ROTATING MACHINERY SERVICES, INC.

VOLUME 9, ISSUE 2
APRIL—JUNE 2013

THE FINISH LINE

PHONE 484-821-0702 FAX 484-821-0710 WWW.ROTATINGMACHINERY.COM

POWER RECOVERY TRAIN (PRT) ROUND TABLE

Rotating Machinery Services will be hosting a Power Recovery Train Round Table scheduled for October 29 and October 30, 2013. A welcome reception will be held on Monday, October 28th.

A general overview of topics to be discussed are:

- Process and PRT Overview
- Expander Reliability Overview
- Axial Compressor Theory of Operation
- Motor / Generator and Steam Turbine Overview
- Field Service / Technical Advisor Support during outage

If you are interested in attending, you can download the registration form on our website at http://www.rotatingmachinery.com/conferences.html or you can contact Don Shafer or Kathy Ehasz at 484-821-0702.

Discounted Hotel rates are available until October 1, 2013. If you have a topic, question or problem area for the Round Table, please email Don Shafer at dshafer@rotatingmachinery.com. Seating is limited, so please RSVP early.

RMS CUSTOMER QUAIL HUNT

By Mike Spangler

RMS held it's annual customer quail and pheasant hunt January 4th, 2013. Customers from the Southeast gathered at Lookout Creek Farms in Valley Head, Alabama. The day started with a lunch followed by a safety meeting by the Lookout Creek Guides. Next, it was on to the fields with a variety of amazing, highly trained, bird dogs. Two English Pointers, one German Short Hair and one English Setter. "*Just watching these dogs work is more than half the fun*" according to one customer.

A total of 34 Quail and 6 Pheasants were taken. Lookout Creek personnel cleaned and prepared all of the birds for cooking and transported to everyone's home. A great day of hunting and fellowship was had by all.

FIRST IN CLASS - TWICE!!!

By Kathy Ehasz

For those who have met RMS President Jerry Hallman, you know he has had a passion for British Cars for as long as anyone can remember. This June he entered his 1968 Triumph TR250 in the British Motor Car Gathering in Hellertown, PA and won "First in Class" He also entered his 1967 Austin Healey in the Redmill British Car Show in Clinton, NJ and won 1st place. Doing things 1st class is how Hallman and the staff at RMS believe it should be done with all things - especially Turbomachinery! Congratulations Jerry!!

What's Inside

RMS IMPORTANT NUMBERS

HOUSTON SALES OFFICE:
Kurt Diekroeger
281-340-8520 (O)
713-898-1015 (C)

TENNESSEE SALES OFFICE:
Mike Spangler
865-981-9831 (O)
484-896-8438 (C)

LOUISIANA SALES OFFICE:
Remus Creel
225-291-4974 (O)
225-939-4680 (C)

RULES OF THUMB - TURBOMACHINERY

By Neal Wikert

GENERATOR

The generator is designed to give many years of reliable service with a minimum of attention. Trouble-free operation cannot be expected if proper maintenance is postponed or neglected. Provide proper maintenance on the equipment. Follow instructions given in the generator instruction manual. Be certain personnel review, understand, and follow these procedures during periodic maintenance inspections. Below is a typical maintenance checklist, which should be performed regularly.

CHECKLIST

- Verify that the generator is clean and verify that stator and rotor ventilation passages are unobstructed.
- Check for excessive loading or service factor.
- Verify winding temperature rise is not in excess of rated value.
- Verify insulation resistance is above recommended minimum.
- Verify voltage and frequency variation.
- Check air gap
- Verify that bearing temperatures are within limits and lubricant is clean and proper level maintained.
- Verify no unusual vibration or noise exists.
- Check alignment.
- Check for proper lubrication.

A definite schedule of preventive maintenance inspections should be established to avoid breakdown, serious damage and extensive downtime. The schedule will depend on operating conditions and experience with similar equipment. It is essential that complete records be kept for each generator including description and rating, maintenance schedule and repairs required are carried out.

CONGRATULATIONS EVA DIAZ & DIRK PARASCHOS

We are pleased to announce the promotion of Eva Diaz to Senior Accountant at RMS. Eva joined our team two years ago. While working full-time she pursued her degree in Accounting, she worked very hard which lead to her promotion to Staff Accountant in 2012.

Eva continued her hard work both at RMS and recently completed her Accounting Degree at DeSales earning her Bachelors in Accounting / Finance. We all wish Eva the best of luck in her new position!

We are pleased to announce the promotion of Dirk Paraschos to Manager - Project Management. Dirk is no stranger to the Turbomachinery field! With thirty three years experience in International Onshore and Offshore Refining and Petro-Chemical Industry, he joined us in December of 2012 . Dirk dove right into managing the various projects at RMS and strengthening the Project Management team.

Our customers have been very pleased with Dirk and his team in keeping them informed of their project's process and meeting delivery dates.

We all at RMS would like to congratulate Dirk for continuing to do an outstanding job!!

STEAM TURBINES LOSSES

By Scott MacFarlane

Steam turbines are far from 100% efficient in converting steam into mechanical power. Most industrial turbines have a flange to flange efficiency of about 55% to 75%. When we calculate turbine efficiency we look at the amount of available energy in the steam that has been converted to useful work. The margin between a maximum attainable efficiency of approximately 80% and a 55% to 75% efficient steam turbine is found mostly in the losses along the steam's flow path. These losses can be categorized into four main types of losses; leakage, friction, moisture, and particle.

Leakage is any flow that escapes travel through the blading. For example, steam seeping through clearances and gaps between the rotating and stationary components. An example of leakage is found when steam passes through the seals on wheels and diaphragms. The loss through each stage is directly proportional to the mass flow of the steam. This leakage from the steam not passing through the vanes is a direct loss of efficiency in the machine. Frictional losses occur when the steam comes into contact with any surface between the inlet and exhaust. The density of the steam is significantly higher at the inlet compared to the exhaust, which causes more frictional losses. Since the rotor is completely surrounded by the steam, the surface roughness of any component in the turbine casing directly impacts the steams energy. Substantial friction between the steam and any of these surfaces may result in windage or turbulence which will affect the steam's flow direction.

Moisture occurs in condensing turbines when the temperature of the steam drops below the saturation line. Moisture loss occurs when the condensed moisture passes through the vanes and affects the moving blades as the temperature of the steam drops. Since the moisture is moving at a much slower rate than the blades, contact with the moisture droplets impedes the motion of the rotor.

Particle loss is a function of steam purity. Steam purity can be categorized as either inert or reactive. Inert describes a contaminant that causes deposit to form whereas reactive describes a corrosion causing contaminant. All solid contaminants produce steam path deposits which roughen steam passage walls and reduce flow areas. An example of damage that can occur from these contaminants is stress corrosion cracking. When any damage or build up occurs on the rotor's surface, each of the previously mentioned losses will increase.

BAPTISM BY FIRE

By Joan Berg

I joined RMS as a Project Manager the end of January this year. Talk about baptism by fire! So many projects on the books and so many coming in! It's been a very busy and very exciting time at RMS. We have inspections, repairs, new designs, emergency breakdowns and turnarounds to coordinate. The shop is jam packed with work. What I've learned quickly is that in order for the jobs to come in and go out the door, it takes everyone in RMS to make it happen; from Sales, to Engineering, to Drafting, to Purchasing, to Administration, to the Shop.

We just recently shipped a repaired 6 stage Steam Turbine in a 9 week timeframe. The rotor came to our site after a failure in the field. The bearings were torn up and there was slight damage to the shaft. Rather then just replace the bearings, we performed a rotor dynamic analysis and upgraded and improved the bearings. We also reworked the damaged shaft, designed a new thrust collar, gear wheel, and probe mounting bracket. We reverse engineered and machined 7 new steam seals, 3 oil deflectors and even inspected and repaired 6 diaphragms. Phew! A ton of work in a short amount of time.

It was a team effort. We were able to help the customer get their "new and improved" rotor back into service by working together. We worked closely with the customer to understand what they needed, communicated the message to all departments, had the support of our vendors and successfully delivered the final product. What a great introduction to RMS business. I'm looking forward to many more projects like this.

EMERGENCY REPAIR OF A DR E-138 FCC EXPANDER

By Don Shafer

Rotating Machinery Services was called to respond to an emergency shutdown of an E-138 Expander in Corpus Christi, Texas in October 2012. RMS sent a team of experts to site immediately to aid in the initial failure investigation as the machine was being disassembled. The evaluation showed a blade failure had occurred and RMS was contracted to perform a Root Cause Failure Analysis on the failed components. RMS was then contracted to provide a new Integral Stator Shroud and Low Erosion Rotor Blades to replace the failed existing components. All of RCA analysis results were used to ensure that the new components that were being produced would not be susceptible to the prior failure modes. RMS was also responsible for restoring the existing casings and components in preparation for reassembly of the unit. RMS was able to provide much shorter deliveries on these key components due the fact that a set of castings for the rotor blades was in RMS inventory and the stator vane casting program had just produced another set of castings for another customer. RMS Purchasing was able find forging suppliers to provide aggressive deliveries for the integral stator shroud inner and outer rings. A March 2013 delivery was predicted based on this and with no unexpected discoveries of the components to be inspected and repaired.

RMS executed the design and manufacture of the new components to support this schedule. During the inspection of the used parts that were to be repaired, some of the casings and the seal housing were found to be in very poor condition. A repair plan was developed and executed to restore these components for one more operating campaign. The amount of repair and rework did extend the actual delivery by 5 weeks, with RMS meeting the adjusted delivery date to have the rebuilt unit back at site for a June 2013 installation.

This project was a prime example of how RMS experience can react quickly to the customer's needs and work to get their equipment repaired and suitable for service in the most efficient manner without compromising quality. It also shows that with teamwork between all the disciplines within RMS along with working closely with the customer these types of aggressive deliveries can be accomplished. This was not a site that RMS had supported in the past for their power recovery train. With the successful execution of this project, we hope to be their preferred supplier to support the entire power recovery train in the future.

NEW EMPLOYEE—RMS POWER SOLUTIONS

By Kathy Ehasz

Paul Poels—Lead Field Service Technician

Paul has 30+ years in the turbomachinery industry starting with Ingersoll-Rand Turbo division in 1981. His work has taken him around the globe as a field service technical advisor, as offshore projects manager for Dresser-Rand in Mexico, and Construction Manager for EPC projects in Mexico. Paul worked with Conmec for nearly eight years from 1992 to 1999 and most recently, he came from Elliott Company where he had worked again as a field service technical advisor.

This August, after three years of online study, he will complete his bachelor's degree in business with a concentration in project management. We all at RMS are happy to have him as part of the team!!

QUALITY CONTROL

By Robert DeHart ASQ CQT

Phase I Inspection processes – customer supplied machine components

Example – Expander Nosecone

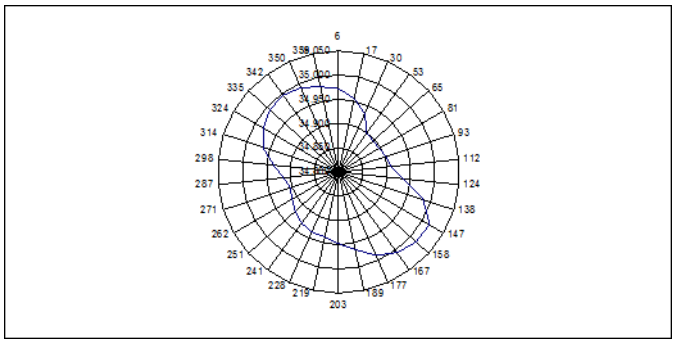
After complete disassembly, the nosecone's fits and machined surfaces are masked in preparation for abrasive cleaning. Cleaning is followed by visual inspection and non-destructive testing. All observations are documented.

The next step in the process is dimensional inspection. Often, after extended periods of service, machine components are worn and misshapen. An accurate characterization of their condition must be obtained in order to determine their suitability for service.

Using the Portable CMM running Polyworks software, datum features needed to create a co-ordinate system; a plane, a circle and a vector are selected and measured. Variation in the points of the datum plane relative to the best fit Z plane is a measure of the flatness of the surface. The data can also be used to determine the parallelism of the datum plane to other planar surfaces. A best fit circle is fitted to the datum diameter's measured points. From this data, the CMM software establishes the center of the coordinate system and determines the roundness of the points of the measured diameter or the radial distance between the maximum inscribed and the minimum circumscribed circles. The datum vector is used to establish the 'clocking' orientation of the co-ordinate system i.e. the direction of the x axis relative a chosen part feature.

Macro routines are generated to streamline and automate the data acquisition and reporting processes. A polyworks macro routine extracts the point data from the circles and planes and exports it as a text file into a temporary folder. From there it is picked up by an excel macro that transposes the xyz cartesian coordinates into polar coordinates. The macro calculates the min, max and TIR values and then plots the result as a chart describing the shape of the measured feature.

Dia c1	TIR = .120, angle max = 150 deg	Diameter 69.888 +.005/-.000 checks 69.900. True Position -A- = .008



All acquired results, visual inspection, non-destructive testing and dimensional inspection are compiled into a report for presentation to the customer.

RMS RAPIDLY GAINING REPUTATION AS THE GO-TO COMPANY FOR EMERGENCY BREAKDOWNS

By Robert J Klova, PE

In the past 6 months, RMS has been called on five (5) times to help our customers get their equipment back on-line in the shortest possible timeframe, after unplanned, emergency breakdowns. We are gaining a reputation in the industry as the company users can count on to quickly get their rubbed, cracked, twisted and broken metal back into a condition where it can once again reliably make power or compress gasses.

Equipment	Industry	T/A Time	Failure	Workscope
FCC Expander	Oil Refinery	5 Months	Disk failure	Field service, field machining, numerous new components, including new casings, casing repairs, shop and field reassembly, failure analysis
Axial Compressor	Oil Refinery	10 Days	Blade failure	Field service – rotor replacement
Power Turbine	Gas Pipeline	4 Weeks	Shaft damage	Field service, rotor overhaul, casing repairs, field welding and machining, new seals and hardware
FCC Expander	Oil Refinery	7 Months	Blade failure	Field service, casing repairs, numerous new components, including rotor blades, and an integral stator/shroud, shop and field reassembly, failure analysis
Steam Turbine	Oil Refinery	9 Weeks	Thrust bearing failure	Field Service, rotor overhaul, diaphragm repairs, rotor dynamics analysis, redesigned bearings, new seals

Why are customers selecting RMS for this critical work with significant lost production and revenue on the line?

Because RMS is truly unique in the industry in being able to focus all of the following factors and resources on an emergency breakdown:

Immediate Response: providing needed field support, ranging from supervision to full crews.

Experienced Engineer to Site: an expert on the failed equipment to assess damage, generate a repair plan, and initiate a failure analysis.

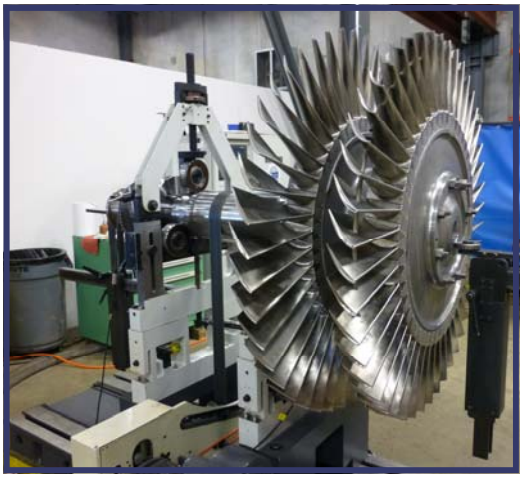
Shop Capabilities: fully equipped service shop, capable of providing 24/7 support.

Rapid Parts Supply: the engineering staff, purchasing, and manufacturing resources to quickly engineer and re-manufacture damaged components.

Repair Experience: repairs engineered to return components to a functional reliable condition.

Failure Analysis Experience: to determine the cause of failure, and recommend changes to prevent recurrence. Experienced engineers backed by structural and metallurgical specialists.

Aftermarket Focus: all of our resources and talent are focused on the aftermarket, ready to serve in the event of an emergency.



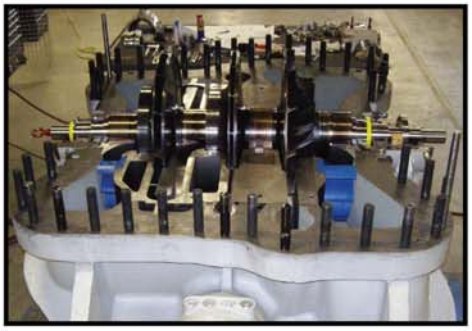
Because of our unique capabilities, in every breakdown listed above, our customers' critical equipment was returned to a reliable state, often with improvements, suitable for long term operation.

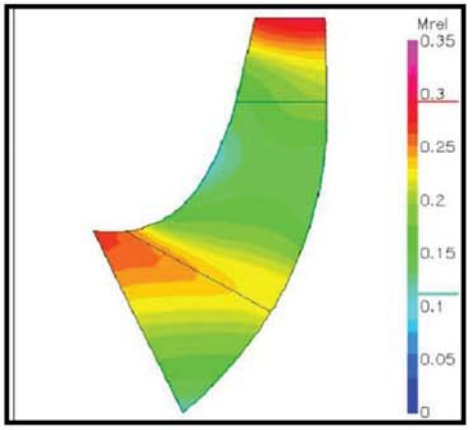
Centrifugal Compressors

Rotating Machinery Services is backed by decades of experience in Centrifugal Compressor design, analysis, manufacture and service. Our Key staff averages over 25 years experience.

Rotating Machinery Services is available to our customers 24 hours, 7 days a week. Visit our web site at www.RotatingMachinery.com to view all our capabilities.





- *Rerates for increased performance*
- *Redesigns for improved reliability*
- *Surplus compressor trains*
- *Rotor overhauls & balancing*
- *Replacement impellers*
- *High Performance seal retrofits*
- *Troubleshooting & failure analysis*
- *Compressor overhauls*
- *Bearing upgrades*
- *Replacement parts*
- *Impeller & shaft repairs*
- *Turnaround support*
- *Engineering analysis*

ROTATING MACHINERY SERVICES, INC.
2760 Baglyos Circle, Bethlehem, Pa 18020 • Main Office: 484-821-0702
Sales Offices: Houston - 281-340-8520 • Tennessee - 865-981-9831

HOW FIT IS YOUR CURVE FIT?

By William Sullivan

Recently, I was fitting thermal expansion vs. temperature data with polynomial equations for use in finite element analysis. Although lower order polynomials would have been sufficient, I tried some higher order equations to get the "perfect" fit based on the correlation coefficient. Since I was using a spreadsheet plot for the curve fits, a plot of the resulting function appeared immediately.

Figure 1 is a plot of the 5th order polynomial fit. Pretty good fit – right down the middle. Figure 2 is a plot of the 6th order polynomial fit. What the heck is that? Figure 3 is a plot of the 6th order polynomial fit with an expanded Y axis. Obviously, using the coefficients from the 6th order fit would not yield the desired results, yet, as seen in Table 1, the 6th order fit yielded the highest correlation coefficient.

If I wasn't using a sophisticated plotting package to generate the coefficients, I most likely would not have seen the actual plotted function until later; possibly not until I tried to make some predictions using the coefficients. Actually, I suspect this happens more often than we realize.

Several years ago, we were reviewing a collection of macros that could be added to spreadsheets to help predict centrifugal compressor performance. Included in the package were various correction curves for estimating performance during off-design operation. In the process of testing the spreadsheet, we noticed that on some occasions the predicted results seemed to be at odds with expectations, and sometimes, with common sense. Since I had considerable experience with scientific programming, starting with Fortran code in 1970, I decided to poke around in the macros myself.

One of the first things I noticed was that the correction curves consisted of coefficients for 4th degree polynomials. This raised a flag and I investigated further. The first thing I did was plot the correction data over a wide but reasonable flow range with enough points to see what the equations were producing. Most of the equations produced believable plots (we did not have the original correction data for comparisons). However, several of the plots clearly were incorrect. An example is shown in Figure 4.

Evidently, the original programmer performed a series of curve fits and loaded the resulting coefficients into the macros, or at best, checked the curves over a limited range. Had the programmer thoroughly checked the curves, he should have at least identified the flow range over which the curves could be used.

The lesson here is that before using any curve fit function (polynomial, power, logarithmic, etc.) always plot the function over the expected range at small enough intervals to verify that the function is producing reasonable results. Remember that the correlation coefficient, while a good general guide, only checks the function against the original data points. The correlation coefficient reveals nothing about what is happening between or beyond the original data points.

Of course, some plots are impossible to reproduce with any type of general mathematical function. To overcome this hurdle, we have been scanning complex plots into a CAD program and tracing the functions with short lines, thus creating points at close intervals, and, with appropriate scaling, using the coordinates of the line end points as data for linear interpolation routines.

Table 1
Correlation Coefficient for Various Fit Orders

Fit Order	Correlation Coefficient	Comment
1	0.57962	Linear
2	0.64071	Quadratic
3	0.64829	Cubic
4	0.64916	
5	0.64918	Figure 1
6	0.78951	Figures 2 & 3

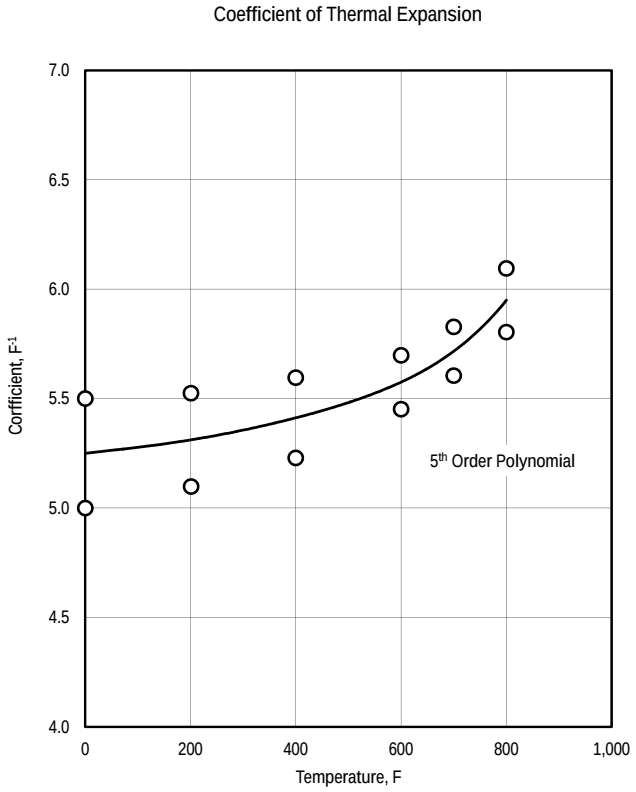


FIGURE 1

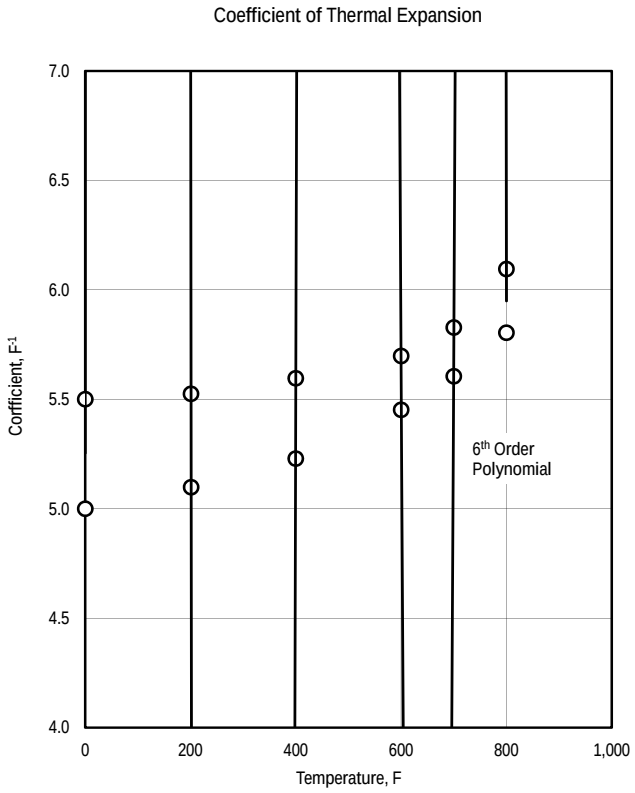


FIGURE 2

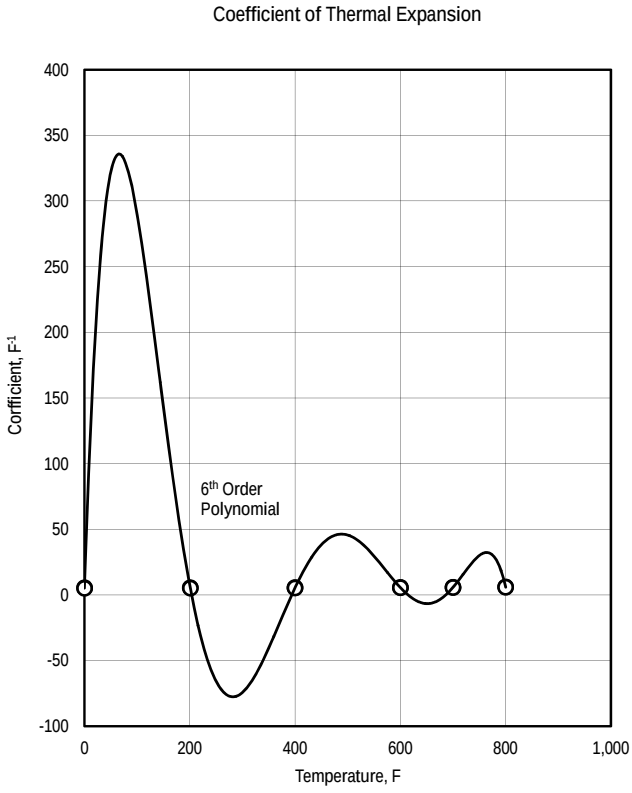


FIGURE 3

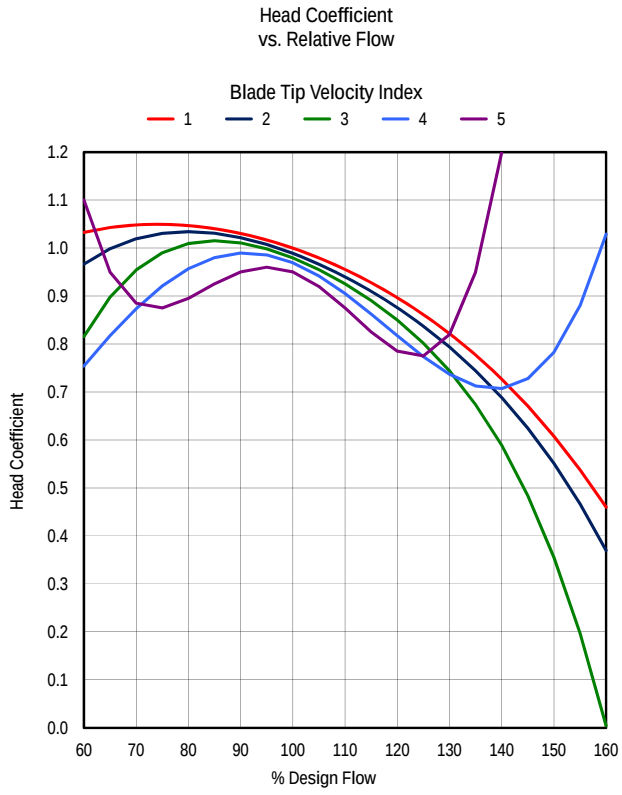


FIGURE 4

Rotating Machinery Services, Inc.

2760 Baglyos Circle
Bethlehem, PA 18020
Phone: 484-821-0702 / Fax: 484-821-0710
www.RotatingMachinery.com

Happy Birthday America!!

PRODUCT LINES

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

RMS POWER SOLUTIONS

By Chot Smith

The RMS Power Solutions Service Shop has been busy during this quarter upgrading the capabilities in the machine shop with the addition of three machine tools. We have purchased and are in the process of refurbishing and installing a 90 inch swing Bullard vertical boring mill, and a 36" Webster Bennett vertical boring mill. We have also purchased a second new Sharp knee mill which we expect to take delivery on within a week. We are currently in the process of reorganizing the shop to accommodate these new additions and relocating existing machine tools into work cells that create a more efficient work process flow on the shop floor.

These additions will enable RMS to keep our critical work in house to enhance delivery schedules and better support our growing customer base.

Webster Bennett

Bullard Dynatrol