How to save energy up to 30–70% in paper machine vacuum system?

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INTRODUCTION:

Today, every mill is looking for ways to save energy – not only to cut down costs but also to reduce its carbon footprint. We at Runtech Systems are happy to share with you some tips how to do it.

Say yes to lower energy consumption and costs

Using vacuum in various paper machine positions is expensive. In fact, vacuum is one of the top three energy consumers in a paper mill. By using vacuum only in the most critical positions, you can fully benefit from a more efficient nip dewatering strategy and save energy. And by measuring the water flow online accurately enables you to optimize vacuum levels and not overdo them.

Heat recovery provides another excellent way to save energy. Using recovered heat instead of primary energy sources, for example, to warm up shower waters or dryer hoods allows you to expect major cost savings.

By optimizing your papermaking process, you can save energy up to 30-70% in vacuum system as well as improve runnability and paper quality.

Ensure optimal operation of your vacuum system

There is vast potential for energy savings in vacuum systems, as many paper machines suffer from poor energy efficiency. Some machines would benefit from a complete system rebuild. But in other cases, the required modifications can be relatively small compared to the savings gained. One often overlooked factor lowering efficiency can be the lack of maintenance.

The benefits of regular and correctly timed vacuum system maintenance are obvious. When properly maintained, the operational efficiency of the vacuum system is kept at an optimum level, and unexpected shutdowns are avoided. It is important to also service the auxiliary equipment.

The cost of energy used by a vacuum system over its lifetime exceeds its purchase price many times over. This means that working at the optimum settings of a vacuum system is one of the most important economic factors in mill operation. If left untouched over long periods, the availability and efficiency of a system will decrease, and operating costs will inevitably increase.

By maintaining your vacuum system, you can keep efficiency at an optimal level and secure the stable operation of your papermaking line.

Switch to an EP Turbo Blower

Did you know that the EP Turbo Blower is at least 15-30% more efficient than a new liquid ring pump (LRP)? And as a LRP wears down, this difference grows. In typical rebuild projects, 40-60% energy savings have been achieved.

Process optimization and lower energy consumption start with the EP Turbo Blower. This completely water-free vacuum solution offers significant heat recovery potential for paper, board and tissue machines. Mills have reported that vacuum system optimization with variable speed and capacity turbo blowers have saved them up to 2,000 kW.

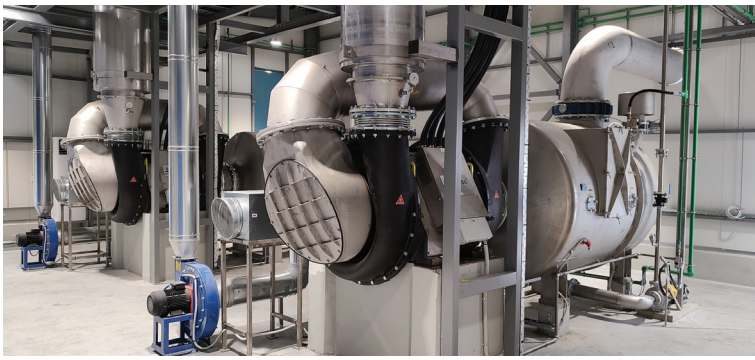

Figure 1: RunEco EP Turbo Blowers are modern blowers with integrated high-speed motor controlled by a frequency converter: rotation speed and vacuum level can be adjusted according to the process requirements.

A typical Runtech RunEco vacuum system consists of several smaller size turbo blowers giving clear design and operational advantages over the competition. In addition, as the only company in the world we also offer liquid ring pump technology to form a combination of both technologies – a hybrid system. With this portfolio, we can always find a perfect fit for our customers' demands, needs and budget.

Quite often a situation has been observed where a single, or a few low air flow consumers (devices) are operating at high vacuum levels, such as a high vac box or a press suction roll high vacuum zone, while the rest use a considerably lower vacuum level. This leads to a situation where the most economical option is to continue the use of the existing LRP. Fully rebuilding a system with blower technology is not always the most efficient solution, especially if this means that different vacuum levels need to be combined in one blower. It is proven that a well maintained LRP operating at low speed to produce high vacuum level can perform at a good efficiency level outperforming systems where a large single blower experiences considerable expansion losses.

For example (see picture 2), a paper machine often has multiple vacuum consumers and vacuum levels. By combining all these together to a single large unit you inherently introduce losses and lower your system's efficiency. As is evident in this case, only one consumer can operate at the blower vacuum and all the others need throttling control that lead to significant energy losses. In addition, as air is a compressible medium which changes volume significantly with the surrounding pressure, a single large unit will experience expansion losses.

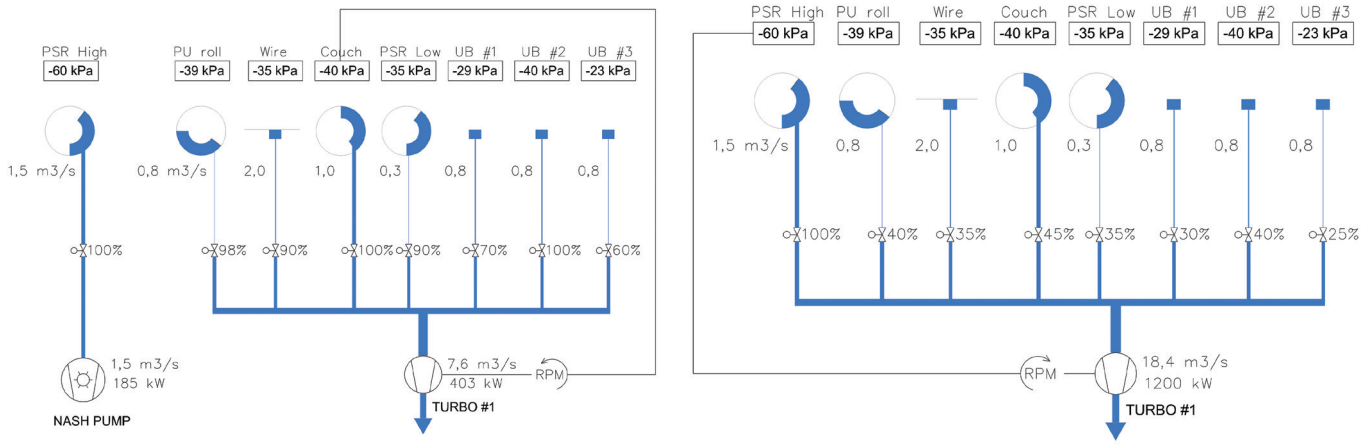

Figure 2a & 2b: Combining all vacuum consumers with different vacuum levels to one unit can destroy system efficiency due to expansion/throttling losses.

Old system	kW	New system	kW	Savings
LRP x 9		LRP x 1		
		EP400-700-D1		
		EP500-700-S x 2		
Total	2,150	Total	1,150	**1000 kW**
				47%

Old system	kW	New system	kW	Savings
LRP x 14		LRP x 1		
Blower		EP600-T1		
		EP600-HF1		
Total	2,150	Total	700-800	**≥ 1,350 kW**
				≥ 67%

Figure 3a & 3b: In these rebuild cases, existing liquid ring pump or pumps are compared to a hybrid system to find an optimal balance between investment and operating costs. A containerboard machine achieved even higher energy savings than expected. The start-up was very smooth and provided instant savings with a flexible vacuum system that provided good vacuum control to the mill. In addition, water savings were significant. On a fine paper machine, eight liquid ring pumps were replaced with three EP Turbo Blowers, and an LRP remained to provide vacuum for high vacuum consumers. The rebuild provided energy savings of 1,000 kW, dropping the specific energy consumption to 24 kWh/t, with Turbo Blower exhaust air also saving one ton of steam per hour. In addition, a cooling water tower was stopped, bringing the mill substantial water savings.

The airflow from a lower vacuum level (higher abs. p) expands over the valve to a higher vacuum level (lower abs. p) at the blower/header and thus the actual airflow seen by the equipment can be doubled or even tripled. An often seen vacuum level difference of e.g. 20 kPa (-60 kPa vs. -40 kPa) between two consumers at the machine can lead to a 100% increase in the air volume through expansion and thus naturally lead to a large increase in the blower's energy consumption.

To improve efficiency, vacuum connections, vacuum levels and system operation need to be surveyed thoroughly for each case. Based on customer needs and targets, as well investment payback, in some cases, given the results of this audit, the decision to go forward with a hybrid vacuum system gives the biggest bang for the buck.

However, to save energy maximally up to 30-70% takes more than just switching over from LRP's to turbo blowers. You need other optimization measures, too. Read on to find out what they are.

Measure water flow to optimize vacuum levels

To save energy, it is essential to use the optimal vacuum level in the forming and press sections. Often paper mills use too high vacuum levels because they do not know the accurate water flow.

The primary function of a wire- and press section in a paper machine is to remove water from the paper sheet. In order to understand the effectiveness of individual elements (such as save-all pans and suction boxes) of a wire- and press section, the dewatering rate must be measured. Without this, critical air flow (i.e. vacuum level) review and consequent optimization cannot be successfully carried out. Water removed from the paper sheet contains air, and is often subject to foaming. Traditional magnetic liquid flow meters demand a homogenous flow and will not be able to provide accurate data. Runtech's Ecoflow dewatering meters are designed to measure water flow across a mechanical restriction and are not sensitive to entrained air or foaming. These devices are used both under vacuum (in a separator drop leg) and in atmospheric conditions.

EcoFlow dewatering measurement system optimizes dewatering and vacuum levels in the forming and press sections. EcoFlow provides maximized sheet dryness after the press section, improved machine runnability and maximum energy efficiency, while providing papermakers with accurate real-time feedback about the dewatering performance along the paper machine.

Go for nip dewatering

EcoFlows are designed to work with doctoring to gain maximum energy efficiency. Dewatering and doctoring are not only related to energy consumption, but they also have big effect on whole machine runnability, efficiency and profitability, as well as the paper profiles. A well-designed and operated dewatering and doctoring system is one of the key issues to a well-performing and energy-efficient machine. A lot a paper machines have them but they are not effective and do not have the adjustability that is needed to optimize them effectively. In order to get the full benefits from

Figure 4: EcoFlow is the only reliable and accurate online dewatering measurement system for water that contains lot of air. When you measure the water flow accurately, you can adjust the vacuum optimally and reach high energy efficiency.

Figure 5: A well-designed and operated dewatering and doctoring system is one of the key issues to a well-performing and energy-efficient machine.

Figure 6: Heat recovery, as an important part of the RunEco solution, cuts down papermaking energy costs radically because the system reuses heat to replace primary energy sources

increased dewatering, an online dewatering monitoring, efficient water discharge and rewet prevention are necessary. Runtech Ecoflow, save-alls and double doctors can perfectly match these needs.

There are some additional ways to ensure optimal vacuum levels and thus save energy. By using nip dewatering instead of uhle box dewatering, you get better profiles and improve dewatering without vacuum.

Here are some things to pay attention to:

- Felt moisture ratio has to be high enough.
- You need to have right type of felts.
- Roll covers need to have grooves instead of blind drillings.
- Well-functioning save-alls and doctors are a must to prevent rewetting. A doctor rebuild can reduce the need for vacuum by up to 50%.
- AirBlades are suitable for lower machine speeds.

Optimized doctoring and dewatering improve process performance and dryness after press, lowering the need for steam (1% dryness means 4% steam savings). This, in turn, results in electrical and steam energy savings.

Recover and reuse exhaust heat

The EP Turbo blower produces approximately from 5 to 20 m^3 of exhaust heat per second. By recovering this 100–180°C heat, you will be able to lower steam consumption at your paper machine. Recovered exhaust heat can be used, for example, to warm up shower waters or dryer hoods.

Since steam is one of the most expensive components in papermaking, heat recovery will lead to significant cost savings. Reusing exhaust heat boosts sustainability, too. Replacing primary energy sources by heat recovery reduces your carbon footprint as in many places steam is produced by combusting fossil fuels that cause CO_2 emissions.

Take a look at these energy savings

- Uhle box vacuum: 15 kW/meter
- Drive power (uhle box friction): 7 kW/meter
- Increase in dryness (after press) 1-2% equals to 4-8% less steam
- At least 25%, typically 40- 60% electrical savings compared to LRP system
- Heat recovery energy savings rate: 80-200% of turbo system total power demand
- Water and cooling tower cost savings: 100,000 EUR/ year
- Easy and fast maintenance of turbo blowers. Bearing exchange during felt change (8h). All maintenance can be done on site.

On average 2MW LRP system produces 3,500 tons of CO2 annually. With Runtech turbo rebuild you will also save 30-70% of these emissions.

Discover the potential of your machine

Vacuum demand varies for different paper grades, felts and machine speeds, therefore, a tailor-made solution with flexible and variable capacity can balance the supply and demand, resulting in optimized dewatering and minimized power consumption. Vacuum levels are measured at the vacuum pumps and blowers to identify problem areas. The dewatering elements such as flat boxes, save-all pans and uhle boxes are reviewed. Specialists study pressure and bleed losses to analyze the energy consumption and evaluate if the vacuum levels are too high.

With the experience of thousands of audits and dewatering studies at paper mills, we are able to benchmark the effectiveness of existing vacuum systems, dewatering equipment, suction elements, fabrics and felts.

Today, over 950 Turbo Blowers have been sold globally. This experience and expertise allows us to work with our customers, help them get the most out of their papermaking process and vacuum systems – and ensure they achieve both their operational and process goals.

Engineered Solutions for Pulp and Paper Industry

Offering the industry's most comprehensive equipment portfolio for paper machine dewatering and vacuum systems, coupled with our extensive papermaking know-how, Ingersoll Rand businesses Runtech and Nash provide optimal solutions for all paper mills, from service and rebuilds to completely new papermaking lines.

Runtech's offering includes save-alls, doctoring, forming and dryer section cleaning systems. Our EcoFlow dewatering measurement system significantly improves dewatering, doctoring and cleaning processes, enabling increased dryness after the press section. Runtech also offers runnability optimization as well as ropeless tail threading.

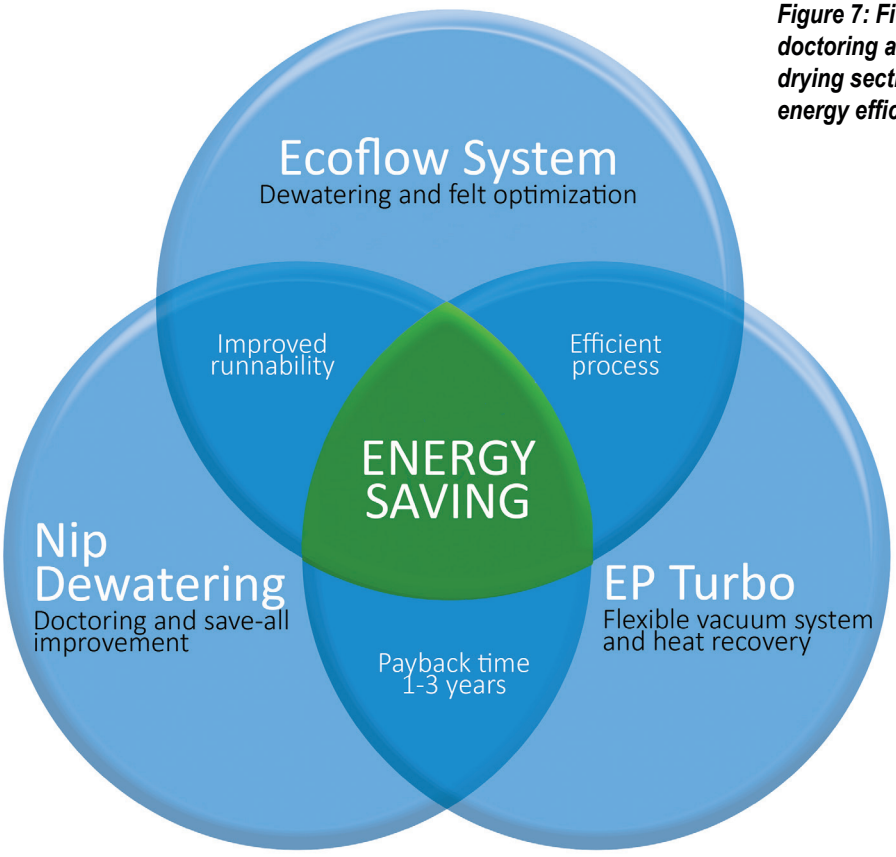

Figure 7: Fit-for-purpose vacuum system and efficient doctoring and dewatering solutions for forming and drying sections are the fundamental base for the good energy efficiency and low cost paper production.