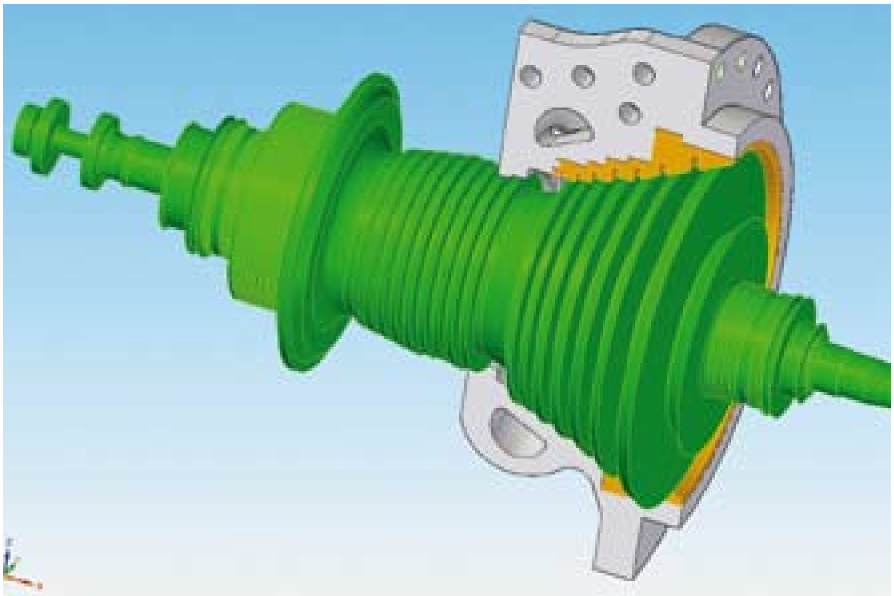
SULZER

Sulzer Turbo Services

Case Study

Lifetime Extension against Minimum Downtime and Cost

Sulzer Repco was requested to perform a on site visual inspection of a 4 MW European manufactured turbine. There were only three of this type of turbine produced worldwide, each made to customer specifications. This turbine which has been operational for more than four decades is a essential link in the desulphurization process of the plant owner. It cannot be taken out of operation without considerable production loss.


Turbine 3D model.

The initial inspection showed that the years of continuous steam erosion were taking their toll on the steam path of the last 7 stationary rows. Whereas the stationary blades remained relatively unscathed, the spacer blocks in-between the blades, and the casing base material were suffering heavily from the higher moisture contents in the steam.

The reason for this erosion rate is that in the 1960's it was more economical to manufacture blade and feet separately, and as in this case from two different materials. The spacer blocks and casing made of a lesser grade steel were simply not suitable to resist the continuous erosion attack. In evaluating the Phase 1 inspection results Sulzer Repco concluded that there was no imminent risk of blade failure, and in agreement with the customer, the turbine was taken back into operation, further degradation of the spacer blocks would be monitored by means of periodic boroscope inspections.

The customer realized that failure of any of the spacer blocks to retain the stationary blades would result in a catastrophic breakdown requested Sulzer Repco to evaluate possible methods of repair.
Any chosen repair method would have meet two essential criteria:

Time
In October 2008 a three week maintenance stop was planned, all repair work; including dismantling and reassembly, would have to be completed in the given time frame.

Money
The cost would have to be reasonable.

The customer supplied Sulzer Repco with all available constructional turbine data available to them. After evaluation of the data and on-site inspection results Sulzer Repco came

Stationary blade erosion.

to the following conclusions:

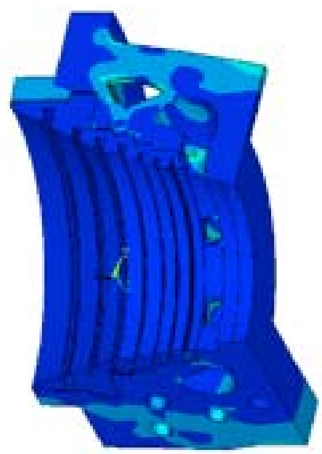
- Due to inconsistencies in the available data it was not possible to pre-manufacture new blades with integral spacer blocks which would fit the old damaged blade grooves.
- The replacement blades would have to be pre-manufactured, as there was just not enough time to start manufacturing them when the the turbine was opened.
- If the old blade slots were to be re-used extensive repair welding was needed, with a certain risk of residual stress in, and deformation of, the turbine shell.
- Machining of the casing was required with any chosen solution

Considering these possible complications Sulzer Repco envisaged a feasible repair proposal, which avoided the complications. The philosophy behind the proposed repair was to remove the casing with its damaged blade grooves, out of the critical path of the repair. This could be accomplisheed by pre-manufacturing a blade insert complete with new blades. The big advantage of this approach was that the blade root dimensions would not be dictated by the casing's slot dimensions, and therefore could be pre-manufactured. The grooves can be machined in the insert and adjusted to a perfect fit. The completely assembled blade insert could then be grafted into the turbine casing, hereby avoiding any time consuming welding repairs. The complete repair work was subdivided into three phases:

- Pre engineering:
- Manufacturing:
- Implementation

Pre engineering

Based on relevant measurements 3D models of turbine casing, blade insert and rotor were constructed. To ensure that the proposed modification of the turbine shell would not generate unacceptable stress levels, a mechanical and thermal stress analysis was per-



Vain carrier.

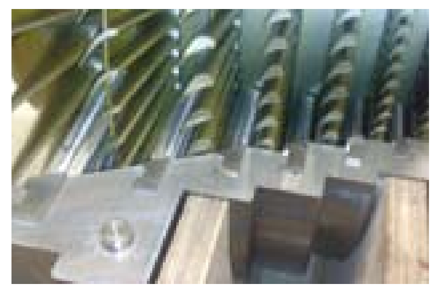
formed on modified and unmodified casing models. The results of analysis indicated that there was no risk of unacceptable stress levels.

Manufacturing

Manufacturing of carrier..

A production drawing for the machining of the blade insert was generated, and the complete blade insert was manufactured in the Sulzer Repco machine shop. Before removing the blade carrier from the lathe all blade root fits were checked using a gauge block and blue print check with a dummy blade, ensuring a perfect fit on assembly.

After loading the blades the blade insert was mounted on a stationary test stand together with the rotor in order to check all axial and radial blade fits. Concluding that only minor diametrical modifications on blade tips were required, the blades were



Checking of blade clearances before finalizing..

permanently locked and machined flat with the insert split line.

To finalize the manufacturing process the necessary diameter corrections were made by precision grinding.An inspection report containing all relevant data was presented to the customer for evaluation and approval.

Implementation

Awaiting the October maintenance stop Sulzer Repco is now making preparations for a swift removal of the turbine casing, thus ensuring a minimum of downtime.

Danny Ketelaar
Sulzer Turbo Services Rotterdam