CO-GENERATION & SUCCESS STORY IN INDIAN CEMENT INDUSTRY

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INTRODUCTION:

Till recently, the co-generation (cogen) / combined heat & power (CHP) were not used / prevalent in Indian Cement Industry i.e. it is gathered that M/s.Transparent Energy systems Pvt.Ltd, Pune have successfully commissioned 2 plants in South India namely one at KCP Ltd, Mancherla 2.4 MW & other at Ultra Tech Ltd Tadipatri 4.5 MW.

Similarly M/s.Raasi Cement Ltd, (now India Cement Ltd) have imported Cogen power plant which is running well.

There are a lot of hot gases having 200 – 350^{o}C temp depending upon the number of stages in pre-heater from kiln & clinker cooler 200 – 300^{o}C which are simply wasted and also they pollute the atmosphere in addition to spreading a lot of clinker dusts from these gases in nearby villages causing harm and nuisance & earning displeasure of villagers.

The writer has worked for 25 years in cement industries upto the level of General Manager & experienced various facets.

It is understood that M/s.Transparent of Pune have developed improved model of Cogen for Cement Industry which is briefly described modifying with knowledge & experience of the writer.

The paper starts with identification of gases, existing system where there are no heat recoveries, factors considered while designing effective system & deals with flow sheet of cogen, good features of the system, steam boiler, vertical coflow technology, improved design version, cost economics of the system, photos of cogen at (a) Ultratech Ltd, & (b) KCP Ltd., etc.

Cogen system: This is mostly low pressure heat recovery & power generation system.

Source of heat: It uses heat from (a) exhaust gases of rotary kiln and (b) clinker cooler in cement industry.

USE OF HOT GASES IN EXISTING SYSTEM:

In cement plant the exit gases from Rotary kilns, pre-heater and Calciners are used to heat the incoming feed material and gases are cooled to around 300 to 350 °C in 4 stage pre-heater and then exhausted to the atmosphere. The exhaust gas temp in case of 5 – 6 stage pre-heater can be 200 – 300^{o}C. Part of this gas is used in raw mills & coal mills for drying purpose. The solid material i.e. clinker coming out of the Rotary kiln is at around 1000 °C and is cooled to 100-120 °C temperature using ambient air. This generates hot air of about 260-300 °C. Part of the hot air generated is used as combustion air in kiln furnaces & remaining is exhausted to atmosphere without heat recovery.

NO HEAT RECOVERY: In most of the cement plants there is no cogen / heat recovery. The temperatures normally observed are;

a) Rotary kiln gases 300 – 350°C incase of 4 stage pre-heater.
b) Rotary kiln gases 200 – 300°C in case of 5 – 6 stage pre-heater.
c) Clinker cooler gases 200 – 300°C

COGEN SYSTEM:
The basic system designed for recovering this heat consists of (a) **Boiler**:- combination of water tube type boiler and economizers installed on various exhaust gas streams (pre-heater exit, clinker cooler), (b) (i) steam turbine driven electrical power gensets, (ii) Water / air-cooled condenser and (iii) condensate tank & (iv) necessary control system.

WATER/AIR COOLED: Depending on availability of water in the area, system can be made water cooled or air cooled.

COST: Systems that are air cooled are little more expensive than water cooled system.

Factors considered while designing the effective system:

1. **Avoidance of dust:** Methods of avoiding Deposition of Cement Powder on the Heat Transfer Surface which otherwise results in fouling and lesser heat recovery.

2. **Design to deal Sticky dust/Abrasive gases:** Appropriate design of the system to perform against gases Sticky dust from pre-heater and abrasive gases from. Clinker cooler should be made.

3. **Make surface free of dust:** Methods of dislodging deposited dust and keep the heat transfer surface free of dust.

4. **No gases to cold surfaces:** Avoiding exposure of the flue gases to cold surface of the equipment during start-up or interruptions, otherwise these results in condensation of the flue gas moisture and when this moisture comes in contact with the cement powder, cement gets “set” on the surfaces which are difficult to remove. Hence slow build-up of such patches results in choking of the system & reduction in effectiveness of heat transfer surface.

5. **Design to conserve water:** Availability of the water and its appropriate utilization to conserve the water by designing the system judiciously.

6. **Select correct electricals:** Selection of appropriate electrical power generation system to maximize the power generation.

7. **Reduce final exhaust temp to max. extent:** Bringing down the flue gas exhaust temperature to sufficiently low level, so that less expensive method of Gas cleaning (after Heat Recovery) of cement powder separation from flue gases can be utilized.

8. **Maintain Low Pressure drop:** Keep flue gas pressure drop in boiler low to economize on fan power.

9. **Configure / Locate boiler correctly:** Utilize the vertical elevation available (due to pre-heater Cyclones already existing) while configuring boilers.

10. **Remove cement dust continuously:** Easy & continuous removal of cement dust separated in boiler should be done.

11. **Maintain Auto diversion / by pass:** Automatic diversion and bypass of hot gases to gas washer / cooler in case of boiler safety / abnormal boiler working conditions.

12. **Pay back period lower:** The system engineered should have attractive payback periods satisfying the investment criteria.

COGEN DATA FOR TWO CEMENT PLANTS IN NALGONDA DISTRICT OF ANDHRA PRADESH (INDIA)

Nalgonda District of A.P. India has largest number of cement plants in India. The typical data for two cement plants of 1500 tpd & 2000 tpd for Co.gen / Waste Heat Recovery (WHR) are given below:

CEMENT PLANT – 1: CAPACITY OF 1500 TPD (TONNES PER DAY)

1. **Heat Stream data:**

   a) Clinker Cooler air available for Heat recovery for Power generation:
      - Mass flow rate: 100000 Kg/ hr
      - OR Volume flow rate : 82,000
      - Type of filter: Multi clones
      - Dust loading : 15 gm / Nm^3
      - Temperature at filter exit: 280 – 300^o C

   b) Pre heater exhaust gases available for heat recovery for power generation.
      * Mass Flow rate: 85,000
      * OR Volume flow rate: 59,000
      * Dust loading : 65 gm /Nm^3
      * Temperature into heat recovery system : 300 – 350^o C
      * Composition of Pre heater exhaust gases: O_2 : 3% CO_2: 28% and N_2 : 69%.

2. Ambient air temperature: Average air dry bulb temperature: 40^o C

3. Site elevation: 100 M above sea level.

4. **Electrical Power specification of Plant grid:** 6600 V, 50 Hz

5. **Plant Data:**
   * Cement Production capacity : 1500 TPD
   * Location: Nalgonda Dist, (A.P.) INDIA.
   * Plants working Hours per annum : 7920 Hrs.
   * Present electricity resources of State Electricity Board
   * Wetness of Raw Materials for clinker : less than 7%
   * Pre heater exhaust gases are used for raw mill and coal mill.

CEMENT PLANT – 2 : CAPACITY OF 2000 TPD

1. **Heat Stream data:**

   a. Clinker Cooler air available for Heat recovery for Power generation:
      - Mass flow rate: 1,55,000 Kg / Hr
      - OR Volume flow rate: 1,20,000 NM^3/hr
      - Type of filter : ESP 1,20,000
      - Dust Loading : 15 gm/m^3
      - Temperature at filter exit : 260 - 280^o C
      - Temperature at clinker cooler exit : 320^o C

   b. Pre-heater exhaust gases available for heat recovery for Power generation.
      - Mass flow rate: 92,000 Kg / Hr
      - OR Volume flow rate: 63,000 NM^3/hr

- Dust Loading : 65 gm/m^3
- Temperature into heat recovery system : 300 - 320^o C
- Composition of Pre heater exhaust gases: O_2: 3%, CO_2: 30% and N_2 : 67%.

2. **Ambient air temperature:** Average air dry bulb temperature: 40 ^{o} C
3. **Site elevation:** 100 M above sea level
4. **Electrical Power specification of Plant grid:** 6600 V, 50 Hz.
5. **Plant Data:**
    - Cement Production capacity : 2000 TPD.
    - Location : Nalgonda Dist, A.P. INDIA.
    - Plants Working Hours per annum : 7900
    - Present electricity resources : State Electricity Board
    - Wetness of Raw Materials for clinker: less than 7%
    - Pre heater exhaust gases are used for raw mill and coal mill.

CASE STUDY / SUCCESS STORY

TECHNICAL SPECIFICATIONS OF HEAT RECOVERY SYSTEMS WHICH IS RUNNING SUCCESSFULLY.

	CLINKER COOLER	PREHEATER EXHAUST
FLUE GAS QUANTITY	113550 Kg/ Hr	175300 Kg/Hr
FLUE GAS TEMPERATURE	295^{o}C	350 ^{o}C
OUTLET FLUE GAS TEMP.	130 ^{o}C	225^o C
TOTAL HEAT RECOVERY	1,12,50,000 K Cal / Hr	
GROSS POWER OUTPUT	2.5 MW	
AUXILIRY POWER REQD.	220 KW	
NET POWER OUTPUT	2.25 MW	

1. All figures are approx. and indicative only.
2. Actual figures are slightly changed.

GOOD FEATURES OF THE SYSTEM SUITABLE FOR CO.GEN FOR CEMENT INDUSTRY

- **Boiler design with dust laden gases:** Boiler is specially designed for high dust laden gases.
- **Mechanized dust removal & collection system:** To provide with special mechanized dust removal and collection system.
- To accept high dust level readily.

- **Bypass arrangement:** Waste Heat Recovery Boiler should be provided with a bypass arrangement so that it will not affect the original process.

- **Optimum Heat recovery:** _Heat Recovery must be done at three stages optimally.

- **Design for abrasive & sticky Gases:** Design system to take care of Abrasive gases from Clinker cooler as well as sticky gases from pre-heater exit.

- **Natural Circulation:** Design Natural circulation

- **Heating System:** Startup heating system to be provided to avoid sticking during cold start.

VERTICAL CO- FLOW TECHNOLOGY

GAS FLOW VERTICAL:

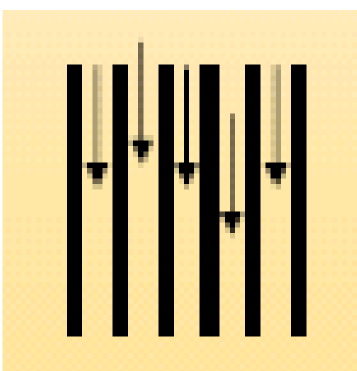
Vertical flow of flue gases assists the dust particles to fall down. Hence the fouling tendency is less than horizontal design.

LESS SPACE REQUIREMENT:
Much lower space requirement compared to horizontal construction.

SAVING OF STEAM
Knocker type dust dislodging. Hence saving of steam required for dust blowing.

IMPROVED DESIGN SUPPLIED INSTALLED & COMMISSIONED BY M/S.TRANSPARENT ENERGY SYSTEM PRIVATE LIMITED,

1. TUBES PLACED VERTICALLY



a) **Vertical tubes:**

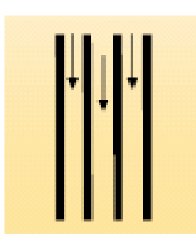
Tubes are placed vertically with axis parallel to gas flow which does not obstruct the flow of gas.

b) **Dust accumulation less:**

Possibilities of dust accumulation are less since vertical downward flow of flue gas will help in dislodging the dust particles.

2. **BARE TUBE VS.**

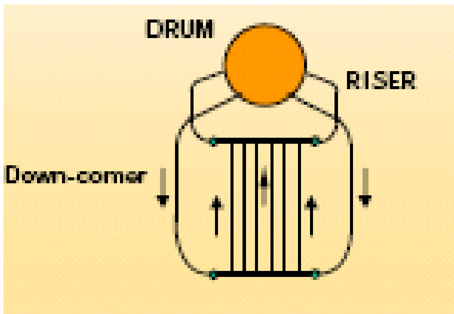
FINNED TUBE:



a) **Less dust accumulation:** Bare tubes reduces possibility of dust accumulation. Particularly for gases with high dust, it is highly recommended to use only bare tubes without finning.

b) **Cost:** Even though manufacturing cost goes up for above, user gets benefited.

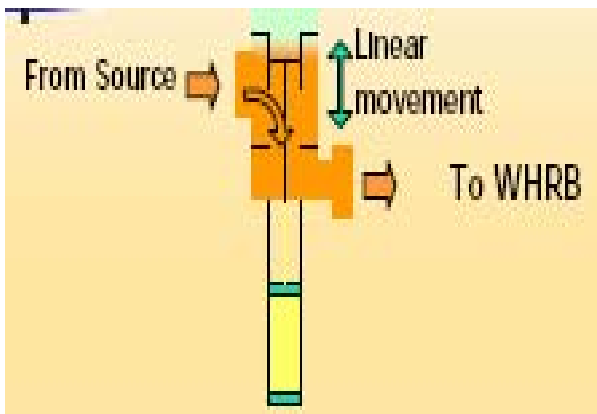
3. NATURAL CIRCULATION Vs. FORCED CIRCULATION:



Natural circulation design:

No dependence on any external equipment for circulation., Uninterrupted circulation eliminates possibilities of higher TDS level in evaporator & subsequent scale deposition.

4. DIVERTER VALVE – HEART OF PROCESS CONTROL:



a) **No Jamming:** Automatic pneumatically operated.
Linear movement of valve (poppet). Hence, no possibility of jamming.

b) **No Leakage:** Positive pneumatic pressure acts as good sealing force continuously when the valve reaches the respective positions. The poppet is pressed against the valve seat by pneumatic pressure **eliminating possibility of any leakage.**

c) **Equal distribution:** Force is applied at center of poppet ensuring equal distribution throughout the sealing edges.

d) **S.S. material**: Can be made of stainless steel which can work upto 850°C continuously.

COST ECONOMICS OF THE SYSTEM
(Given by M/s.Transparent, Pune in Seminar at CII, Hyderabad)

NET POWER GENERATED PER HOUR	2.2	(MW)
TOTAL WORKING HOURS OF THE YEAR	8000	
COST OF POWER CONSIDERED	3.75 (RS. KWH)	
TOTAL SAVINGS PER ANNUM	660	(LAKHS)
TOTAL INITIAL INVESTMENT (RS. IN LAKHS) 1364	(LAKHS)	
ESTIMATED PAYBACK PERIOD	24.8	(MONTHS)

SUMMARY:

This is high time when cement industries must plan & go for cogen which is requirement of the day & very economical system / technology is made available by M/s.Transparent. It is gathered that the capital cost is only Rs.50 – 60 Lacs / MW as against 4 – 6 crores / MW for Conventional systems. The operating cost for above cogen is only 20 – 30 paise / unit (Kwh) as against Rs.4 – 6 per Kwh by utility companies. These figures are given by M/s.Transparent as per their experience.

References:

1) Seminar paper presented by M/s.Transparent Energy System Pvt.Ltd, Pune.
2) KCP Limited (Macherla) - 2.5 MW.
3) Ultra Tech Ltd, (Tadipatri) - 4.5 MW
   * Heat recovery by TESPL & Power generation by ORMAT (ORC System)
4) Data collection & presentation by Master Consultancy & Prod.Pvt.Ltd, Secunderabad – 500 003 (A.P). INDIA.
5) Raasi Cement Ltd, (now India Cement) Co-generation.