ROTATING MACHINERY SERVICES, INC.

THE FINISH LINE

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Volume 2, Issue 2

June—December 2005

Inside this issue:

HAPPY HOLIDAYS

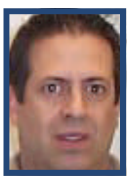
Letter from the President

2005 was another year of solid growth for Rotating Machinery Services. I want to take this opportunity to thank our customers for their continued loyalty and support, and thank our outstanding suppliers and our dedicated and talented staff for their contribution to RMS's success. The company's growth has allowed us to serve our customers on even larger and more complex projects. We are growing to meet these challenges by adding staff, expanding our facilities and adding sophisticated engineering and inspection technologies.

As RMS has grown, we have continually strived to maintain the same level of individual attention to our customers and their projects that we feel is so necessary to truly be of service to engineered turbomachinery users. We look forward to maintaining that approach in the new year, and will continue to work hard at helping our customers solve their turbomachinery problems and bring their machinery to higher levels of performance and reliability. I speak for all of us at RMS in wishing our customers and suppliers the very best in 2006.

Regards,
Robert J. Klova

RMS's Newest Addition



Frank Marrone, Jr.
Manager of Purchasing

Frank joined our staff in September 2005. He brings with him over 22 years of experience in Material management, procurement and production planning/scheduling. Fourteen of the last 22 years were spent specifically in the Turbomachinery industry. In his roll as manager of purchasing, Frank will be responsible for the continuous supplier development, supply chain performance management as well the progressive advancement and streamlining of RMS's procurement function. You can contact him at 908-859-8440 ext. 311. Email address- fmarrone@rotatingmachinery.com

Turbomachinery Symposium 2005

By Kurt Diekroeger

The Turbomachinery Laboratory at Texas A&M hosted another outstanding event, even with the added complexity associated with re-scheduling on such a short notice. We are thankful for all the effort that the Advisory Committee and the staff expended to ensure the 34th annual meeting took place.

As always, we had a great opportunity to spend quality time with old friends and to meet new ones.

We look forward to the 2006 Show!

Honorable Mentions

- ***Congratulations Sydney Gross!***

  Sydney has been promoted to the position of Product Manager—Steam Turbines. We would like to commend Sydney for his hard work and dedication to RMS.

- ***Congratulations Kurt Diekroeger!***

  Kurt has been awarded the 2004-2005 RMS Sales Award.

- ***Congratulations to RMS Staff & Management!***

  Their contributions to neighboring communities, outreach programs, blood donations, various other organizations and charities have touched many. They have given one of life's most precious gifts—**their time**.

Rule of Thumb - Lubricants, Sealants & O-Rings

By Neal Wikert

CAUTION: The use of proper lubricants, sealants and o'rings are critical to successful operation of equipment. Consult RMS prior to actual application.

Lubricants

Bolt Lubricants for High Temperature machines:

1. FEL-PRO Heavy Duty Anti Seize—used to be C-102
2. Milk of Magnesia is a good choice for high temperature fasteners.
3. Anti Seize—N—5000 Nuclear Grade—Nickel based

Sealants

Permatex "Ultra Blue" - Oil resistant RTV. Not high temperature.

Permatex Aviation Form-A-Gasket Sealant Liquid 3H—Gasket sealant, non-hardening, used on metal –to-metal joints, mainly bearing casing joints

Dow Corning 3120RTV, Red—Joint sealant for centrifugal compressors. Check temperature capability prior to use on equipment.

GE RTV60—High temp RTV. Uses a catalyst—Used on Axial Compressor horizontal splits. Can be used on LP steam turbine joints. Use of a primer is recommended for improved adhesion.

Turbo R—Joint sealant for steam Turbines horizontal joint.

Triple Boiled Linseed Oil—successfully used on steam turbine joints.

Tite-Seal—Joint sealant for steam turbines.

"Silver Seal—Some (limited experience/success on high temperature horizontal joints.

Temp-Tie—Steam turbine joint sealant. Comes in string form (sealed in can).

O-Ring Temperature limits

Description	Continuous high temp	Hardness Range (Shore A)	National Compound Prefix
Nitrile (BUNA-N)	257 deg. F.	40-90	B,C,D
Ethylene-Propylene	302 deg. F.	50-90	E
Neoprene	284 deg. F.	40-80	N
Fluorocarbon (Viton)	437 deg. F.	70-90	V
Silicone	482 deg. F.	40-80	S
Fluoro-Silicone	347 deg. F.	60-90	F
Styrene-Butadiene	212 deg. F.	40-80	Gs
Polyurethane	212 deg. F.	60-90	U
Butyl	212 deg. F.	50-70	J

Quote:

Choose a job you love, and you will never have to work a day in your life" -- Confucius

Steam Turbine Uprates, Performance Issues

By Sydney Gross

In the last issue, we examined two important mechanical components that would seriously limit the feasibility of the steam turbine rerate, the casing and the shaft. Assuming, you've put those hurdles behind you and plan to use both in your rerate, it would be useful to have an understanding of the internal changes to expect based on reasonable performance assumptions. When we talk about internal changes, we are referring to the stationary blading, or nozzles and diaphragms, and the rotating blading, often referred to as buckets in an impulse style turbine, which is our primary focus here. Before we get into the reasons for changing components, a little background is necessary.

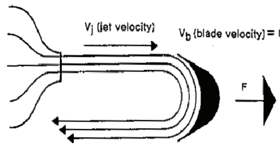
It would be useful at this point to understand how an Impulse turbine works on a basic level. Steam turbine designs are classified as either Impulse or Reaction depending on how the pressure drops occur through the steam path. If the turbine is designed so that the pressure drops occur predominantly across the stationary components, the turbine is an Impulse design. A Reaction turbine is designed so that pressure drops occur across both the stationary and rotating components. The term Impulse refers to the way in which work is derived from the steam jet, simply from the force of the steam jet being turned by the blading or buckets.

Do you have an Impulse turbine? Let's see. Visually distinguishing features of these two types of turbines can be seen in the rotor. Reaction turbines utilize a drum style rotor where the blades are mounted on a large diameter drum body. Impulse turbine rotors, on the other hand, have a disc-on-shaft design where the blades are mounted on thin discs, which may be mounted or integral to a relatively small diameter shaft. Other differences include sealing arrangements. Since the Impulse turbine has little or no pressure drop across the rotating blades, preventing steam from going around or over their tips is not nearly as critical to the performance as for the Reaction turbine. Therefore, there will almost always be tight clearance radial blade tip seals on a Reaction turbine and not on the Impulse turbine. There are other differences but that should be enough to go on for now. If you have an Impulse turbine, read on.

In Volume 1, Issue 1 of the RMS Newsletter, I said that the way to get more power out of the turbine was to put more steam through it. True enough. I also said that horsepower was roughly proportional to steam flow. Minor caveat here. The use of the word roughly refers to the turbine efficiency. The same turbine with the same inlet pressure and temperature and the same exhaust pressure will have different efficiencies for different steam flow rates. Fundamental to understanding how this pertains to the rerate of your turbine is understanding the Impulse Principle.

For a given set of steam conditions there is an optimum number of stages for your turbine based on rotational speed and wheel diameter. Why is that? Consider the figures to the right. Steam exits a nozzle or a diaphragm at the left side of each figure with a velocity of V_j and is turned by the concave surface of the rotor blade moving at a speed V_b.

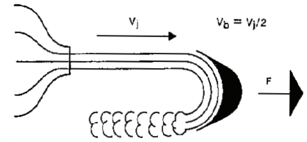
In the first figure, the rotor blade does not move (V_b = 0). The force on the blade is a maximum because the steam is experiencing maximum acceleration (subtract vectors to prove this), it has the same speed entering the rotor blade as it does exiting



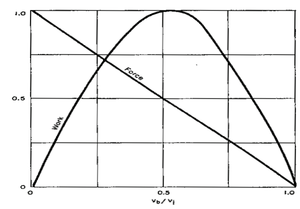
except in the opposite direction. Since the blade doesn't move, no work is being done and the steam jet has the same Kinetic Energy.

Although not shown, consider the other end of the spectrum where V_b is equal to V_j. The steam would never catch the rotor blade and no force would be imparted on it resulting in no work being done.

Now look at the figure top right. V_b is one half of V_j resulting in the steam exiting the rotor blade with zero velocity and hence, zero Kinetic Energy. This magic ratio of velocities, V_b/V_j=0.5, is the most efficient combination because it uses up all the Kinetic Energy of the steam. We refer to the ratio of V_b/V_i as the blade



velocity ratio and we use it to judge the efficiency of the turbine stages. It is shown graphically in the figure below.



If the rotational speed and wheel diameter of a stage are fixed, then V_b is also fixed. The only way to change our velocity ratio to get close to the magic ratio is by changing V_j. So how do we do that? The steam jet velocity is proportional to the stage energy drop. There is a total available energy between the inlet steam state and the exit steam pressure. We take that total energy and divide it up equally to yield a change in energy that gives us the right V_j.

The number that we divide the total energy by will be the number of stages.

So far, we haven't introduced flow rate into our calculations, just wheel speeds and steam states. The power requirement placed on the turbine by the driven equipment will dictate the steam flow rate. Our turbine stage flow path sizes will be designed to accommodate that flow while yielding the energy drop that we calculated above. Since the stage sizes, or areas, in our turbine are for the most part fixed, a change in the flow rate will change the distribution of energy drops across the stages and therefore change the stage efficiencies.

In the upcoming issues, we will see some of the equations used to do what we did above and go through an example of how to apply it to your turbine. But first we will need to understand steam a little better.

Brain Teasers!

1.	M&AR	4.	Lang4uage
2.	Go it it it it	5.	Either weigh or whey
3.	roforkad	6.	noon good

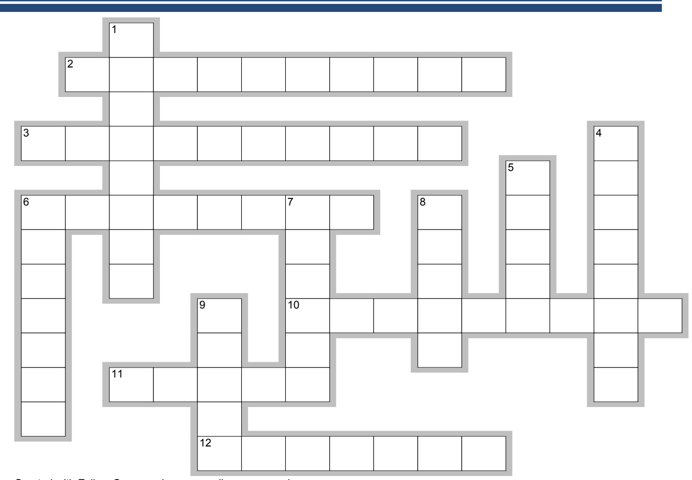
answers:

1. Mandarin orange
2. Go for it
3. Fork in road
4. Foreign Language
5. One way or another
6. Good Afternoon

Answers from Last issue's crossword puzzle:

Down		**Across**	
1. Solar	10. freezing	2. ebony	14. scape
4, Impulse	12. Kabul	3. paint	15. clearance
5. ERG	16. Earth	6. gas horsepower	17. ten
7. six	18. PI	11. scape	19. axially split
8. cosmos		13. bronze	20. curtis
			21. everything

Crossword Puzle: The World Around Us



Created with EclipseCrossword — www.eclipsecrossword.com

Answers in next issue

Down

1. Oil resistant RTV. Not high temperature. Also referred to as Ultra Blue
4. 1973 Superbowl Winner
5. President of Egypt; 1970-81
6. Capital of New Jersey
7. to prevent the formation of or remove stresses in plastics by cooling from a suitable temperature.
8. drill

Across

2. also called electrophotography
3. a pump, for compressing air, gas, etc.
6. Joint Sealant for steam turbines
10. device for changing rotary to back-and-forth motion
11. of or like an axis
12. tumult; commotion

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"Quality Service from Start to *Finish*"

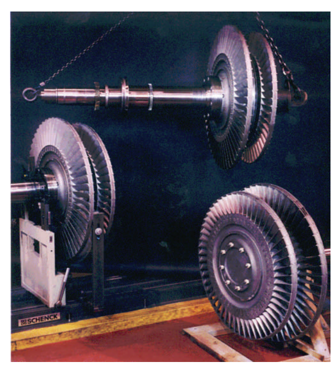
We're on the Web!

www.rotatingmachinery.com

If you would like to receive our newsletter via email, please contact Kathy Ehasz at 908-859-8440 or kehasz@rotatingmachinery.com.

Rotating Machinery Services, Inc. provides a wide range of turbomachinery engineering, rerate, overhaul and field services to users of compressors, steam turbines, expanders and gas turbines. ***RMS*** serves the refining, chemical, gas transmission, power generation and steel industries. ***RMS***' experience, expertise and knowledge of a wide range of rotating equipment provides our customers with assurance that their work will be performed by recognized experts in their field who care deeply about their work. It is this dedication to our customers that allows us to provide

"Quality Service from Start to *Finish*"



1998 - 2005

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YEARS OF EXCELLENCE

Rotating Machinery Services, Inc.