ENERGY SAVINGS FOR SUCTION ROLLS

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DO YOU DRIVE YOUR CAR WITH ONE FOOT ON THE GAS AND ONE ON THE BRAKE? WHAT DOES THAT DO FOR GAS MILAGE?

YOUR SUCTION ROLL SEALS MAKE AN EXCELLENT BRAKE. HOW MUCH ENERGY CAN THAT WASTE? YOU MAY BE SURPRISED.

Do you drive with your foot on the brake?

Almost every paper machine has at least one suction roll, and some have as many as five, plus spares. They are a critical path element in the operation of the machine, and improper operation can significantly impact power consumption, and decrease the operating interval between changes.

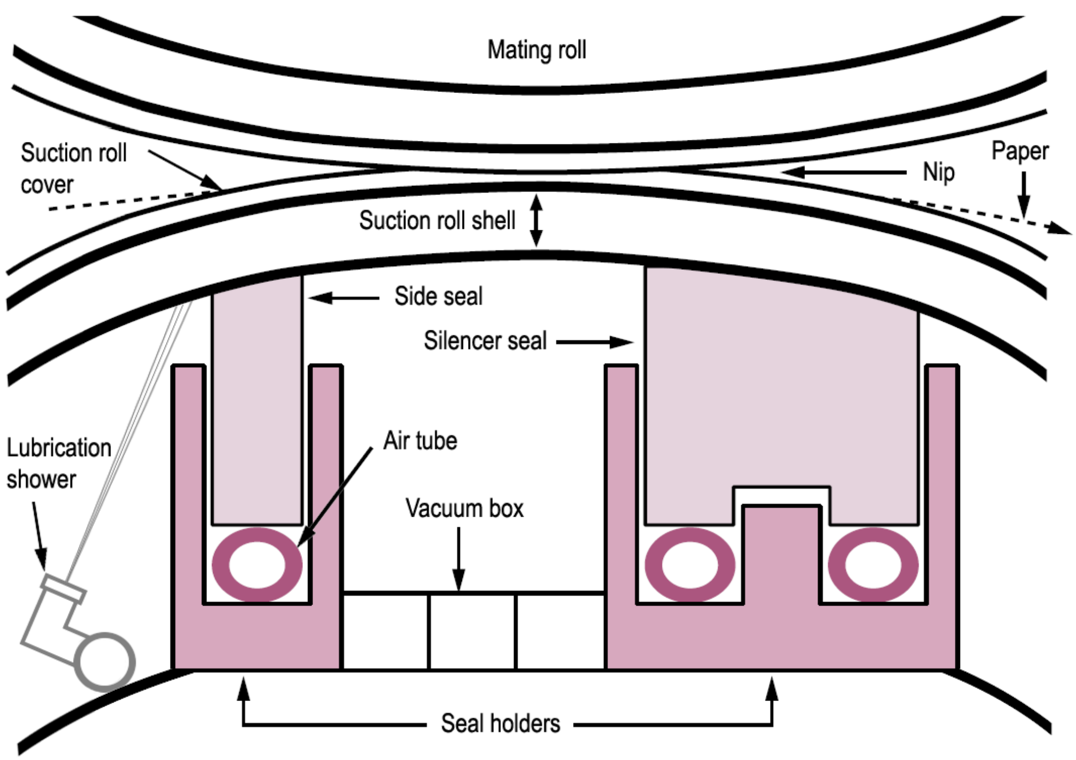

Figure 1 Typical suction roll seal configuration

A typical seal assembly is shown in Figure 1. In most modern designs, the side and silencer seals rest upon air tubes that lie under the seals in a U-shaped holder. The end deckles can be either fixed or resting on springs. The exact configuration depends on the manufacturer of the suction roll and the position.

Everyone understands what the seal is supposed to do – keep the vacuum from leaking. However, very few understand how the suction roll seal assembly is designed to work, and that is the source of much of the wasted power and shortened run times.

HISTORY and DESIGN

Wooden seals resting on springs were used in early suction rolls. Later rolls used seals of UHMW, asbestos, Micarta or Kevlar. The most common material today for modern high-speed machines is a rubber-graphite (RG) composite resting on a flexible tube instead of springs.

A common misconception is that the tube is there to "load" the seal into the shell, but the tubes are intended to be variable tension springs. The purpose of the springs in the original designs, and thus the tubes in more modern designs, is to let the seals or deckles depress away from the shell, not to lift the seals into the shell. If the seals and deckles can depress, then water can lubricate the seals and let them glide on the shell.

Water itself can seal the vacuum even if the seal is 0.5mm (0.020") below the shell. Therefore the pressure in the tubes is designed to be very light, 0.3 Bar or less (< 5 psi) in most rolls.

THE BRAKE

What happens if the tubes are pressurized enough to turn the seal assembly into a brake? Nothing is visible from the outside of the roll to indicate any problems. Only by comparing drive loads under various tube pressures while maintaining vacuum does the scale of the problem become apparent.

In testing done by a major suction roll OEM, the difference in power between running a 5 meter suction roll at 1.0 Bar pressure in the tubes, versus 0.3 Bar, was in excess of 100 amps! According to Fisher International, paper mills in the United States and Europe pay from $0.035 to $0.114 per kw-hr depending on the power source. 100 amps of wasted power costs between $25,000 to $65,000 per year on each roll.

NOT ME!

Some suction rolls cannot reach full vacuum at 0.3 Bar tube pressure. There are several explanations. Rolls that have had shells bored or honed have a much bigger gap to close, for example. The problem is not unique to older rolls. Even in new suction rolls there are manufacturing tolerances on the bore diameter and on the fabricated suction box, yet the seal height that is supposed to close the gap between the two is typically the same for a given OEM.

The most economical way to operate suction rolls with low air tube pressure while maintaining full vacuum is to have the seals custom fit to the roll, often by adjusting their height.

Large multi-zone suction box with classic RG seals, deckles and tubes.

Most OEM's and some seal suppliers will provide the custom fitting service for a nominal charge. It typically consists of taking exact measurements of the suction box and the shell I/D, and calculating how tall the seals should be to assure full vacuum at the lowest possible air tube pressure. When properly done, the seals should just lightly touch the shell, or be up to 0.020" (0.5 mm) clear of the shell with no pressure in the tubes. Vacuum is often possible with no pressure in the tubes, especially with certain roll designs. Always use the lightest pressure possible.

LUBRICATION

Lubrication is essential for the sealing assembly to work. The lubricant is typically a combination of white water and fresh water. Lubrication should be provided through showers located just before the lead-in seal with nozzles directed to hit the shell just before the seal. Lubrication is also provided by white water trapped in the holes of the shell as it passes over the vacuum zone. In higher speed machines showers are installed inside the vacuum zone to lubricate intermediate seals between vacuum zones and the silencer seals. It is very common for showers to be in the wrong place, or pointed in the wrong direction, and this should be checked at maintenance intervals. Many mills today use filtered white water in the suction roll showers to reduce the amount of fresh water consumption.

Most seal materials contain some form of lubricating agent as well, from graphite to PTFE to silicone oil. These agents help lubricate the seal during brief intervals of dry contact with the shell, but none has significantly changed the need for water as the primary lubricant.

MORE POWER SAVINGS

The effects of lubrication can be dramatic when it comes to power consumption. In a US mill that had consistently short seal life in a suction couch position, lubrication showers were added, and their seal vendor custom fit the seals to the roll. They saw an immediate effect. Seal life extended beyond the one-year interval they sought, and the drive load on the couch roll dropped 125 amps from the reduced braking effect. Correspondingly the load on the wire turning roll was reduced by 100 amps. The showers paid for themselves in a matter of weeks.

Another recent innovation that impacts power is the advent of flexible RG seals. By 2007 it is clear that flexible RG seals are lasting longer than the classic rigid RG that has dominated the world market for twenty years.

Classic RG seals are extremely hard (75 Shore D) and extremely brittle and easy to break in shipment and in handling, but typically run very well in most rolls. A wear pattern in the shape of a smile is

New flexible rubber graphite being installed typically observed, with more wear in the middle than on the ends.

The flexible RG seals were originally developed to help solve the breakage and shipment issues. It was only after they were observed wearing far less than the classic RG in the same conditions that the operational improvement was understood.

The binder in classic RG does not conduct heat very well. If heat is applied to the top of the material, a temperature gradient will exist between the top and bottom for some time as the heat slowly moves through it. The material tries to expand from applied heat, but this temperature gradient limits the expansion of the bottom relative to the top causing the material to bend upwards toward the source of the heat.

In a suction roll during start-up the top of the seal contacts the shell as everything expands, and this contact generates localized friction heat. The seal grows toward the heat, thus into the shell, favoring more contact, heat, wear, and the familiar smile shaped wear pattern emerges. After an hour of operation the roll and seal reach thermal equilibrium, lubrication finds the voids, and the classic RG runs on, but already very worn.

The new flexible RG is simply too limber to lift its own weight from thermal expansion. Placed side by side with similar heat applied to the surface of classic and flexible RG, the classic variety was observed to raise 5 mm (0.200") from a flat surface, while the flexible laid still. This lack of "thermal bowing" at start-up by the flexible RG has significantly reduced the amount of contact the seal has with the shell, greatly extending the seal life. Lack of contact also means no drag load and less power consumption. All RG has a low coefficient of friction, but the best coefficient of friction is the near zero contact these flexible RG seals provide.

SUMMARY OPERATING TIPS

Reduce power consumption and extend run times with a few simple steps:

- Monitor the tube pressure closely and keep it below 0.3 Bar.
- Have the seals custom fit to the roll.
- Operate, aim, and maintain the lubricating shower.
- Use the flexible rubber-graphite. It offers significant advantages and is typically the same price as the classic RG material.

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