Root cause failure analysis

Sulzer is your global partner with reliable and sustainable solutions for your key operations. We offer repair and maintenance services for turbines, compressors, pumps, generators and motors. We also offer OEM and aftermarket parts. With one of the largest service networks in the industry, we are close to our customers with over 180 production facilities and service centers worldwide. Our cutting-edge engineering services provide unique and innovative solutions customized to your equipment needs.

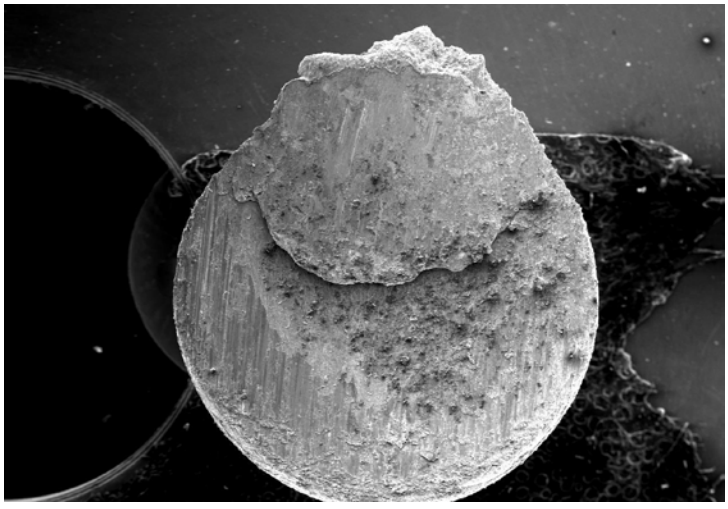
Locking blade failure analysis

In one of the stages of the hot gas expander (operating speed = 6'400 rpm) the locking blade liberated in operation and left pieces of the locking pin in place. The customer requested Sulzer to perform a root cause failure analysis (RCFA) to determine the reason for the failure and mitigate it to improve reliability of the equipment.

Failure analysis consisted of the following steps:

- Visual inspection and non-destructive examination of the rotor and area of the failure.
- Metallurgical studies of the locking pin pieces.
- FEA of the pin assembly to determine the stresses.

Metallurgical studies showed that the pins failed in ductile overload suggesting a possible overspeed above the trip speed intended for the unit. Also, the testing determined that the H46 material has the hardness of 26-30 HRc, while Sulzer specification requires >40 HRc hardness for lock pins. This suggests the tensile and yield strength of the original pin were lower than necessary, which potentially contributed to the failure.

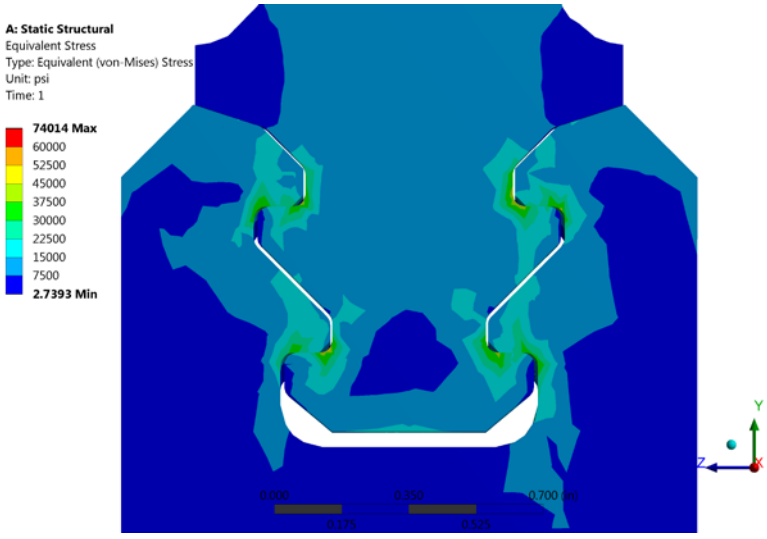


- State-of-the-art analysis techniques
- Mitigate failures
- Improve equipment reliability

Stresses in the pin at the design rotational speed were evaluated using 3D FEA. Structural analysis confirmed that the pin design had a sufficient safety margin. However, it was proposed to switch from locking blade to locking block design in order to reduce the stress and to increase the safety factor even more.

The following design changes to increase reliability of the rotor were proposed:

- Upgrade the pin material from H46 to 422SS, which will provide higher yield strength at the operating conditions.
- Change the lock to locking block design to reduce stresses.
- Upgrade pin material for the other stages as a preventative measure.



Engineering services capabilities/service offering:

- Alignment tracking
- Machinery diagnosis
- Field balancing
- Performance rerates
- Technical upgrades (blade design improvements)
- Root cause failure analysis
- Rotordynamic analysis
- Turbomachinery engineering seminar series

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