



ENERGY EFFICIENCY CONSIDERATION IN VACUUM SYSTEMS UPGRADATION

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Abstract:

For removing moisture from pulp and to hold the pulp on wire, there is a vacuum system underneath wire which will be sucking water from the liquid pulp over the wire. The vacuum is created through a series of vacuum pumps stationed in the paper/board machine. These pumps run continuously and consume lot of power. Hence upgradation of conventional pumps with energy efficient pumps will save lot of power.

Keywords: Wet End, Wire part, UHLE box, Conventional vacuum pumps (liquid ring pumps), Man Turbo Blower, Run tech Eco pump (High speed Vacuum pump).

Introduction

The paper or board making process start with bleached pulp as input material in the machines. This pulp with 1% consistency enters the Wet end section of machine on to the wire part through head box. After passing forward on the wire, there are bottom suction boxes called UHLE boxes, which suck the water from the pulp through wire, leaving behind pulp on the conveying wire. To maintain continuous vacuum to suck water from the pulp, there are series of vacuum pumps in the machines which create vacuum at wire and press parts by sucking the air at their place and vent it into atmosphere. The conventional vacuum pumps are liquid ring ones. These pumps create low vacuum, medium and high vacuum zones at various locations in the machine.

In 2012, during PM7 project at unit BCM, Man Turbo Blower was commissioned for vacuum application in that machine. This is single equipment catering all the vacuum requirements in the entire machine unlike multiple liquid ring pumps in other machines.

In 2019, during PM1A project at unit BCM, 3 nos Runtch Eco pumps (High speed vacuum pump) were

commissioned which are the lower specific power consumption equipment in paper machine vacuum applications.

Method:

The vacuum pumps are significant energy consumers in board and paper machines. The energy consumptions across various pumps and vacuum levels were different across the machines. Hence it was decided by the ENCON cell at BCM to get the vacuum system study by reputed liquid ring vacuum pump manufacturers. The mill approached 3 reputed liquid ring vacuum pump manufacturers to conduct detailed study of existing vacuum system in our machines at PM5 & PM6. However only one vendor M/s Kakati Karshak Industries has shown interest in detailed vacuum system audit and give solution based on audit findings.

The study was done in two phases – First one is studying the actual vacuum levels and flow requirements at consumption ends (ULHE boxes – Capacity calculations) and categorize them into low, medium and high vacuum zones. Second one is performance assessment of existing individual vacuum pumps. The pumps were isolated from the vacuum header and closed with orifice plates. Then taking of power consumption readings at different levels of vacuum and shut off vacuum. Based on these readings, the pumps efficiency was assessed by vendor.

Thus, the vendor suggested after study, that if the existing more numbers of small vacuum pumps were upgraded with lesser numbers of big vacuum pumps catering low, medium and high vacuum zones, there will be drastic reduction in absolute power consumption in total vacuum requirement. This was implemented in paper machine 5 & 6 and resulted in saving of about 651 KW in two machines.

When going for subsequent project PM7 in 2012, Man Turbo Blower was commissioned and its specific power consumption was equal to energy efficient liquid ring vacuum pumps of higher capacity with single equipment only.

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When going for latest project PM1A in 2019, Runtech Eco pumps were commissioned which are the lowest specific power consumption equipment for vacuum application in paper industry.

Results and Conclusion:

The upgradation of 12 nos vacuum pumps to 5 nos bigger vacuum pumps in PM#5 resulted in net savings of 235 kw per hour as shown below:

Category	Location	Equipment	Installed capacity		Existing Pumps' Performance (audited during shutdown)			M/s.Kakati			
			Flow (m3/min)	Vacuum level (mmHg)	Flow (m3/min)	Vacuum level (mmHg)	Power consumption (kW)	Flow (m3/min)	Vacuum level (mmHg)	Power consumption (kW)	Savings
Low vacuum	Wire part	VP-1	70	278	45	250-300	54	235	270	216	23
		VP-2	150	278	145	250-300	134				
		VP-3	42	278	47	250-300	51				
High vacuum	Couch	VP-4	80	427	80	450	139	160	400-450	150	212
	Press section Pick up zone	VP-5	80	547	90	450	127				
		VP-6	90	547	72	450	111				
		VP-7	80	547	80	450	135				
Medium vacuum	UHLE Boxes	VP-8	126	353	105	340	103	190	340	190	49
		VP-9	126	353	Removed						
		VP-10	126	353	110	340	118				
		VP-11	126	353	105	340	102				
		VP-12	126	353	90	340	106				
		Total					1180			945	235

The upgradation of 10 nos vacuum pumps to 5 nos bigger vacuum pumps in PM#6 resulted in net savings of 416 kw per hour as shown below :

Category	VP NO	APPLICATION	Existing pumps performance (during audit)			M/s.Kakati			
			Vacuum-mmHg	Flow	Power consumption (kW)	Flow (m3/min)	Vacuum level (mmHg)	Power consumption (kW)	Savings
LV	VP-1	FLAT SUCTION BOX	150	102	152	180	300	165	207
	VP-2	COUCH LOW ZONE	250	81	113				
	VP-3	SUCTION PRESS T/F ZONE	250	88	107				
HV	VP-4	COUCH HIGH ZONE	380	66	149	110	450-500	130	57
	VP-5	PICK UP ROLL	450	105	160				
	VP-6	SUCTION PRESS NIP ZONE	450	93	163				
	VP-8	1st FELT UHLE BOX			0				
	VP-9	TOP FELT UHLE BOX			236	280	285		
MV	VP-7	P.U FELT UHLE BOX	300	125	0	175	375	165	152
	VP-10	UHLE BOX	375	320	446	305		365	
					1526			1110	416

The comparison of all vacuum systems:

Description	Small liquid ring vacuum pumps in PM5 (12 nos running)	Bigger capacity energy efficient pumps (5 nos running)	Man turbo blower in PM7	Runtech Eco Pumps
Avg prod rate	14 TPH	14 TPH	20 TPH	20 TPH
Vacuum power	1180 units/hr	945 units/hr	1350 units/hr	894 units/hr
Specific power	84 kw/hr/Ton	67.5 kw/hr/Ton	67.5 kw/hr/Ton	44.7 kw/hr/Ton

Savings got by upgradation is 18.29 lakhs units.

When converted to cost it is about Rs 73 lakhs.

Investment made Rs 255 lakhs.

Payback is 3.49 years.

The project cost of Runtech Eco pumps (3 nos) is Rs 800 lakhs.

The saving per ton compared with liquid ring pumps is 22.8 kwhr/Ton.

The annual savings in cost or Runtech eco pumps compared with liquid ring pumps for a machine with average production rate of 20 TPH is Rs 145 lacs.

Payback is 5.53 years.

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