INSTALLATION OF ENERGY EFFICIENT AGITATOR SYSTEM FOR REACTION VESSELS

(For Ankleshwar Chemical Cluster)

Cluster Brief:

Gujarat is a major contributor in the production of basic chemicals as well as petro-chemicals with 54% and 59% share of the country's production, respectively. Also, chemicals /petro-chemicals and pharmaceutical sectors contribute to about 60% in the entire manufacturing output of Gujarat. About 50% of the total chemical production in Gujarat is contributed by industries in Ankleshwar. Ankleshwar and Panoli industrial areas has more than 1,200 industries, manufacturing diverse range of chemicals, pesticides, pharmaceuticals, bulk drugs, petroleum products, engineering, textiles, plastics, rubber, and packaging. Out of these 1,200 units, more than 600 are MSME units manufacturing various types of chemicals, like dyes, pigments, insecticides, specialty chemicals, petrochemicals, pharmaceuticals, and paints. Varieties of basic chemicals are used as raw materials to manufacture major chemical products. These basic chemicals, used as raw materials, are classified according to a variety of features:

- ✔ Based on their chemical composition (organic and inorganic),
- ✔ Based on their origin (mineral, vegetative, and animal), and
- ✔ Based on their state of aggregation (solid, liquid, and gaseous).

Majority of the industries located in Ankleshwar and Panoli are wet processing units which requires high amounts of thermal energy in the form of steam and thermic-fluid and electrical energy. The sector is unorganized in nature, mostly using old and inefficient technologies. There is a significant potential to make these units energy efficient and cost competitive, through accelerated adoption of energy efficient technologies in the cluster.

Existing practice:

Majority of agitator systems used for stirring the chemicals in reaction vessels are of horizontal type belt driven, which are inefficient and thus result in loss of energy during transmission. Conventional agitator systems are not designed for specific viscosity and specific gravity of particular material; this causes the poor heat & mass transfer in conventional agitator system. Due to poor design of impeller system in agitator system mixing time of chemicals in reaction vessels is more. Almost of 20%, energy is wasted in the transmission system in belt driven agitator system. This can be avoided by being use of energy efficient direct drive transmission system instead of belt driven gear system in horizontal agitator system. This automatically reduces the size of the motor i.e. reduces the operational and capital cost of drive. Conventionally, worm gears are used in horizontal agitator system which has poor efficiency compared planetary or helical gear system. Majority of the industries use bigger size of drives in reaction vessel, which can be reduced by proper selection of suitable impeller in agitator system, material of impeller system, reduction of transmission losses, use of energy efficient gear system and vertical mounting of drive system.

In most units, agitator systems are designed based on the following thumb-rule:

- Volume of tanks = kW of the motor,
- Multiply by Sp. Gravity and Viscosity factors.
- Then they arrive at the selection of impeller diameter and speed.

The following table shows the number of horizontal reactor out of total reactors in the 8 chemical units where energy audit has been conducted under the current project:

Table 1: Number of Horizontal agitators in units

Units Name	Numbers of reactors	Number of horizontal reactors	Number of vertical reactor
Rashdeep Chemical Pvt. Ltd	8	8	0
Minol acid and Chemicals Pvt. Ltd	14	2	12
Blitzkrieg Organic and Biochemical Industry	7	5	2
Pragna Dyechem Pvt. Ltd	41	41	0
Prudence Pharma Chem Pvt. Ltd	14	2	12
Movie coat Pvt. Ltd	4	4	0
Pooja Chemical Inustries Pvt. Ltd	3	3	0
Ridhi Pharma Pvt. Ltd	44	9	35

Source: Energy audits under GEF-5 project

Proposed technology:

Existing agitator system situated in the reaction vessels are of very primitive design, it is recommended to replace the conventional agitator system with scientifically designed energy efficient agitator system by considering the viscosity, specific gravity of material etc. By considering these parameters into the design of agitator, system will improve the heat and mass transfer in system in process liquid; which will improve the quality of the final product. By replacing the conventional horizontal agitator system with vertical agitator system will improves the transmission efficiency.

The Energy Efficient Agitator system is design based on the process requirement like flow, tip speed, impeller diameter ratio Vs tank diameter since Agitator operates on axial / radial flow principal. The shaft motor rating is arrived at based on the shaft power requirement. Motor power is selected with suitable margin.

Justification of technology selection:

The proposed technology of vertical agitator in reactor not only helps to improve the efficiency of agitator system but also improves the product quality, drive transmission efficiency, percentage loading of motor, power factor and save time. The improvement envisaged through the installation of the system has been summarized in the table below:

Table 2: Performance parameters of reactor

Parameter	Current Operation	Ideal Operating Scenario	Effect on reactor Performance	Post Implementation of ideal scenario

Power consumption	7.5 kW	3.7 kW (Planetary/ Helical gear leads up to 25-35% power savings in reactor	More stirring time leads more power consumption in reactor.	Installation of planetary/helical gear will reduce power consumption, which help to maintain specific energy consumption within limits.
Transmission efficiency	90	98%	Overweighing of belting, improper pulley size and belt size and Belt slippage leads poor transmission efficiency of belt	Installation of planetary gear / helical improves transmission efficiency up to 8 % which helps to maintain specific energy consumption of reactor within limit
Percentage loading of motor	80-85%	90-100%		
Power factor	0.76	Near unity		

Estimated Energy & monitoring saving:

The benefits envisaged through installation of energy efficient vertical agitator system in place of horizontal agitator system for a unit having 5 reaction vessels have been summarized in the table below:

Table 3: Cost benefit analysis for energy efficient transmission system

Replacement of belt driven agitator to direct coupled energy efficient agitator		
Particulars	Unit	Value
Total number of Belt operated reactors	#	5
Capacity of each tank	kL	5
Rated power of each belt driven reactor motor	kW	7.5
Total measured power of belt driven reactor	kW	37.5
Proposed kW of energy efficient agitator motor	kW	3.7
Total power consumption of energy efficient agitator motor	kW	18.5
Energy saved	kW	19.0
Daily operating hours	h/d	24
Annual operating days	d/y	330
Annual energy savings	kWh/y	150,480
Unit rate	Rs./kWh	7.5
Monitory savings	Rs. Lakh/y	11.3
Estimated investment	Rs. Lakh	19.8
Simple payback period	y	1.8

The benefits can be summarized as:

- ✔ Transmission efficiency improves 90% to 98%
- ✔ Less power consumption by 15-20%
- ✔ Percentage loading of motor improves which improves power factor.
- ✔ Productivity improves.

Replication Potential:

Ankleshwar has a large number of chemical processing units .The Ankleshwar Industries Association (AIA) is the biggest association operational in the cluster, with close to 600 registered chemical units. To establish the replication potential of the technology in the sector, the following were considered:

- ✔ Technology feasibility and adaptability through energy audits in eight units.
- ✔ Survey of 100 units (under process)
- ✔ Meetings held with associations / stakeholders (including technology suppliers)

The technology of horizontal to vertical agitator has significant demand, with 14 out of 100 surveyed units so far, showing interest in the technology. Each units have somewhere around 10 to 20 reaction vessels on an average.

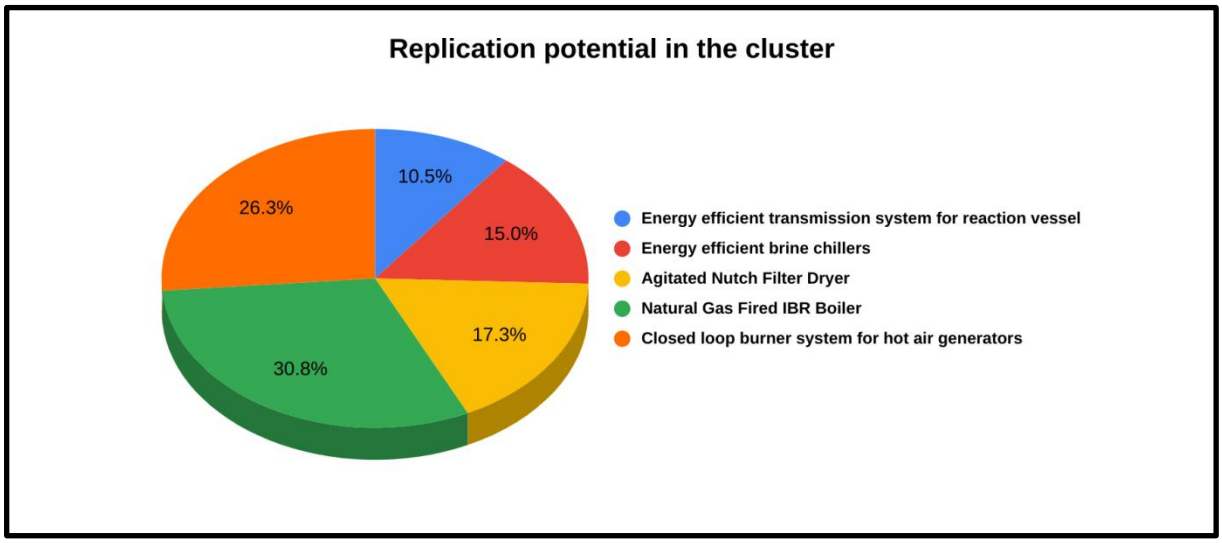

Figure: Summary of survey results

Considering the survey results and based on further discussion with associations, units, stakeholders and outcome of the energy audits, it is estimated that the technology has a replication potential of 10% in the cluster, i.e. 14 units consisting of 5 agitator system per unit. Based on 10% replication, the overall project benefits will be as follows:

Table 5: Impact of replication of technology

Parameter	UoM	Value
Annual electrical energy saving (one unit)	kWh/y	150,480
Annual electricity saving (considering 14 units)	kWh/y	2,106,720
Annual energy saving (considering 14 units)	MJ/y	7,584,108
Annual CO2 emission saving (one unit)	tCO2/y	135.4
Annual CO2 emission saving (considering 14 units)	tCO2/y	1896
Estimated investment in technology (one unit)	Rs Lakh	19.8
Estimated investment in technology considering 14 units (assuming price down due to demand aggregation)	Rs Lakh	277

Total Investment	Mn USD	0.39
Total energy savings (in 10 years)	TJ	75.8
Annual CO2 emission saving (in 10 years)	tCO2	18,960

Barrier for implementation:

Although the technology has been successfully proven, there has been limited replication of the technology in the cluster. The barriers identified for limited penetration of the technology in the cluster are as follows:

- ✔ **Knowledge barrier:** Based on discussion with units, it has been found that knowledge dissemination related to the technology has been limited. Planetary gearbox in reactor is not dependent upon raw material and its desired properties.
- ✔ **Lack of after-sales service:** The technology penetration has been limited due to the lack of after sales service. The delay in such services forces the units to bypass the automation system. The annual maintenance contract and warranty, which has been inbuilt in the present model, is expected to take care of the issue.
- ✔ **Lack of skilled work force:** The technology requires skilled manpower and /or training within the existing manpower to operate the system at optimum level. Such training has been incorporated in the model.
- ✔ **Risk related to implementation:** The units lacks confidence related to performance of the technology. The risk of performance has been covered under the project.
- ✔ **Lack of monitoring instruments:** Not clear about their existing level of operations and efficiency, due to lack of instrumentation & non availability of energy consumption data
- ✔ **Narrow focus on energy:** The units have much interest in production figures and committed for target production
- ✔ **Limited manpower:** implementation of new technology in unit may require skilled man power which is also a barrier

Availability of technology supplier:

The technology of **Energy Efficient Agitator System for reaction Vessel** has been well established. A large number of reputed technology suppliers cum integrators are involved in supply and service of the technology. Most of these technology suppliers have local offices / representative at Ankleshwar, Surat and nearby. In addition to the established names, a large number of smaller system integrators are also involved in the supply of this technology. Some of the established technology suppliers are:

- ✔ A.S.P. CHEM- EQUIPMENTS
- ✔ Rollsun Marketing
- ✔ SHREE VIRKRUPA ENGINEERING