Capacity Building workshop

Energy Efficiency in Kiln and associated systems

1st May 2018 at Thangadh

Under the project

Capacity Building of Local Service Providers (LSPs)

Supported by

GEF-UNIDO-BEE Project

Promoting Energy Efficiency and Renewable Energy in selected MSME clusters in India

PANCHAL CERAMIC ASSOCIATION
VIKAS TRUST-THANGADH

Table of contents

Workshop summary

Overview of workshop

Capacity Building workshop of Local Service Providers (LSPs) on Energy Efficiency in Kiln and associated systems was organized by TERI on 1st May 2018 in association with Panchal Ceramic Association Vikas Trust (PCAVT) under GEF-UNIDO project. Total 31 participants were present during the workshop. Agenda of the workshop and list of participants are attached in the annexure 1 and annexure 2 respectively.

Summary of points discussed in the meeting

Mr. Kirti Bhai Maru, President, Panchal Ceramic Association Vikas Trust welcomed the participants and thanked the team of TERI and UNIDO for arranging the capacity building workshop. He deliberated the necessity to conserve energy in ceramic manufacturing. He urged to all kiln fabricators and kiln maintenance service providers to take the benefit of the training programme and support the industries in the cluster in order to maintain the optimum efficiency.

Inaugural session was attended by other vice presidents/trustees of the PCVAT and they sensitised the participants and encouraged to adopt best operating practices in operations as well as maintenance of the kiln and associated auxiliaries.

Mr P Vora, cluster leader, UNIDO gave a brief background of the GEF-UNIDO-BEE project activities in Thangadh cluster and also explained the objective of the workshop. He informed about the current available equipment's at energy cell and how industries can benefit by availing energy audit services at low costs.

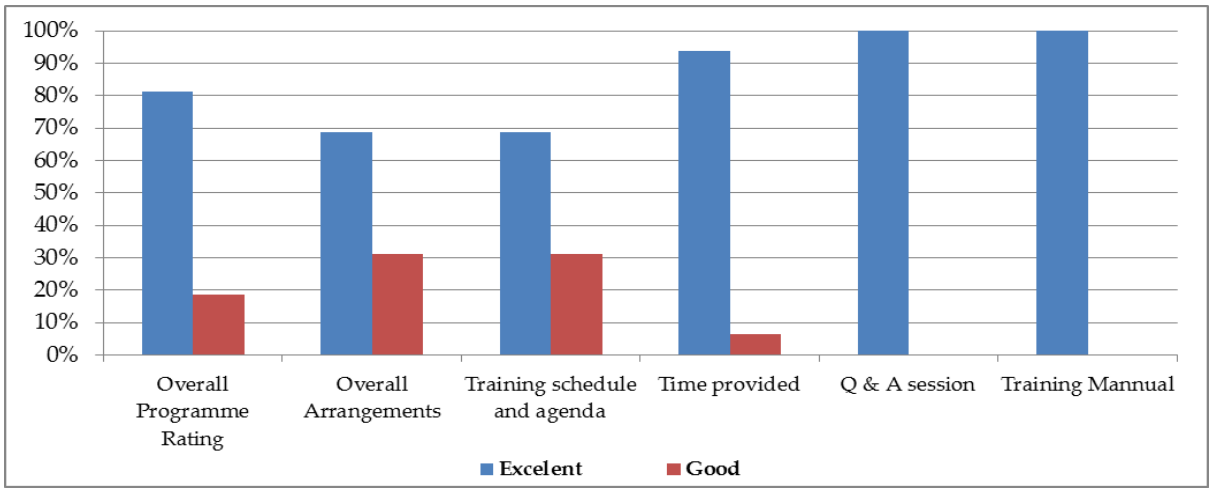
Mr. Ayan Ganguly, TERI, has given the presentation on the energy conservation measures/techniques which can help to optimise the energy consumption in the existing tile making units. He presented outlines the various losses in the kilns and possible potential of reduction such as dry flue gas losses, surface loss, cold air ingression, improper temperature of zones, etc. He also shared various case studies to optimise the existing thermal and electrical system of the kiln and associated auxiliaries.

Mr. Pawan Tiwari, TERI, presented the energy efficient kiln control system being used in developed countries and large industries in India. In the Thangadh ceramic clusters, mainly pusher type tunnel kilns are most common. The efficiency of the kiln depends not only on its design parameters but also on operation and requirements for uniform heating. He discussed the automation tool "Kiln thermal parameters controller" comprises kiln temperature, pressure and atmosphere controlling. In different stages, the control act differently, in firing process, PLC control inverter adjust the combustion fan to change air flowing in air hose. Electric valve of fire nozzle is set by numerical program to setup kiln atmosphere during heating process. He has presented various case studies on new and renewable energy technologies which has a significant effect on reduction of energy consumption.

Selected photos of the workshop are attached in the Annexure-3.

Feedback forms

Based on the analysis of the feedback forms received from the participants, it is observed that workshop was well received by the participants and 77% participants were satisfied with site visit, Q&A session and training module provided to them. About 91% participants have rated overall program as "excellent" while rest of them have rated it as "good". More than 90% of participants were satisfied with arrangements made, training schedule and agenda of the program. Few sample feedback forms are attached in the annexure 4.



Analysis of feedback forms

Suggestions by participants

Some participants have made suggestions as follows;

1) Low thermal mass application demonstration project

Learning's by participants

Some of the topics learned by the participants and mentioned by them are listed below;

1) Kiln combustion system automation
2) Waste heat recovery using heat pipe
3) Low thermal mass materials

Annexures

Annexure 1: Agenda of the program

Capacity building workshop

Energy Efficiency in Kiln and associated systems

Tuesday, 01st May 2018

Auditorium, PCAVT Building, Thangadh

Under the project:

Capacity Building of Local Service Providers (LSPs)

Supported by:

GEF-UNIDO-BEE Project

Promoting Energy Efficiency and Renewable Energy in selected MSME clusters in India

Agenda

10:30 – 11:00	**Registration**
11:00 – 11:15	**Welcome Address** Mr Kirti bhai Maru, President, Panchal Ceramic Association Vikas Trust
11:15 – 11:30	**Address** Vice Presidents, Panchal Ceramic Association Vikas Trust
11:30 – 12:00	**Project overviews and EE initiatives in Kilns** Mr P. Vora, UNIDO Cluster Leader – Thangadh
12:00 – 13:00	**Energy conservation opportunities in Kiln & its associated systems** Mr Ayan Ganguly, TERI
13:00 – 14:00	Lunch
14:00 – 15:00	**New and renewable technologies options in Kiln & its associated systems** Mr Pawan Tiwari, TERI
15:00 – 16:00	**LSP Presentations** Q&A
16:00 – 16:15	**Vote of thanks** Mr Ashwin Bhai, Panchal Ceramic Association Vikas Trust

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Annexure 2: List of participants

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gef

UNIDO

ENERGY IS LIFE CONSERVE IT

Capacity building workshop

Energy Efficiency in Kiln and associated systems

01st May 2018, Auditorium, PCAVT Building, Thangadh

S. No	Name	Organization	Mobile No	Email ID	Signature
1.	M.S. JAVIA	Rcole Renewable Energy Dev. pvt Ltd	9227574027	cso@rathegroup.com	[illegible]
2.	Rupesh Chauhan	"	9227874032	rupesh@rathegroup.com	[illegible]
3.	Pradip Vora	UNIDO	9824384224	~~[illegible]~~ cl.thangadhcluster@gmail.com	[illegible]
4.	Suresh. P. Sonkar	Anand sanitary Ltd	98252 18177	choice_traders@yahoo.com	[illegible]
5.	Kirtikumar Maru	Sunrise Pottery Works	98252 17642	ssspw@gmail.com	
6.	Girish Parmar	Kilan cons.	9909630500	gparmar103gp@gmail.com	[illegible]

S. No	Name	Organization	Mobile No	Email ID	Signature
7.	Smit Bhavsar	Vbtech Automation	9978849845	smit@vbtechautomation.com	
8.	H. S. Lalate	@kilan com.	7874834429		
9.	S. A. Lalate	kiln com	8849783363		
10	Uday Salcavia	Unique Furnaces	9857660016	-	
11	Bhagirath Bhatt	Vbtech Automation	8866845530	bhagirath@vbtechautomation.com	
12	S. B. Dhebadya	Kilan Consult	98248 92386		
13	H.S. Sherwad	AMRUT Ceramic	9734-79124		
14	Gadhavi. 12-D	Anchor	9909973367		
15	K. D. Zala	Zipal Firing	9825212607		
16	Nanjibhai Patel	Reliance Ceramics	98255 64999	~~reliance@~~ reliance_ceramic@yahoo.in	

S. No	Name	Organization	Mobile No	Email ID	Signature
17	MUKESH BHAI	RAJDEEP CERAMIC IND.	9825191827		[signature]
18	Rohit. Bhai	RajDeep Ceramic In	8128950037		[signature]
19	[illegible]	[illegible]	[illegible]		[signature]
20	[illegible]	[illegible]	[illegible]		[signature]
21	[illegible]	[illegible]	9825054335		[signature]
22	[illegible]		9879063919		
23	[illegible]	Lanco Sanitary	9879950146		[signature]
24	[illegible]	[illegible]	9979904145		[signature]
25	Dinubhai Bhagat	Gurukrupa Ceramic	98252 17718		[signature]
26	[illegible]	[illegible]	9825218199	newlightceramic@gmail.com	J.K. [signature]

S. No	Name	Organization	Mobile No	Email ID	Signature
27	Dr. Kalpesh Trivedi	Admistrator	96381 00420		
28	રાજનભાઈ પરમાર	ઓપરેટર	98798 43240		
29	Hitesh Patel		9825133144		
30	પારસભાઈ ગોંસાઇ	ઓપરેટર	90997 77803		
31	Rajnikant Shah	Operator	9825218197		
32					
33					
34					
35					
36					

Annexure 3: Selected photographs of the event

Annexure 4: Sample feedback forms

Capacity building workshop

Energy Efficiency in Kiln and associated systems

Tuesday, 01st May 2018

Auditorium, PCAVT Building, Thangadh

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Promoting Energy Efficiency and Renewable Energy in selected MSME clusters in India

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Evaluation Sheet for Participants

Feedback Form for Participants			
Parameter	***Feedback***		
	Excellent	Good	Average
How would you rate the overall programme?	✓		
How would you rate overall arrangements?	✓		
How was the training schedule and agenda?	✓		
How was the industrial site visit?	✓		
Do you think that adequate time was provided for each topic?	Yes [✓]	No [ ]	
Do you think that satisfactory answers were given to your questions during the training programme?	Yes [✓]	No [ ]	
Do you think that the background training manual is informative and useful enough?	Yes [✓]	No [ ]	
Do you think that the discussion on EE/RE will help you in your work?	Yes [✓]	No [ ]	
Suggestions & Recommendations for improvement:			
Exllent very Good			
Name two learning, which from this programme you will be able to implement in your plant?			
Signature:			
Name of participant:			
Organization:			
Mobile No: 98799 50146			
Email ID:			

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VIKAS TRUST-THANGADH

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Do you think that the discussion on EE/RE will help you in your work?	Yes [✓]	No [ ]	
uggestions & Recommendations for improvement:			
Name two learning, which from this programme you will be able to implement in your plant?			
Signature:			
Name of participant:	Anchor Sanitarywares Pvt LTD		
Organization:	Director		
Mobile No:	98252 18177		
Email ID:	choice_trads@gmail.com		

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Do you think that the background training manual is informative and useful enough?	Yes [✓]	No [ ]	
Do you think that the discussion on EE/RE will help you in your work?	Yes [✓]	No [ ]	
Suggestions & Recommendations for improvement:			
Name two learning, which from this programme you will be able to implement in your plant?			
Signature:			
Name of participant:	Suresh B Dholadiya.		
Organization:	Kiln Konsalting.		
Mobile No:	98248 92386		
Email ID:			

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Name two learning, which from this programme you will be able to implement in your plant?			
Signature:			
Name of participant:			
Organization:			
Mobile No:	8849783363		
Email ID:			

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Annexure 5: Copy of presentations

Combined presentation by Mr Pawan Tiwari and Mr Ayan Ganguly

Energy Efficient in thermal system in ceramic industries

Creating Innovative Solutions for a Sustainable Future

Thanghar Ceramic Cluster
01.05.2018

Outline of presentation

1. Share of energy consumption
2. Details of kiln
3. Energy profile of kiln
4. Energy conservation options
5. Thermal systems
6. Electrical systems

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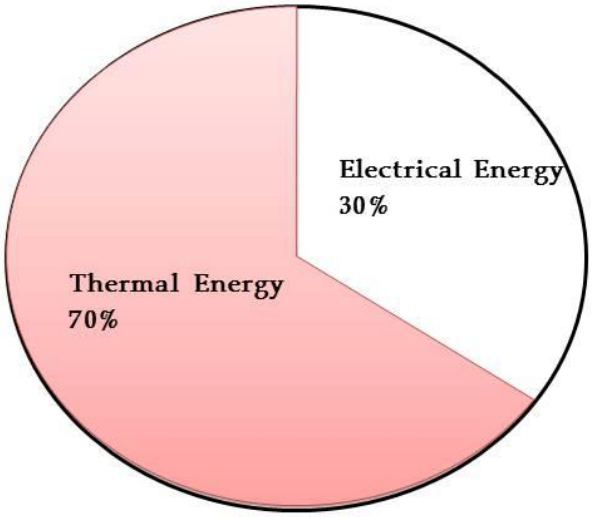
Share of energy consumption in typical ceramic manufacturing unit



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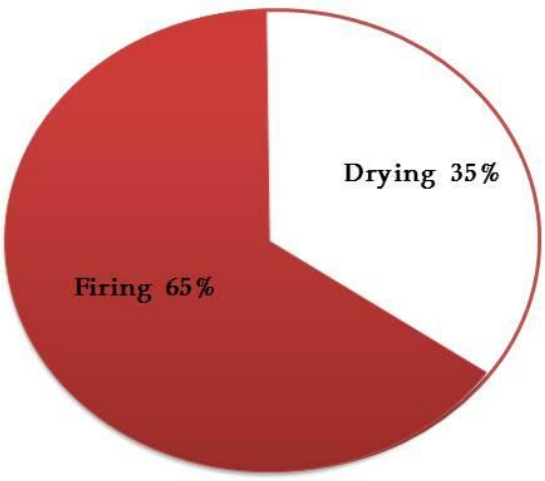
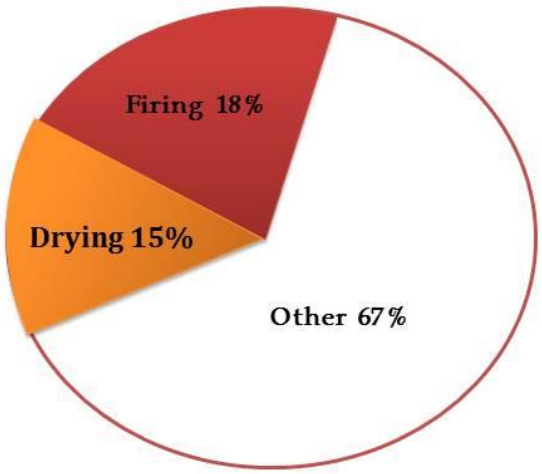
Share of energy thermal section



Share of thermal energy



Share of electrical energy of thermal utility

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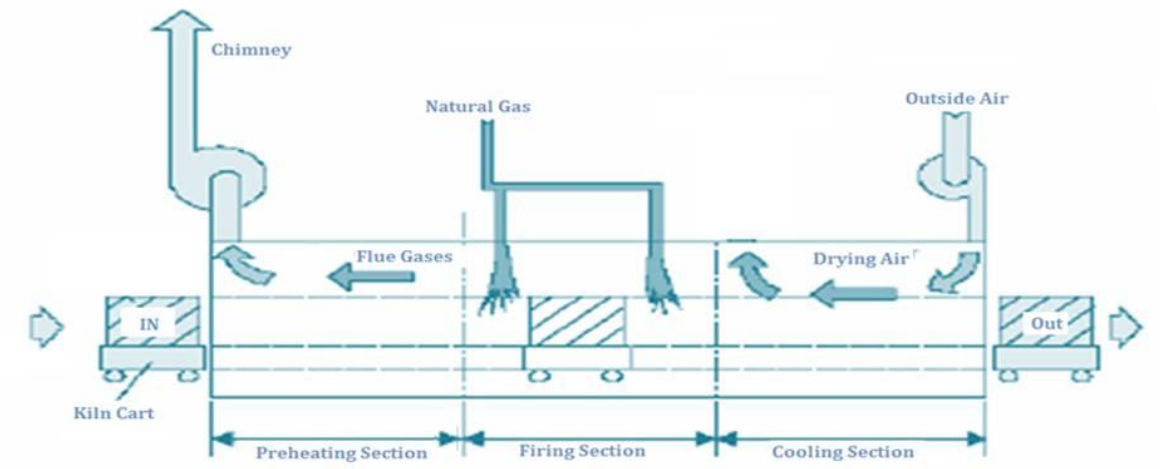
Tunnel kiln



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Typical details of Tunnel kiln

Parameters	Units	Type - 1	Type – 2	Type - 3
Internal kiln width	m	2.62	3.04	3.45
Useful car width	m	2.42	2.83	3.23
Car length	m	1.4	1.4	1.4
Useful car length	m	1.38	1.38	1.38
Useful loading height	m	0.8-1.1	0.8-1.1	0.8-1.1
Useful car area	m^2	3.35	3.92	4.48
Kiln length	m	45-90	45-100	60-110
Maximum temperature	oC	1350	1350	1350
Indicative firing cycle	Hours	10-14	10-14	10-14
Indicative specific consumption	Kcal/kg	1100-1300	1100-1300	1100-1300

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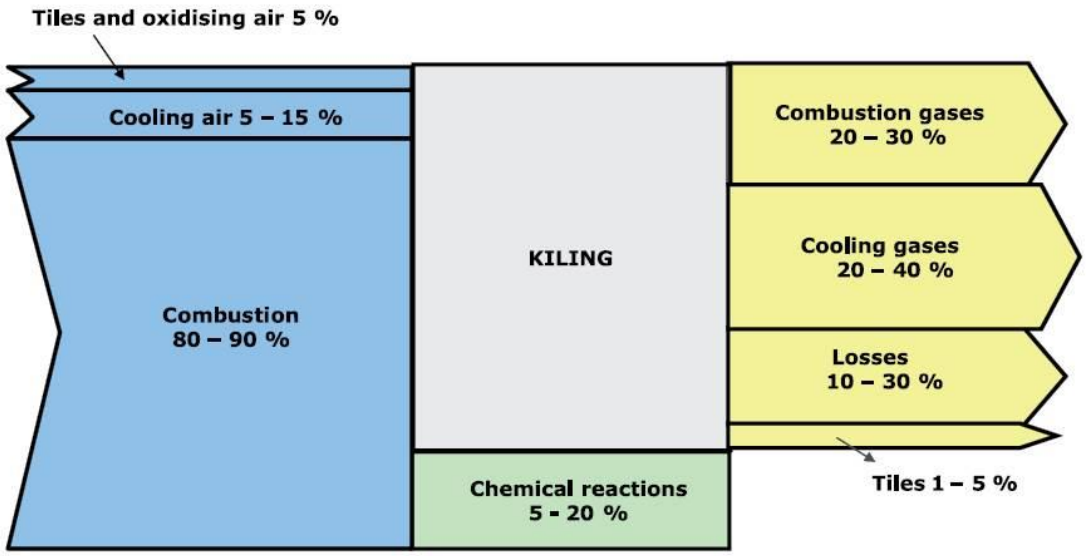
Shan-key diagram for typical ceramic kiln



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Energy conservation and technology options in thermal system

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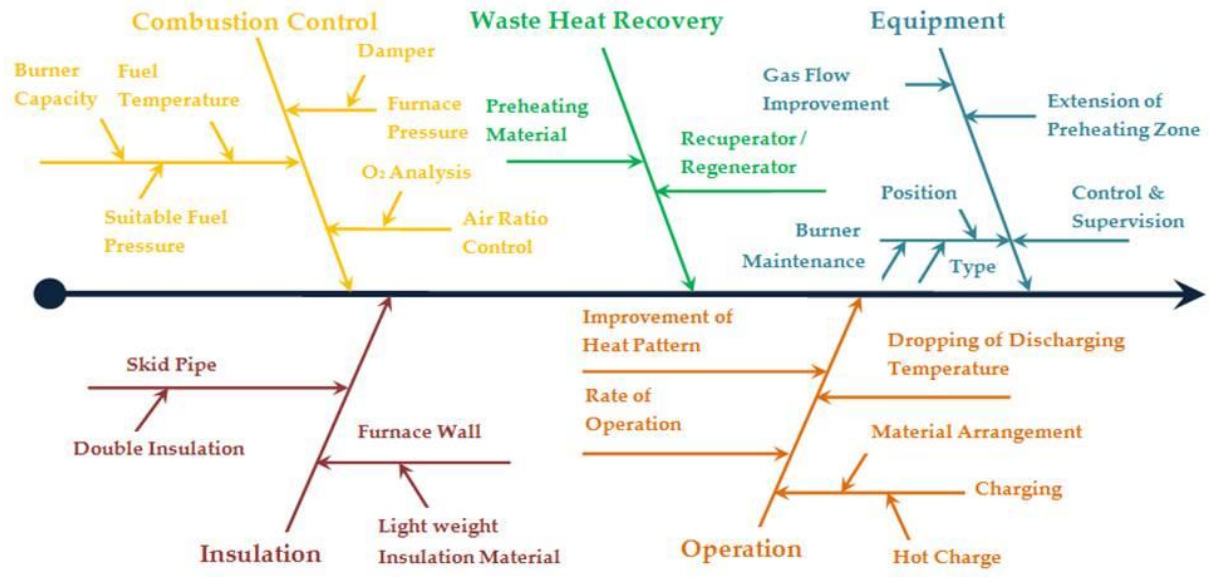

Characteristic diagram of energy optimization, maintenance practices and control system in kiln

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COMBUSTION

HydroCarbon Carbon Dioxide

$$CH + O_2 \rightarrow CO_2 + H_2O$$

Oxygen Water

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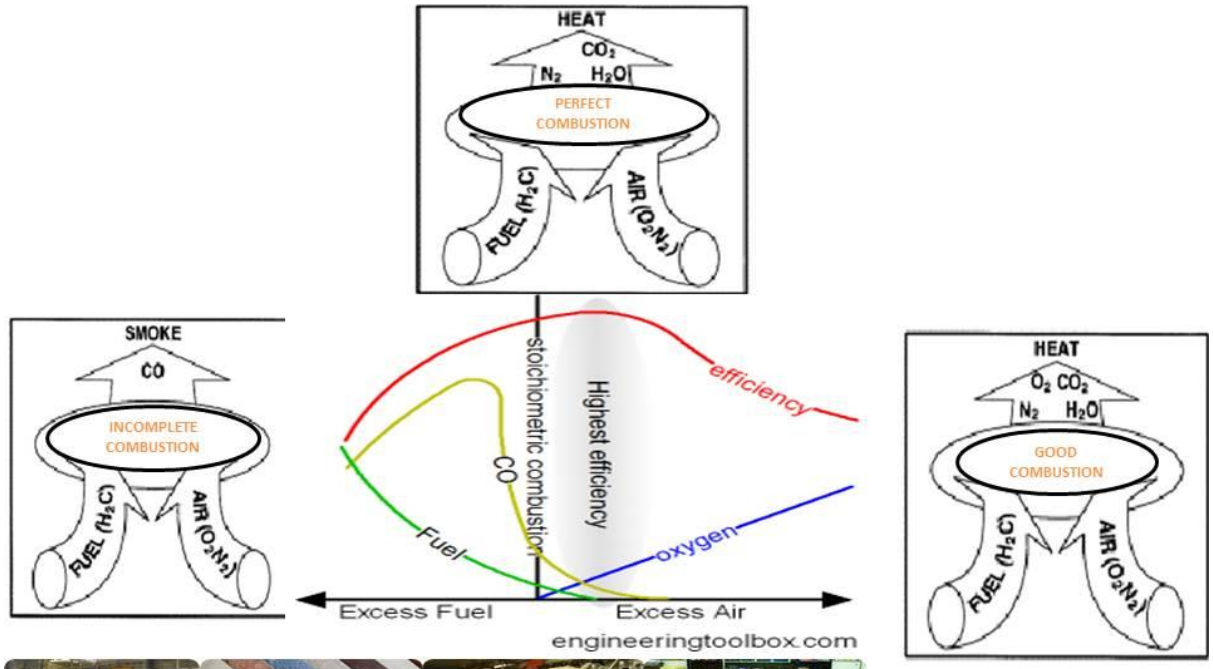
Three types of combustion



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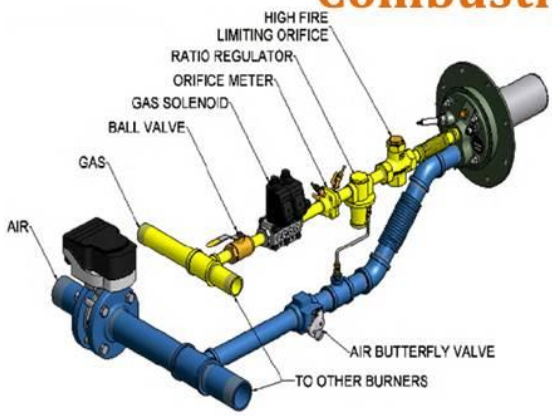
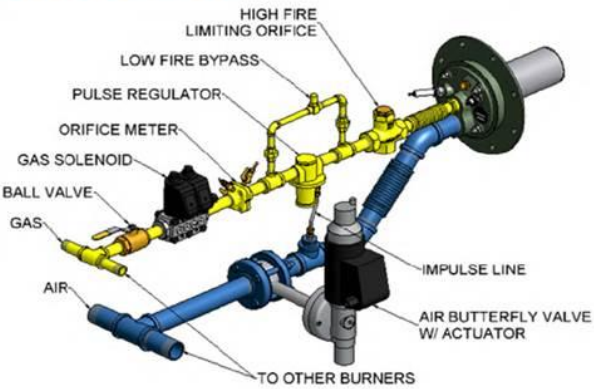
Combustion Control



Modulating control



On Off control

Benefits of combustion control

- Reduce excess fuel consumption.
- Reduce blower power consumption
- Increases exhaust temperature
- Give higher benefits in preheated combustion air as well as in dryer applications

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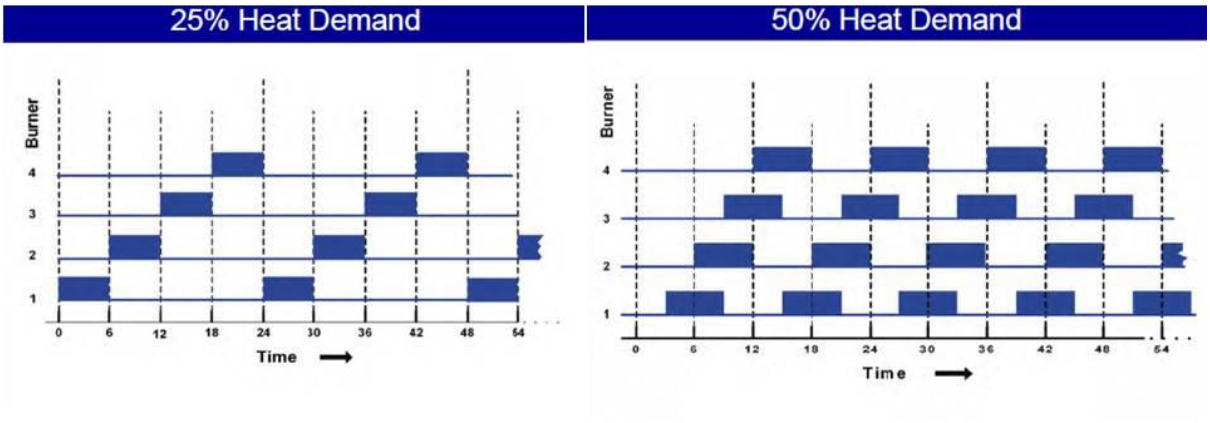
Burner control with variation of heat load



- Pulse firing converts an analog heat demand signal to a digital firing sequence.

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Waste Heat Recovery

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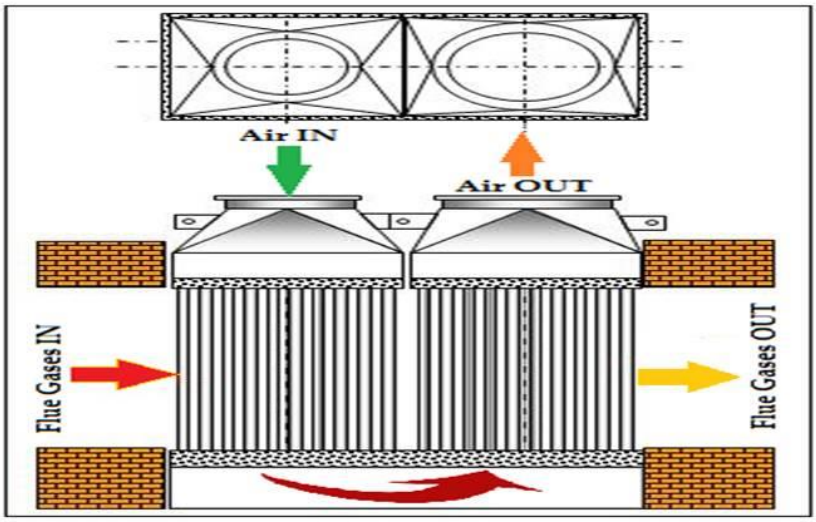
Recovering waste heat from flue gas



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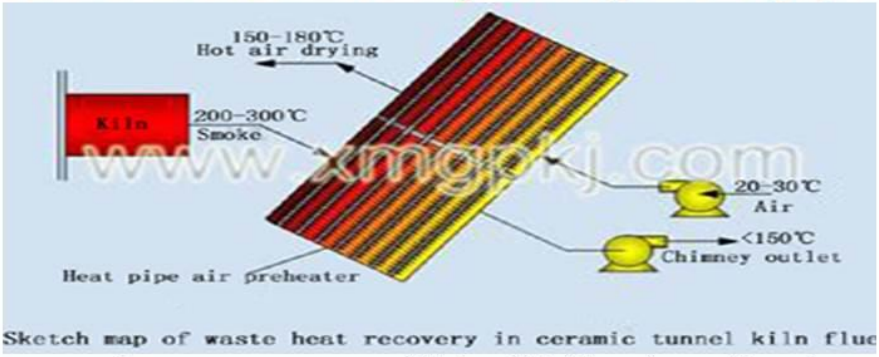
Waste heat recovery using heat pipe



Sketch map of waste heat recovery in ceramic tunnel kiln flue

- With a waste flue gas temperature of 200 to 300 ^{0}C, preheated hot air temperature of about 150 to 180 ^{0}Cel can be achieved from a heat pipe technology.

Utilisation of waste heat:

- kiln waste heat recovery is mainly used for heating air as heat source for drying blank pieces,
- Used in preheating combustion air to improve the thermal efficiency

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Radiation Loss

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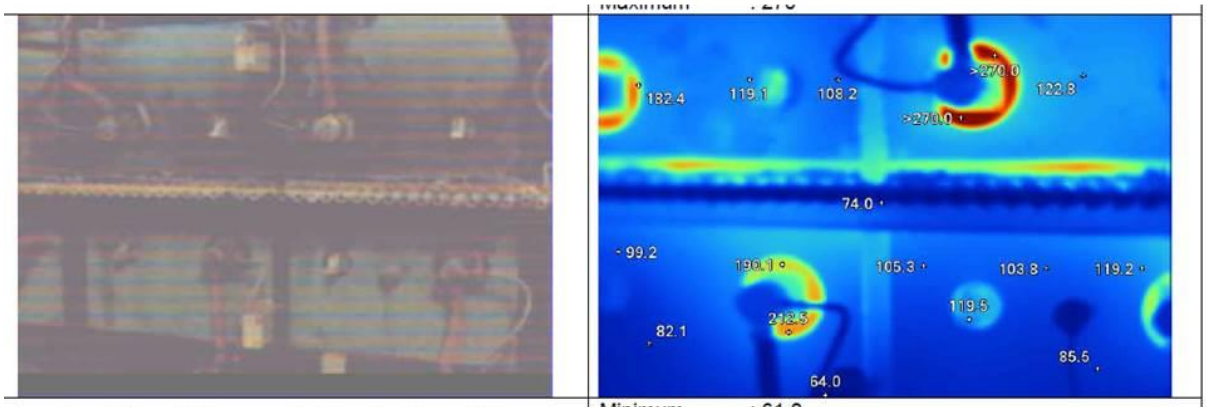
Reduction of radiation loss



Description:- Firing zone Module 21 of Biscuit Kiln (RHS)

Minimum : 61.0
Average : 165.5
Maximum : 270

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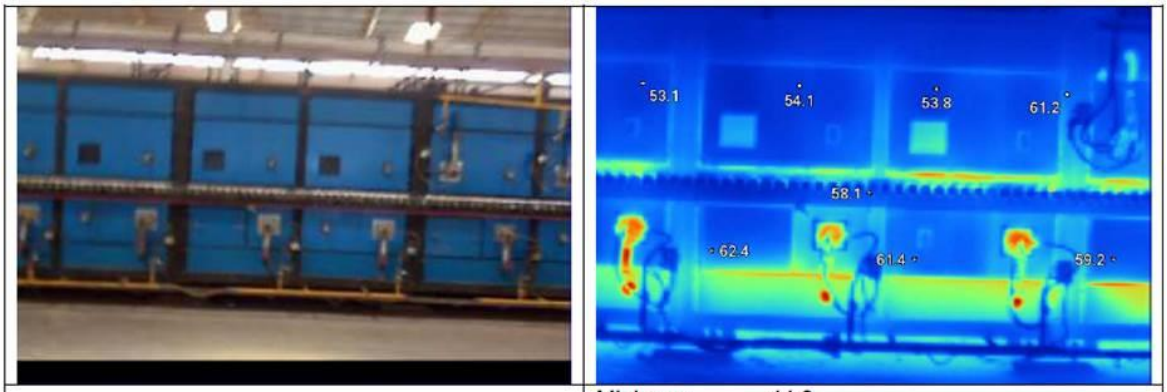

Description:- Firing zone Kiln (LHS)	Minimum :44.3 Average :62.9 Maximum :123.5

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Reduction of dead weight

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Principle

- Use of low thermal mass for kiln cart to **reduces the thermal weight** of the kiln considerably
- Weight reduction in kiln car saves significant amount of energy and also **improve material to car weight ratio**
- Reduces excess the **thermal energy storage** in the kiln furniture (**Roller**)

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Ways out and benefits

- Use of improved insulation material such as ultralite and hollow bricks
- Ultralite insulating material with supporting block gives proper support and increase the strength of the kiln base
- Replacing refactory bricks with hollow ceramic coated pipes at the supporting pillars for holding racks
- Dead weight can be cut down to 15 to 25% of the existing weight

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Low weight and density

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Energy saved by reduction of dead weight

$$Q = mass\ x\ Cp\ x\ (Tin\ -Tout\ )$$

50% of existing energy can be saved

Example

Without low thermal mass

$$Q_1 = 10\ kg\ x\ Cp\ x\ (Tin\ -Tout\ )$$

With low thermal mass

$$Q_2 = 5\ kg\ x\ Cp\ x\ (Tin\ -Tout\ )$$

Q_2 will be 50% lower than Q_1

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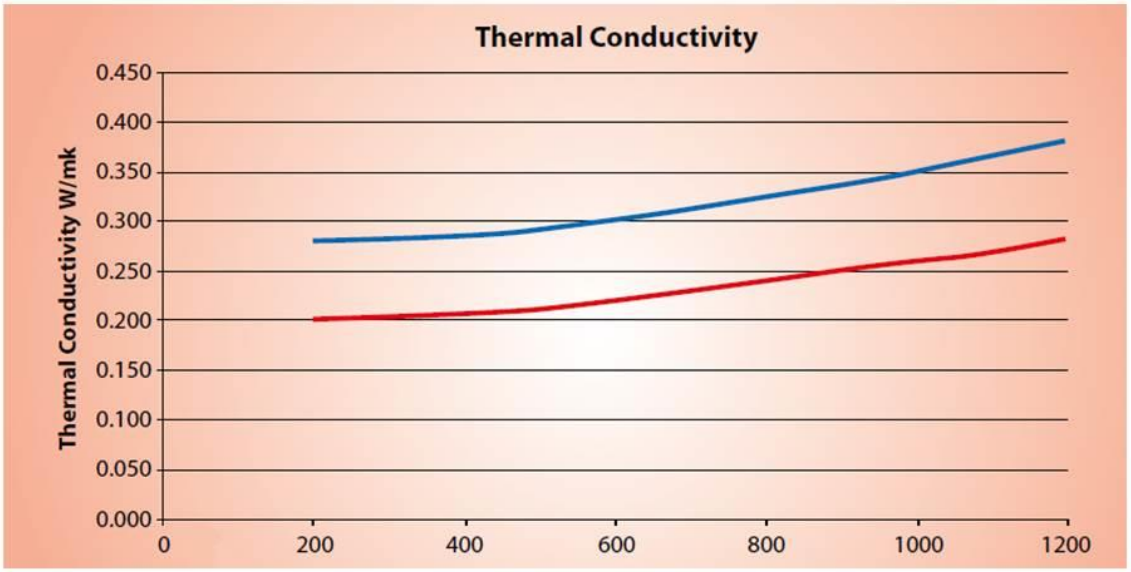
Low thermal conductivity



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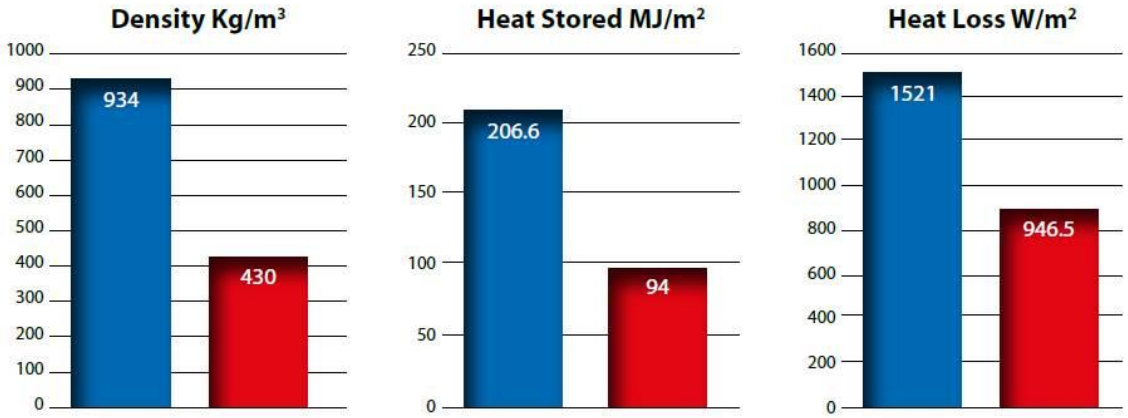
Less heat stored and lower loss



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Advantages of Ultralite insulating material

- High open porosity
- Low thermal mass
- Low permeability
- Low thermal conductivity
- Low bulk density
- Lightweight

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Undercar Temperature Comparison	Traditional Construction	Ultralite Construction
Hot Face/Peak Firing Temperature (°C)	1250	1250
Undercar Temperature/Cold Face (°C)	111	97
	Undercar Temperature Saving ‡ 12%	

Heat Energy Comparison in Kiln Car Base	Traditional Construction	Ultralite Construction
Total Heat Flow (MJ)	170.1	137.9
Heat Stored (MJ)	433.7	206.7
Combined Heat in Kiln Car Base	603.8	344.6
	Energy Saving in Kiln Car Base Insulation ‡ 43%	

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Electrical Utility

INDUCTION MOTORS AND ASSOCIATED AUXILIARIES

Why EE Motors

- More than 300 million motors are used in industry
- About 30 million new electric motors are sold each year for industrial purposes alone.
- Electric motor driven systems in industry are estimated to be responsible for 69% of industrial electricity consumption.
- Most of the motors installed in Indian industries are standard efficiency class (IE-1 or Non IE)
- Approximately 16% motors are rewinded multiple time

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Electric motor driven systems

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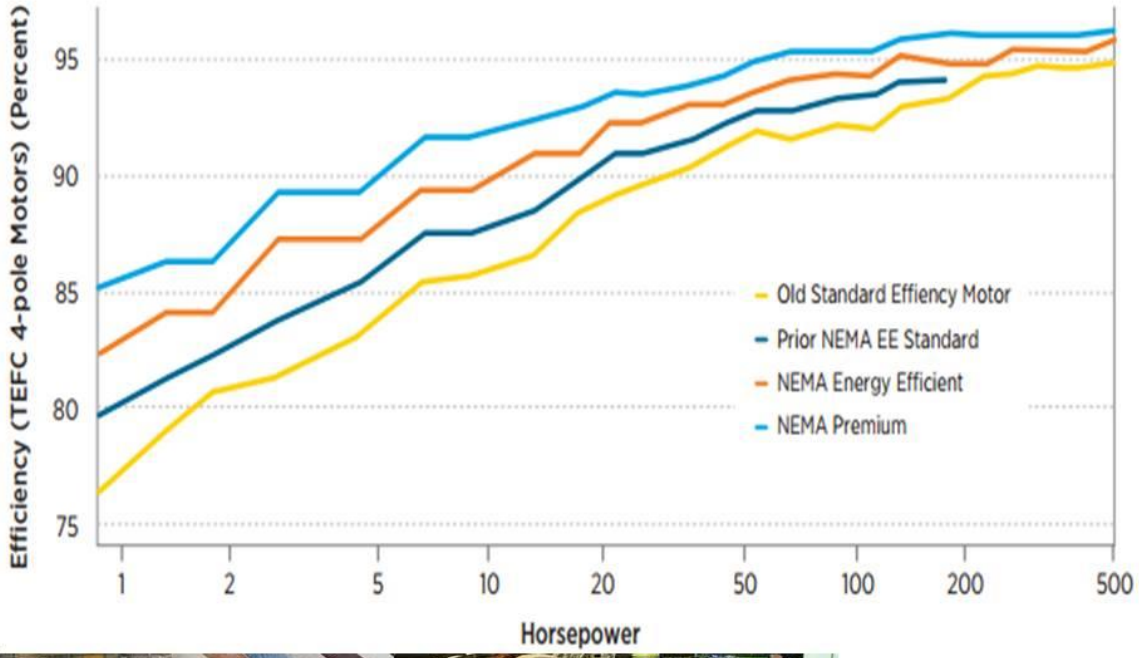
Premium Efficiency Class Motor (IE3)



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Motors Not Covered by IE3

- Single-phase motors
- DC motors
- Two-digit frames (48-56)
- Multi-speed motors
- Medium-voltage motors
- Totally enclosed nonventilated (TENV) and
- Totally enclosed air over (TEAO) enclosures
- Motors with customized OEM mountings
- Intermittent duty motors
- Submersible motors
- Encapsulated motors
- Motors that are integral with gearing or brake
- where the motor cannot be used separately
- Design D motors
- Partial motors

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Cost of operation – Life cycle costs

Description	Unit	IE1	IE2	IE3
Motor Load Requirement	kW	13.5	13.5	13.5
Motor Rating	kW	15	15	15
Motor Efficiency at operating load	%	88.7	90.6	91.4
Input Power	kW	15.2	14.9	14.8
Motor loading	%	90.0	90.0	90.0
Annual electricity consumption (@ 5000 hours per year)	kWh/Year	76,099	74,503	73,851
Difference in electricity consumption	kWh/Year	-	1,596	2,248
Increased in running (@ Rs. 6.5 per kWh)	Rs./Year	-	10,373	14,612
Initial investment	Rs.	25,500	29,950	31,875
Increase in Investment	Rs.	-	4,450	6,375
Lifecycle cost (@ 5 Years)	Rs.	24,98,724	24,51,308	24,32,039

Incremental cost of motor (IE3) will be recovered within 5 months.

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Variable loads and VFD or ASD

- Many motor applications have high operating hours but variable loads.
- VFD/AD helps in adapting motor speed and torque to the required load.
- Largest benefit comes with pumps & fans in closed loops for which power consumption varies as a cubic power of their rotational speed.
- In air-conditioning systems, the temperature and flow control of pumps and fans can be achieved with VSDs, reducing on/off cycles and providing a more stable indoor climate

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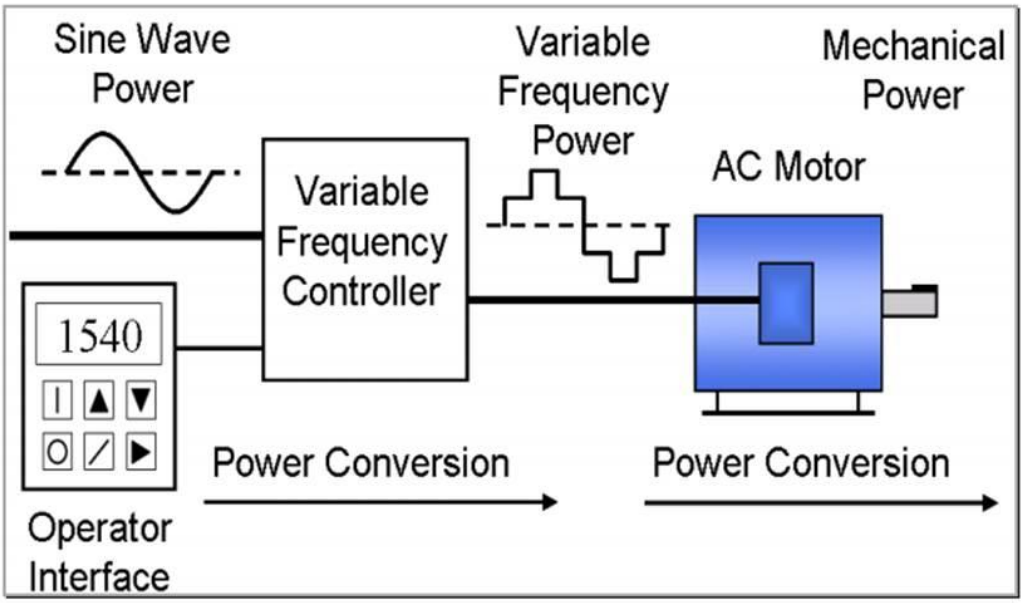
Schematic variable-frequency drive



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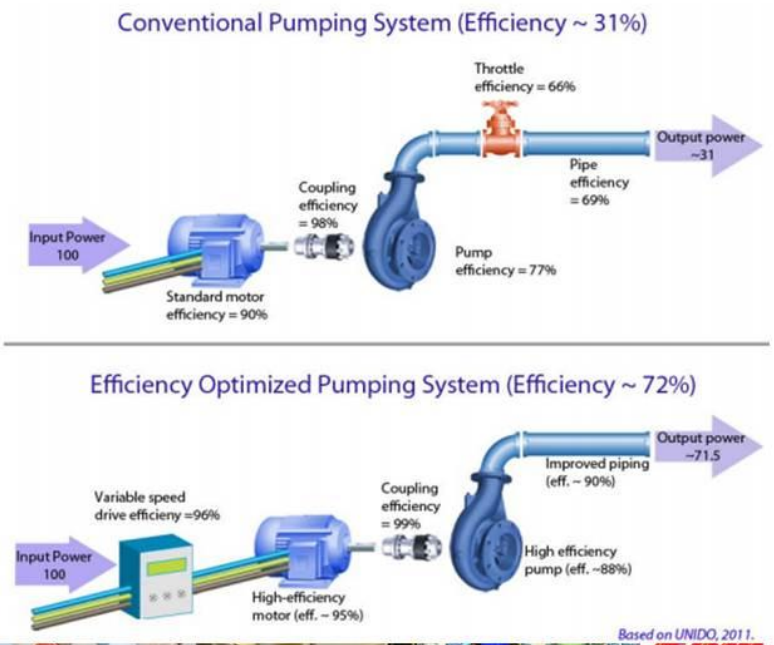
Application of VFD



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Thank you

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