INSTALLATION OF DIRECT COUPLING FOR DRIVING AGITATOR SYSTEM

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

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. Different type of papers produced in the sector are:

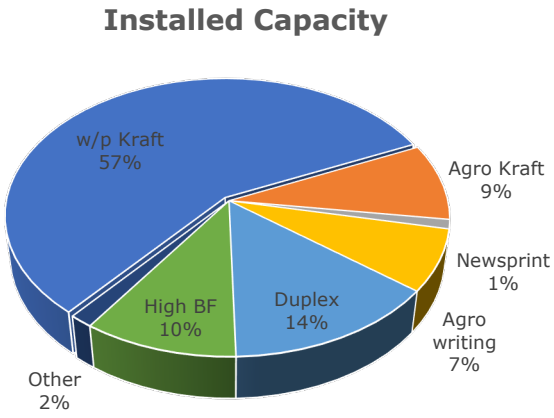


Figure 1: Break-up of installed capacity in Muzaffarnagar by type of final product

- Waste paper based Kraft paper (w/p Kraft): 78,500 tons per year
- Agro waste based Kraft and writing paper: 22,400 tons per year
- Duplex: 19,300 tons per year
- Newsprint, High Break Factor (BF) & others: 17,400 tons per year

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

In addition, the Kashipur and Bazpur region have total 17 operating units. Out of these 17 units, five units fall under large scale industries and only 12 fall under MSME category. Most of the units operating in Kashipur are engaged in production of kraft and writing paper. Summary of the units are:

	Muzaffarnagar	Kashipur
Total number of units	27	17
Total MSME units	24	12
Total large scale units	3	5
Major Type of paper produced	• Waste paper based Kraft paper • Duplex paper • Tissue Paper	• Writing paper • Waste paper based Kraft paper

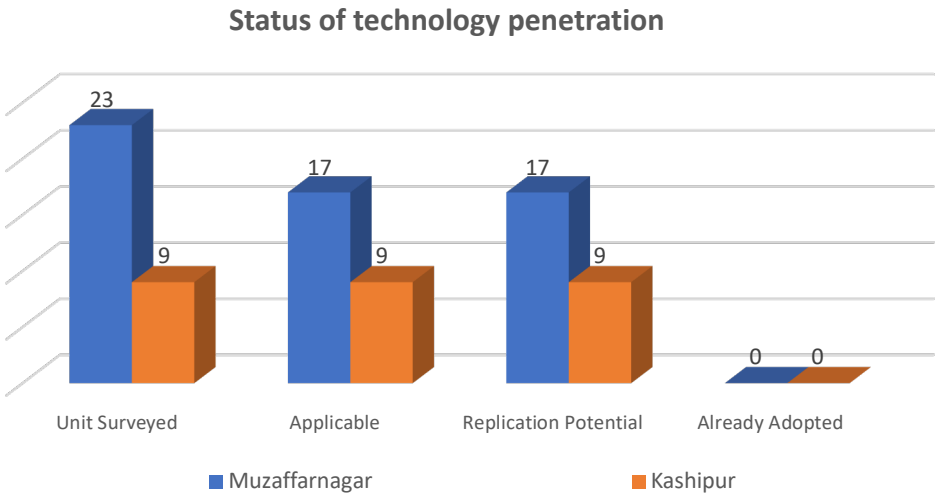
The units in the cluster are mostly dependent on rice husk, bagasse and wood chips to meet their heat requirement. Few units also use coal. For electricity the units are dependent on grid, with few other units having installed either high pressure or low pressure cogeneration system to meet their heat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

Existing practice:

In a pulp and paper mill, agitators play an important role in maintaining the quality of pulp. The quality of paper manufactured is dependent on the consistency of the pulp. The agitators prevent the pulp to settle in chests, thus maintaining uniform consistency. Currently, the agitators are mostly powered through a 6 pole motor. However, the impeller of agitator is not needed to rotate at the speed of 960 rpm. Depending on the consistency and type of pulp, the impeller speed used in chests ranges between 200 rpm to 450 rpm. To

reduce the speed, the units currently make use of pulley driven system. In the current scenario, all the units in Muzaffarnagar and Kashipur are operating agitators in this conventional method only.

Out of 32 units surveyed (23 Units in Muzaffarnagar and 9 units in Kashipur), the proposed technology is applicable in all the surveyed units. Out of the 32 units surveyed, the data for the agitators installed was shared only by 26 units. None of the 26 unit has installed the proposed solution. This also means that the replication potential of this technology is in all of these 26 units.



The details of the existing pulley driven system at one of the unit is shared below:

Table 1: Details of existing sample agitator system

S. No.	Parameter	Value
1	Rated capacity of agitator motor (hp)	20
2	Size of pulley on motor side (inch)	8.5
3	Size of pulley on impeller side (inch)	24
4	No. of poles and Speed of motor (rpm)	6-pole, 960 rpm
5	Speed of impeller (rpm)	230 rpm
6.	Operating load of agitator motor (kW)	7.1

Figure 2: View of current agitator system installed at factory

Justification of technology selection:

The main drawback of this pulley driven system is that the reduced speed of the impeller is fixed. This will not take into account the consistency of pulp in the chest and will also limit the flexibility of the system. The above data also reflects that the agitator motor is operating at almost 50% of the rated power. In addition, the pulley driven system will have inherent transmission losses.

To overcome all these challenges and make the system more flexible and agile we propose to operate the impeller of the agitator by directly coupling it with newly installed inverted duty, 8-pole motor controlled with the help of a VFD.

In the existing system, the motor of agitators is only 50% loaded. This was proven by the measurements done on the system. This is a clear case of over designing. Also, the additional capacity is needed for meeting the starting torque and starting current requirements. The system also utilizes the belt and pulley drive system. If the unit need to change the rotating speed of agitator, they need to stop the system, remove the pulley installed and install a new pulley of different diameter. This usually consumes 3-4 hours of operation. In addition the belt is a consumable and has to be replaced after fixed duration of operation. This may vary from 1000 hours to 2000 hours depending on quality of belt.

The new system will have an 8-pole inverted duty motor with VFD and direct coupling. The new system will have following advantages:

1. 8-pole inverted duty motor:
    a. The 8 pole motor has rotating speed of 750 rpm. Thus controlling the speed is easier as compared to 6-pole motor
    b. The inverted duty motor can also be operated at very low frequency without issue of heating up
2. Variable frequency drive:
    a. The drive gives flexibility of regulating the speed of motor. This allows to change agitator rotating speed without stopping the system and reducing downtime
    b. Reduces the requirement of inrush/ starting current and torque
    c. Eliminates the pulley-belt system, thus consumables are eliminated
    d. Elimination of transmission and slippage losses in pulley belt driven system
3. Reduction in electrical consumption by regulating the speed of motor through VFD
4. Speed of agitator can be regulated easily depending on consistency of pulp

The technology has been analyzed and tested on following parameters/ criteria:

Parameter	Criteria	For the proposed technology
Energy Conservation potential	15% of equipment/ technology	>30%
Payback period	Less than 2 years	12 months – 18 months
Replication Potential	min 20 MSME or 30% of MSME	All units: 24 MSME (Muzaffarnagar) 12 MSME (Kashipur)
Vendor availability	Yes	Yes
Ease of implementation	2 - 3 months	0.5 day per agitator

The technology is discussed with the following stakeholders in the cluster and we received encouraging feedback and principal agreement that the technology implementation will save energy for the unit and overall cluster:

S. No.	Name	Designation	Unit name
1	Mr. Pankaj Agarwal	President Proprietor	Muzaffarnagar Paper Mill Association Bindlas Duplex
2	Mr. Amit Garg	Director	Silvertoan Papers Limited
3	Mr. Abhishek Agarwal	Director	Agarwal Duplex Board Mills Ltd.
4	Mr. Anubhav Garg	Director	Mahalaxmi Crafts and tissues Pvt. Ltd.

Mr. Pankaj Agarwal, President - Muzaffarnagar Paper Mill Association, has multiple units in Muzaffarnagar. He also owns one Paper unit which falls under the category of large industry. He has installed a similar system in his unit on the agitator system with slight modification. He claims to have achieved the savings of approximately 25% in that system.

Energy & monetary saving:

For calculating the energy and monetary benefits, a typical case is considered where the motor of agitator fan has rated capacity of 20 hp and the fan is operated for an average duration of 20 hours per day at 200 rpm. The benefits envisaged through implementation of this technology has been summarized in the table below:

Parameter	Unit	Value	
		Before	After
Rated Capacity of agitator pump	hp	20.00	20.00
Rated Capacity of agitator pump	kW	14.92	14.92
Size of pulley installed on motor side	inch	5.20	
Size of pulley installed on impeller side	inch	24.00	
Number of poles of motor	No.	6.00	8.00
Slip in motor	%	4.0%	4.0%
Rated speed of motor	rpm	960.00	720.00
Frequency of operation of motor	Hz	50.00	33.27
Operating speed of motor at given frequency	Hz	960.00	479.09
Rotating speed of impeller	rpm	208.00	169.68
power factor		0.82	0.99
Operating load of agitator pump	kW	7.10	4.73
Operating hours in a day	hr	20.00	20.00
Total electricity consumed	kWh/day	142.00	94.54
Number of operating days	days	330.00	330.00
Electricity consumed in a year	kWh/year	46,860.00	31,199.32

Number of agitators operating in factory	No.	8.00	8.00
Total electricity consumed in a year	kWh/year	3,74,880.00	2,49,594.6
Cost of 1 kWh electricity	INR/kWh	7.50	7.50
Total electricity spend	INR/year	28,11,600.00	18,71,959.47
Total electricity savings in a year	kWh		1,25,285.4
Total financial savings in a year	INR		9,39,640.53
Total investment	INR		10,40,000.00
Payback	months		13.28

The cost for single system is ₹ 2,00,000 which include cost of 8-pole inverted duty motor, VFD and coupling. This cost is calculated based on discussion with motor and VFD vendors and coupling manufacturers:

The benefits can be summarized as:

- ✓ Reduction in electricity consumption
- ✓ Higher flexibility in controlling speed of impeller
- ✓ Reduction in starting current, thus improving the life of motor

Replication Potential:

Based on the 32 energy survey conducted in Muzaffarnagar and Kashipur, 8 energy audits and 2 technology audits conducted in Muzaffarnagar and discussion with association president and associated unit owners, it is identified that the technology has a replication potential in all 26 units in Muzaffarnagar and Kashipur cluster. Brief summary from the surveys conducted is shared below:

S. No.	Parameter	Muzaffarnagar	Kashipur
1.	Total surveys conducted	23	9
2.	Number of units that shared details of agitators installed	17	9
3.	Total number of installed agitators	152	101
4.	Average number of installed agitators per unit	9	11

A brief summary of different sizes of agitators installed in 26 out of 32 surveyed units is as below:

Capacity (HP)	5	7.5	10	12.5	15	20	25	30	40	50
Number	5	1	29	13	25	47	60	29	34	10

Total number of agitators: 253

Average rated power capacity of each agitator: 24 HP

Based on the details shared by 26 out of 32 units in Muzaffarnagar and Kashipur we have calculated the replication potential for all agitators. The calculation of replication potential is as below:

Assumptions Considered:

Motor loading on each agitator: 50% (Based on measurements done on experimental set-up)

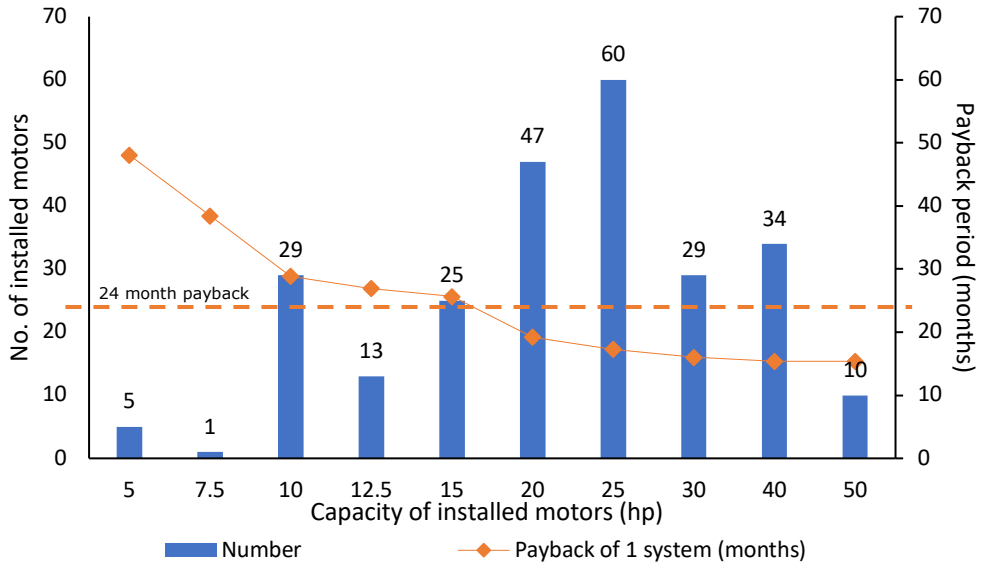
Efficiency improvement: 33.8% (Based on measurements done on experimental set-up)

The detailed calculation are presented at the end of the narrative. The summary of the savings achieved in the total cluster of Muzaffarnagar and Kashipur based on the available data is presented below:

Replication potential

Parameter	Value
Total number of agitators	247
Total agitator population covered (%)	97.63%
Total electricity savings (kWh)	49,90,450
Total electricity cost savings (₹)	3,74,28,376
Total investment (₹)	5,66,55,000
Payback (months)	18.16
Total tons of oil equivalent saved (TOE)	429.10

The agitators of 5 hp and 7.5 hp are not considered as the saving potential and relative investment do not have financial feasibility. A graphical representation of number of motors of each capacity installed and their payback period is presented below:



In addition to the above replication potential in only Muzaffarnagar and Kashipur cluster, this technology is applicable in MSME units of other paper clusters like Vapi, Coimbatore, Meerut, Yamuna Nagar, Roorkee, Assam, Tripura, Rajasthan and Kerela.

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. **Siemens**

   Plot No. 78, JIL Jagatjit Industries Ltd., Tower A & B, Sector 18, Gurgaon - 122015

2. **ABB**

   14 Mathura Road, Faridabad

3. **L&T**

   Electrical & Automation Campus, Unnati Building, A-600, TTC Industrial Area,

   Shil-Mahape Road, Navi Mumbai - 400 710

Effect on the process

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

Reasons for unavailability

- Limited number of skilled technology integrators in the cluster
- Ready availability of 8 pole IE3 inverted duty motor in the cluster with local suppliers
- Lack of skilled manpower for maintenance of IE3 and above motors
- Focus of engineering and maintenance staff to keep the plant up & running all the time
- Non-familiarity with new technologies available in market

Parameter	Motor Capacity									
Capacity (HP)	5	7.5	10	12.5	15	20	25	30	40	50
Number	5	1	29	13	25	47	60	29	34	10
Capacity (kW)	3.73	5.595	7.46	9.325	11.19	14.92	18.65	22.38	29.84	37.3
Motor loading (%)	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
Power Consumed (kW)	1.865	2.7975	3.73	4.6625	5.595	7.46	9.325	11.19	14.92	18.65
Efficiency Improvement (%)	33.80%	33.80%	33.80%	33.80%	33.80%	33.80%	33.80%	33.80%	33.80%	33.80%
Power consumption (kW)	1.23463	1.851945	2.46926	3.086575	3.70389	4.93852	6.17315	7.40778	9.87704	12.3463
Total operating hours (hr)	20	20	20	20	20	20	20	20	20	20
Electricity consumption before replacement (kWh)	186.50	55.95	2163.40	1212.25	2797.50	7012.40	11190.00	6490.20	10145.60	3730.00
Electricity consumption after replacement (kWh)	123.46	37.04	1432.17	802.51	1851.95	4642.21	7407.78	4296.51	6716.39	2469.26
Electricity Savings in one day (kWh)	63.04	18.91	731.23	409.74	945.56	2370.19	3782.22	2193.69	3429.21	1260.74
Electricity Savings in a year (kWh)	20,802.21	6,240.66	2,41,305.64	1,35,214.37	3,12,033.15	7,82,163.10	12,48,132.6	7,23,916.91	11,31,640.2	4,16,044.20
Cost of 1 kWh electricity (₹)	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Total electricity savings (₹)	1,56,017	46,805	18,09,792	10,14,108	23,40,249	58,66,223	93,60,995	54,29,377	84,87,302	31,20,332
Investment for 1 system: Motor + VFD + Coupling (₹)	1,25,000	1,50,000	1,50,000	1,75,000	2,00,000	2,00,000	2,25,000	2,50,000	3,20,000	4,00,000
Payback of system (months)	48.1	38.5	28.8	26.9	25.6	19.2	17.3	16.0	15.4	15.4
Total investment (₹)	6,25,000	1,50,000	43,50,000	22,75,000	50,00,000	94,00,000	1,35,00,000	72,50,000	1,08,80,000	40,00,000