Energy efficiency through 'false air reduction'

In the present environmental scenario, due to energy crisis and steep increase in the cost of energy and other input materials, it has become imperative to give a serious thought on how to make operations and equipment efficient towards use of energy and adopt latest technology equipment to retain the requisite competitive edge in the market, discusses **KK Sharma of Invotech Industrial Solutions.**

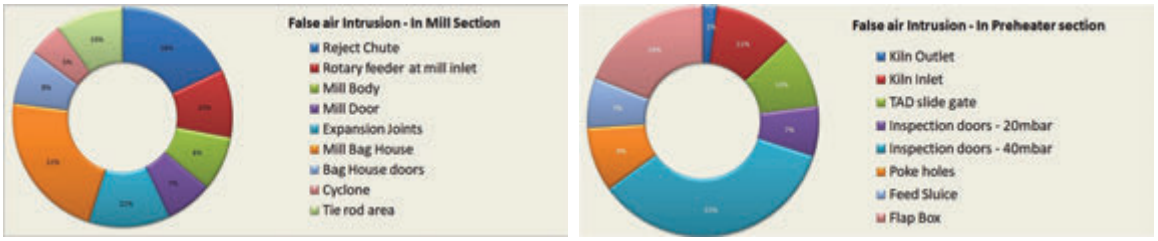

Fig.1: False air intrusion points in kiln and mill section.

India was the second largest cement producer in the world in terms of cement capacity during 2020. Therefore, one can easily assume the amount of energy being consumed in cement production facilities and its wastage attributed to non-availability of proper technology to plug the leakages. We can find hundreds of research papers/case studies discussing the effect of different factors on energy consumption in cement manufacturing facilities. Some researchers also discuss this issue with the help of mathematical models. However, all the researchers more or less agree to the fact that "false air" not only but may be one of the factors of more energy consumption in cement industry. Further, based on the several studies in the field of operational audit, it can be concluded that production level can be improved and energy consumption minimised by reducing "false air" as well as improving energy efficiency.

WHAT IS FALSE AIR?

False air is any unwanted air entering into the process system. The exact amount of false air is difficult to measure. However, an indicator of false air can be, increase of % of oxygen between two points (usable for gas stream containing less than 21 per cent of oxygen). Due to unwanted air, the power consumption increases and system's temperature decreases. Therefore, to maintain the same temperature fuel consumption has to be increased.

- Impact of false air in cement plant.
- Increase of power consumption
- Increase the fuel consumption
- Unstable operation
- Reduction in productivity
- Higher wear of fans

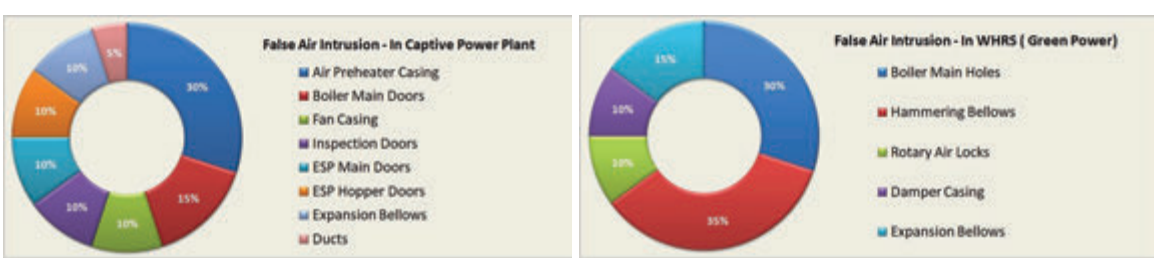

Fig. 2: False air intrusion points in CPP & GPP.

Fig. 3: False air detection by ultrasonic leak detector.

FALSE AIR INTRUSION POINTS

In a cement plant, generally false air intrudes in kiln section through kiln outlet, inlet seal, TAD slide gate, inspection doors and flap box. Similarly, in mill section false air intrudes through rotary feeder at mill inlet, mill body, mill door, flaps, expansion joints, holes of ducts and tie rod entry point.

In a power plant, generally false air intrudes in CPP section through air pre-heater casing, boiler main door, fan casing, inspection doors, ESP main doors, ESP hopper doors, expansion bellows, ducts. Similarly, in GPP section false air intrudes through main holes, hammering, bellows, rotary air locks, damper casing, expansion bellow, etc.

HOW TO MEASURE FALSE AIR

The formula used for measuring false air is as under:

$$\% \text{ of False air} = \frac{\% \text{ Outlet } O_2 - \% \text{ Inlet } O_2}{(20.99 - \% \text{ Outlet } O_2)} \times 100$$

Atmospheric air normally has a content of 0% CO and 20.99 % O_2

How to measure false air across pre-heater and mill: Based on the oxygen content and flow measurement at particular location, we can find out amount of false air across the pre-heater and mill circuit. For this purpose, % of O_2 is measured at different locations i.e., pre-heater inlet and outlet, cyclone inlet and outlet, mill inlet and outlet, mill outlet to fan inlet, across bag-house or ESP.

False air detection through ultrasonic leak detector: Ultrasonic Leak detectors often called sniffer, especially designed to find small leaks, are being used in power plants. However, cement plants are still lacking use of ultrasonic leak detector. Since ultrasonic leak detectors search for the sounds of leaks rather than escaping gases, they are able to detect leaks of any gas type. Though the device is unable to measure gas concentration, it is able to determine the leak rate of an escaping gas because the ultrasonic sound level depends on the gas pressure and size of the leak.

Functioning of ultrasonic leak detector: When gas escapes a pressurised line, it generates a sound in the range of 25 kHz to 10 MHz, well above the frequencies, the human ear is sensitive to but in a range easily identifiable to ultrasonic sensors. When the detector senses ultrasonic frequencies, they are isolated from normal background noise, amplified, and converted to a frequency audible to humans.

Detection principle: When a gas passes through a restricted orifice under pressure, it goes from a pressurised laminar flow to low pressure turbulent flow. The turbulence generates a broad spectrum of sound called "white noise". There are ultrasonic components in this white noise. Since the ultrasound is loudest at the leak site, it can be detected very easily.

FALSE AIR ARRESTING IN CEMENT AND POWER PLANTS

Usually cement and its associated power plants use conventional methods to arrest false air, but these conventional methods are not reliable or permanent in nature. In fact, it works more like a silencer,and just after a few days, it gets damaged.

Therefore, Invotech Solution & Systems now

Fig 4: Conventional false air arresting methods (By sodium silicate + mortar/raw mill powder, by ceramic blanket + sodium silicate).

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Fig 5: Conventional false air arresting methods (by ceramic paper + sodium silicate).

Invotech Industrial Solutions, a Rajasthan-based company has come up with a unique product range after their years of extensive research, which are being used in many cement manufacturing facilities and their associated power plants. Their client list figures renowned names like JK Cement, Dalmia Bharat, Nirma Group (Nuvoco Vistas), UltraTech, India Cements, Sagar Cements, Birla Corporation, The Mehta Group, Shree Cement, Chettinad Cement, Tata Chemicals, Jindal saw and many more in pipeline.

Invotech Industrial Solutions provides innovative andcost-effective industrial solution for arresting false air in cement plants i.e., pyro-process, raw mill, coal mill, cement mill section and bag-house and its associated power plants. The 'Arrest Master' (Product Name) is user friendly and safe to use.

PRODUCT RANGE: FALSE AIR ARRESTING COMPOUND

- Arrest Master 1001: For upper cyclones, VRM's andpower plants, shell temperature resistant upto 180 degree Celsius
- Arrest Master 1002: For bag-house and bag-filters top doors.
- Arrest Master 1003: For high temperature zone upto 500 degree Celsius
- Arrest Master 1004: For high temperature zone upto 800 degree Celsius
- Arrest Master 2001: For areas having vibrations, shell temperature resistant upto 180 degree Celsius

Properties of Arrest Master: False air arresting compound: Application of 'Arrest Master series' of product brings down the level of false air and it is useful in all cement and power plants. It hugely impacts plant productivity and contributes towards better housekeeping. Its other characteristics are:

- Gets further strong with heat
- Once cured, Arrest Master becomes rock hard ensuring no leaks
- High compressive strength and impact resistant, which can only be removed by hammering
- Non-shrinkable properties andno tools required for application

CASE STUDIES

Case Study 1

- Single string, 5-stage ILC Pre-heater, KHD
- Annual losses due to false air- 46.26 lakh
- Products used: 2.5 lakh
- Payback period: 1 month

CASE STUDY- 1

S No	Particulars	Plant Details	
1	Type Of plant	Single string ILC	
1.1	Kiln length	65 Mtr.	
1.2	Kiln Dia.	4.2 Mtr.	
1.3	Heat Consumption	750 K Cal/ Kg-Clinker	
1.4	Type of Cooler	Grate cooler	
1.5	Calciner Type	ILC	
1.6	PH Make	KHD Humbolt	
1.7	PH Stages	5	
S No	**Particulars**	**Unit**	**Values**
2	Plant Data		
2.1	Kiln Feed	TPH	318
2.2	Clinker Factor		1.62
2.3	Barometric Pressure at site	mmWg	10036
2.4	Ambient Temp.	Deg C	25
2.5	Power Cost	Rs/Unit	3.2
2.6	Coal CV	K Cal/Kg Coal	7800
2.7	Coal Cost	Rs/Kg	8
2.8	PH Out let pressure	mmWg	820
2.9	PH Outlet Temp.	Deg C	302
2.1	Flow at PH Outlet	m3/Hrs	732000
2.11	Flow at PH Outlet	Nm3/Hrs	310002

3	False air 1.5%		
3.1	False air Volume	m3/Hrs	10980
3.2	False air Volume	Nm3/Hrs	4650
4	LOSS in Power		
4.1	Loss on account of PH Fan	KwH	31.85
4.2	Loss in money	Rs/Hr	101.91
4.3	Annual Loss due Power	In Lacs	8.07
5	Loss in Heat		
5.1	Loss on account of heat	Kcal/hr	470141
5.2	Loss in money	Rs. /hr	482
5.3	Annual Loss due to Heat	In Lacs	38.19
5.4	Total Loss in money	Lacs per annum	46.26
5.5	Arrest Master 1001 Cost	Lacs	2.5
5.6	Payback period	In one month	

Note: Considering 330 days run plant in a year
Conclusion: Arrest Master 1001- Cost-effective Industrial Solution

CASE STUDY2

- Double string, 5-stage ILC Pre-heater, KHD
- Annual losses due to false air: 42 lakh
- Product used: 4.2 lakh
- Payback period- 1.11 month

Fig 7: Arrest Master ABS: Compressor air saving device- for kiln shell, bearing housing cooling energy efficient device

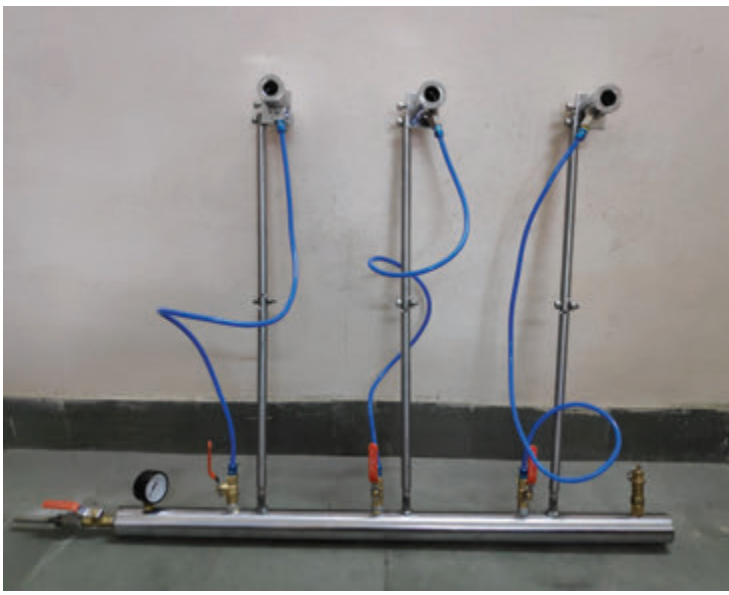

Fig 9: Three nozzle arrangement (Arrest Master ABS)

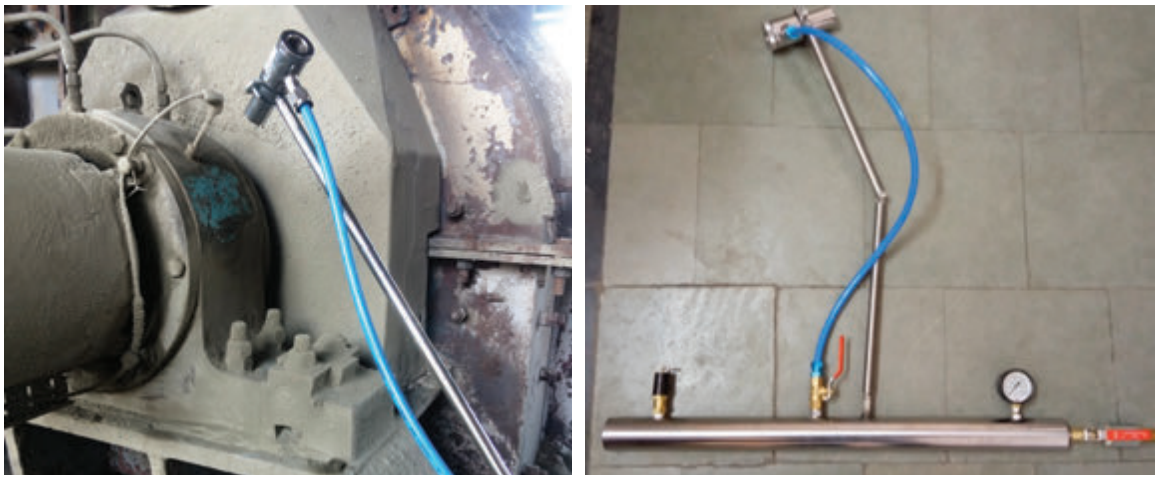

Fig 8: Bearing housing cooling by energy efficient device (Arrest Master ABS)

CASE STUDY-2

S No	Particulars	Plant Details			
1	Type Of plant	Double string ILC			
1.1	Kiln length	55.8 m			
1.2	Kiln Dia.	3.8 m			
1.3	Heat Consumption	815 K Cal/ Kg - Clinker			
1.4	Type of Cooler	Grate Cooler with IKN KIDS			
1.5	Calciner Type	ILC			
1.6	PH Make	KHD Humboldt			
1.7	PH Stages	5			
S No	Parameters	Unit	Values		
2	Plant Data				
2.1	Kiln Feed	TPH	216		
2.2	Clinker Factor		1.64		
2.3	Clinker production	TPH	3161		
2.4	Barometric Pressure at site	mmWg	10017		
2.5	Barometric Pressure at sea level	mmWg	10336		
2.6	Ambient Temperature	Deg C	35		
2.7	Power Cost	Rs/Unit	3.2		
2.8	Coal CV	K Cal/Kg Coal	7800		
2.9	Coal Cost	Rs/Kg	8		
3	Reduction in False air after using " ARREST MASTER 1001"				
3.1	Reduction in False air	%	2.15		
	Parameters	**Unit**	**Kiln**	**Calciner**	**Total**
4	Preheater outlet				
4.1	Temperature	deg c	390	392	
4.2	Draft	mmWG	-620	-825	
4.3	Flow	M3/h	228000	325000	
4.5	Flow	Nm^3/h	85353	118654	204007
5	False air = 2.15%				
5.1	False air volume	Nm^3/h	1835	2551	4386
5.2	False air = 2.15%	M^3/h	5032	7176	
6	LOSS				
6.1	Loss on account of Power in SG fan	kwh	11	21	32
6.2	Loss in money	Rs. /hr	36	67	102
6.3	Loss on account of heat	Kcal/hr	235828	329683	565512
6.4	Loss in money	Rs. /hr	177	247	424
6.5	Total Loss in money	Lacs per annum	17	25	42
6.6	Cost of Arrest Master 1001	Lakh	4.2		
6.7	Payback period	Month	1.11		

Note: Considering 330 days run plant in a year
Conclusion: Arrest Master 1001- Cost-effective Industrial Solution

(RECENT WORK- 2020) CASE STUDY-3				
S No	**Particulars**	**Plant Details**		
1	Type Of plant	Single String SLC Pre-heater		
1.1	Kiln length	51 m		
1.2	Kiln Dia.	3.6 m		
1.3	Heat Consumption	850 K Cal/ Kg - Clinker		
1.4	Type of Cooler	Grate Cooler		
1.5	Calciner Type	SLC		
1.6	PH Make	KHD Humboldt		
1.7	PH Stages	5		
S No	**Parameters**	**Unit**	**Values**	
2	Plant Data			
2.1	Kiln Feed	TPH	111	
2.2	Clinker Factor		1.61	
2.3	Clinker production	TPD	1650	
2.4	Barometric Pressure at site	mmWg	10333	
2.5	Barometric Pressure at sea level	mmWg	10173	
2.6	Ambient Temperature	Deg C	25	
2.7	Power Cost	Rs/Unit	6.5	
2.8	Coal CV	K Cal/Kg Coal	7800	
2.9	Coal Cost	Rs/Kg	12	
3	Process Calculation			
3.1	Kiln String & Pyro String		PH-1	
3.2	**Before & After**		**Before**	**After**
3.3	False air reduction	%	3.5	
3.4	PH Fan flow	m3/hr	338000	316709
3.5	PH Out let temp.	deg C	315	300
3.6	PH Pr.	mmwg	-550	-550
3.7	T & P correction factor		0.43	0.44
3.8	Flow (nm3/hr)	nm3/hr	143777	138247
3.9	Air power	kwh	488	457
3.1	Shaft power	kwh	751	703
3.11	Motor power	kwh	790	740
3.12	Savings in power	kwh	50	
3.13	Savings in heat	kcal/kg Clk	3.08	
3.14	Benefit through power saving	Rs/yr	1773643	
3.15	Benefit through heat saving	Rs/yr	6146575	
3.16	Total savings (Heat + Power)	Rs/yr	79.20	
3.18	Total Investment	Rs.	275000	
3.19	Payback	months	0.42	

Note: Considering 330 days run plant in a year

Conclusion: Arrest Master 1001- Cost-effective Industrial Solution

Invotech Industrial Solutionshas also recently developed a product called Arrest Master ABS for enhancing energy efficiency. It can be used to cool down the area rapidly with less air consumption but gives output seven to eight times as compared to normal air consumption. It is a special design nozzle, works on COANDA EFFECT. Arrest Master ABS uses little amount of compressed air to deliver high volume output. Arrest Master ABS, a compressed air boost device, has been designed to give trouble free and maintenance free service as there is no moving part in it.It can also be used to cool down bearing housing, cutting hot material, cooling of lathe machine jobs, etc.

Fig 6: False air arresting by Arrest Master range of products.

Product highlights of Arrest Master ABS:

- Energy efficient device
- Provides efficient cooling
- User friendly and ready-to-use modules
- Easy installation and Relocation

Invotech Industrial Solutions keeps itself abreast of latest development in cement and power industry so as to cater the need of the Industry using latest technology and quality systems. Also, with a view to retain the requisite competitive edge in the market, participated and will be participating in various seminars, details as under:

- 15th & 16th NCB International Seminar on cement, concrete & building materials held from December 5-8, 2017 and December 3-6, 2019 at Manekshaw Center, New Delhi. Will also be participating in upcoming 17th NCB International Seminar to be held during December 2021.
- "National workshop cum technology exhibition to promote energy efficient & cleaner production for sustainable industrial growth" held from March 8-9, 2018, at India Habitat center, New Delhi, where presented a Technical Paper on "significant savings in energy through false air reduction" and received an award for "upcoming entrepreneur in the field of energy efficiency".
- 14th Green Cementech 2018 held from May 17-18, 2018 at Hyderabad International Convention Center, Hyderabad where presented a Technical Paper on "Enhancing Energy efficiency in Captive Power Plants by reduction of False Air".
- Some of our articles also published in CMA's Technical Journal "Cement Energy & Environment", Vol. 17 No. 1 (January – June 2018) and Vol. 18 No. 1 (January – June 2019).
- Our latest article "Compressed air saving device: portable, economic hot spot cooling solution to plug and eliminate routine energy waste in cement plants" will be publishing in upcoming edition of CMA Technical Journal 2021.

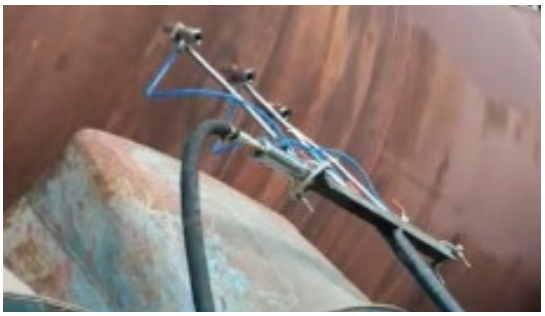

Fig 10: Kiln shell cooling by energy efficient device (Arrest Master ABS)

CONCLUSION

Substantial potential for energy efficiency improvement exists in the cement and power industry. Persistent efforts are also being made to improve energy efficiency and reduce energy cost for the cement and power industry for survival and growth. Our baby step towards arresting "false air" and improving "energy efficiency" can contribute immensely towards cost cutting of cement and power manufacturing and improving energy efficiency. It is needless to mention that our efforts to improve energy efficiency will also minimise greenhouse gas and mitigate the environmental problems associated with cement and power production.

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