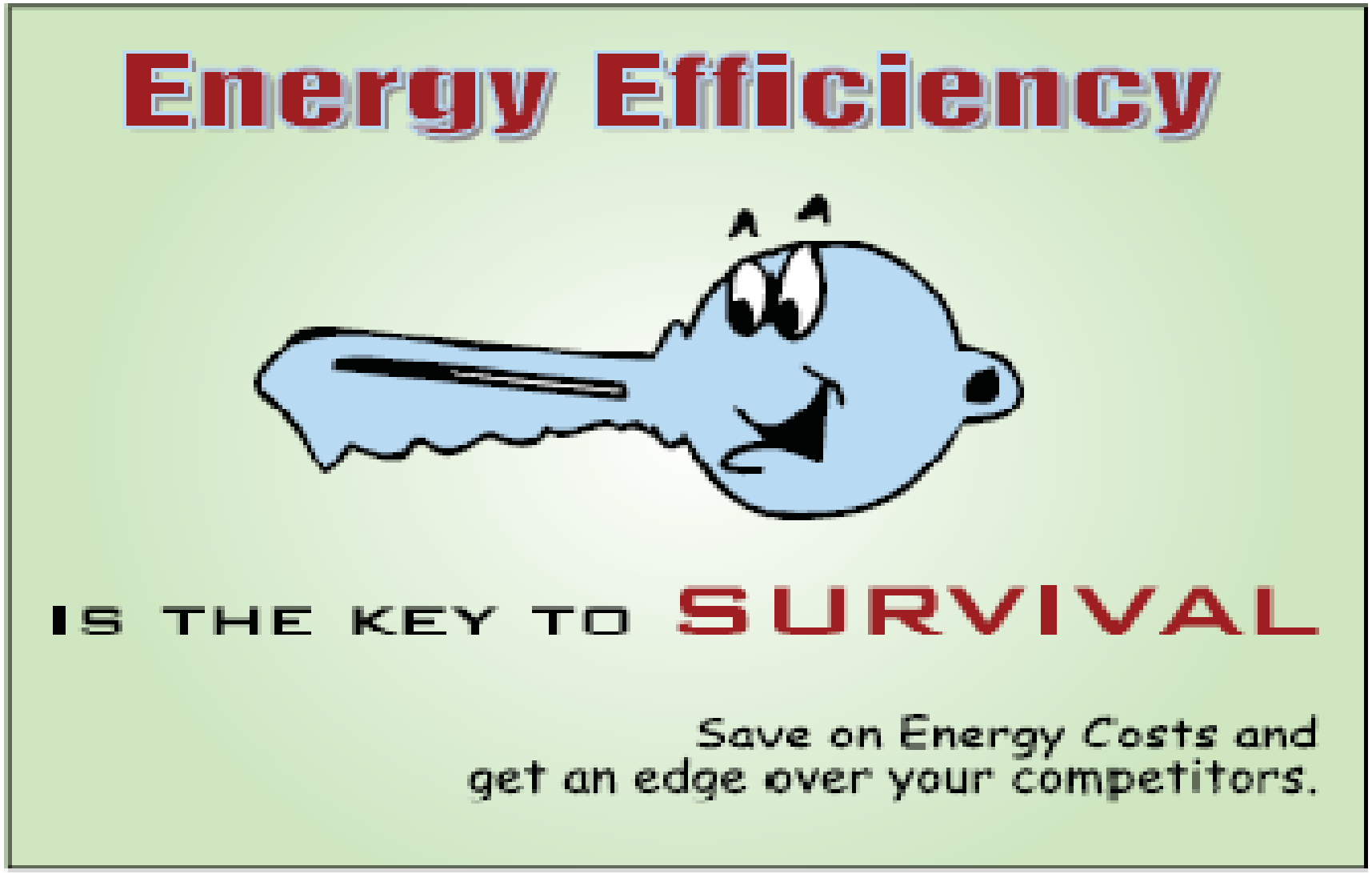
Energy Saving improves Operating Profit Margins



Need for Energy Audit

- Three top operating expenses are

- **energy (both electrical and thermal),**
- **labour and**
- **materials.**
- **Primary objective of Energy Audit is**

- **to determine ways to reduce energy consumption per unit of product output**

- **or to lower operating costs**

Consumer Power bill – what is the breakup ?

- When EB is charging the industry in KVA, KW, PF then we should be in a position

- to measure power parameters of individual equipments
- & account for total EB consumption.

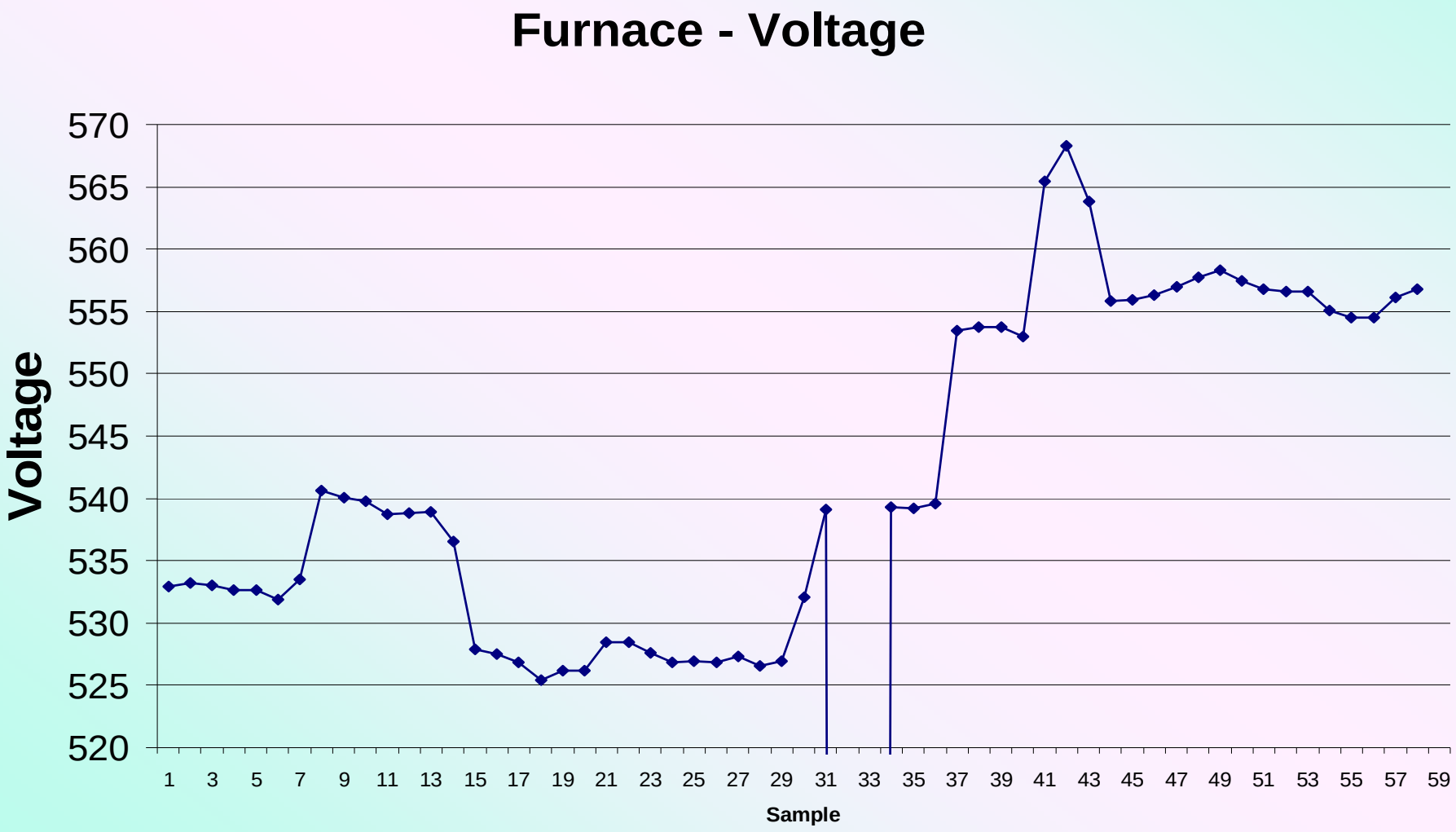
- By energy conservation in the industry,
- we try to recover the losses which go as waste.

- By Energy Measurement, we draw a line between Avoidable and Unavoidable Losses
- and plan to minimize same.

Condition based monitoring in Foundry

- Low cost Thermal Imager for Utility equipments
- to monitor electrical conductor losses at Transformer & MV panel, upto the motors to find and arrest Hot spots.
- Before & After Refractory Lining Hot spots and surfaces
- radiation losses leaked from induction furnace surfaces,
- cooling pump circuit + cooling tower temperatur gradient
- High cost Thermal Imager to monitor Molten metal temp.
- Pump Input & output field pressure, flow measurements
- Fans input & output Pascal and CFM measurements.
- MD controller for each furnace to utilize each compressor
- By manual, semi-automatic and fully automatic means.
- Compressor online FAD and pressure drop measurements.

Induction Furnace – voltage Drops and voltage Fluctuations increase the heat time for the same KWH consumed & for same KG of metal melted.



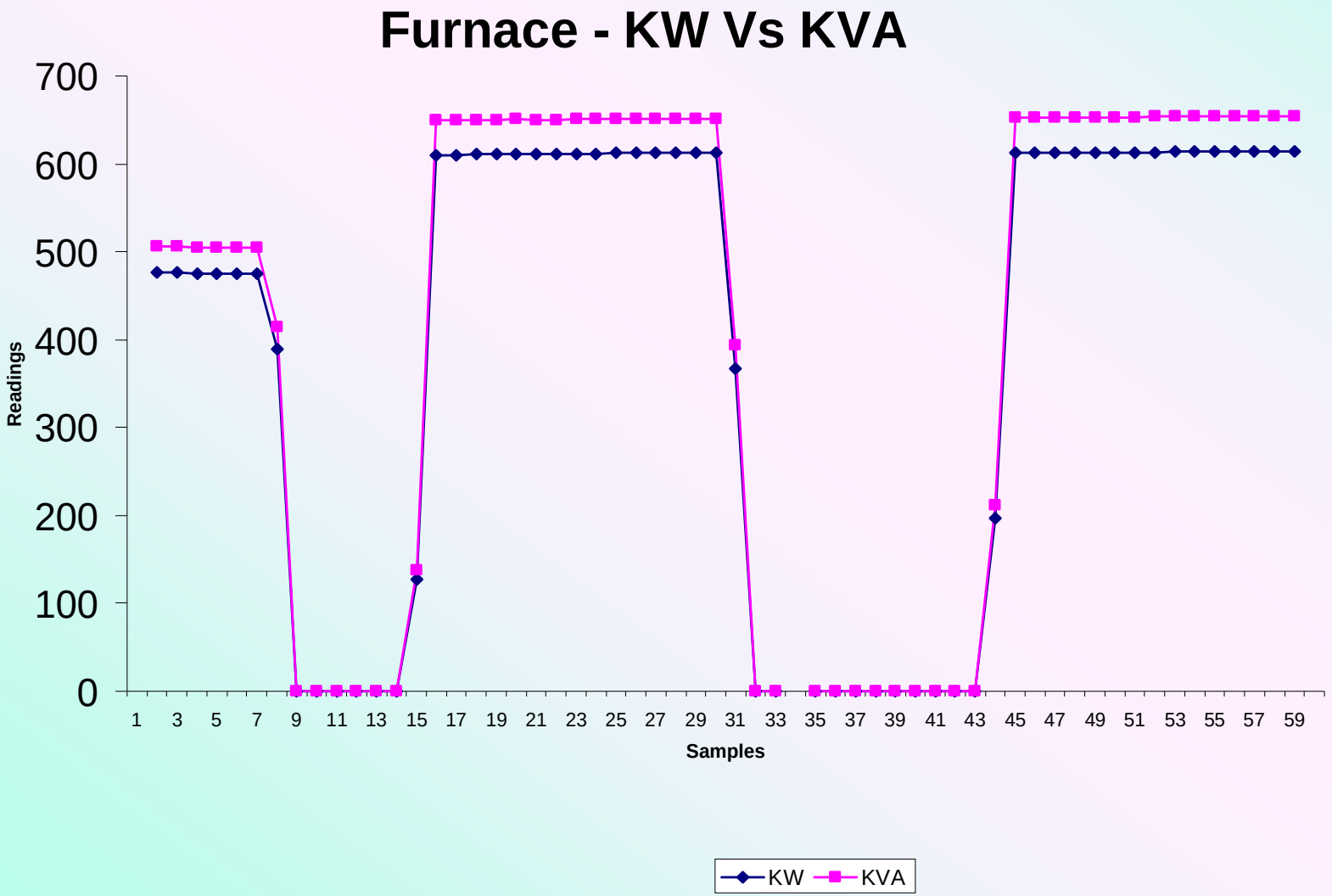
Thermal Efficiency parameters of Induction Furnace

- 3 to 10 % Losses in the Electrical System in connecting the bus bars
- 18 to 22 % losses in Induction coil as well as the water cooled leads
- 4 to 6 % losses in keeping the lining hot
- 2 to 4 % losses in radiation etc.
- **55 to 75 % Thus the Thermal Efficiency of Induction Furnace varies in the range.**

Energy Balance in Induction Furnace

Material Grey Iron	Crucible Capacity	3200 Kg
	733 KW Production capacity	 1600 Kg /hr
Input Energy	660 Units / Ton	100 %
USEFUL HEAT	380 units / ton	58.5 %
Coil I2R losses	130 units / ton	20 %
Radiation losses	97.5 units / ton	15 %
Conduction losses	34 units / ton	5.2 %
Unaccounted loss	18.5 units / ton	1.3 %

Induction Furnace KW & KVA
To make use of Maximum Demand Controller to Maximize & Automate the demand from load



Induction Furnace Efficiency Vs Power Density

Increased power levels reduce melting Cycle, hence units per ton reduces, when utilised FULLY.

Poor utilisation increases Power Consumption

Furnace Capacity Tons	**Power KW**	**Power Density KW / T**	units / ton **100 %utilised**	units / ton **Actual**
2	700	350	580	700
5	1500	300	590	700
3	700	233	618	760
10	1800	180	625	762

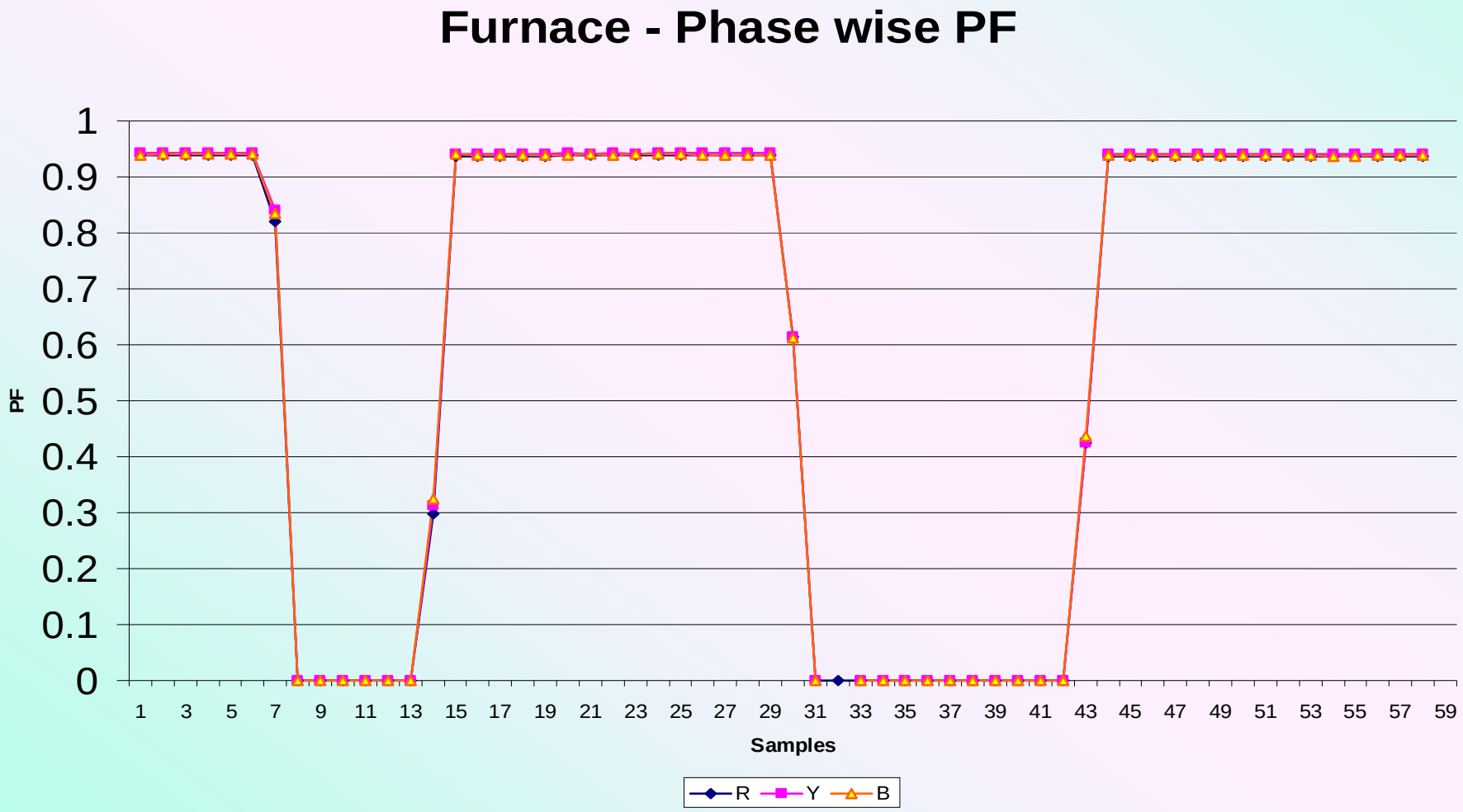
BEE case study show that due to harmonic loads the full load losses on transformer have gone up by 40 % in 1250 kVA,

This leads to de-rating to around 80 % of the rated KVA of the transformer. **Here we are losing around 200 units per day in a transformer from operating at half load to full load. So Monitor the KWH at HT and LT of each transformer for savings now.**

So the KVA demand reduction by Harmonic reduction filter indirectly provides more KVA released to productivity.

(Oil Transformer) Losses		
KVA	Half Load (w)	Full Load (w)
500	2465	4930
750	3950	7900
1000	4360	8720
1500	6940	13880
2000	8155	16310

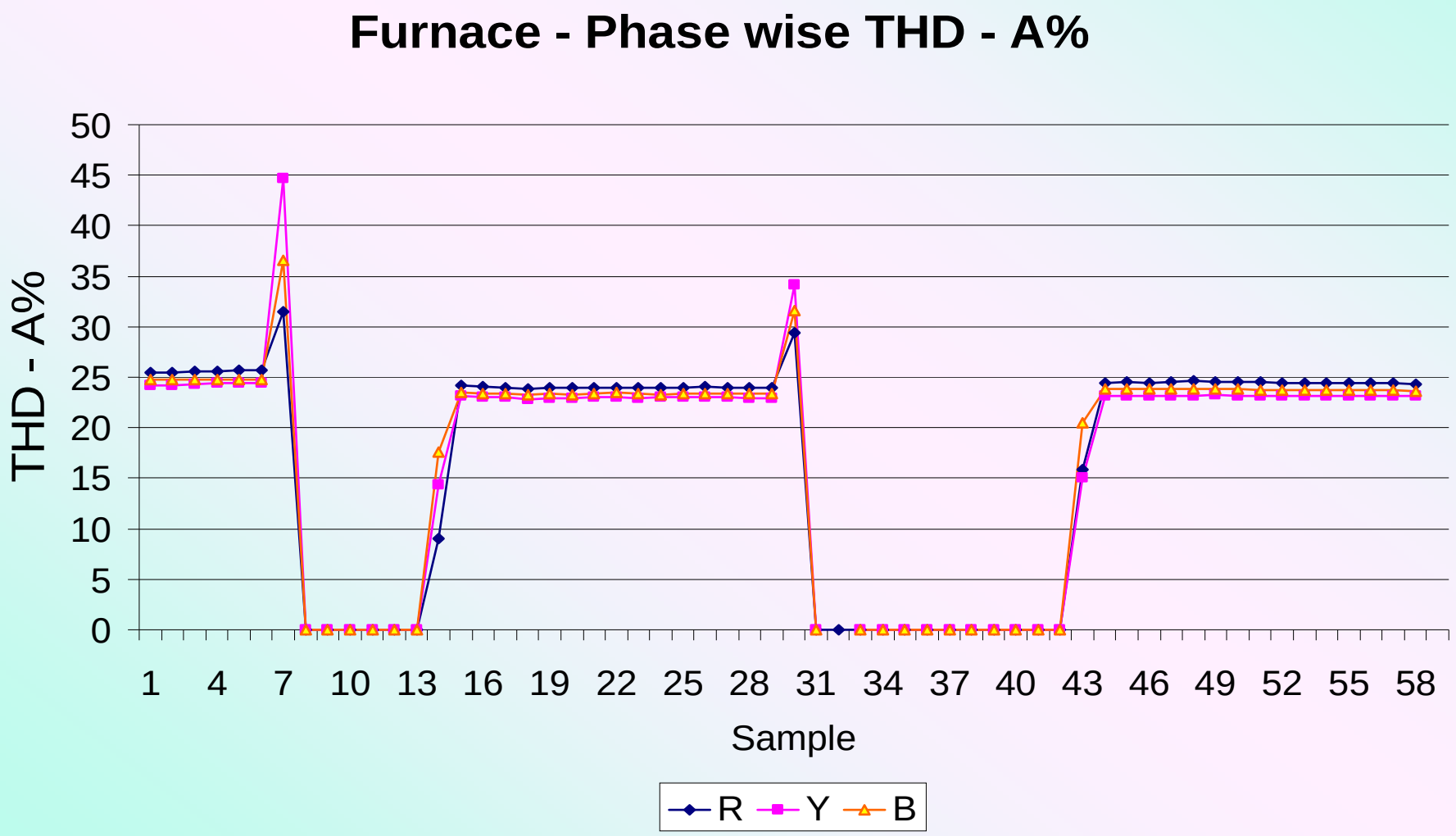
Induction Furnace – compensate with adequate sized reactance coupled capacitor to increase PF & reduce the demand KVA



Industry is Overdoing EB's PF incentive !
2 % less KVA @0.98 PF can be safely consumed instead of paying 15 % Harmonic penalty to EB.

- Indirectly it is a LOSS to the industry and EB in the case of non-linear loads and leading PF voltages.
- And same needs to be monitored by 3 CT APFC at Power House to maintain steady Lagging PF
- The industry to be satisfied with PF 0.98 instead of pumping THD to grid at the UPF.
- The industry with non linear loads can utilize Less % in KVA instead of dumping more harmonics to the EB grid incoming.
- Our Energy audits in big industry groups have shown that maintaining at 0.97 to 0.98 PF the THD comes down in many industries, and many benefits of safe electrical distribution.

Induction Furnace – Steps to reduce Harmonics dumped to EB side by sized Harmonic Filtering



CAPACITOR OF THE OLDEN DAYS
VS HARMONIC FILTER OF THE PRESENT DAY

- **Load end Capacitor + fixed bank +**

Automatic PF controller for linear loads =

- **Filter Choke + Reactance coupled Capacitor**

+ Active Harmonic Filter for non linear loads.

- **PF improvement IN STAGES done before & now**
- **Harmonic distortion reduction IN STAGES will be the**
- **Practically Possible Energy Efficient Solution.**

Capacitors condition in location and sizing & LC type in industry & Harmonic Increase

Capacitors themselves do not cause harmonics, but only aggravate potential harmonic problems.

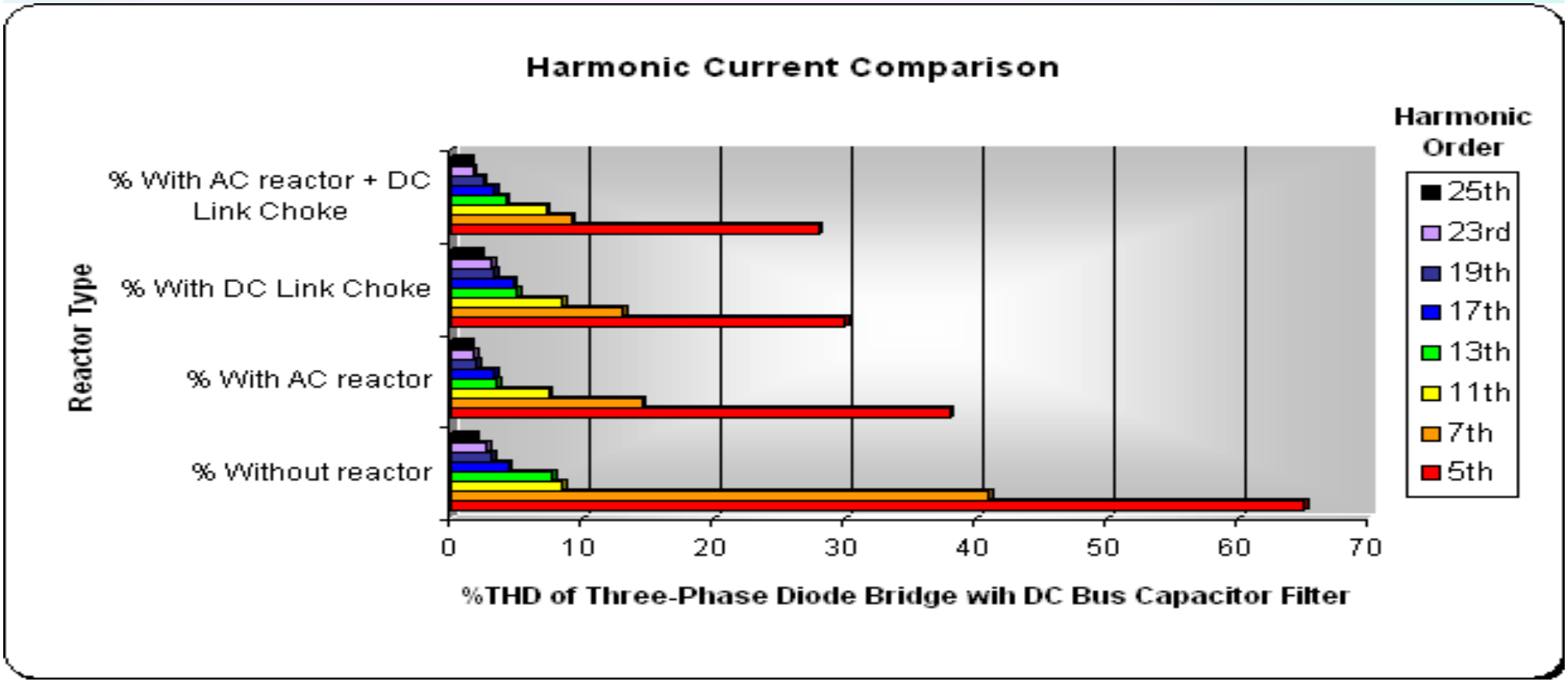
Often, harmonic-related problems do not "show up" until capacitors are applied for power factor correction.

Harmonic currents if not arrested at the VFD by the Reactors, the same will be dumped to MV panel to grid !

and the Active Harmonic filter needs to oversized.

H 5 Amps is reduced from 65 %to 28 % using passive Reactors.

Please don't' oversize Active filter. This will consume more KW power compared to load end passive filters in hybrid combo.



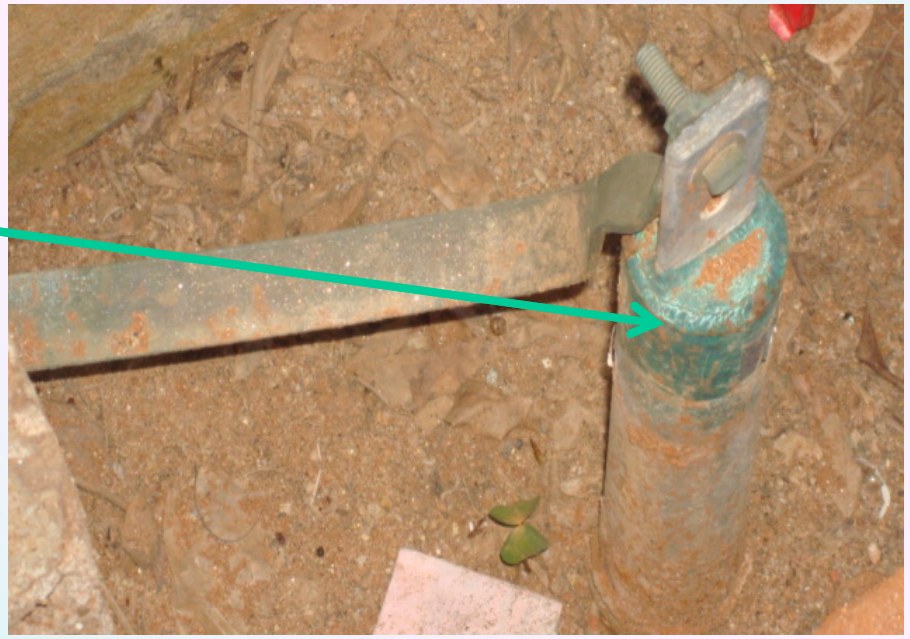
EARTHING TO BE WELL MAINTAINED TO PREVENT THE SURGES ATTACKING THE MACHINES

CONVENTIONAL EARTHING

PAINTING LOOKS OK BUT EARTHING IS POORLY MAINTAINED

MAINTENANCE FREE EARTHING :

EARTHING IS GOOD IN THE LONG RUN and well maintained.



Radiation losses in foundry

- **Temperature * C -** **Energy loss in kwh units.**
  - **1100** **15 units / sq ft.**
  - **1400** **36 units / sq ft.**

- **Practice to allow 100 –150 *C higher temp for melt to take care of heat loss in sadle & during transit up to the Mould machine**

- **Radiation – Line of sight phenomenon : Heat loss roportional to difference of 4^{th} power of hot & cold surface temperature.**

- **Each 1* extra temp > 1 to 2 units extra consumed / ton melted.**

- **To lid the furnace or at least lid the ladle during pre-heating to reduce heat losses due to radiation**

Foundry furnace savings aspects

- Busbar losses - joints inpsect, overheating, discolor
- Pneumatic ckt - demoist, lubricate, press regulate
- Hydraulic ckt - oil level, filter, proper functioning
- Refractory lining - to check before & after melt'
- Transformer - ventilation, forced, oil temp, connect'
- Water ckt - quality, temperature, pressure ratings
- Water temp < 42 * C to prevent scale formation
- CT - functioning and water In /Outlet temperature monitoring etc., wooden fill > pvc fills practically.

MOTOR SURVEY Recommendations

•The following recommendations suggested after motor loading survey in the industry :-

• Identify motors by "Loading Versus Rating" value

• Below 50 % loading,

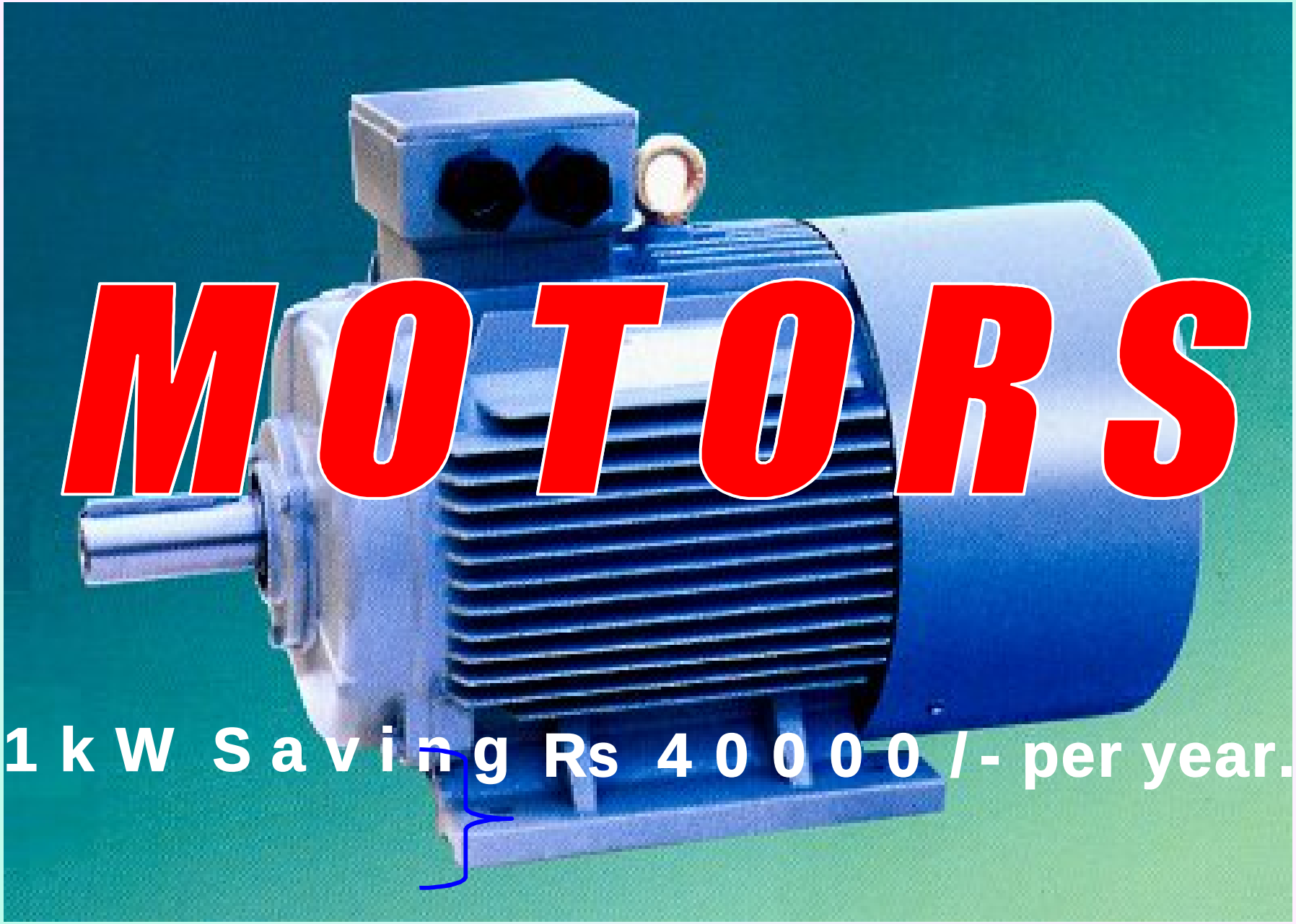
• 50 - 100 % loading,

• over 100 % loading.

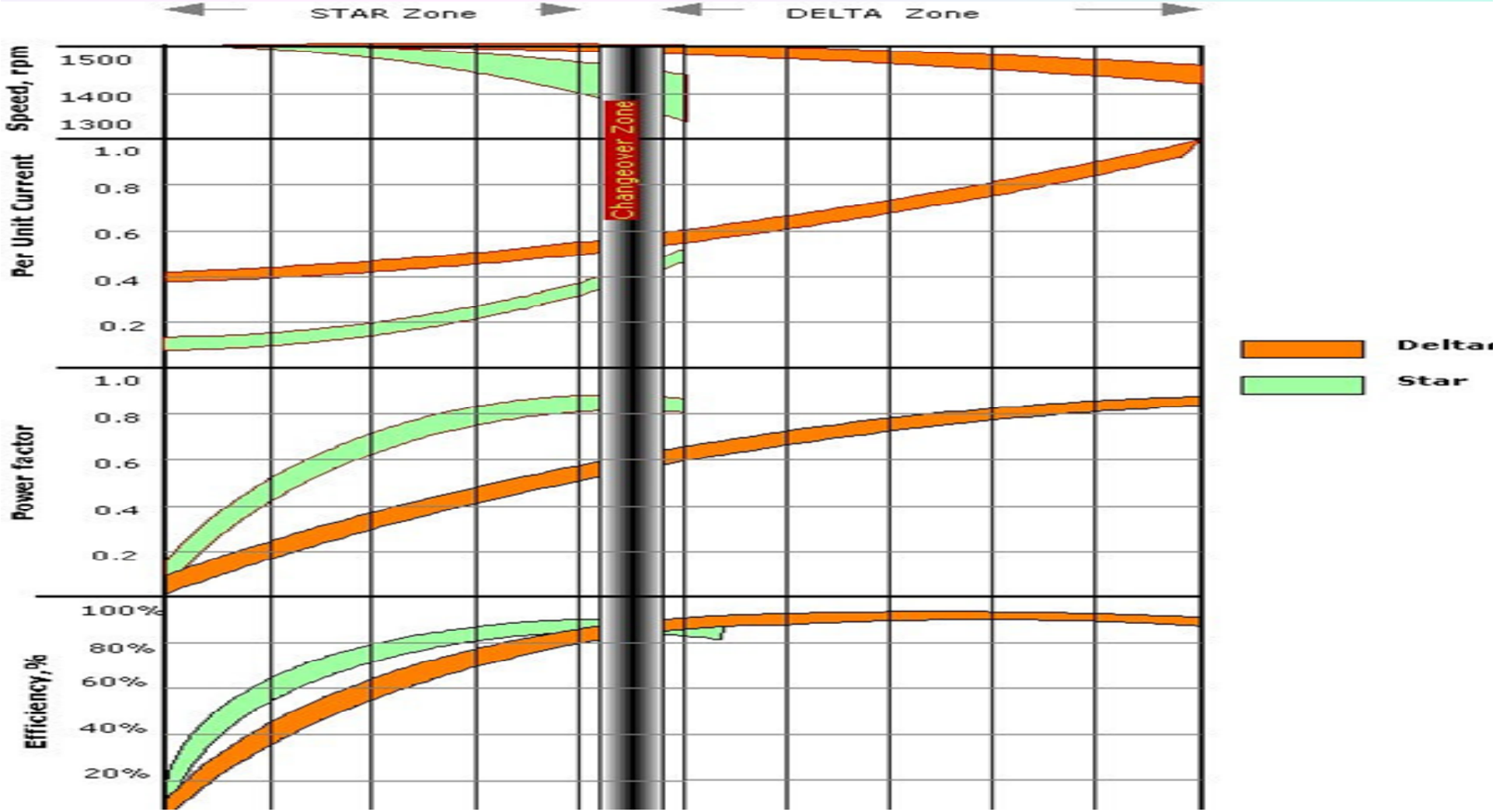
•Identify motors with machine side losses / inefficiencies like idle operations, throttling / damper operations for avenues like automatic controls / interlocks, variable speed drives, etc.

•Replace with smaller size motors.

•Reduce the load on 100% loaded motors or replace with higher size motors.


MOTORS
1 kW Saving Rs 40000/- per year.

Motor Efficiency drops by 10 %, if the motor is loaded around 30 % only. To bring back the efficiency, you can run the motor at Star mode using Auto Delstar Retrofit to regain the lost efficiency.



Motor Replacement to IE 3 version

•EESL conducted a motors replacement pilot project in a Surat textile cluster.

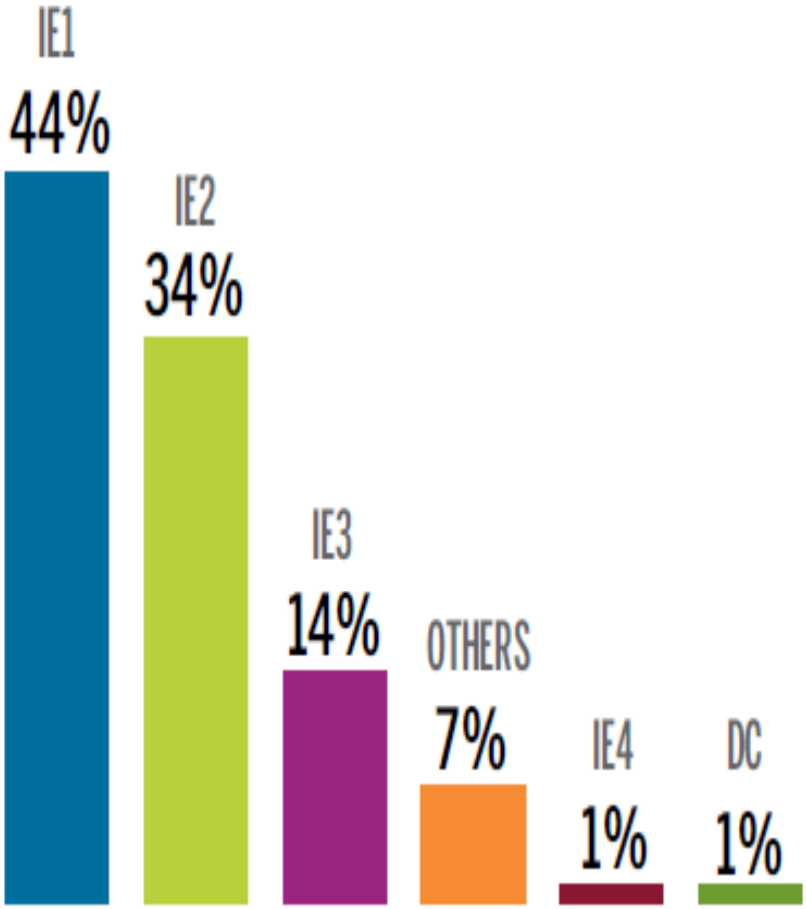
- Replacing only 10 inefficient industrial standard motors with energy-efficient IE3 motors

- may led to an annual cost saving of Rs. 800,000 and energy saving of over 110,000 kWh.

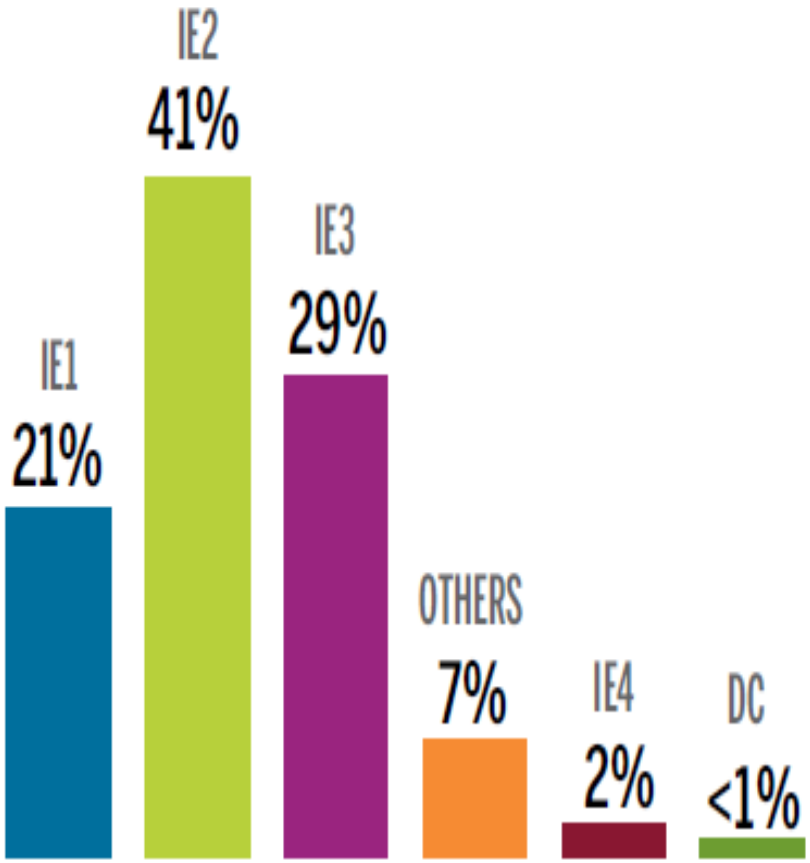
•All this with an investment of just Rs. 4,26, 500!

•On 8000 hour run motor, the payback is just 6 months.
•So plan TODAY to study the replacement costing and RETURN ON INVESTMENT in how many Months now?

Globally, IE 1 MOTORS GROWTH HALVED & IE3 MOTORS GROWTH DOUBLING NOW.



2014 Market Size (Units)
45.8 Million



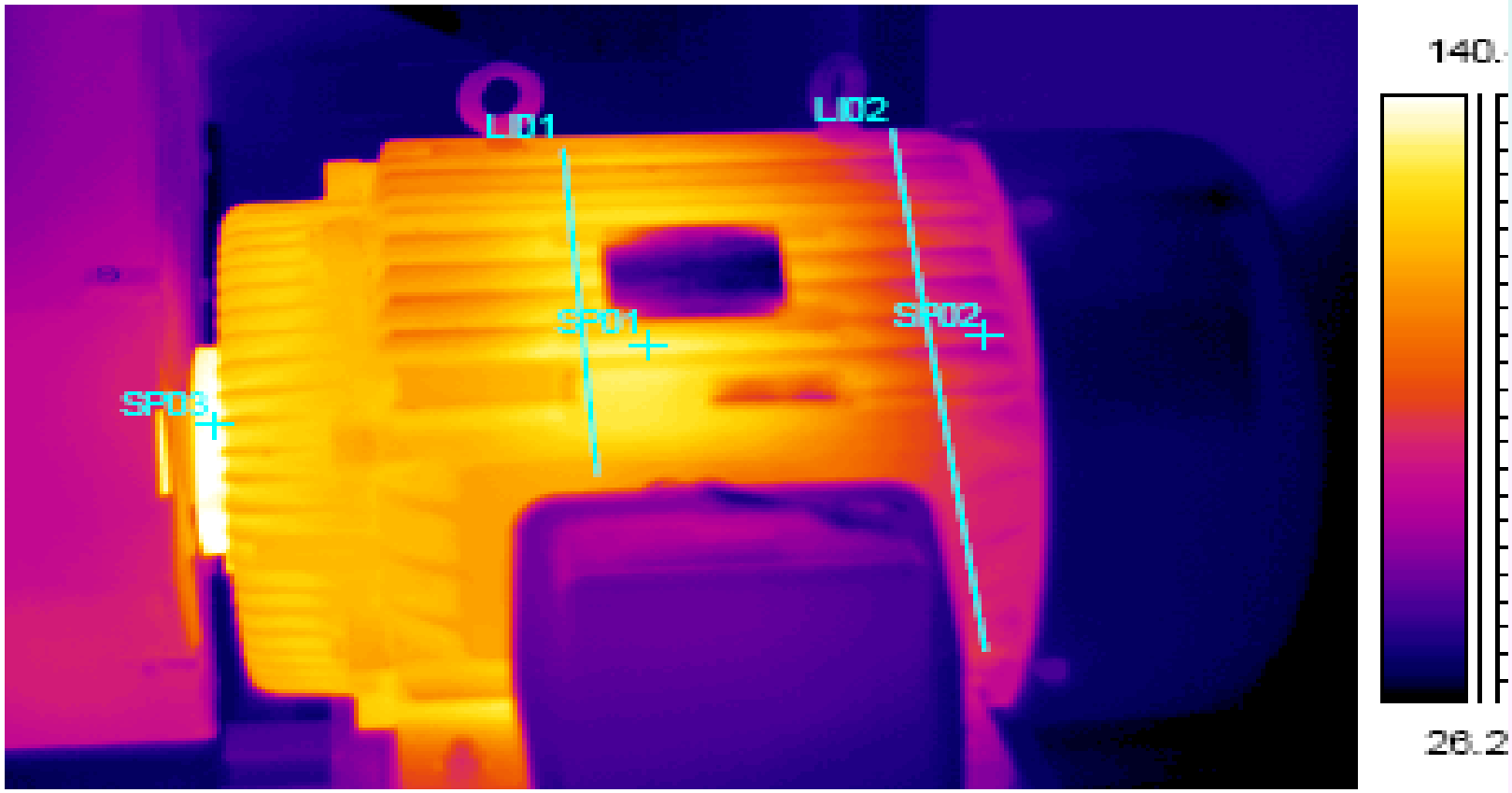
2019 Market Size (Units)
51.6 Million

Healthy Running MOTOR SKIN TEMPERATURE

To be less than 20 *C above Ambient.

Symptoms for healthy Running –

Warm & not Hot motor, Temperature difference in Drive & Non drive, Left & Right, Top & Bottom' to be minimum



Motor drive transmission efficiency –

Visible losses seen in Belt Losses from motor to load

The efficiency of mechanical power transmission depends on grip between pulley and belt, further depends on μ (Co-efficient of friction) and strength (Tensile) of the belt. In case of

Table 3.4: Losses in V Belts

Sr. no.	Motor HP	Losses %
1	2	8-15
2	3	7-13
3	4	6-12
4	6	5.5-10
5	8	5-9
6	10	4.5-8.2
7	20	3.5-7
8	30	3.2-6
9	40	3-5.5
10	60	2.8-5
11	80	2.5-4.5
12	100	2.5-4.5

Motor belt & pulley hotter than motor drive end. When replacing the belt, worn out pulley also to replace to suit to today's loading requirements.

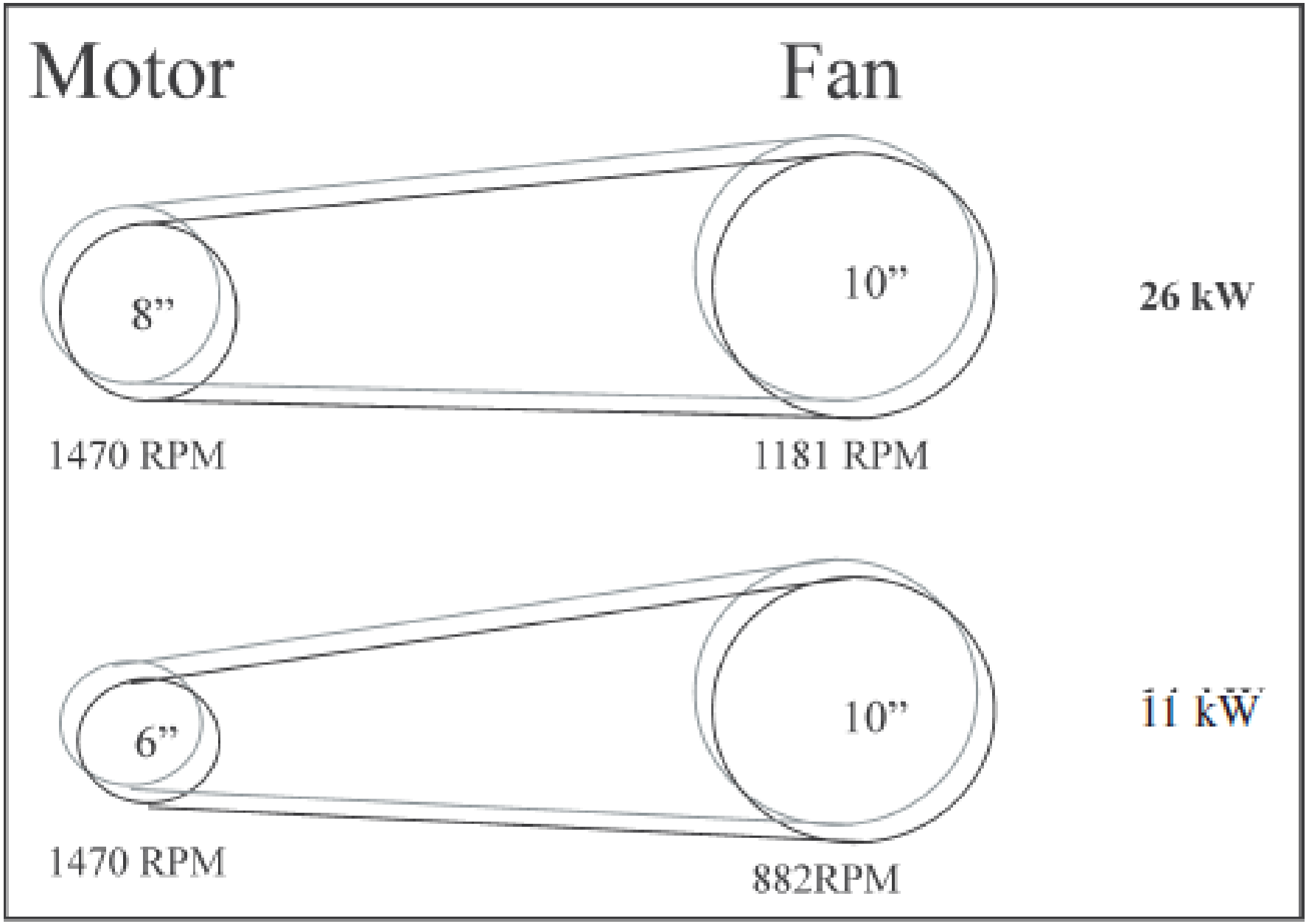
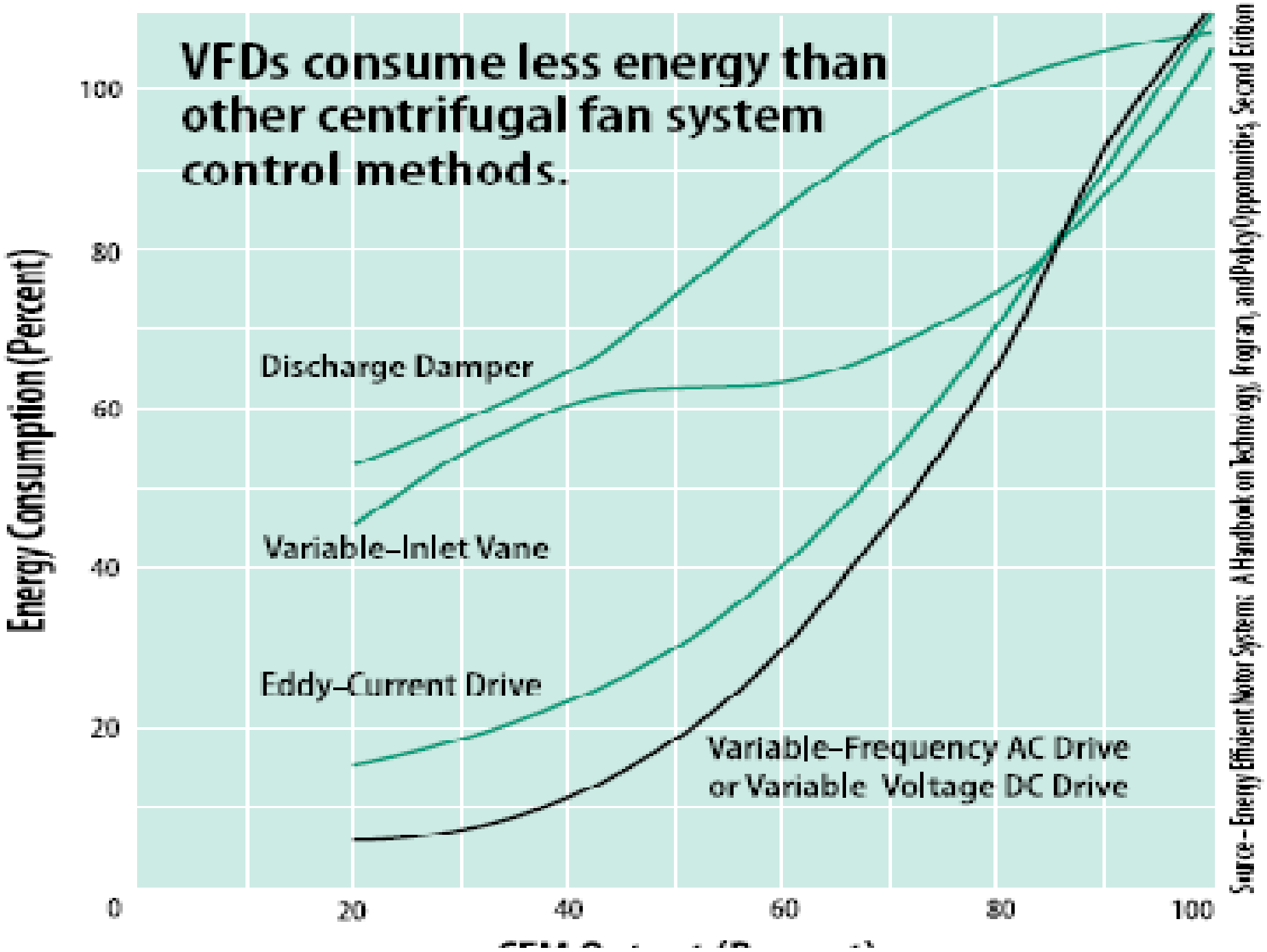
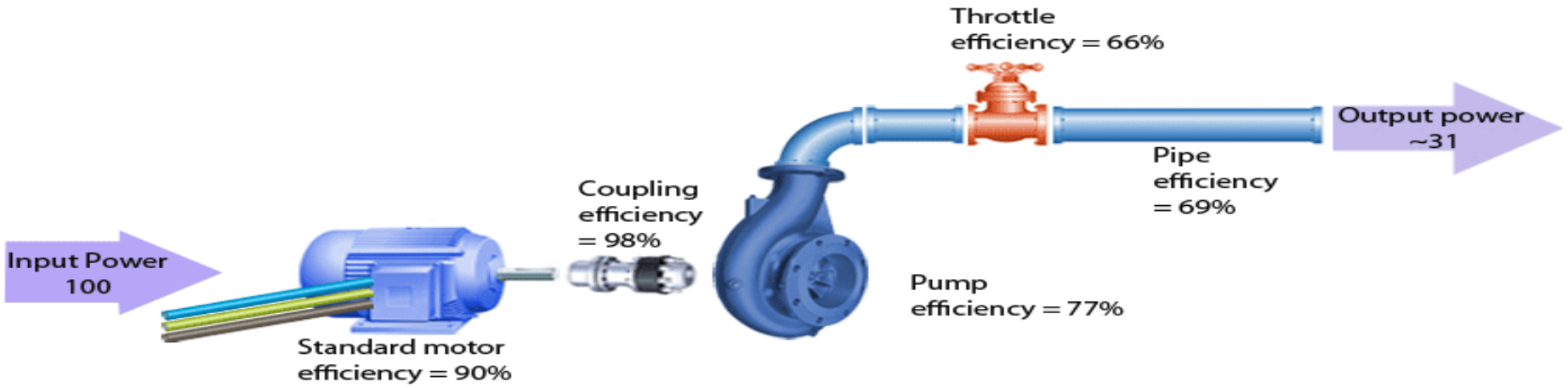


Figure 5.10 Pulley Change

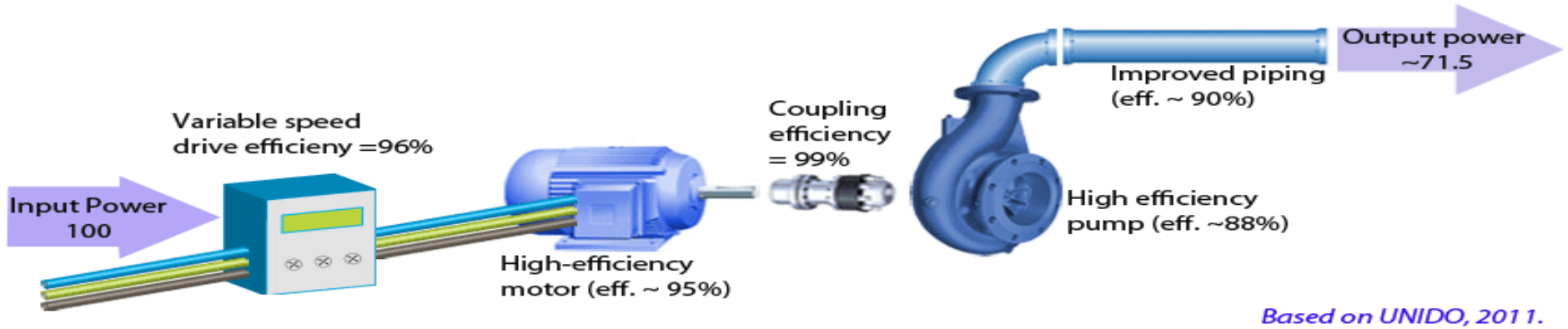

VFDs consume less energy than other centrifugal fan system control methods.
Energy Consumption (Percent)
100
80
60
40
20
0
20
40
60
80
100
Discharge Damper
Variable-Inlet Vane
Eddy-Current Drive
Variable-Frequency AC Drive or Variable Voltage DC Drive
Source: Energy Efficient Motor Systems: A Handbook on Technology, Program, and Policy Opportunities, Second Edition

Each sub system of pump loses power. Measure the break up of pump losses and correct each component to achieve energy savings in pump.

Conventional Pumping System (Efficiency ~ 31%)



Efficiency Optimized Pumping System (Efficiency ~ 72%)



Based on UNIDO, 2011.

Thermography based Predictive Energy Management practices.

- **Energy Auditing Practices using the Thermal Imager in the industry areas, especially in the Electrical Prime Mover Systems in the field, Process flow trains in the Production and utility,**
- **Machine condition monitoring as a System.**
- **Energy & Raw Material given in the Input**
- **And energy & product delivered in the output**
- **& Energy & Material in Exhaust, wasted areas.**
  - **MLM – Micro Level Monitoring &**
  - **MLA – Macro Level Analysis -what is wanted now !**

Emissivity of the surfaces is critical and prone to false reading when using thermal imager.

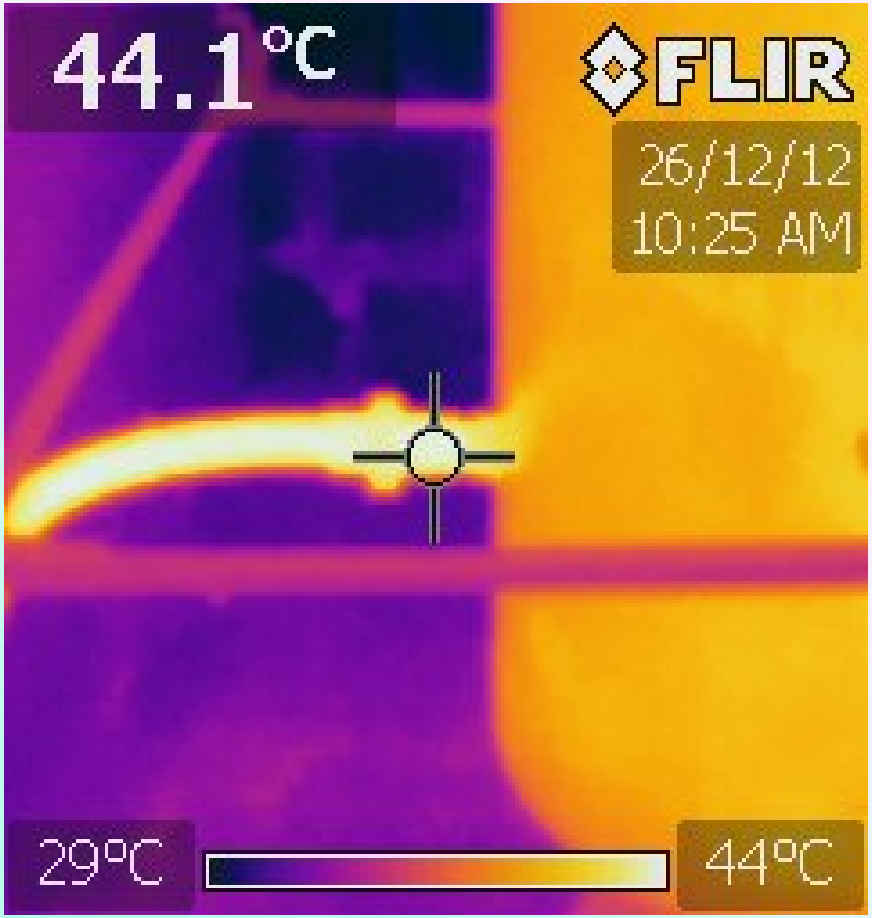
That is why, all thermal imaging display is marketed by non metallic surfaces having emissivity of 0.95, thus showing the electrical hot spots accurately.

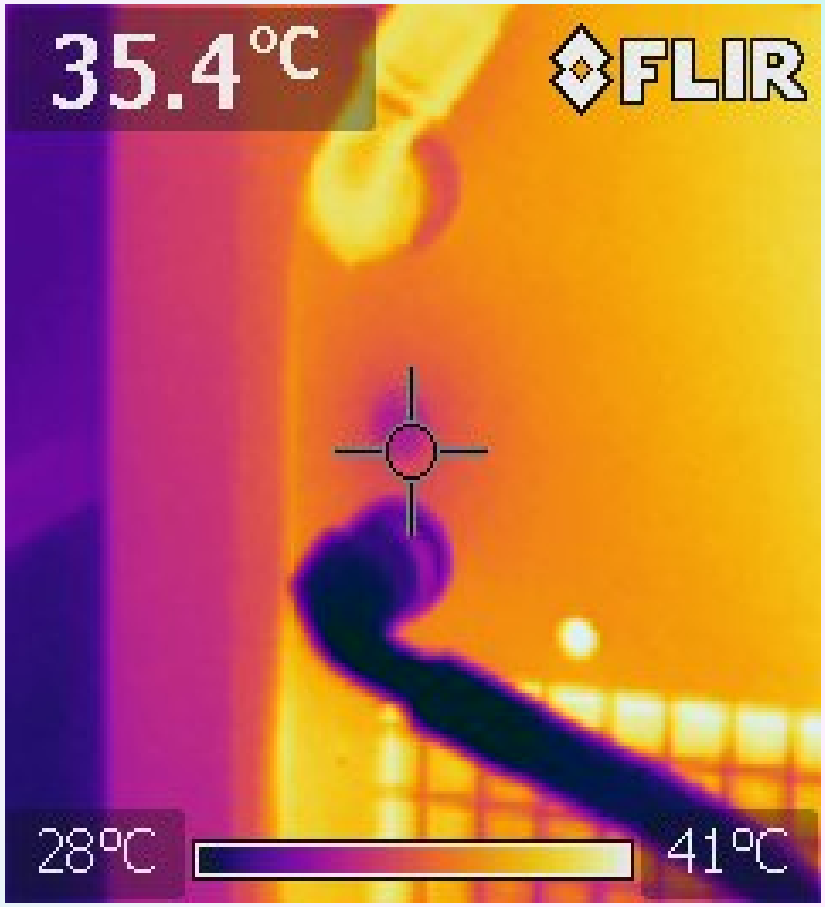
But many more inferences can be analyzed in process & utility by correctly inputting emissivity

Table 6-2: Coefficients A, B for estimating 'h' (in W/m^2-K)

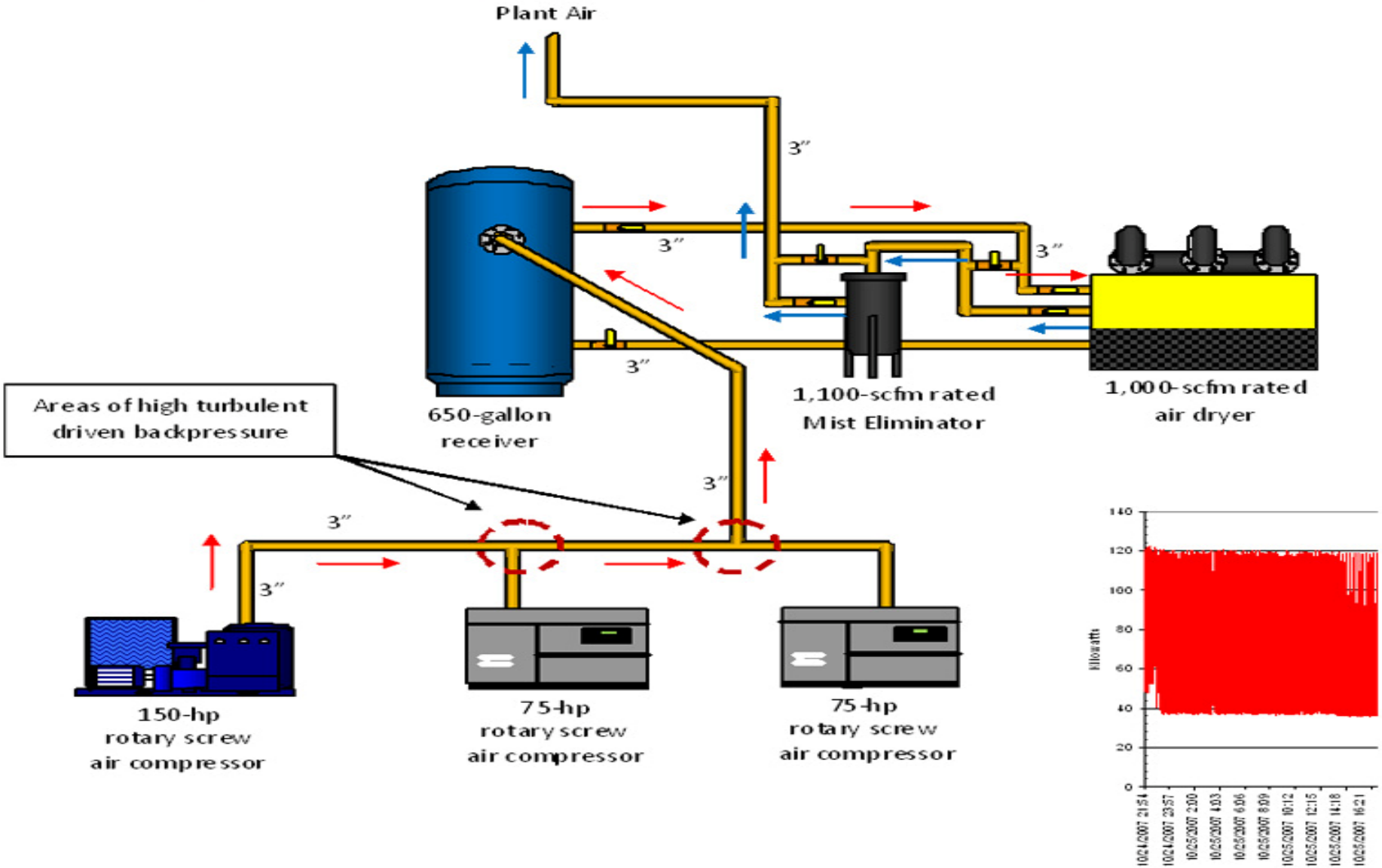
Surface	ε	A	B
Aluminium , bright rolled	0.05	0.25	0.27
Aluminium, oxidized	0.13	0.31	0.33
Steel	0.15	0.32	0.34
Galvanised sheet metal, dusty	0.44	0.53	0.55
Non metallic surfaces	0.95	0.85	0.87

Compressed air is not healthy when its discharge temp is above 5 *C than ambient. Refrigeration dryer working is healthy when there is appreciable difference between inlet and outlet air temperature.



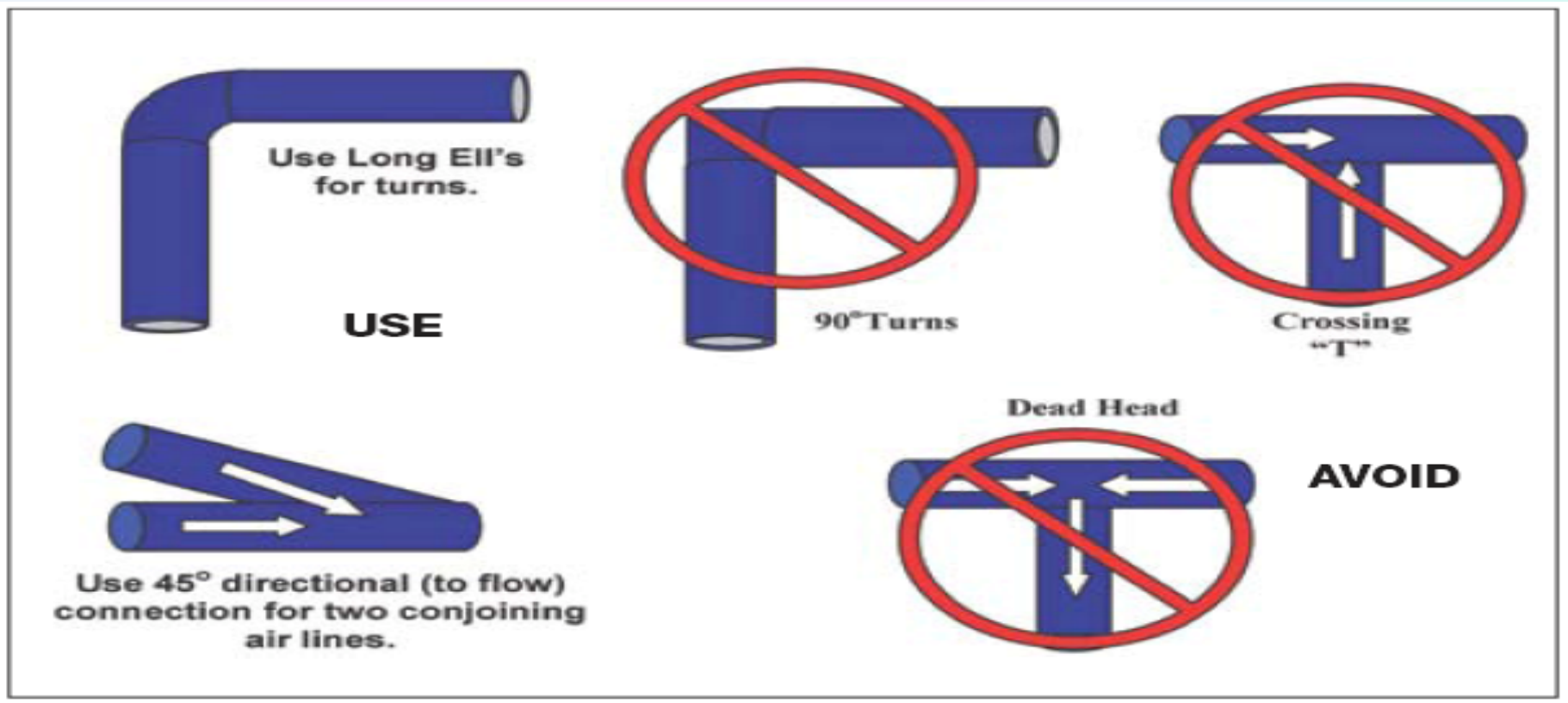


Infra red imaging and ultrasonic leak detection testing have become condition monitored maintenance practices today.



Thermal Imager is the tool to show in running process system - Do's and Don't's of piping.

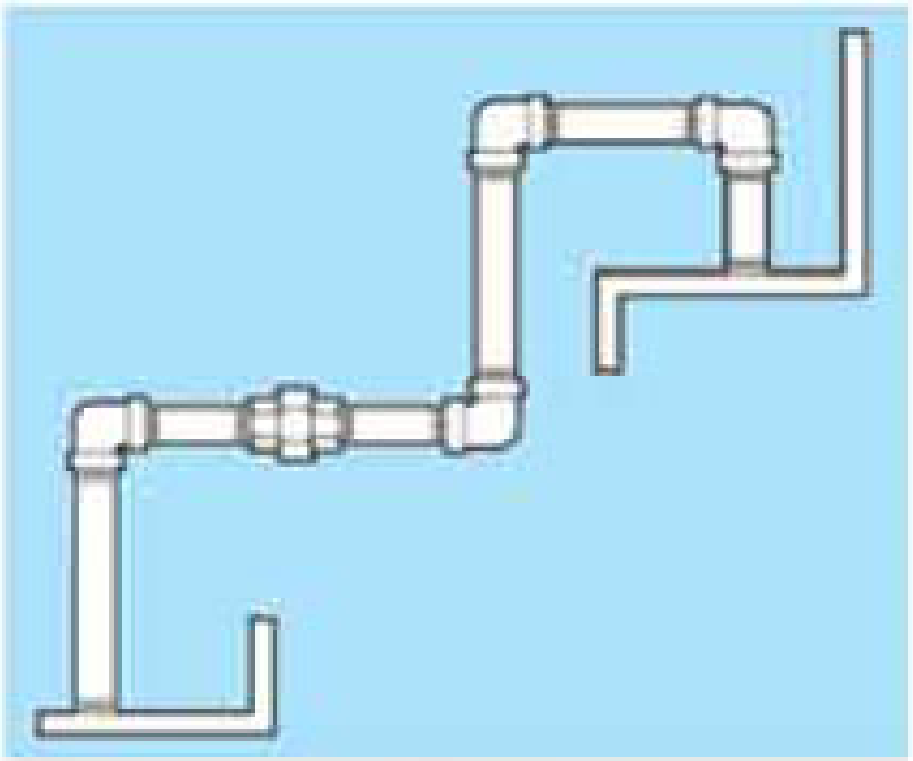
The universal concept of Slow IN – Fast OUT for any vehicle traffic is applied here too. Process flow needs to be streamlined or turbulent at each pipe junction. Analyze each pipe joint / junction now.



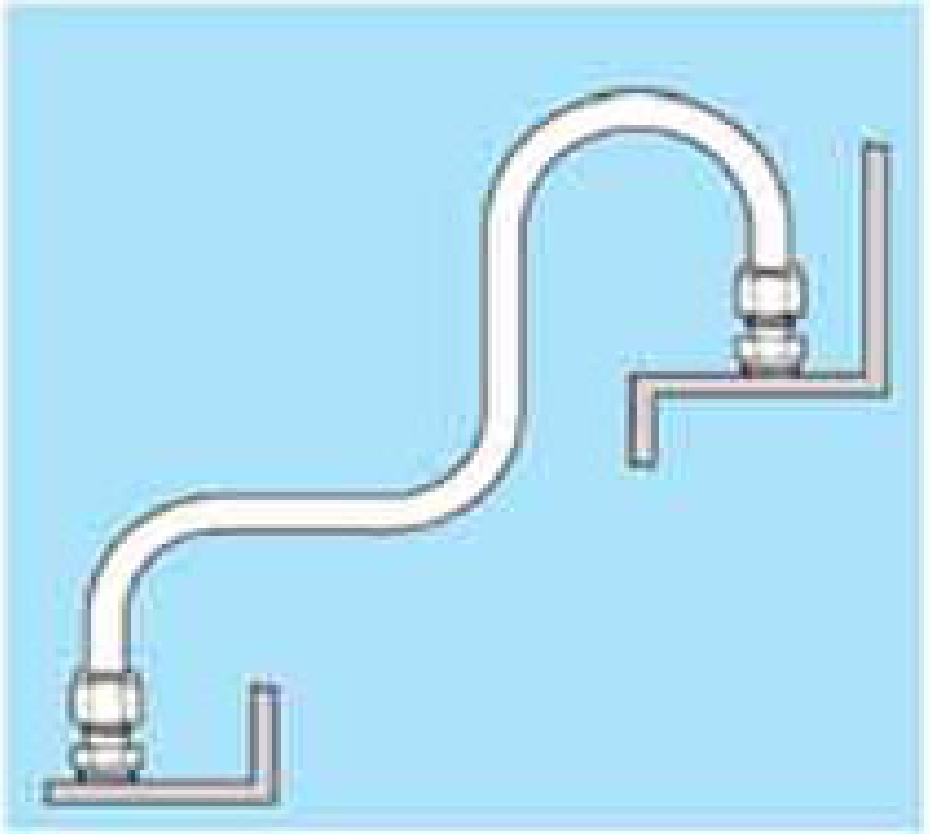
Tubing Vs Piping: Enhancing Plant Efficiency

PCRA agriculture bulletin says

Sharp bends and L-joints in the pipe can lead upto 70% more frictional loss than standard pipe bends.



Pipe typically relies on 45° and 90° elbows to route a system. Eliminating these fittings can speed assembly, reduce potential leak points and improve flow characteristics.



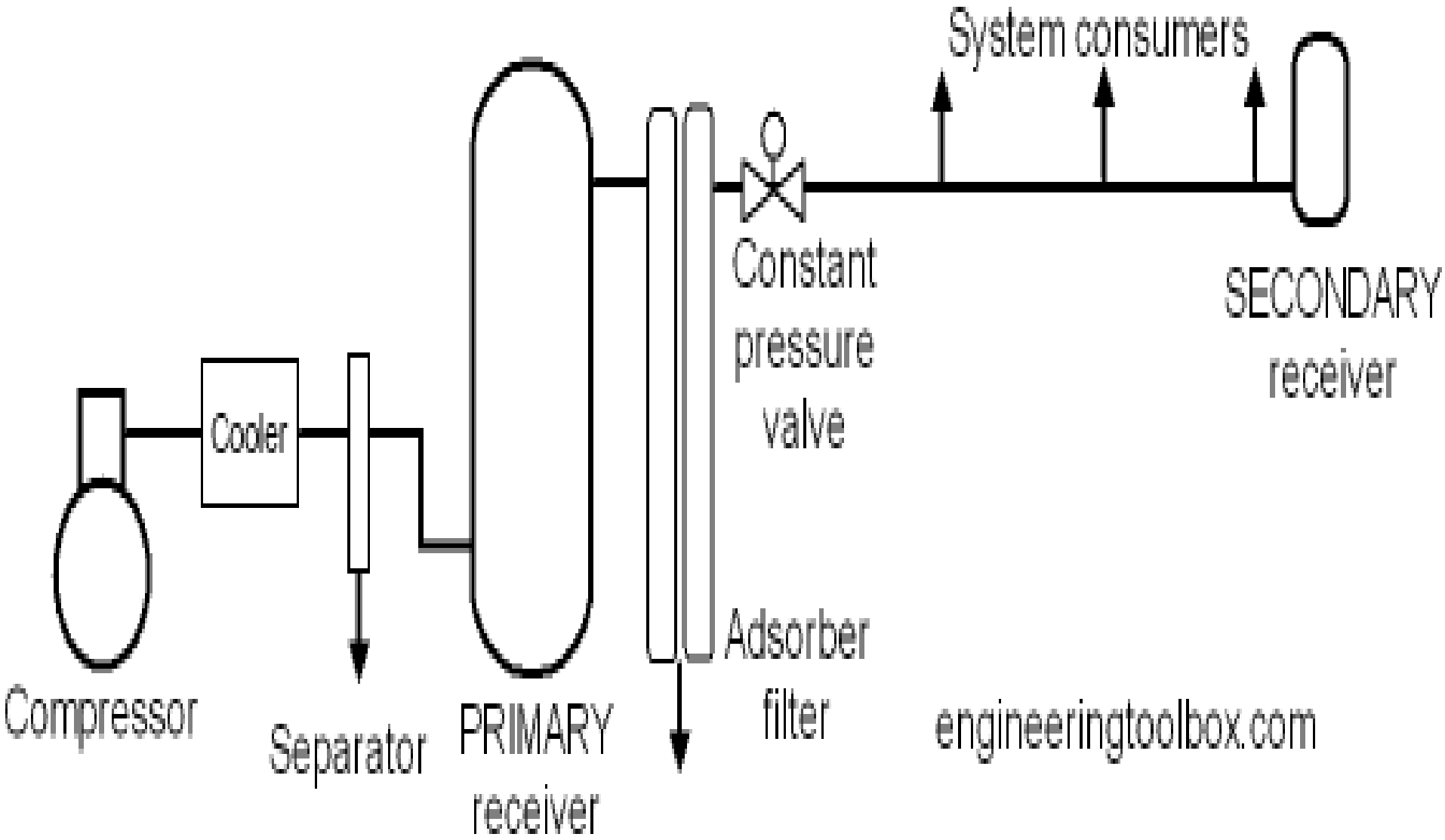
Tubing provides a more compact system and fewer leak points than an equivalent run in pipe

Short cut to compressor savings - Feed the FAD Free Air Delivery to Air compressor intake cool & dry air with daily cleaned air pre - filter / exhaust hot air out of compressor house.

- It has been observed that Free Air Discharge (FAD) by compressors increases by as much as 12.5% in some cases by simply cleaning the air intake filters.

Figure 7 & 8: Choked filters of compressors

COMPRESSED AIR HEADER FLOW DECIDES DYNAMIC PRESSURE DROP IN COMP AIR SYSTEM



GENERAL TIPS TO SAVE ENERGY IN COMPRESSED AIR USAGE

- Use of portable hand blowers (high velocity) for cleaning applications instead off compressed Air//section//equipment
- Operate machine at required pressure only not high pressure.
- Application of electrical tools in place of pneumatic tools
- Use of blower air instead of compressed air (aeration in effluent treatment plants, drying applications, etc.)
- Alternate means – There may be more efficient ways to meet need, explore them.

Lighting – Sustainable Lumens per watt & Bulb LIFE is important now.

Lamp type	Lumens per watt
Incandescent bulbs	15
CFL	60
Fluorescent tube LIGHTS	60 - 100
HP Sodium Vapour lamps	100 – 150
LED TUBE LIGHTS	**120**
Induction lamps & 1 Lakh hrs	**130**
Light intensity from sun	1, 20,000 lumen/m2
Diffused daylight near window	500 –600 lumens / m2

INSULATION

Measure:

- **Estimated surface heat losses indicated that about 16-17 lph of furnace oil was consumed to compensate the losses.**
- **Plant has taken immediate measure to replace the entire insulation and replaced with 2-3” of insulation**

Insulation details before and after implementation

Particulars	Value	Units
Surface temperature before replacing the insulation	68-80	^{0}C
Surface temperature after replacing the insulation	35-37	^{0}C
Estimated FO oil loss – before modification	16.7	lph
Estimated FO loss after the insulation	2.8	lph
FO savings	13.9	lph
	100	KL/year
Cost savings	12.7	Rs. Lakh/year
Investment	3.0	Rs. Lakh
Payback period	3	Months

Compressed Air systems – Are we Healthy ?

- **Don’t crack drains manually all over. Auto-drain valve with balancing pipes to be effective.**
- **Regulate at start & Demarcate HP & LP air usage & shut off the airlines when not in use**
- **Provide large air receiver near heavy consumer to avoid shock load, fluctuations in system pressure**
- **Filter Lubricator Regulator at end usage point to be inspected daily and oil maintained regularly.**
- **PLMS pipe line moisture separator to be active at start and end of line, & at usage point.**

Why we use air blow guns instead of blunt nylon hose ?

- The flow through a leak is similar to an orifice in that the flow is determined by the pressure immediately upstream of the opening.

- The pressure drops in the line supplying air to the leak based on line's ability to support rate of flow.

- For example, the air flow across a 1/4" orifice at 90 psig is 94 scfm

- but the flow through ten feet of 1/4" I.D. copper tube at 90 psig will be less than 40 scfm because the pressure will drop to 35 psig in the tube.

" we must know what we consume where "

Preliminary energy audit is a relatively quick exercise

- **to Establish energy consumption in the organization**

- **Estimate the scope for saving**
- **Identify the most likely (& easiest areas for attention.)**

- **Identify early (no-/ low-cost) improvement & savings**
- **Set a reference point / Bench mark within the machine**

- **Identify areas for more detailed study/measurement**
- **Preliminary audit uses existing, and easily obtained data.**

Shock, Relief & Delight

- The three stages of accepting results of an energy study or audit of process & utility are
  - **Shock, Relief and, finally, Delight !**
- The general wrong opinions about Maintenance has been
  - **"Maintenance is a necessary evil"**
- "Nothing can be done to improve maintenance costs"
- Please remove the opinions & now Remember:
- **Where Safety (Conservation) Fails, Pollution Starts.**
  - **Maintenance is a Tool to Productivity**
- Utility to process is like Medicine in bottle to our body.
- **Shake bottle before use & shake our body after intake** for quick & better results of medicine.

Energy to Equipments – Target End Use

- **The difference between the primary and final**
- **energy consumption lies in the following.**
- **The industry must focus the quality & quantity**
- **of fuel at entry of equipments**
- **Transport,**
- **Transmission &**
- **Distribution,**
- **and the Refinement.**

Flames leaping out of Treatment furnace

- Two identical furnaces taken for case study
- Gun metal to be melted was weighed & charged.
- One furnace was operated normally by the operators by leaping out the flames outside.
- Other furnace was operated by confining the flame within the furnace
- **Time taken to melt the charge is same for both furnaces;**
- **but the fuel consumption was only half.**

FOUR FUNDAMENTAL WAYS OF SAVING ENERGY:

1. **Accurate monitoring of the utilities in plant.**

2. **Reduction in the amount of Energy required for the generation and use of the utility.**

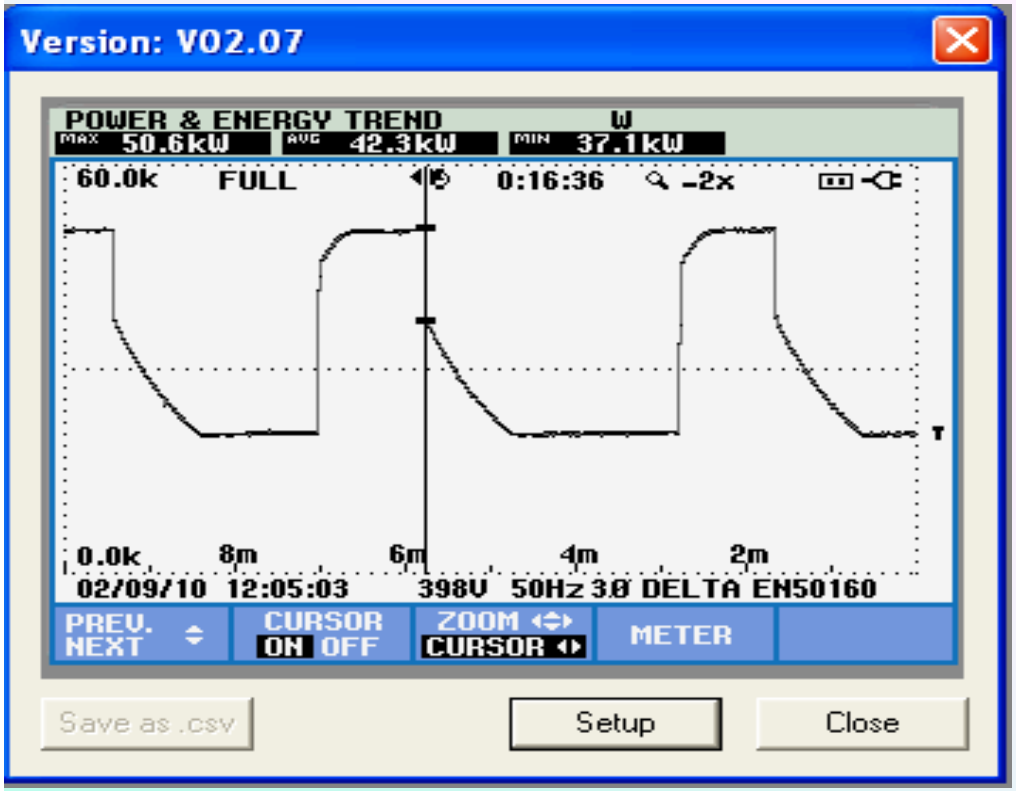
3. **Trapping of any unused energy**

4. **Recycling and use of energy over & again.**

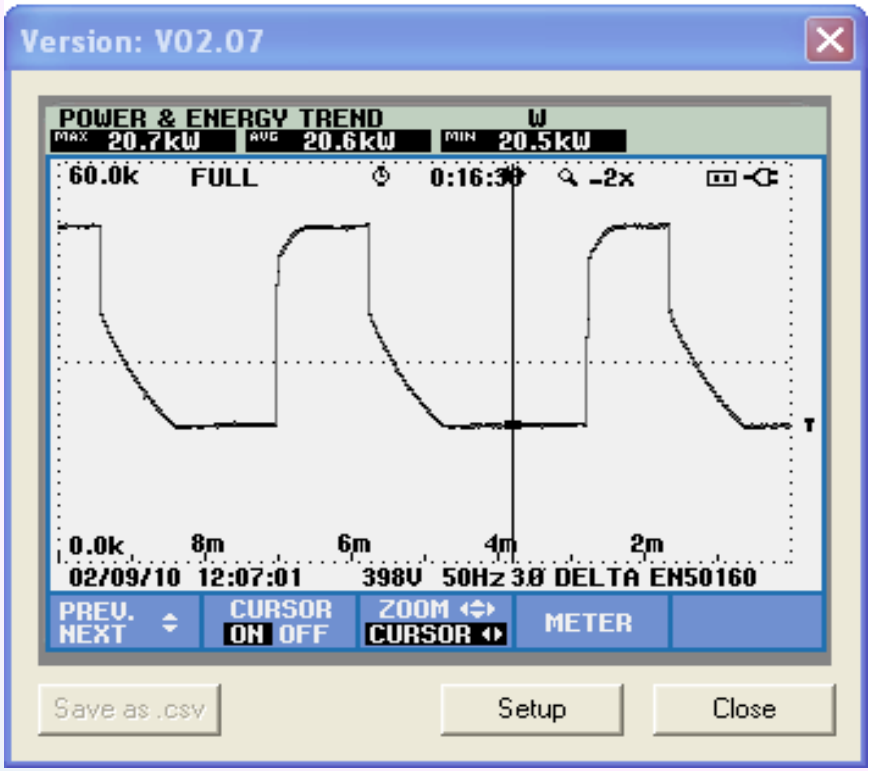
Electricity KWH can be used as tool to monitor daily health of Machine

The machines run from no load to full load in a day;

This custom built panel multi function energy meter can provide to the user what are the no load KWH and load KWH of machine.



COMPRESSOR LOAD KW = 50.6 KW



COMPRESSOR UNLOAD KW = 20.7 KW

Thank you for your kind attn Pls!

Please Feel Free to ask More Questions!!

S.ASHOK, BEE Accredited Energy Auditor /

AEA 071 / 2013 / / Coimbatore / 94437 20220

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As Energy Conservation is all about

our collective responsibility for better tomorrow.