UPGRADING AN ALLIS-CHALMERS AXIAL COMPRESSOR FOR RELIABILITY AND MAINTAINABILITY

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Allis-Chalmers (A-C) axial compressors were mostly designed and manufactured in 60s and 70s. They are robust machines that still perform reasonably with many of the originals still in operation. However, many of the legacy design and manufacturing processes were limited to the technology of half a century ago and are presently antiquated. This article briefly summarizes some design limitations in the original design and RMS improvements for these machines.

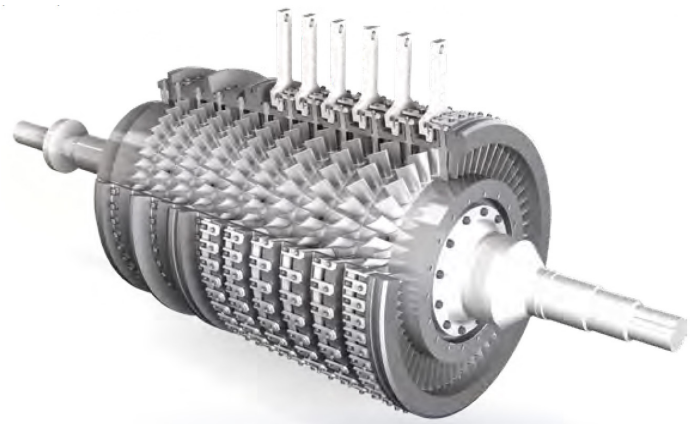

Figure 1

Rotor

The original A-C rotor is comprised of two drums with conical holes intended for blades. The blades are inserted in the hole and held at a defined angle with a fixture, and second person (from inside the drum) has to tighten the nut. The limitations include:

- The blades are held by means of a large nut. Poor contact on the conical face or any loosening in the nut will 'unseat' the blade and change its natural frequency which could potentially cause catastrophic failures.
- To remove or replace a rotor blade, at least one stub shaft has to be removed, which is problematic with regarding to reassembling the rotor and maintaining journal, probe area and shaft end concentricity.
- There is no bare shaft balancing feature. Although the rotor may be balanced at the journals, there may be large coupled forces within the drums.
- Low accuracy of the blade angle setting and room for error such as assembling blades backwards.

RMS upgrades:

- RMS provides a rotor assembly that eliminates most of the above maintainability concerns by using a proven blade attachment (circumferential dovetail), while maintaining the cost and rotor stability advantages of a drum rotor construction.
- The blades are installed into the circumferential groove alternating with spacer pieces.
- The rotor is designed to include balance provisions by using blade balance weight grooves at each stage and sacrificial material at the drum ends. In addition, the blades and spacers can be drilled for weight normalization and balance corrections at each stage.

Figure 2

- The rotor does not need to be taken apart for a blade replacement overhaul.

Stator

The original A-C rotor is comprised of two drums with conical holes intended for blades. The blades are inserted in the hole and held at a defined angle with a fixture, and second person (from inside the drum) has to tighten the nut. The limitations include:

- Casing: The original (internal) casings are made out of gray cast iron which is prone to cracking and thermal induced warping. Additionally, the cast iron material is not readily weld repairable. RMS manufactures new casings from high quality steel forged material that is more resistant to erosion and enables design and reliability upgrades. All the critical surfaces and fits are retained for interchangeability to the outer casing, so there is no need for re-piping and grouting, etc.
- Variable stator vanes: The existing design requires setting the vane angles and match drilling fork vane assembly during assembly which is inaccurate and laborious. RMS upgrades the variable vanes with a wrench drive assembly configuration to facilitate reassembly for overhauls. The wrench drive upgrade saves many labor hours to assemble, and the vane angles are set during design and manufacturing. Therefore, it significantly increases the precision and eliminates assembly mishaps.
- Fixed stator vanes: The fixed vanes have a conical seat attachment similar to rotor blades. For a new casing, RMS upgrade is a tangential entry blade attachment like the rotor. If the customer elects to reuse the casing, RMS has developed a proprietary method of pre-setting the tangential angle with precision.

Bearings

Most of the bearings for the A-C axial compressors were designed prior to advent of rotordynamic analysis as we know it today. Many include 'field-stabilizing' features that stabilizes the bearings, but to the expense of reducing reliability. There is a well-known history of journal scoring during operation for virtually all the above-mentioned bearings. Repairing journals or making specialized bearings can be very costly and confusing to keep track. RMS performs thorough rotordynamic analysis for each individual machine and designs appropriate modern day conventional bearings to suit.

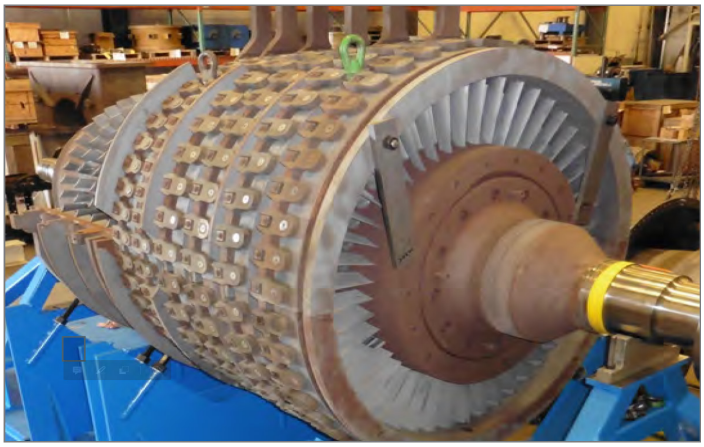

Figure 3

Actuators

The variable stator vanes are rotated by means of archaic pneumatic cylinders that need to be custom-made and can be very expensive. Many of our customers experience hysteresis (swinging back and forth) due to poor controllability of these actuators. RMS replaces the old actuators with a closed-loop hydraulic system that includes internal control logics and has proven to be extremely accurate and reliable. The replacement actuators are 'dropin' and do not require re-wiring or making changes to the Data Control System (DCS) signals.

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