Thermal Economy In Sugar Plant For Maximum Conservation Of Bagasse

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Of late, there has been a rising awarenes that bagasse is now too valuable to be used solely fuel. That bagasse can be inducted as the basic raw material for paper and pulp is not new. But the urgency to divert it from its usual function as fuel in the sugar factory has cropped up because of the growing scarcity of the conventional raw material for paper and the rapidly escalating demand of the latter. This diversion of bagasse for the manufacture of paper is, hence, fast becoming the new trend so much so that spurred by favourable climate gene ated by a major relief in excise duty on bagasse-based paper, a few enterprising paper manufacturers have already installed captive sugar plants for supply of bagasse to their paper plant while a few others are thinking of following suit. However, the philosophy of having captive sugar plants for feeding the paper factory with bagasse stands on a completely different pedestal than the diversion of bagasse from the existing sugar plants. production of excise-free bagasse-based paper providing a prolific source of revenue it is the bagasse of the captive (sugar) plant on which the eyes of the entrepreneur are firmly set; the production of sugar here takes the level of by-product.

In the second case while the opportunity for such large scale revenue inflow from excise relief is sought to be fully harvested by embarking on a bagasse-based paper-plant, sugar in the sugar plant is not relegated to a secondary product neither the efficiencies at various stages of its manufacture.

The diversion of bagasse for the paper plant tends to become total where the paper plant is installed under the same management as owning the group of sugar factories and a major interest is displayed by the management in efficient running of the paper plant. With equal stakes stocks in both the lines of manufacture bagasse of the sugar plants becomes as important to the management as the sugar.

But inspite of being under the same management the two lines of production are separately accounted for as in individual independent units. Under the arrangement where the revenue advantage arising from the excise relief is credited entirely to the paper plant and where the entire bagasse is lifted in lieu of coal/steam to meet the thermal need of the sugar manufacturing plant the latter are deprived of the revenue benefits arising from the trade in bagasse as one of its principal by-product. Though this is of little significance which way the revenue flows in from the same material where the management is common, it is vital interest where the management of the two are separate and the reduction of price of sugar is important.

Where however, the two plants are under different managements, the natural preference is for the sell out of the saved surplus (Bagasse). The reluctance arises because of the

(i) Unpredictability associated with regards to the supply of coal, the replacing fuel. Unsatisfactory past history with regards to supply of coal to sugar factories only confirm that priority-wise the supply to sugar factories has so far been in the lower rung of the ladder which continues to be headed by such vital consumers as thermal power plants, railways and other essential industries. Where power plants, themselves are frequently infested with low stocks of coal, very often reduced to only a couple of days supply, where instances of cancellation of trains on account of poor supply of coal are not rare, it will be too optimistic to expect that sngar factories will be insured against such failure of diversion of coal supplies.

But sugar being a seasonal industry and the raw material and the various intermediate products during the manufacturing process being fast perishable it can hardly afford any shut down arising from the...failure

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in the timely supply of coal because of the industries lower priority.

(ii) Further, bagasse being rich in volatile constituents and coal rich in fixed carbon, each has different characteristic requirements for efficient burning and heat transfer leading to furnace and boiler of specific designs. Hence, induction of coal to replace the bagasse would involve the replacement of the baggasse-fired steam generation units with the coal fired ones. Any subsequent failure on the coal supply front would leave these sugar factories idle and helpless; having disposed of their bagasse firing system they are left high and dry.

(iii) With vigorous persuit for the cultivation of soft wood and hardwood plantations and mobilisation of the collecting system for agriculture remains viz. straw, it is not yet firmly known that bagasse will continue to be as highly sought for as the current craze. With lower return from bagasse and the rising prices of coal a stage might develop when it may not become remunerative to run on coal while bagasse tends to pile on in the yard. Even with slight enrichment of the pulp with the fibres from the favoured sources there might be tendency for less draw of bagasse. Having changed to the coal firing system the switch back again to the bagass firing system will iuvolve fresh investments on capital items.

(iv) Further, unlike baggse which is produced continuously in the required size and fed continuously with ease to furnances, with coal almost a month's inventry has to be provided for which adds to the cost of manufacture. To add to this, the coal has to undergo size reduction at site and in consequence, considerable handling all of which not only involve additional equipment but power consumption too.

In view of the aforesaid inhibiting limitations and apprehensions discouraging the managements of individual sugar plants against the diversion of their entire bagasse, a more pliable and accommodating alternative would be to plan-out for maximum saving of bagasse by various fuel and stem economy measures and let out the saved bagasse for use in the paper and pulp industry. It is not realised perhaps that simply by augmenting the already known conservation measures a sugar factory (300 psi system) can be balanced on 20/21% (on Cane) bagasse; and if this 20% is saved between (15% on Cane) and coal (equivalent of 5/6% bagasse on cane) it becomes obvious that it will not be difficult for a sugar factory to spare almost 60% of its bagasse (i.e. 300/350 tonnes of wet bagasse per day in a 200 tpd sugar plant). This line has the advantage of sparing more than half of the bagasse produced without starving the factory of its conventional fuel and disturbing the factory equipment specially of the steam generating section, excepting for the induction of auxiliary coal firing system in the existing boilers failing which the installation of (12 tonnes steam/hr for a 2000 tcd unit) coal fired unit.

Equally important is the massive inflow of revenue from the sale of bagasse to the paper unit; as has been indicated towards the end of this paper gross value (in rupees) of this sale is estimated in a season of 180 days.

It is worth while to recall further that coal is a non-replenishable fuel whose stock is decreasing at an increasing rate while bagasse is a renewable source available a fresh every year. Equally relevant is the worry of the ecologists who being concerned about the rapidly deteriorating delicate environmental equilibrium arising from, amongst others, the rising CO_2 level in the atmosphere have laid stress on the increased reliance on to the biological sources for our energy sources for our energy requirements in prefarence to the fossil fuel Instead, hence, of being carried away by the need for short term solutions (contrary to the red signal of the ecologists) it is prudent to have rather a long term perspective in view of the nemasis that has raised its menacing head and is threatening the existence of the human race.

Any rational apportioning of bagasse between its conventional use as fuel and the current demand for its induction as industrial raw material for its balanced utilisation is the sagacious and proper approach. It is towards this end objective that the discussions in this paper is directed.

In order to achieve a surplus of bagasse of the afore-indicated dimension, it is necessary to recall the two basic concepts about heat. According to one, it is energy in transition form one reservoir acting as source to another acting as sink; the oceans, the atmosphere, the earth are reservoirs which generally serve as sink. The second one is the law of conservation which, as is commonly known, stipulates that energy is neither ereated nor destroyed; from these two it hence follows that heat that escapes into the sink must have originated at the source. In otherwords, under steady state condition the heat escapping out of a system is equal to the heat input to the system. Consequently, the heat demand of such a system will be decided by the quantum of heat escaping out of the system and can be reduced if the quantum of this heat escape can be reduced.

In the case of sugar factory heat arising from the combustion of bagasse escapes out of the furnace-boiler complex and ultimately to the atmosphere, through three main routes viz (i) the gas stream escaping through the chimney, (ii) the steam outflow from the boiler and (iii) radiation across the furnance walls; unburnt fuel on the grates and carry over can also lead to considerable loss.

The heat carried away by the hot gas stream (i e. flue) depends upon its constituents, its quantity and its temperature. The constituents comprise the dry gasses (CO_2, O_2, N_2, etc) and the water vapour, the water vapour in the flue originates from (i) the residual moisture accompanying the bagasse after the milling process and (ii) the combustion of the constituent hydrogen in the fuel. The two are in the relative preporation of 60:40, of the two only the fraction originating from the residual moisture in bagasse is amenable to reduction and that too over a limited range depending on the efficiency of the milling process; a figure of 48% is indicative of a fairly good achievement. With the current trend, however, in favour of higher imbibition (180% and above) it has become difficult to contain the moisture content in bagasse within the figure mentioned; it tends toward 5 % on Cane. Obviously, with the increase in the quantity of water vapour in the flue, losses (condensation) through the chimney increases Table 1 reflects of increasing moisture on the condenstion loss. Where however maximum saving of bagasse becomes one of prime necessity, one has to appoition appropriate weightage to the basic need of low residual moisture in bagasse by close operation control and fixing the optimum level of imbibition. Apart from higher condensation losses through the chimney the 'burnability' of bagasse and in turn the boiler capacity gets, as has been odserved in many plants, adversely affected by higher moisture. A reduction in moisture content from 51% on bagasse to 48% by itself results in the saving of 1.6% (vide Table-1) of the bagasse fed. Encouraged by the advantages of lower moisture content in bagasse proposals have occasionally been floated for the drying of bagasse by the hot flue gas the object being the reduction of condensation loss; it is the sensible loss that gets reduced. However, there is one distinct advantage in the drying of bagasse; it provides relief to the hard-pressed boiler station by improving the burnability when residual moisture in bagasse rules high (i.e. 50% and above).

TABLE 1, CONDENSATION LOSS

Moisture % Bagasse

GCV btu/16) :	45	46	47	48	49	50	51
	4523	4440	4356	4273	4190	4106	4023
NCV " "	3698	3610	3522	3434	3346	3259	3171
Condensation Loss % GCV	18.2	18.7	19.1	19.6	20.1	20.6	21.2

The heat carried away by dry gaes in the form of sensible heat alongwith that escaping as superheat in water vapour are grouped as Sensible Loss'. Its quantum is dependent on the quantity of the dry flue and its temperature above the ambient (85 Degree F). The quantity factor, in turn, is dependent on the amount of excess air. The sensible loss, hence, can be reduced by reducing both, (i) the amount of excess air and (ii) the temperature of the flue. A reduction of excess air from 100% to 50% at 600 Degree F flue gas temperature enables a reduction of 3 3% GCV in sensible loss (vide Table-II). Similarly a reduction of flue gas temperature from 700 Degree F at 50% excess air enables a reduction of 10.6% GCV in sensible loss.

The excess air has been termed as necessary evil. While its induction is necessary for complete combustion of the fuel, it simultaneously results in increased heat loss through the chimney. Efforts will have to be direc'ed to contain this induction to the minimum The old type step-grate furnaces take-in larger amount of excess air than the modern installation which with forced-draft arrangement and various controls have reported satisfactory working at 30% excess air and even lower. Where maximum saving of bagasse is the prime objective it is not difficult to achive a

TABLE 2. CO_2, EXCESS AIR & THE SONSIBLE LOSS.

Bagasse Moisture : 49%
Dew Point : 145%
Ambient Temp : 85F

CO_2%		: 20.80	16.0	14.9	13.9	13.0	10.9	11.9	10.4
1. Excess air %		: 0.0	30	40	50	60	75	90	100
2. Total flue 391 gas per 100 of its bagasse.		: 391	478	508	53.7	566	610	653	683
3. Sensible Loss % GCV at Temp F									
	700	16.3	19.3	20.3	21.3	22.3	23.8	25.3	26.3
	600	13.3	15.8	16.7	17.5	18.3	19.5	20.8	21.6
	500	10.6	12.6	13.3	13.9	14.5	15.5	16.6	17.3
	450	9.1	10.8	11.4	12.0	11.6	13.4	14.3	14.9
	400	7.7	9.2	9,7	10.2	10.7	11.5	12.2	12.7
	350	6.5	7.6	8.0	8.4	8.9	9.5	10.1	10.5
	325	5.7	6.9	7.3	7.6	8.0	8.6	9.1	9.5
	300	5.0	6.0	6.3	6.7	7.0	7.5	8.0	8.4

TABLE 3, HEAT RECOVERIES BY SIMULTANEOUS LIST OF ECONOMISERS & AIR–PREHEATERS.

Equipment	Flue gas cooled from	Water/air heated to
Economiser :	675 — 550 F	20.5 — 275 F
Air Preheater	550 — 315 F	8.6 — 360 F

figure ranging between 35%–40% excess air through instrumentation and control and alertness at all levels to achieve the objective through close checks and supervision.

The flue gas temperature ranges between 700 Degree F at the furnace outlet. Where air is preheated, as in modern furnaces, it tends towards 700 Degree F. Flue gas temperature can be reduced by using air-preheaters or economisers or both. Usually the choice is for the air preheaters which while preheating the air cools the flue gas around to 450 Degree F. Where however, maximum recovery of heat the crying need induction of both economisers and air -preheaters are required, economisers preceding the preheaters so as to bring the flue gas temperature close to 300 Degree F.

Many modern installations with the initial of air-preheaters as integral part do have the provision for later addition of economisers. In case of other installations manufacturers have to be refered to as to the manner such a provision can be introduced For all new installations it is of great advantage to have provision for such incorporation as and when required, specified while placing the order. Some corrosion of the air heater, IDfan vanes and chimney due to condensation may become comparatively slightly more pronounced but then these can be suitably protected against. In order to be more effective the external surface of the economisers and the air-preheaters have to be properly logged against heat loss by radiation.

Equally important is the plugging of all cracks in furnace walls against cold air leaks which bring down the temperature of hot gases flowing past the damper and thereby reduce effectiveness of the heat recovery units.

Radiation losses from the furnance walls is also an important contributing element of heat losses grouped under 'unaccounted'—All other factors remaining the same smaller sized individual boiler units have proportionately larger wall surface area and hence incur relatively larger radiation losses. Larger sized units will hence help in cutting down the radiation losses.

Summing up, the recommendations suggested have in for maximum fuel economy leads to the following figures.

1.	GCV bagasse at 49% Moisture	:	4190 btu/lb
2.	Sensible heat loss at 315° F flue temperature & 37% Excess air	:	6.6% GCV
3.	Condensation Loss at 49% Moisture	:	20.1% GCV
4.	Radition etc. Losses	:	6.3% GCV
5.	Total Losses	:	33.0% GCV
6.	Boiler Efficiency	:	67.0% GCV
7.	Heat in Steam/16 of bagasse	;	2807 btu
8.	Total heat in steam at 300 psig & 550°F	:	1290 btu/lb
9.	Less heat in condensates returned back to boiler feed	:	180 btu/lb
10.	Net heat transferred to steam in the boiler	:	110 btu/lb
11.	lbsteam generated per lb of bagasse	:	2.53 lbs
12.	Bagasse demand for 50% Steam consumption on Cane	:	19.76% on Cane, say 20% on Cane

If this demand of 20% bagasse on cane is shared between bagasse on (15% cane) and coal (Equivalent of 5% bagasse on cane) it will be possible to divert almost bagasse on cane (i.e. the balance out of 33% total bagasse on cane) for paper. For a 2000 tcd plant this diversion amounts to 360 tonnes of bagasse/day.

On setting aside 5% bagasse on case out of this 18% bagasse on cane to account for the replacement by the equivalent amount of coal, 13% bagasse on cane or 260 tonnes/day in the case of 2000 tcd sugar plant becomes the net out flow for commercial sale to the paper plant; this is equivalent to 175 tonnes/day of pulpable wood which at Rs. 300/ per tonne is valued at Rs. 52 000 per day or a gross cash inflow of Rs 93.60 000/– in a season of 180 days with careful planning under expert guidance it is not difficult to achieve the technical efficiencies and the figures for bagasse saving referred to here. Aspects connected with the steam and its conservation will be discussed in subsequent commnucation.