

Consequences of Flexible Power Plant Operation

Experiences from vgbe's Service Division

November 2023



Operational Regime of Coal-Fired Plants: in the Past

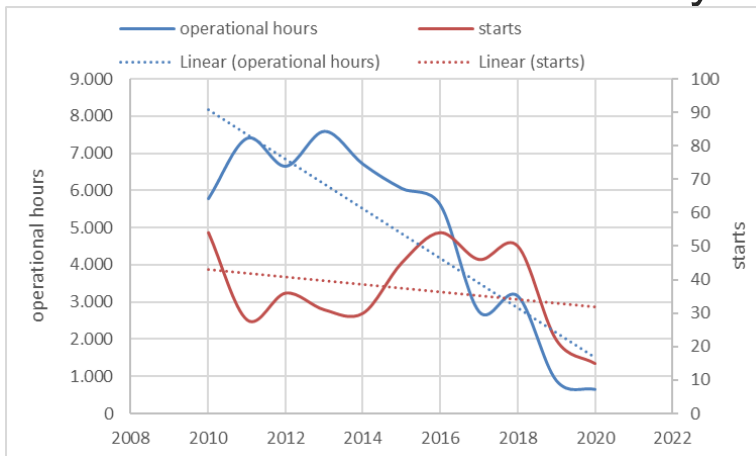
- › Regularly the plants had more than 7,000 full load operational hours per year
- › Plants were only shut down for maintenance
- › Creep was the main damage mechanism on the components
- › Number of starts in correlation to the operational hours was low nearly no impact on lifetime consumption
- › vgbe standards compile best practices to optimize:
 - Operation
 - Inspection
 - Maintenance



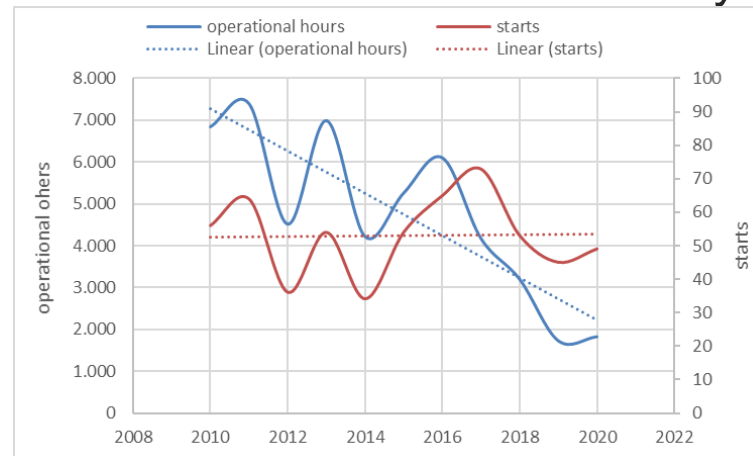
Operational Regime of Coal-Fired Plants: over the Years

- › Number of starts in correlation to the operational hour is increasing → more flexible operation
- › Operational hours clearly decreasing in the last decade at all locations → less creep exposure
- › Number of starts very dependent on plant location → partly higher exposure
- › Lifetime consumption due to cyclic exposure becomes more dominant at some locations
- › Lifetime consumption at many locations is not significantly influenced due to reduced operation

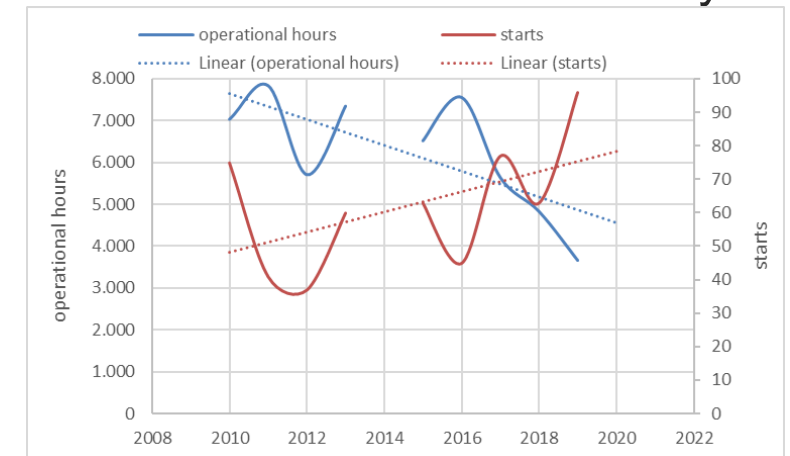
Plant A: North of Germany



Plant B: Middle of Germany



Plant C: South of Germany



Consequences of a Changed Operational Regime

- › Consequences are very plant depended and can differ
- › For many plants no negative effect on the “yearly” lifetime consumption expected → expected to reach year 2035 without “flexibility” damage
- › Longer periods of non-operation → **preservation concepts**
- › Cycling operation requires:
 - generally more complicated **lifetime monitoring**
 - **different inspection methods**
 - **strict water chemistry management**
- › Some plants are more affected by cycling
- › Up to now no significant increase in damages due to cyclic operation observed → however some specific failure occurred



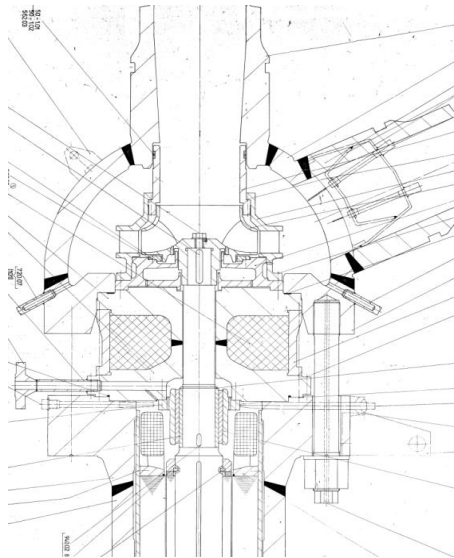
Example: Damage Event in a Boiler Recirculation Pump 1/3

- › Failure of recirculation pump led to a massive damage in one German plant
- › Operational hours of the plant approx. 170,000 hours
- › Approx. 1,400 starts/stops
- › Pump was inspected with conventional methods some time before
- › Identification of root cause to be carried out



Example: Damage Event in a Boiler Recirculation Pump 2/3

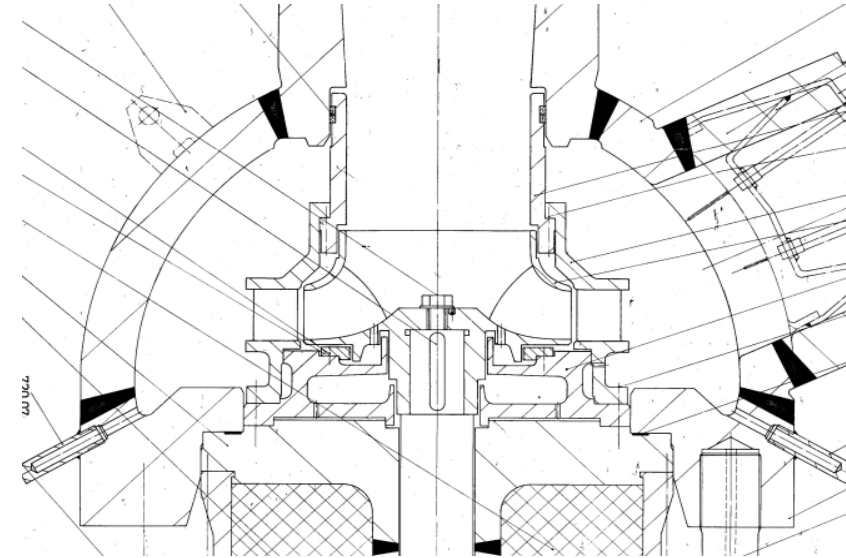
- › 20 years of operation and changed operational regime led to damage
- › Stresses are concentrated in the notch
- › Many pumps with similar design were investigated



Overview drawing



Overview picture

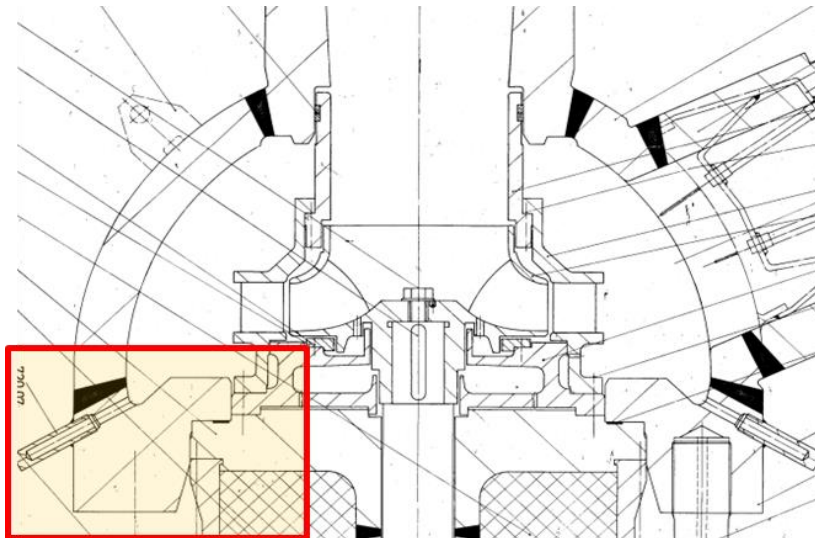
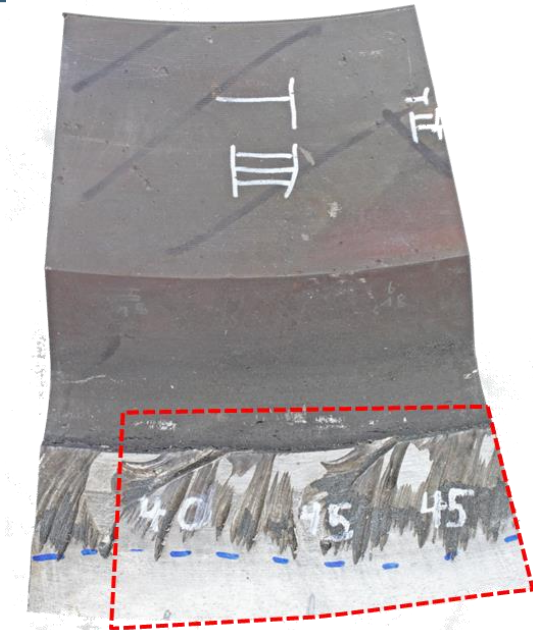


Detailed drawing of the casing

Example: Damage Event in a Boiler Recirculation Pump 3/3

Failure investigation showed following results:

- › Macroscopically clear line of crack arrest → cyclic crack propagation
- › Stresses were concentrated in the notch
- › Pump was not pre-heated during periods of not operating
- › Higher oxygen content present in the water allowed attack



Cleaned fracture surface

Conclusions

Example: damages a boiler circulation pump:

- ✓ Several cracks are initiated in the notch
- ✓ Starting points are corrosive/oxidative attacks
- ✓ Clear cyclic growth can be detected
- ✓ Clear characteristics of strain induced corrosion cracking
- Optimize design for cyclic/flexible operation
- Pre-heating to reduce stresses

O&M:

- ✓ Exposure will be plant dependent
- ✓ Generally cyclic exposure becomes more relevant
- ✓ Different inspection methods to be applied
- ✓ Adjusting other operational parameters (e.g. water chemistry, warming-up components, preservation...)



Flexibility

Thank you for your attention

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