ROTATING MACHINERY SERVICES, INC.
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THE FINISH LINE

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2010 GG4 / FT4 SYMPOSIUM, MAY 19, 2010

By Kathy Ehasz

Rotating Machinery Services hosted the this years GG4/FT4 Industrial Symposium in Bethlehem, PA. The Symposium is specifically designed for the GG4/FT4 operator.

The symposium assists Key leaders in the GG4/FT4 community to support their fleet through informative presentations, sharing insights, exchanging ideas and roundtable discussions with topics such as, rotating machinery, inlet filters, exhaust stacks, control systems and more to help find solutions. The symposium also provides colleagues a chance to network and gain valuable contacts in the industry.

To kick off the event, a Welcome Reception was held Tuesday evening, May 18th and the symposium itself was held on Wednesday, May 19th. Both End Users and Suppliers found the symposium very informative. The symposium ended with a tour of the RMS shop and equipment demonstrations.

The following are opinions about the symposium:

"*It was very organized and I think everyone left with something that will help them in running their Units or an option to talk with someone that might help them with a problem.*" **Dennis Sawyer, Twin Manufacturing.**

"Just a note to say "thanks!" for an excellent symposium." **Rick Kowalski, MT R&O, LLC**.

API 687 SEMINAR AT RMS—NOVEMBER 1 - 5, 2010

Rotating Machinery Services will host the API 687 Rotor Repair Course at our Bethlehem, Pa office on November 1—5, 2010. The API Rotor Repair Course, based on API standard 687, covers the minimum requirements for the inspection and repair of rotating equipment rotors, bearings and couplings used in the petroleum, chemical and gas industry services.

RMS engineer Tony Rubino contributed to the writing of the API 687 standard. For more information on the API 687 course, please visit the API website at www.api-u.org/rotorrepair.html.

What's Inside

39th Turbomachinery Symposium

OCT 4 - 7, 2010

Houston, Texas

BOOTH 741

PLEASE JOIN US!!!

We have many new capabilities!

Let us help you achieve the optimum solution for your Turbomachinery Needs!!

RULE OF THUMB - CENTRIFUGAL COMPRESSORS

By Neal Wikert

API Standard Conditions: 60 deg F, 14.7 PSIA, Dry (0% RH)

Sizing: Old days, compressors 15% oversized. Today often have no rerate ability.

Terminology: Inlet Plenum - Name for inlet

Discharge Volute - Name for discharge

Seals: On low coefficient stages, can massage labyrinth seals and balance piston seal and get 3-5% boost.

Open Wheels

Vibration: IGVs excite the inducer portion of the blade

Diffuser vanes excite the educer portion of the blade

4x and 5x running speed interferences have been problems

Vane thickness distribution

A first guess tip thickness equal to 1% of the OD should be fine. In the case of a small value you can start with a 0.040" to 0.060" thickness. A base to tip taper ratio of 2 is a start. As for thickness distribution, the general trend is to increase in thickness around the bend and then taper back down.

Impeller Repair Notes:

Impeller Bore Repair:

API687: Welding and thermal spraying are the only accepted methods. Chrome or nickel plating is strictly forbidden due to the difference in thermal growth coefficients.

Thermal spray coatings have recommended finished thickness limits as follows:

7-25 mils for high velocity fuel processes and

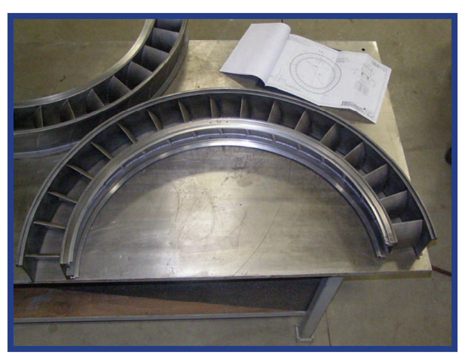
3-10 mils for combustion processes

Gas Horsepower: The term gas horsepower refers to the input shaft power, free of mechanical losses, which have no thermal effect on the gas. This value is attained by subtracting the (.4 root) of the Brake Horse power (BHP) from that BHP value. For example, the BHP is 5000; the .4 of BHP root is 30 hp of friction; the Gas Hp = BHP—BHP $^{0.4}$ = 5000 – 30 = 4970.

IR FIXED STATOR ASSEMBLY SEAL REPAIR

By Tony Rubino

Fixed stator assemblies originally manufactured by IR utilize a staked in place strip to form the seal between the stator and the rotor. Successive reworking results in substantial loss of material in the stake area rendering the stake retention less than satisfactory. Rather than scrapping an otherwise functional stator assembly, most manufacturer's have developed a method to replace the material in the seal holder area permitting the stator assembly to be salvaged. RMS has further refined this process to modify the seal retention to allow a sliding fit rather than a stake to simplify future overhauls. New seal strips are slid into tightly toleranced grooves and then pinned to prevent unwanted motion. Seal strips may be manufactured from either aluminum or bronze and are designed with a robust retention foot. RMS has provided both repaired and new stator assemblies to suit specific customer requirements.



23,000 lb STEAM TURBINE ROTOR INSPECTION

By Chris Browne

RMS was recently contracted to clean and inspect this Steam Turbine rotor assembly. The rotor assembly is part of a 20MW, 8-stage Steam Turbine and is used as a generator drive.

The rotor assembly weights approximately 23,000 lbs. and spans up to 9 feet in diameter. Included with this contract, RMS will repair diaphragms and upgrade interstage seals to spring loaded type to improve efficiency. RMS will also replace the current crush pin design with shim adjusting locating pins. Horizontal joint inspections will be done to all the diaphragms, oil deflectors, the high pressure steam seal and low pressure water box. Weld repair and new replacement seals will be used to restore required clearances.

STEAM TURBINE DEPOSITS

By Sydney Gross

Steam turbine deposits are a direct result of boiler water impurity from all sources of water that enter the system such as feed water, make up water and attemperation. Impurities may also originate internally from paints, sealants, gaskets, blasting media, corrosion products, etc. Often, impurities will settle in the drum only to be stirred up and carried over in high concentration during boiler upsets. Although these impurities may be in low concentration in the steam, a few parts per billion (ppb), their concentrations can become much higher as they deposit in the turbine. The most common impurities found in steam are sodium chloride, silica and iron oxide.

Turbine deposits may start out as solid particles in the steam but more commonly exist in solution. As the steam looses pressure and temperature in the turbine, impurities come out of solution much like dissolved salt will come out of a water solution as it cools. The impurities will then attach to the turbine components through different mechanisms such as impact or evaporation.

Steam impurities deposit in various locations in the turbine wherever expansion of the steam occurs. Deposits form on valve parts causing sticking and in seal areas between the rotor and stationary seal causing wear damage to the rotor, seal or both. Deposits form on the rotor discs, blades and shrouds resulting in pitting corrosion, stress corrosion cracking and corrosion fatigue. In more severe instances, rotor to stator clearances may be closed and rubbing can occur. Deposits also adhere to the flow path components, diaphragm and nozzle vanes and rotor blade surfaces, thus reducing flow area and increasing surface roughness resulting in reduced capacity, reduced efficiency and higher thrust loading. Uneven deposits on the rotor can result in elevated vibration levels.

Turbine performance should be monitored regularly for signs of deposits. These signs include first stage pressure and active thrust temperature trending upward and radial vibration levels trending upward or jumping upward. Visual signs of deposits can be detected where steam escapes the turbine at locations such as seals, valves or casing joints of dubious integrity. Deposits are typically white and crystalline. Samples of deposits should be collected and analyzed to determine their origin.

The most obvious preventative measure but hardest to implement is improving the purity of the water. Tighter boiler controls, which limit upsets, and regular boiler blow down will help prevent deposits resulting from upsets. Other methods for preventing turbine buildups include improved flow path surface finishes and anti-fouling coatings. Both will extend the period before fouling becomes an issue. Once adhered, some deposits can be removed through on-line or off-line water washing. However, silica deposits tend to be more tenacious and often require blast cleaning of the rotor.

RMS ADDING TO OUR TOOLS OF THE TRADE

By Barry Ruch

With literally owning over hundreds of inspection tools, RMS has recently added a coordinate measuring machine to our arsenal. As everyone in the turbo machinery part producing world knows, interchangeability of parts can not be compromised. Replacement or rerated parts <u>must</u> fit into place of their original components. This is just one facet where RMS takes great pride in the field we specialize in.

Our newly purchased (CMM) is a Brown & Sharp Micromeasure Validator. With its versatility and capabilities it adds another method, in which we assure the accuracy level we know our customers not only expect, but reply upon.

Other recent purchases by RMS include a 12"-60" outside micrometer set and an ultrasonic precision thickness gage (for measuring wall thicknesses where only one side is accessible).

As always, RMS strives to out perform our competition and the accuracy of our products, whether a new design or a replicated replacement part, stand second to none.

LOCATING EXCITATIONS on the INTERFERENCE DIAGRAM

By William Sullivan

In this installment of the interference diagram series we will describe how possible sources of excitation are located on the interference diagram. The discussion will be limited to evenly spaced disturbances located along a path concentric to the circular path of the blades around the rotor axis. Most typically, the excitation sources are upstream vanes, but downstream vanes and other structures such as upstream struts, could be sources of excitation as well.

To illustrate, we will start with an impeller with 12 blades that will be operating at 7,200 rpm. A source of excitation consisting of 4 evenly spaced struts will be plotted on an interference diagram (Figure 1). Then, sources of excitation consisting of 10 and 15 vanes will be added to the diagram.

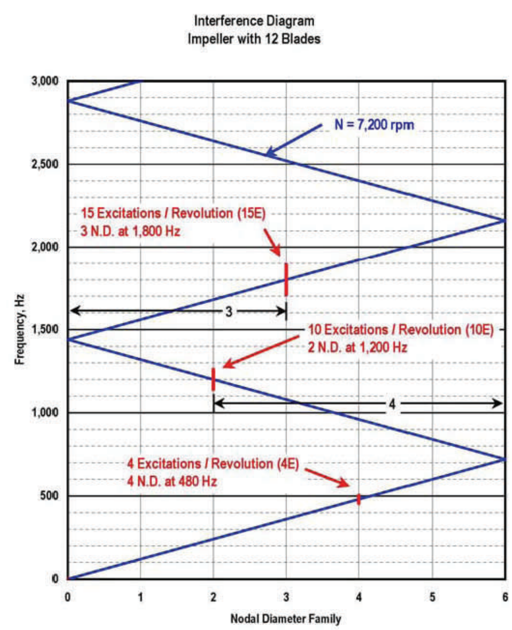


FIGURE 1

As mentioned in earlier installments of this series, nodal diameters from 0 to ½ the number of blades are plotted along the X Axis of the interference diagram. The subject impeller has 12 blades. Therefore, 0 to 6 nodal diameters have been plotted on the diagram. Since the 4 struts are less then ½ the number of blades, the nodal diameter for the struts is plotted where the speed line crosses the 4 nodal diameter ordinate.

The 10 nodal diameter excitation will be located using the "reflection" phenomenon described In the first installment of this series. The sixth nodal diameter position is at the extreme right of the diagram. The seventh nodal diameter is just to the left, on the 5 nodal diameter position as indicated on the X Axis.

LOCATING EXCITATIONS on the INTERFERENCE DIAGRAM Con't

Therefore, a 10 nodal diameter excitation is plotted 4 nodal diameters from the right of the diagram, at the 2 nodal diameter position as indicated by the X Axis.

The 15 nodal diameter excitation is more than the number of impeller blades but less than 1 ½ times the number of blades. It is located on the speed line at the 3 nodal diameter position (15 – 12 = 3). This procedure continues for higher excitations.

The frequency of an excitation for any rotor speed can be found using the following relationship:

$$F = \frac{E * N}{60}$$

$E =$ Excitation Order (The Number of Excitations per 1 revolution of the Rotor)

$N =$ Rotor Speed, rpm

$F =$ Excitation Frequency, Hz

This relationship can be useful for determining frequency separation margins, etc. The interference lines in Figure 1, for example, were plotted with +/- 5 % margins on frequency (which is the same as +/- 5 % margins on rotor speed).

Rotors with odd numbers of blades are handled similarly except that the right side reflection is at a ½ blade position. Remember that at the 0 nodal diameter position at the extreme left of the interference diagram, the excitations always are whole number multiples of the number of blades. Figures 2 and 3 have been included to help visualize the excitation positions. Figure 2 is Figure 1 with no excitations plotted. Figure 3 is a diagram for an odd number of blades (specifically 13).

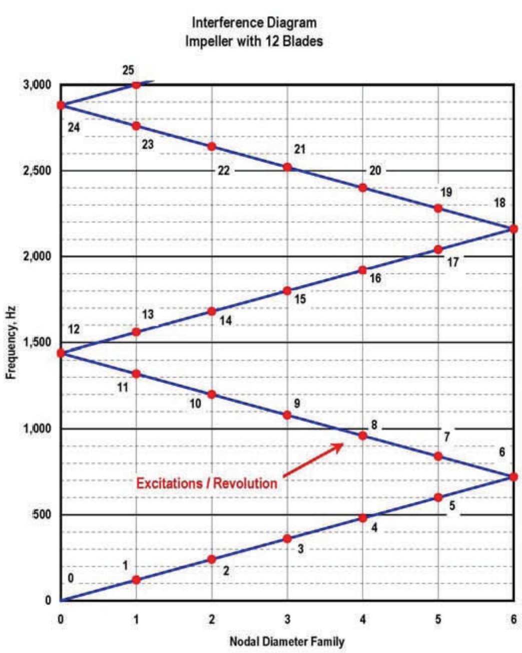


FIGURE 2

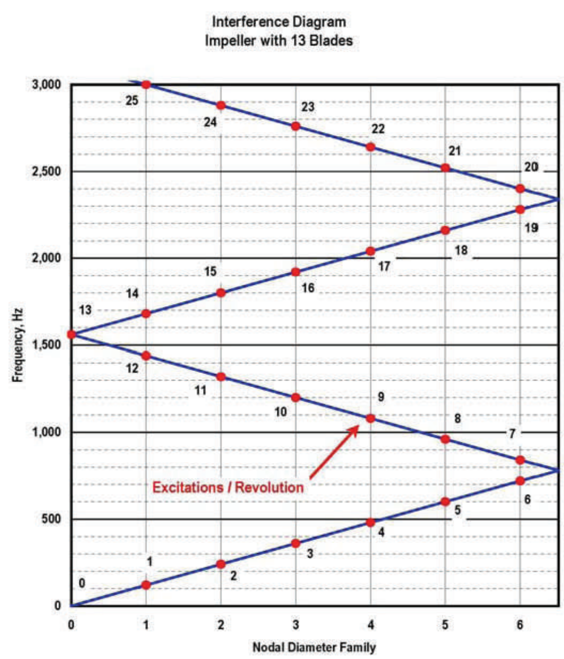


FIGURE 3

WORKING WITH NEIGHBORING COMPANIES

By Paul Poley

Several month ago, the executives at RMS and Strahman Valve informally met which resulted in the discovery that each company had needs that could possibly be satisfied with resources from the other's company. It didn't take long for representatives from both companies to start working together on several projects. One project was considered a major accomplishment for RMS Power Solutions. We have had the a need to process the repairs of vibration probe tracks on turbomachinery rotors shafts. Strahman had recently installed a 42-inch Axelson Lathe and this machine seemed to have the potential for doing this work.

Strahman Valve modified the machine under the supervision of Rudy Shuck of Strahman and Paul Poley of RMS. Machinist from both companies, Gary Rohn of RMS Power Solutions and Don Zellner of Strahman worked together to perform the work. They performed rotor probe track burnish repairs on RT-48 and GT-61 rotors that involved the grinding and burnishing of 2 probe surfaces on each.

RMS WELCOMES ...

Robert Dehart
Quality Control & Shop Operations

Bob has over twenty two years of experience in inspection and quality control working with axial, centrifugal and reciprocating compressors, expanders and steam turbines. He previously held positions at General Electric Oil & Gas, Conmec and Cooper Industries.

John Smolko
Design Engineer

John recently graduated summa cum laude from Drexel University with a Bachelor of Science in Mechanical Engineering and Mechanics. Throughout his five years at Drexel, he participated in 3 cooperative education experiences, each lasting a period of 6 months. These co-ops offered him the opportunity to work on the design and manufacturing of numerous types of industrial size pumps and rotating equipment. During his senior year at Drexel, he also had the opportunity to work with one of the leading aerospace companies, The Boeing Company, on a senior design project that earned his team first place in the Mechanical Engineering and Mechanics design competition and fourth place in the overall College of Engineering design competition. The project was titled "Energy Absorbing Composite Structures to Increase Rotorcraft Crashworthiness" and utilized graphite/epoxy tubular structures to increase the energy absorbing capabilities of a military helicopter in the event of a vertical impact or hard landing.

Mike Spangler
Regional Sales Manager—Northeast

Mike has over 20 years of turbomachinery experience including Sales Account Management and Industrial Sales, project development and field support. Experienced in various types of rotating equipment including single and multistage steam turbines, centrifugal compressors and reciprocating compressors and customer support functions. He previously held position with Dresser-Rand as Account Manager with experience on Elliott, AC, Terry, Worthington, Turbodyne General Electric and Westinghouse equipment in technical sales for turbomachinery upgrades, re-rates, field services and shop repairs.

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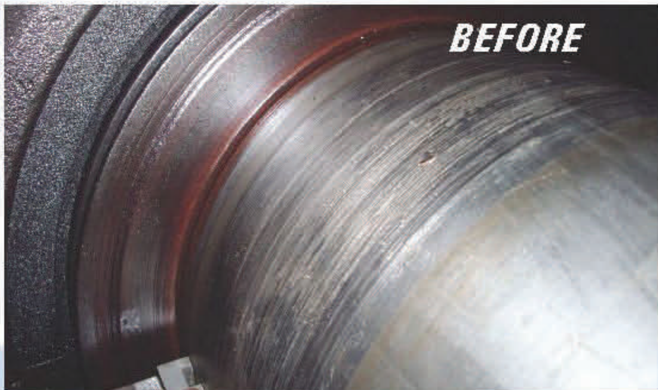
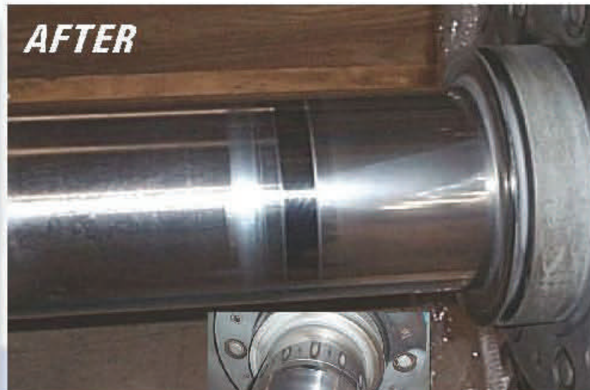
Emergency Repair





PROBLEM: Emergency turnaround inspection & repair of IR JP125 power turbine rotor

SOLUTION: RMS Power Solutions cleaned, inspected & repaired rotor in "*7 days*"

- Solvent cleaned shaft & wheel indicating areas
- Detailed visual & dimensional inspection
- Indicated rotor & performed glitch check
- Removed blades with lacing tubes in packets
- Grit blast cleaned disc, blades & lacing tubes
- FPI inspected disk & blades
- Repaired shaft journal area (Pregrind, HVOF chrome carbide coating & final grind)
- Reassembled blades with new locking wire
- Final balanced rotor assembly
- Prepared & boxed for shipment
- Detailed final report

"Quality from Start to Finish"

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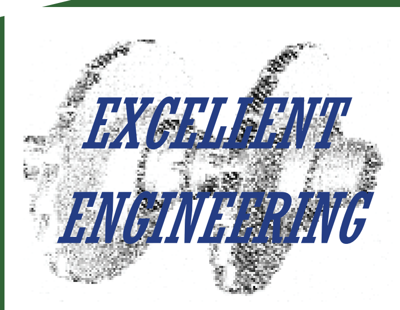

PRODUCT LINES:

AXIAL COMPRESSORS • CENTRIFUGAL COMPRESSORS • EXPANDERS • GAS TURBINES • POWER TURBINES • STEAM TURBINES

ROTATING MACHINERY SERVICES, INC.

RMS GOES GREEN

By Caleb Guhlin

At Rotating Machinery Services, our daily business mission extends well beyond our employees, clients, suppliers, and contractors, and into how we affect the world around us. It is our goal to reduce our carbon footprint and our impact on the environment while not sacrificing the quality of our product. As of April 1st, 2010, RMS has developed and committed to a gradual "green initiative" aimed at becoming a responsible carbon neutral company. At RMS we are dedicated to a sustainable future for our planet through the three R's:

Reduce

We make an effort to minimize materials used and needed in packaging and daily use around the office. We want to reduce consumption, waste, and pollution.

Reuse

We aim to reuse any and all materials used in conjunction with our business. We reuse cardboard boxes, packing materials, printer paper, tools, and equipment where applicable.

Recycle

RMS has recently begun recycling starting with cardboard boxes. Gradually we plan to incorporate everything that is accepted by our city. By midsummer we plan to be recycling paper, plastic, and cans which are widely / commonly used within our company.

Through education, conservation, and compliance Rotating Machinery Services is committed to supporting a greener work environment and world. At RMS we want to be green because we care about the impact we have on the planet. We also value working with people, customers, vendors, and clients who care in the same way.