INSTALLATION OF ENERGY EFFICIENT VACUUM PUMP INSTEAD OF ORDINARY VACUUM PUMP

(*For Muzaffarnagar Paper Cluster*)

Cluster Brief:

Muzaffarnagar contributes to highest production by volume from any district in India. The concentration of units in the cluster is concentrated around Bhopa road and Jansath road. There are total of 33 units in the cluster of which 6 are closed. Total production from these 27 units stand at 1,37,600 tons per year of which 80% is waste paper-based production and 20% is agro waste based production. The different type of papers that are produced are:

- Waste paper-based Kraft paper: 78,500 tons per year
- Agro waste-based Kraft and writing paper: 22,400 tons per year
- Duplux: 19,300 tons per year
- Newsprint, High BF & others: 17,400 tons per year

Out of these 27 units, 3 fall under large scale industries and 24 fall under MSME.

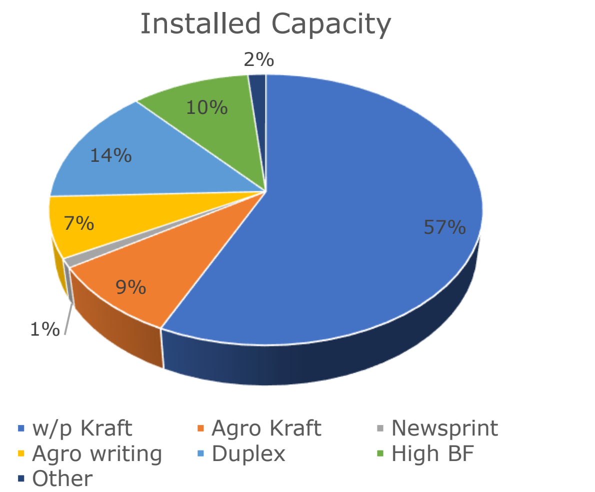

Figure 1: Break-up of installed capacity in Muzaffarnagar by type of final product

The units in the cluster are mostly dependent on rice husk, bagasse and wood chips to meet their heat requirement. Few units also use coal. For electricity the units are dependent on grid, with few other units having installed either high pressure or low-pressure cogeneration system to meet their heat and electricity requirements.

Existing practice:

In a pulp and paper mill, water ring vacuum pumps play an important role in paper manufacturing. Vacuum systems perform three main functions on paper machines. In the forming section, vacuum is used to help de-water the stock as the sheet forms. In the press section, vacuum is used to de-water and clean the press felts, which in turn remove water from the sheet. And, at several locations, vacuum is used to help transfer the sheet between sections.

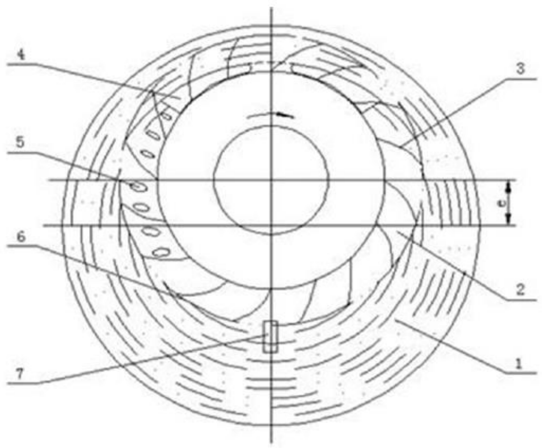

Figure 2: Working principle of water ting vacuum pump

The water ring vacuum pump creates vacuum by rotating a vaned impeller located eccentrically within a cylindrical casing. Water is fed into the pump and, by centrifugal acceleration, forms a moving cylindrical ring against the inside of the casing. This liquid ring creates a series of seals in the space between the impeller vanes, which form vacuum chambers. The eccentricity between the impeller's axis of rotation and the casing geometric axis results in a cyclic variation of the volume enclosed by the vanes and the ring. Air is drawn into the pump through an inlet port in the end of the casing. Air is trapped in the chambers formed by the impeller vanes and the liquid ring. The reduction in volume caused by the impeller rotation compresses the air, which reports to the discharge port in the end of the casing.

Traditionally these vacuum pumps are made of casted. Use of casted pump leads to design imperfections, increased dead weight and enhanced wear and tear. This leads to inefficiency and increased power consumption, which increase further during the course of operation of vacuum pumps

Justification of technology selection:

We propose to replace the casted water ring vacuum pumps with fabricated water ring vacuum pumps. These new vacuum pumps have following advantages:

1. Precise design as the pump is fabricated
2. Reduced dead weight of the pump
3. Reduced wear and tear over time

With these advantages, there is a 40% to 60% reduction in electricity consumption. 25% to 30% of the units have installed the fabricated vacuum pumps. However there are many other units that have the potential to install fabricated vacuum pumps. Despite quick payback period, the main challenge for less penetration of this technology in the cluster is attributed to associated capital investment.

Energy & monetary saving:

For calculating the energy and monetary benefits, a typical case is considered where the fabricated vacuum pump is compared with a casted vacuum pump. The benefits through implementation of this technology have been summarized in the table below:

Duplex paper

Parameter	Unit	Value	
		Casted pump	Fabricated pump
GSM of paper produced	gsm	230	250
Speed of paper machine	mpm	115.1	150
Width of paper	m	1.65	3
Paper production	TPH	2.62	6.80
Vacuum pump power consumption	kW	222	229
Specific power consumption	kWh/T	84.73	33.68
Operating hours per day	Hr.	22	22
Annual operating days	days	330	330
Annual power consumption	kWh/year	16,11,720	
Projected annual power consumption (With fabricated pump)	kWh/year	6,55,305	
Electricity savings	kWh/year	9,56,415	
Electricity rate	₹/kWh	5.00	
Savings	₹/year	47,82,075	
Total investment	₹	55,00,000	
Payback	Months	14	

Kraft paper

Parameter	Unit	Value	
		Casted pump	Fabricated pump
GSM of paper produced	gsm	100	140
Speed of paper machine	mpm	300	329
Width of paper	m	2.20	2.30
Paper production	TPH	3.96	6.35
Vacuum pump power consumption	kW	286.45	324.20
Specific power consumption	kWh/T	72.34	51.05
Operating hours per day	Hr.	22	22
Annual operating days	days	330	330
Annual power consumption	kWh/year	20,79,627	
Projected annual power consumption (With fabricated pump)	kWh/year	14,67,667	
Electricity savings	kWh/year	68,11,960	
Electricity rate	₹/kWh	5.00	
Savings	₹/year	30,59,800	
Total investment	₹	40,00,000	
Payback	Months	16	

The cost provided above includes vacuum pump, motor and installation.
The benefits can be summarized as:

- ✓ Reduction in electricity consumption
- ✓ Reduction in wear and tear, thus improving the life of pump

Replication Potential:

Based on the discussion with association, units, sample survey and energy audits, it is estimated that the technology has a replication potential in 60% to 70% units in Muzaffarnagar. This would mean, a replication potential in approximate 14-17 units. There are 18 Kraft paper mills and 3 Duplex paper mills. Based on replication potential in 16 units (14 Kraft and 2 Duplex), the overall project benefits will be as follows:

Duplex paper

Parameter	Unit	Amount
Electricity saved in one vacuum pump	kWh/T	51.05
No. of units for replication	no.	2
Average production in one unit	TPD	160
Annual electricity saved (considering replication in 2 units)	kWh/year	53,90,880
Cost of 1 kWh electricity	₹/kWh	5.0
Total financial savings in 2 units	₹/year	2,69,54,400
Estimated investment in technology considering replication in 2 units (4 vacuum pumps)	₹	2,50,00,000
Total GHG emission reduction potential in 2 units in a year[1]	kgCO_2	43,12,704
Total tons of oil equivalent saved	TOE	463.53

[1] Considering electricity purchased from grid

Kraft paper

Parameter	Unit	Amount
Electricity saved in one vacuum pump	kWh/T	21.29
No. of units for replication	no.	14
Average production in one unit	TPD	145
Annual electricity saved (considering replication in 2 units)	kWh/year	1,42,62,171
Cost of 1 kWh electricity	₹/kWh	5.0
Total financial savings in 2 units	₹/year	7,13,10,855
Estimated investment in technology considering replication in 2 units (21 vacuum pumps)	₹	8,40,00,000
Total GHG emission reduction potential in 2 units in a year[2]	$kgCO_2$	1,14,09,737
Total tons of oil equivalent saved	TOE	1,226.33

Availability of the technology

There are good many technology providers available in India and many of them have their base in Delhi and UP. The following are the technology providers available in the cluster.

1. **Annapurna Imports**
   31-A, New Mandi Muzaffarnagar 251001

2. **Shandong Jinggong Pumps Co., Ltd (Chinco Pumps)**
   Juxin Jinqiao Park, Free Trade Industrial Park, Shanghai, China.

3. **Kakati Karshak Industries Private Limited (Kakati Vacuum Pumps & Systems)**
   Nacharam Industrial Area, Hyderabad-500076, Telangana, INDIA.

4. **Gardner Denver Engineered Products India Pvt Ltd (NASH Pumps)**
   Gat No: 182, 183, 184, Alandi - Markal Road, Fulgaon, Pune, Maharashtra, 412216

Effect on the process

This technology has no effect on the existing production process, it will only reduce the electricity consumption. There is also a possibility of resizing the motors and reduce the connected load of the unit.

[2] Considering electricity purchased from grid