ROTATING MACHINERY SERVICES, INC.

VOLUME 4, ISSUE 1

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THE FINISH LINE

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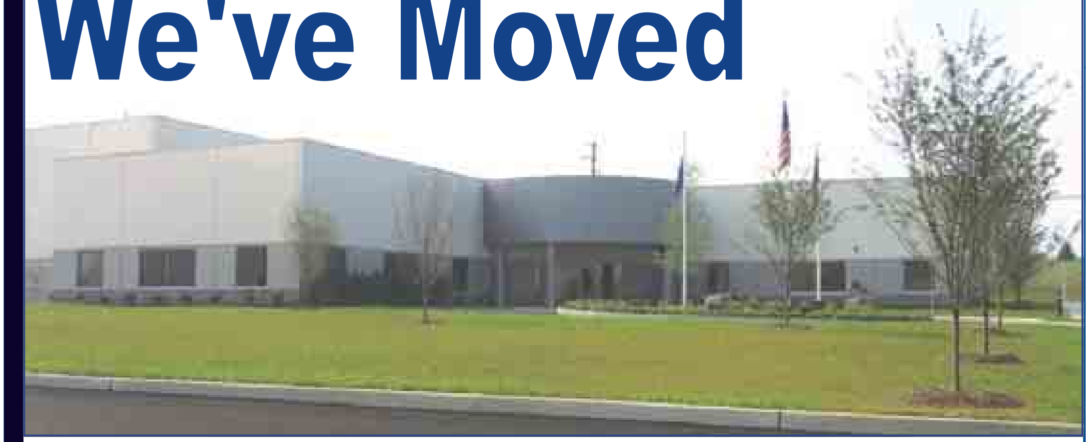
We've Moved



Rotating Machinery Services is excited to announce the opening of our new facility in Bethlehem, Pennsylvania. The 14,000 sq. ft. building is located on 3-1/2 acres in a corporate / industrial setting that is conveniently accessed by major highways and nearby airports. We are situated in the Lehigh Valley, less than two hours away from both Philadelphia and New York City.

Expanding into this new space allows us to better serve our customers by providing room for continued company growth, permitting RMS to increase our variety and level of services. Our new facility includes visiting customer office space, expanded meeting and manufacturing areas and in-house training facilities. Besides our new Pennsylvania location, Rotating Machinery Services will continue to maintain our sales office in the Houston area.

ROTATING MACHINERY SERVICES, INC.
2760 BAGLYOS CIRCLE
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What's Inside

2007 Tradeshows

RMS would like to thank all who stopped by to visit us at the following conferences.

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Vibration Institute
Western Turbine Users
GG4 Users Symposium
GMC 2006 Conference

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RMS would like to invite you to stop by and visit us at the

36th Turbomachinery Symposium
Houston, Texas

September 11—13

Booths
555 & 557

RULE OF THUMB - GENERAL

By Neal Wikert

COUPLING BLUING MINIMUM CONTACT

Hub to Shaft	75%
Gauge to Gauge Lapping to Lapping Gauge to Lapping	95%
Gauge to hub or shaft	85%

MATERIALS

Bearings

a. Babbitt is ASTM B23 grade (or Alloy) 2. This is tin based with some copper and antimony. For journal bearings in high-speed industrial-sized machinery, we use 7 mils thick babbitt on bronze back pads (for increased fatigue strength) and 25 mils on copper thrust pads. We normally use 1/16th inch babbitt thickness on steel pads (journal and thrust)

b. Bronze used for some sleeve bearings and some ball-and-socket tilt pads is a bearing grade bronze that is babbitted. Bronze is 50% more heat conductive than steel.

c. Copper (for thrust shoes) is 99% cu, 1% chrome (chrome added for stiffness and strength). This copper is 450% more heat conductive than steel. This upgrade alone (from steel to copper) can drop hot running thrust bearing temperatures as much as 35degF.

Casings	Material	Specification	
	250psig, 500 deg. F	cast iron	ASTM A-278 Cl. 40
	600psig, 750 deg. F	cast steel	ASTM A-216 WCB
	900psig, 825 deg. F	alloy cast steel	ASTM A-217 WC1
	900psig, 950 deg. F	alloy cast steel	ASTM A-217 WC6 (1¼ Cr, ½ Mo)
Rotors	Hot rolled	alloy steel	SAE 4140
	Forged	alloy steel	SAE 4340 (ASTM A291 or A668)
	Integral forged	alloy steel	ASTM A-470 Cl. 7

FASTENER REMOVAL

Nut removal: To remove hex nuts, heat one of the hex flats until red and break nut loose. On Allen head bolts, heat down in the Allen head and break loose. This heat effectively loosens the nut and gives room for corrodents to move.

Socket head cap-screw removal: Heat the head of the cap-screw until cherry red. Allow cap-screw to cool momentarily so that heat can soak down the threads. Turn to remove. Capscrew will loosen.

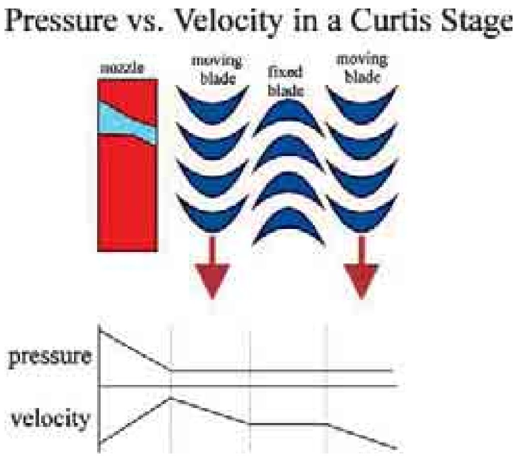
STEAM TURBINES - Curtis or Velocity Compounded Stage

By Sydney Gross

We calculated the number of stages for a hypothetical turbine using an impulse stage design called Rateau in the last issue. Recall that a Rateau stage is comprised of a single row of stationary and a single row of rotating blades and that almost all of the pressure drop occurs across the stationary row. Recall also that the ideal velocity ratio, V_b/V_j, is approximately .5 for that stage meaning the steam is traveling twice as fast as the blade when it enters the rotating row and has next to 0 speed when it leaves.

Frequently it is desirable or necessary to create a stage where the steam jet velocity is four or five times the rotor blade speed. For a conventional Rateau stage, this would mean that the steam exiting the rotor blades would still have considerable tangential velocity and therefore considerable kinetic energy that has not been converted to work.

However, if we install a second set of stationary vanes or reversing blades to turn the steam flow without reducing the pressure into a second set of rotor blades, we can make effective use of the remaining energy in the steam. We call this a velocity compounded or Curtis stage after its inventor, Charles Gordon Curtis, who patented the concept in 1896. To the right is a diagram of a Curtis stage and its pressure and velocity relationships across the blade passages.



It is distinguishable from the Rateau stage in that the rotating blades are most frequently mounted on a single wheel. And, rather than having a diaphragm or nozzle before the second row of rotating blades, the Curtis stage has what is often called a reversing segment with airfoils more closely resembling the rotating blades instead of the nozzle. The function of the reversing segment is to redirect the steam from the first row of rotor blades to the second without a change in pressure or speed.

While the approximate ideal velocity ratio for the Rateau stage is .5, the Curtis stage has an ideal velocity ratio of approximately .25 in order to leave us with next to 0 steam velocity after the second row of rotating blades.

There are a few reasons why a Curtis stage might be favored over a Rateau. As we will see shortly, one Curtis stage can do the work of several Rateau stages therefore reducing the overall size of the turbine and lowering initial cost. A Curtis stage is also used where wheel speed is low and a second row of blades is needed to remove the energy from the steam. Typical Curtis stage blade speeds are in the range of 450 to 650 feet/second while Rateau stages are typically 600 to 800 feet/second. Curtis stages are most commonly used in single stage machines where efficiency is not important and as control stages, or the first stage of the turbine followed by either Rateau or reaction stages.

Going back to our last discussion where we calculated the number of Rateau stages in a hypothetical turbine, we're going to see what happens if we use a Curtis stage of the same diameter, 21 inches, and speed, 7,000 rpm. Our blade speed is calculated in the same way to give us 641 feet/second. With an ideal Curtis stage velocity ratio of .25, we would want a steam velocity of 2,564 feet/second. Using our equation for calculating jet velocity from the Isentropic Enthalpy drop,

$$V_j \text{ (feet/second)} = 223.7 \times \sqrt{\Delta H_{is}}$$

we rearrange using the jet velocity of 2,564 feet/second to calculate an Isentropic Enthalpy drop of 131.4 Btu/lbm. As calculated previously, our total Isentropic Enthalpy drop across the entire turbine is 147.8 BTU/lbm. So we could replace almost four Rateau stages with a single Curtis stage for this application, theoretically.

As mentioned earlier, both Curtis and Rateau stages operate on the Impulse principle as opposed to reaction. In practice, there is some degree of reaction in all stages and it varies from the hub to the tip of the airfoil. With increasing degrees of reaction, sealing becomes more important in maintaining efficiency in a turbine. In the upcoming issue, we will be looking at the various sealing designs and applications in the steam turbine.

Rotating Machinery Services, Inc.

WE'VE MOVED!

PLEASE MAKE NOTE OF NEW ADDRESS, FAX & TELEPHONE NUMBERS

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"Quality Service from Start to *Finish*"

Editor: Kathy A. Ehasz

We're on the Web!

www.rotatingmachinery.com

If you would like to receive our newsletter via email, please contact Kathy Ehasz at 484-821-0702 or kehasz@rotatingmachinery.com.

PLEASE JOIN US!!

September 11—13, 2007

36th Turbomachinery Symposium

George Brown Convention Center
Houston, Texas
Booths 555 & 557

Let us show you:

- **How we can enhance your business**
- **Our Latest work**

Customer Service is our top priority

Engineering Excellence guaranteed!