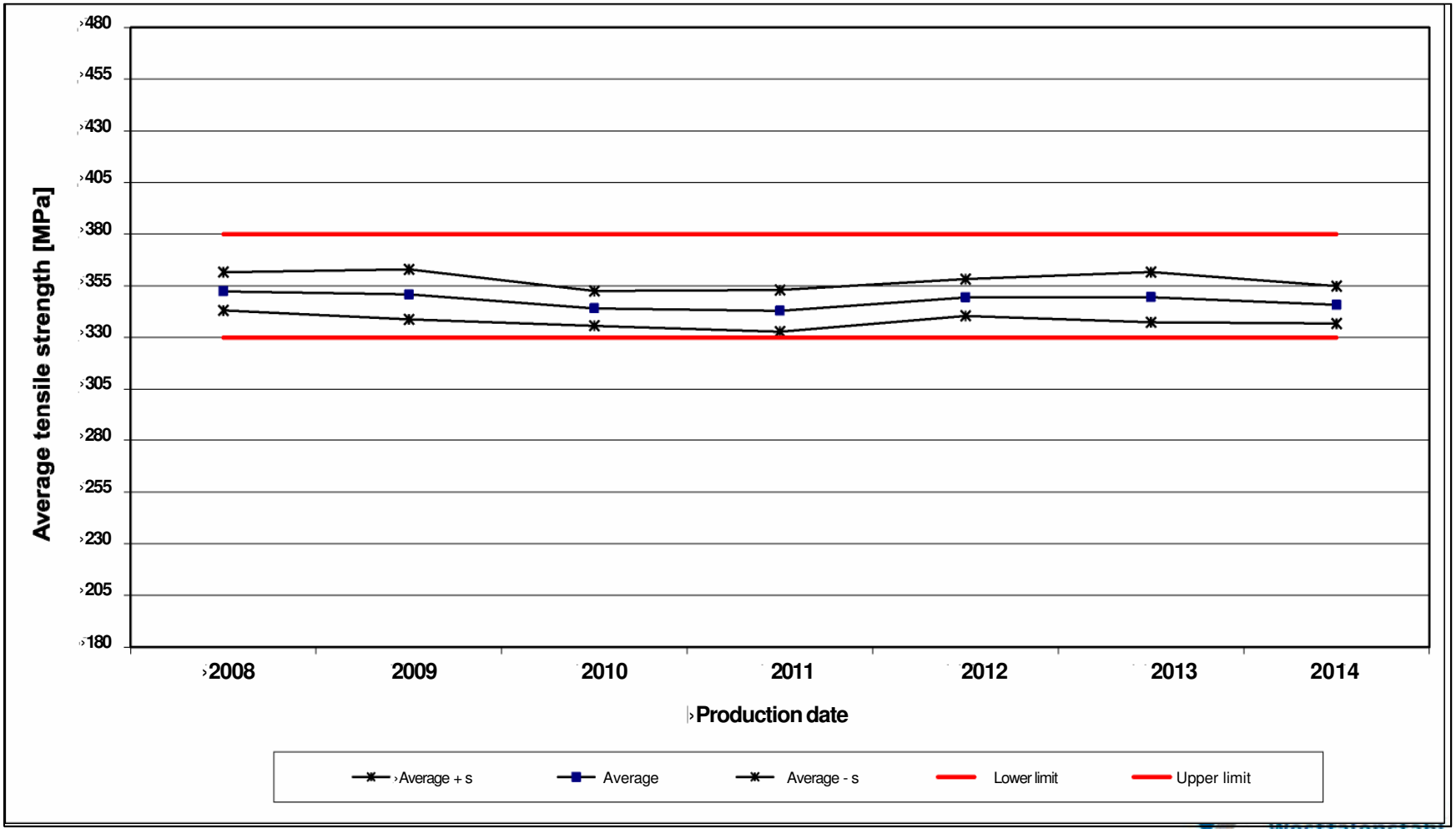
Customer	Material	Dimension	Tolerance of layer thickness
All	Feran for ACC	1,52 x 460 mm	min. 50 µm



Wickeder Westfalenstahl
Wickeder Group

Statistical data (tensile strength)

Customer	Material	Dimension	Tolerance of tensile strength
All	Feran for ACC	1,52 x 460 mm	330 - 380 Mpa



Typical failures with not qualified materials

- Bundles after <1 year in the field
- Not qualified material + wrong engineering

Alternative material – big gap

Alternative material – begining of the gap

Wickeder Westfalenstahl
Wickeder Group

Typical failures with not qualified materials



Delamination caused by brittle interlayer phases at the interface between aluminum and steel

Wickeder Westfalenstahl
Wickeder Group

Typical failures with not qualified materials

Delamination caused by brittle interlayer phases at the interface between aluminum and steel

Wickeder Westfalenstahl
Wickeder Group

Efficiency of cooling systems

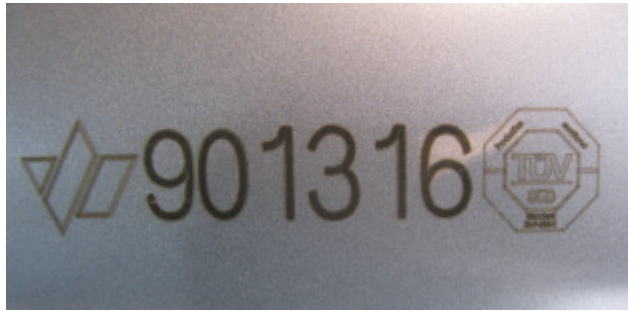
What can be the consequences of the usage of not qualified material?

Wickeder Westfalenstahl
Wickeder Group

Why FERAN® for power plant?

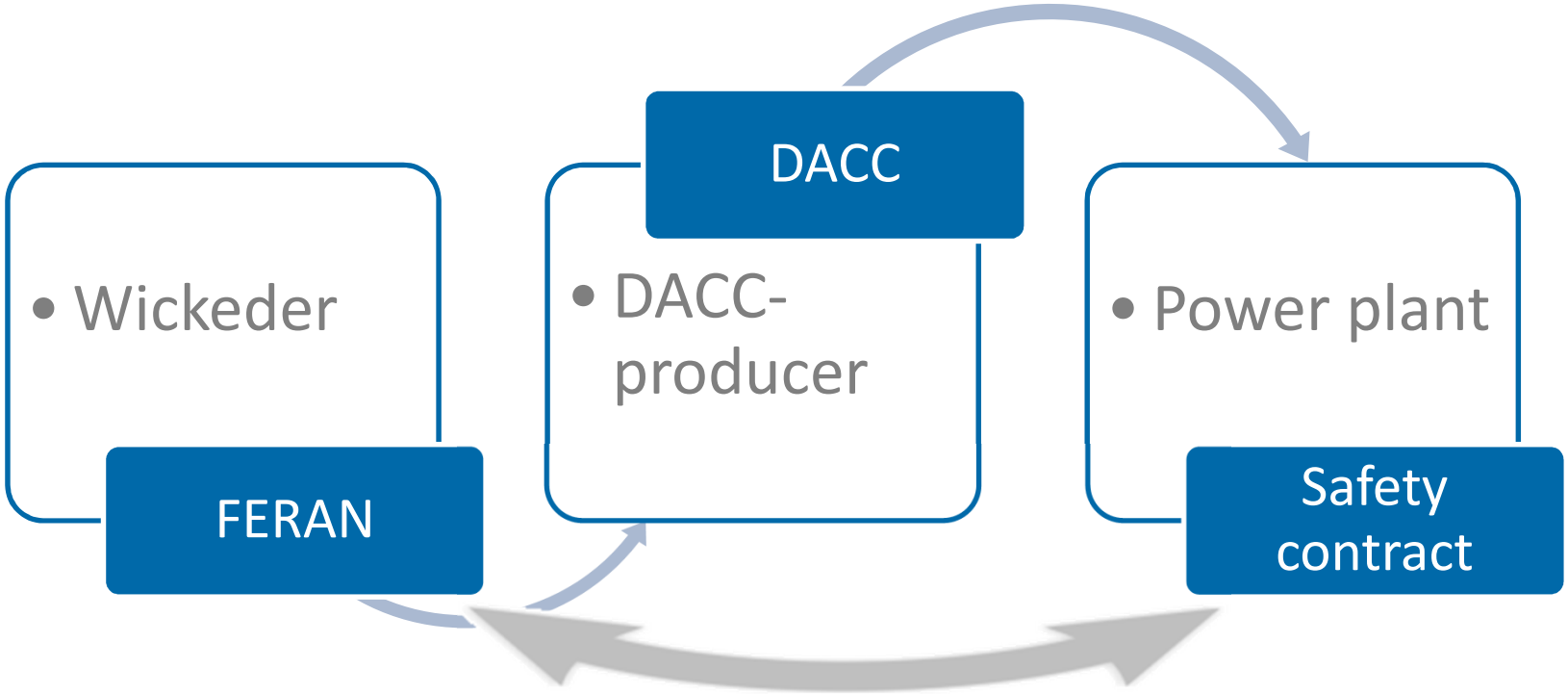
➔ Safety through traceability

- „European Aluminum-clad material“ or „Wickeder FERAN®“ is listed in your contract to ensure you receive the proven Wickeder material
- Wickeder Westfalenstahl has established a tracing system based on:
- Internal documentation & shipping and inspection documents since **more than 20 years**
- Special marking of every single production lot with individual and not copyable parameters **since two years**
- All delivered FERAN® coils are marked with individual numeric marking **since May 2014**
- In 2014: first projects were realized with a numeric marking predetermined by the end-users



Wickeder Westfalenstahl
Wickeder Group

Safety through traceability



Wickeder Westfalenstahl
Wickeder Group

Power Plant Application

Wickeder Westfalenstahl has delivered a high amount of FERAN® tons for DACC systems during the last 20 years:

- With this it is possible to build:
- 460 power plants @ 2 x 600 MW

Responsability for humam & environmental saftey

- Become a responsible power plant!
- It‘s the issue of your future!
- Maximum power for power stations!

Wickeder Westfalenstahl
Wickeder Group

Keep on cooling!

Wickeder Westfalenstahl GmbH
Hauptstraße 6
58739 Wickede an der Ruhr
Deutschland

Phone +49 2377 917-764
Hans-juergen.gauger@wickeder.de

Wickeder Westfalenstahl
Wickeder Group