SULZER

Sulzer Turbo Services

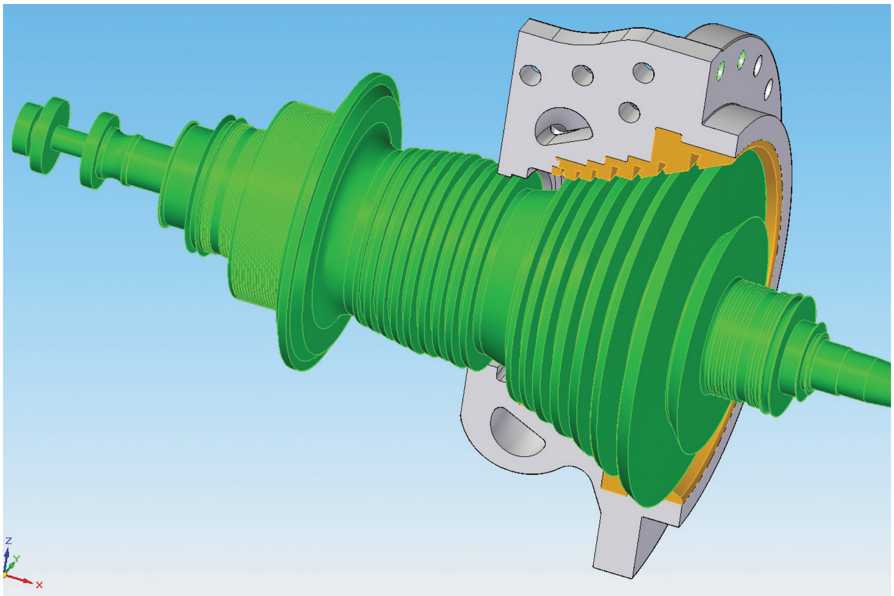
Case Study

Lifetime Extension against Minimum Downtime and Cost

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

The initial inspection showed that the years of continuous steam erosion were taking their toll on the steam path of the last seven stationary rows. Whereas the stationary blades remained relatively unscathed, the spacer blocks 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 Turbo Services concluded that there was no imminent risk of blade failure. 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.



Turbine 3D model.

The customer realized that a failure of any of the spacer blocks to retain the stationary blades would result in a catastrophic breakdown and requested Sulzer Turbo Services to evaluate possible methods of repair.

Any chosen repair method would have to meet two essential criteria:

Time

During a three-week maintenance stop all repair work including dismantling and reassembly would have to be completed.

Money

The cost would have to be reasonable.

The customer supplied Sulzer with all available constructional turbine data available. After evaluation of the data and on-site inspection results Sulzer Turbo Services came to the following conclusions:

Stationary blade erosion.

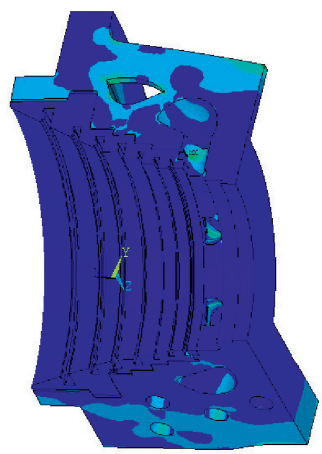
- Due to inconsistencies in the available data it was not possible to pre-manufacture new blades with integral spacer blocks which would fit the old damaged blade grooves.
- The replacement blades would have to be pre-manufactured, as there was just not enough time to start manufacturing when the turbine was opened.
- If the old blade slots were to be reused 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 Turbo Services proposed a solution avoiding the complications. The solution 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 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 performed on modified and unmodified



Vain carrier.

casing models. The results indicated that there was no risk of unacceptable stress levels.

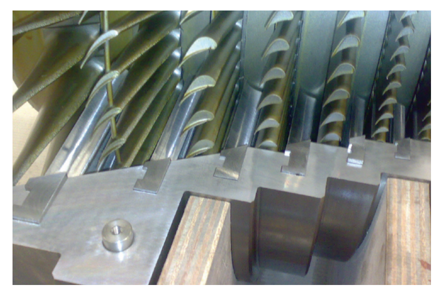
Manufacturing

A production drawing for the machining of the blade insert was generated, and the complete blade insert was manufactured in our 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

Manufacturing of carrier..

order to check all axial and radial blade fits. Concluding that only minor diametrical modifications on blade tips were required, the blades were permanently locked and machined flat with the insert split line.

To finalize the manufacturing process, the necessary diameter corrections were made by precision grinding.



Checking of blade clearances before finalizing..

An inspection report containing all relevant data was presented to the customer for evaluation and approval.

Danny Ketelaar
Sulzer Turbo Services Rotterdam