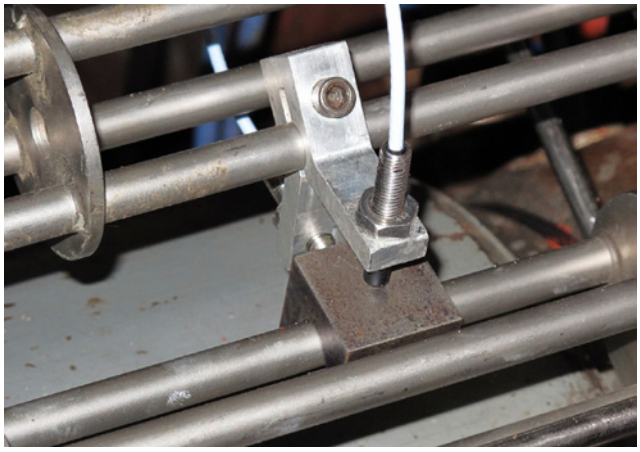
Alignment tracking



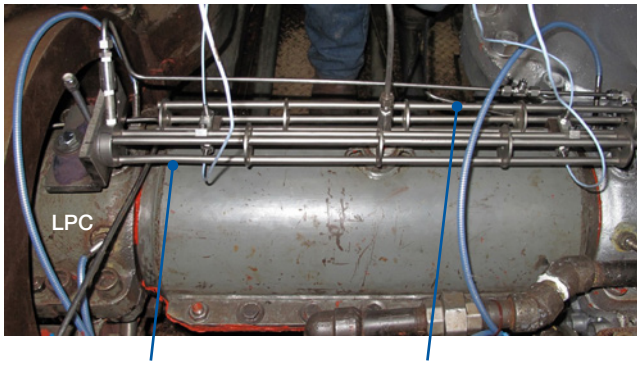
Sulzer is your global partner with reliable and sustainable solutions for your key operations. We offer repair and maintenance services for turbines, compressors, pumps, generators and motors. We also offer OEM and aftermarket parts. With one of the largest service networks in the industry, we are close 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.

The customer experienced a series of mechanical problems on the expander train in a nitric acid plant resulting in unacceptable vibration amplitudes when operating at normal speed of 10'900 rpm. Following various expander bearing changes and alignment offsets, the hot gas expander was removed, and overhauled by Sulzer in La Porte, TX. Detailed phase I and II inspections were performed, and the expander was subjected to extensive repairs of casing, nozzles, blades, and bearings. The overhauled expander was returned to the customer and reinstalled by Sulzer field services.

Due to the previous alignment issues associated with this expander, it was considered necessary to perform continuous alignment offset tracking from cold slow roll conditions to fully loaded service conditions. For reference purposes, the outboard expander inlet temperature was 1'150°F with 550°F exhaust at the inboard coupling end. The low pressure air compressor suction temperature was 30°F, with a discharge of 120°F. With this large temperature differential across the coupling assembly, it would be normal practice to position the cold centerline of the expander below the compressor centerline. However, it has been the Sulzer's experience that the majority of these expander units actually drop in relative elevation during startup. This is attributed to the deflection of the front (inlet) wobble leg combined with compression of the Transite insulating blocks and exhaust end pedestals.

Complete bar installation

Maximum temperature for standard probe = 350°F



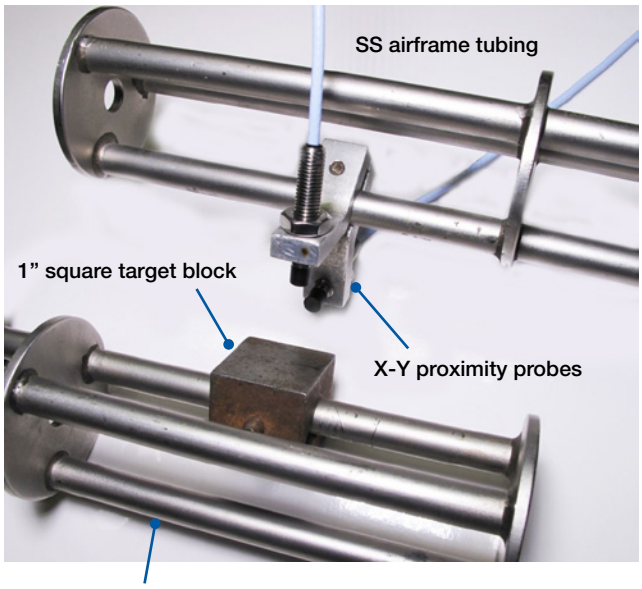
Bar with X-Y proximity probes mounted on LPC bearing housing

Bar with targets mounted on expander bearing housing

- Solution for complex alignment issues
- Get an insight into your train thermal growth

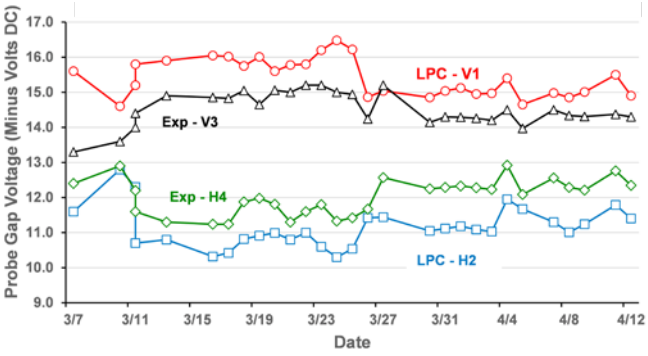
The physical configuration for alignment tracking consisted of two sets of X-Y proximity probes mounted on a horizontal alignment bar attached to the LP compressor (fixed machine). The X-Y probes observed square steel blocks mounted on a separate alignment bar attached to the expander (moveable machine). The adjacent photo documents this field installation. The four proximity probes were connected to Proximitors mounted in an adjacent cabinet. The Proximitor output signals were directed to an ADRE 408 system. This allowed documentation of the transient probe voltages as a function of time and speed during startup. It also provided direct correlation to vibration characteristics.

Bar configuration



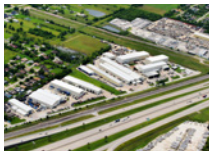
Setting the expander centerline position above the LP compressor proved to be correct, and shaft vibration amplitudes across the coupling were low and acceptable. Following machinery train thermal stabilization the probe DC gap voltages were manually acquired on a daily basis and plotted on the adjacent diagram. It is noted that the position variations during the five weeks after startup were minimal and indicative of constant alignment offsets.

Alignment probe gap voltage variations at full operating speed of 10'900 rpm: March 7 to April 12



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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