Thoughts on energy conservation in chemical recovery section of a pulp and paper mill

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SUMMARY

A few thoughts have been discussed which can be tried in chemical recovery section of a Pulp and Paper Mill for energy conservation. Use of less power consuming equipment in salt cake handling, using boiler's blow down water for green liquor heating and evaporator's combined condensate as process water and reduction in pumping heads, wherever possible, are some of the measures which can be adopted for energy conservation without major modification in an existing setup.

The above measures can save a significant amount of energy and obviously have its impact on the overall economy. The measures discussed are also to be considered for new installations.

The Pulp and Paper Industry, being an energy intensive process industry, needs special consideration for energ conservation in the present era of energy crisis. The impact of growing shortage of energy and its cost on the overall economy is very significant, which is also clear from the fact that the recurring cost of energy is about 20% of the manufacturing cost of paper[1]. The pattern of energy consumption varies from mill to mill depending upon individuels attempt in this direction and modernisation of process equipments etc. An idea of energy consumption in different sactions of a mill can be had from Table–1, which indicates that about 35% of steam and 11% of the power required for a mill is consumed in its chemical recovery section only.

Literature review reveals some of the following measures to be adopted for energy conservation in Chemical recovery section.[1–4]

1. Use of long tube forced circulation evaporators instead of short tube evaporators, increasing number of effects, using falling film evaporators, thermo-compression, filtering feed liquor and increasing its concentration in the Pulp Mill itself, using vacuum pump in place of steam ejector etc.

2. Improving boiler design for higher thermal efficiency, higher steam pressure to co-generate back pressure power, higher chemical recovery, lower auxiliary fuel and power consumption, thermal insulation, maximising black liquor solid fed to the furnace, controlling excess air to boiler and salt cake makeup, heat recovery by cascade evaporator or air heater after electrostatic precipitator, optimising boiler cleaning system, maintaining efficient process control system by better maintenance of instruments such as Oxygen monitor, air flow recorder, draught gauges, temperature recorder and black liquor desilication etc.

3. Good house keeping, eliminating steam leakages, recovery of condensate, steam and electricity load management, combustion control through Operator's skill, replacing reducing valves by back pressure turbine, maximising capacity utilization, installing barometric leg in lime mud filter before vacuum pumps etc.

No doubt, some of the measures mentioned above are being followed in some mills or the other but much of them have to be adopted by many of the mills. The authors discuss some of the thoughts with typical illustrations, which can be adopted without major modification in an existing set up Also these are worth consideration for new installations.

A. REDUCTION IN PUMPING HEAD

It is a well known fact that power consumption can be

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TABLE—I : ENERGY CONSUMPTION IN DIFFERENT SECTION OF A PAPER MILL[3]

Sections	Steam (T)/tonne of paper				Power (KWH)/Tonne of Paper			
	Mill—1	Mill—2	Mill—3	Average	Mill—1	Mill—2	Mill—3	Average
1. Pulp Mill	4.3	3.1	2.9	3.43	420	390	325	378
2. Paper Machine	4.0	3.0	3.6	3.53	750	680	642	691
3. Chemical Recovery	4.5	3.6	3.2	3.77	180	120	115	138
4. Share of Chemical recovery in total consumption (%)	35.15	37.11	32.99	35.13	13.33	10.08	10.63	11.43

Table—I also suggest ample scope for steam as well as power conservation in Chemical recovery section, based on the consumption of energy in Mill—3, for those mills who consume energy similar to Mill 1 & 2.

reduced by reducing pumping head. In causticizing plant overflow liquor of lime mud washer thickner II (LMWT II) is pumped to recausticizer for diluting sludge from white liquor thickner going to Lime mud washer thickner I (LMWT I). Also, over flow liquor from the Drags washer thickner (DWT) is pumped to the same recausticizer to recausticizeany uncausticized lime in the sludge. A typical flow diagram is shown in Fig. I for the above, where the recausticizer is situated at the height of 10 m from the ground floor. Hence, 25m³/hr of LMWT II over flow liquor and 5m³/hr of that from DWT is pumped to 10m height as the overflow sump boxes of both the thickners are at ground floor. If the LMWT II overflow sump box is elevated to 1.5 from group floor (providing sufficient space for pump operation and maintenance etc.) and overflow liquor of the DWT is taken to it by gravity (by proportionately increasing its holding capacity), 30m³/hr overflow liquor can be pumped (employing a single pump) to 8.5 m height to the recausticizer.

This can save about 1,800 KWH/annum by reducing 1.5 m pumping height, which comes to about 40 KWH/m³/annum/meter reduction in pumping head as per the following calculations.

a) Power consumption in pumping 25m³/hr overflow liquor from LMWT II sump

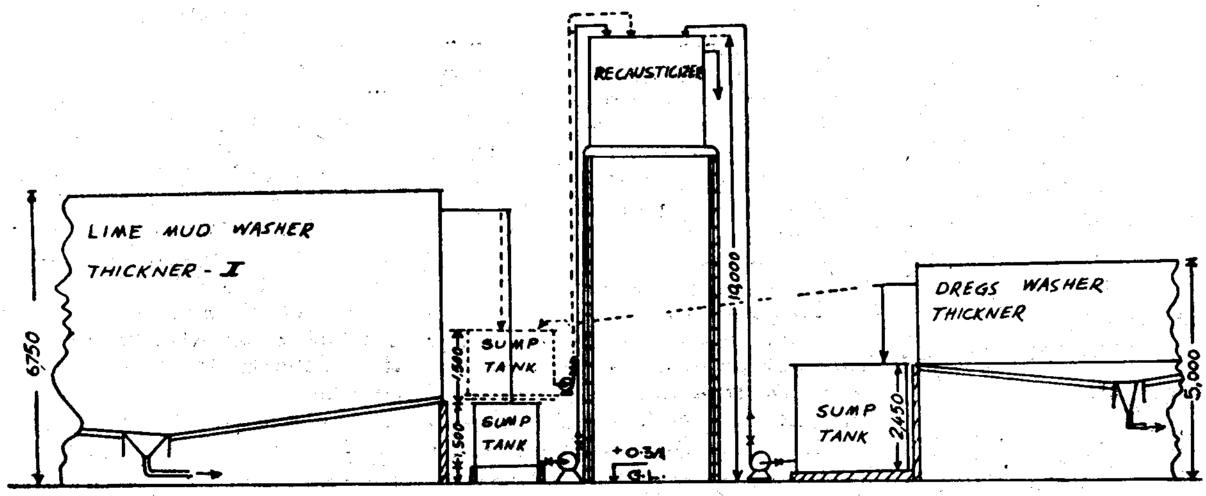

Fig. 1: Pumping of overflow from lime mud washer thickner II and Dregs washer thickner to Recausticizer.

......Denotes Proposed Equipments
Denotes Existing —Equipments

box to 10m pumping height to the recausticizer=1.173 KWH.

b) Pumping $5m^3$/hr overflow liquor from DWT sump box to 10m pumping height to the recausticizer=0.235 KWH.

c) Pumping $30m^3$/hr overflow liquor from LMWT II and DWT to 8.5m pumping height to the recausticizer=1.196 KWH.

∴ Power saving due to reduced pumping height

per annum=(a+b—c)×24×350=1781 KWH say 1,800 KWH.

Similarly power can be saved in case of pumping overflow liquors from Lime mud washer thickner III (LMWT III) to dilution box for diluting sludge from LMWT I. Fig 2 shows a typical flow diagram of the above where the dilution box is situated at 12m height and $30m^3$/hr of overflow liquor from LMWT III is pumped to it. If the overflow sump box is elevated to 4.5 m from ground floor and the dilution box is lowered to 2m (considering the sump box receives overflow from a height of 6.5m, height of sump box as 1.5m and the dilution box feeds 7m height LMWT II) the total height for pumping can be reduced to 5.5m which in turn can save about 7,700 KWH per annum or 46 KWH/ms/annum/meter reduction in head as per the following calculations.

a) Power consumption in pumping $30m^3$/hr overflow from LMWT III to the dilution box to 12m pumping height=1.689 KWH.

b) Power consumption in pumping $30m^3$/hr over-flow liquor from LMWT III to the dilution box to 12m pumping height =1.689 KWH

∴ Power saving due to reduced pumping

height per annum=(a—b)×24×350=7,686 KWH say 7,700 KWH.

Note :

1. In above calculations sp. gr, of overflow liquors from different thickners are taken as 1.0 and pump efficiency as 60%.
2. Calculations were made taking the same pump into consideration even for the reduced head. If a proper size pump is employed further saving can be achieved.

USING LESS POWER CONSUMING EQUIPMENTS :

The present trend is to use equipments which consume less power, wherever possible. One of such areas is salt cake feeding to the salt cake bin from godown using bucket elevator in place of vacuum pump. Fig. 3. shows a typical flow diagram of salt cake handling where salt cake is stored at a distance of 45m from salt cake bin and the bin is situated at a height of 18m. Salt cake is being sucked through a vacuum pump which discharges it to the bin. It consumes about 40 KWH for sucking one tonne of salt cake to a horizental distance of 45m and vertical distance of 20m. Prior to feeding the salt cake to the vacuum system, it is being passed through a salt cake crusher where salt cake lumps

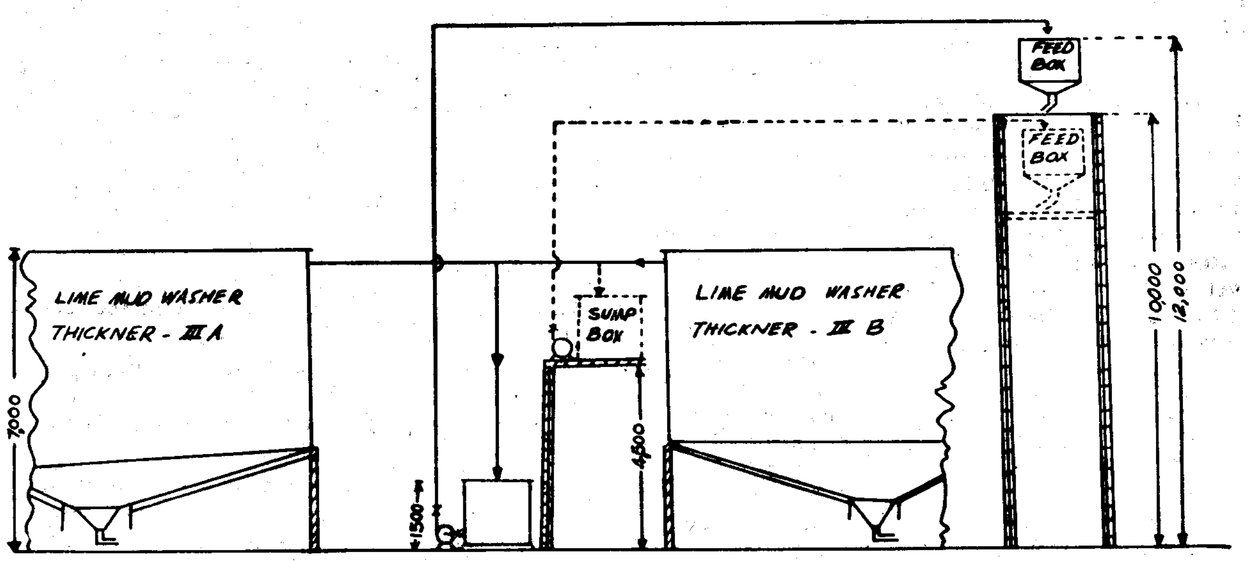

Fig. 2. Pumping of overflow from lime and washer thickner III A & B to Feed box.

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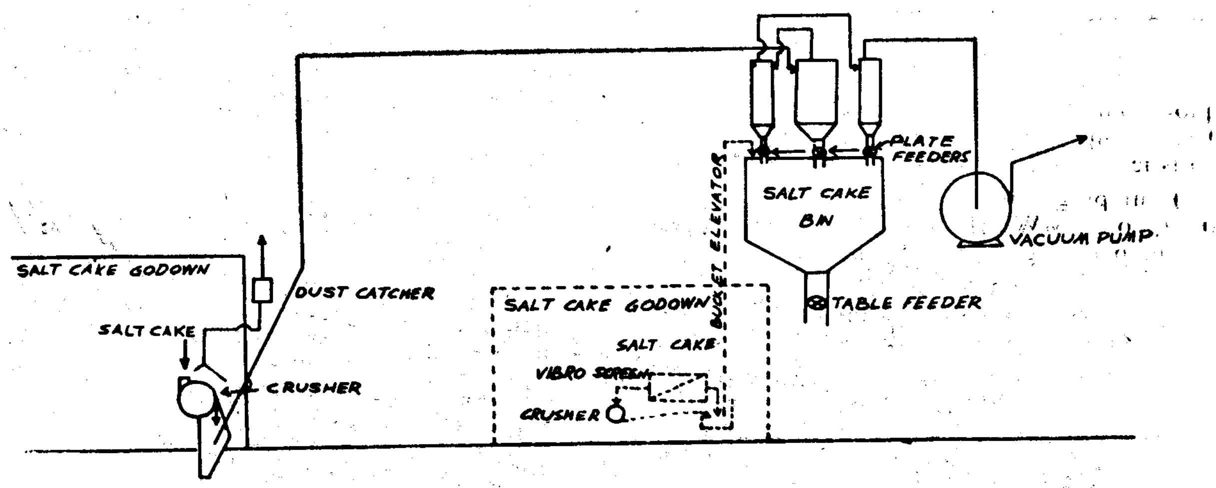

Fig. 3. Salt cake feeding to salt cake bin

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are crushed and screened. Crusher consumes about 15 KWH/tonne of salt cake. As the salt cake contains maximum 5% lumps, continuous running of crusher can be avoided by screening salt cake over a vibratory screen and crushing the lumps collected from vibratory screen as per convenience.

If the salt cake godown can be shifted to a convenient place from where salt cake can be fed directly to the bin employing a bucket elevator and a vibratory screen for screening the salt cake before feeding it to the bucket elevator, about 17,000 KWH power can be saved per tonne/annum as per the following calculations :

a) Power consumption in crushing and sucking 1 T Salt cake $=40+15=55$ KWH

b) Power consumption in screening and lifting 1 T Salt cake (taking 2.5 KWH/tonne for screening, by vibratory screen and 3.5 KWH/tonne for lifting by bucket elevator) $=2.5+3.5=6$ KWH.

$\therefore$ Power saving per tonne/annum $=(a-b)\times 350=17{,}150$ KWH say 17,000 KWH

USE OF BOILER'S BLOW DOWN WATER AND EVAPORATOR'S COMBINED CONDENSATE :

It can be seen from Table—I that about one third of the mill's total consumption of steam is used in the chemical recovery section only. Though, a major portion of it is used for concentrating black liquor only, some portion of it is also used for heating green liquor before slaking and process water. The boiler blow down water, which possesses sufficient heat energy, can be taken to hot water tank after heating green liquor. Uncontaminated combined condensate from evaporator plant can also be taken to hot water tank reducing the use of live steam for heating process water. These two measures can save sufficient amount of steam which is otherwise used for heating green liquor and process water. In one of the Indian Mills about 12 tonnes of steam is saved per day by using about 24 tonnes/day of blow down water for heating green liquor. Also 24 tonnes of steam is saved per day by taking combined condensate into hot water tank instead of heating process water.

CONCLUSION

There are many ways and means by which energy can be saved, to some extent, in chemical recovery plant. Some measures are discussed with the help of examples. Though, the examples may not hold good for a particular mill, it can however, serve as a guide line for energy conservation. These measures are :-

(i) Reducing pumping heads wherever possible. About 40–45 KWH/m³/annum/meter reduction in head can be saved.

(ii) Replacing vacuum pump by bucket elevator for lifting salt cake which saves a considerable amount of power.

(iii) Reducing the use of salt cake crusher by amploying vibratory screen to screen out lumps from salt cake and crushing only the lumps.

(iv) Using boiler blow down water for heating green liquor and using it as process hot water, which comes out from heater, along with combined condensate from evaporators.

The measures suggested for energy conservation can easily be adopted by existing units with minor modifications

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