A Case for Cross-Recovery

L. N. CHOWDHARY and R. P. BHARGAVA

Kraft pulping process is one of the most successful and dominant pulping process. Other pulping processes characterised by some advantage or the other over the kraft process are in use but none of them offer such a versatile use of recovery of pulping wastes as in Kraft. In this article we will deal with sodium base pulping processes and study the wonderful opportunities offered by kraft process in its recovery system. The base demand in normal Kraft pulping is to the extent of 375-400 kgs. Na_2O per ton of pulp compared to about 60 kgs. Na_2O per ton in NSSC. In normal kraft cycle the losses vary from 15 kg. to 40 kg. Na_2O per ton pulp in the form of Na_2SO_4. The base demand of 60 kg. Na_2O per ton in NSSC and its associated losses in pulping immediately flashes a thought in mind. Why not use the waste liquor from NSSC for the make up of the kraft cycle ? So the NSSC will be considered to balance 3—4 times larger kraft mill. In a balanced cross recovery system the total losses of kraft cycle should be met by the pulping wastes of the NSSC. So the only chemicals used as make up for Kraft cycle in such a system would be supplied by the NSSC waste liquor.

Kraft cycle losses :

As far as chemical requirement for the kraft process is concerned there are two types of main losses; (i) Na losses, and (ii) Sulphur losses. A kraft process cycle is termed in chemical equilibrium when compensation of Na losses are made up by chemicals of such sulphur content so as to maintain the sulphidity around 20-30% for reasons of pulp quality and yield. Two main factors which govern this are : (a) the total losses in kraft cycle, (b) type of equipment, its efficiency and operating parameter in the pulp mill. Na and S balances varies from mill to mill and is rather difficult to predict precisely for new installations. Most of the Indian Mills operate with losses of 80-150 kg. Na_2SO_4 per ton compared to 40-60 kg., Na_2SO_4 per ton for Scandinavian mills. It may be practically feasible to have mills going as low as 30-35 kg. Na_2SO_4 per ton as far as only sodium balance is concerned.

L. N. Chowdhary, Soda Recovery Plant Supdt., and R. P. Bhargava, General Manager, Star Paper Mills Ltd., Saharanpur.

The main sources of Na losses are :

i) Digester house liquor losses — knots, washed pulp.

ii) Evaporator — liquor losses, tall oil skimmings etc.

iii) Rec. boiler, dissolver, causticiser, sludge losses.

Sulphate losses can be divided in two broad classes :

a) Losses associated with Na and will take place in all the above mentioned places.

b) Independent sulphur losses in gaseous form :

i) Digester house relief vapours, blow vapours.

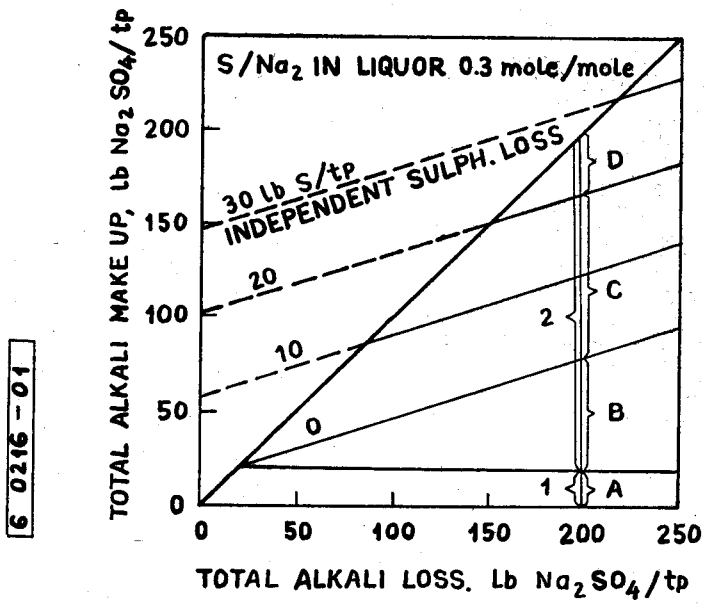
ii) Evaporation — combined condensates and non-condensible gases to ejectors of vacuum pump outlet.

iii) Recovery boiler — Direct contact, chimney stack.

Sulphur losses in liquors can be safely considered to be proportional to Na-losses and the proportionality constant will be approximately the sulphidity of the liquor.

Sulphur losses in gases show erratic patterns but a linear variation can be considered with sulphidity.

To make up of losses in Kraft cycle is explained in detail in Fig. 1.



1. SODIUM LOSS IN SALT
2. " " " LIQUORS

A. SULPHUR MAKE UP FOR SALT LOSS (1 lb/Na_2SO_4/ lb Na_2SO_4 LOST)

B. SULPHUR MAKE UP FOR LIQUOR (0.3 lb Na_2SO_4/Lb Na_2SO_4 LOST)

C. SULPHUR MAKE UP FOR INDEPENDENT SULPHUR LOSS (4.4 lb Na_2SO_4/lb S LOST)

D. SULPHURFREE SODIUM MAKE UP

FIG. 1
ILLUSTRATION OF KRAFT MILL SODIUM BALANCE

Possibilities of cross recovery :

From the foregoing it is now apparent that the following three factors are responsible for a cross recovery :

i) The recovery boiler furnace is big enough to burn the extra load of bl. solids and the evaporator plant has extra capacity to take care the dilution of liquor from NSSC or acid sulphite.

ii) Kraft cycle can conveniently absorb the Na supplied by the other cycle.

iii) Sulphur input from the other cycle is sufficiently enough to maintain the sulphidity level of the kraft cycle.

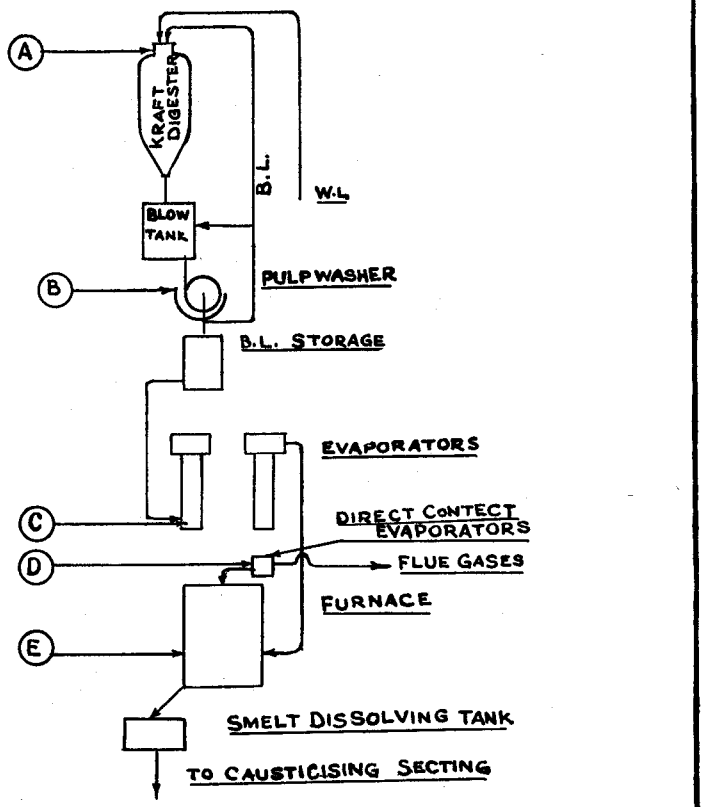
The assimilation or absorption of chemicals recovered from the NSSC spent liquor into the kraft process depends upon the make up requirement of kraft mill. If the Na requirement of kraft mill is balanced by Na from NSSC spent liquor than a sulphur deficiency occurs on the otherhand if sulphur requirements are matched then an excess of white liquor results. Now the limitations are imposed on the system by the amount of spent NSSC chemical which could be absorbed by the kraft process. If Na make up from the NSSC mill is more than the kraft mill losses, there will be an excess of white liquor which has to be consumed or disposed off in any convenient manner.

Imbalances in the sulphur make up will result in sulphidity variations.

The kraft mills where losses are very critical (40-60 kg. Na_2SO_4) this indeed presents a problem and to get a balanced operation NSSC/Kraft ratio has to be adjusted. But for most of the Indian mills where the kraft losses are in the range of 80-150 kg. Na_2SO_4 per ton, this presents no difficulty and practically any ratio between NSSC/Kraft 1:3.5 to 1:1.5 can be used. Apart from balanced operations there are now available processes and equipment to convert the ex cess chemicals suitable for reuse in the preparation of NSSC or other Na base liquors and in this context NSSC/Kraft ratio is no longer valid.

Mixing of the spent liquors :

Depending upon installation the most convenient locations for the mixing up of the two liquors are : (Figure 2)



BASIC KRAFT PROCESS FLOW SHEET WITH INDICATION POINTS "A" TO "E" WHERE NSSC SPENT LIQUOR CAN BE INTRODUCED.

fig - 2

a) Kraft digester — The NSSC spent liquor can be utilised as dilution in place of conventional black liquor.

b) Kraft blow tank/Brown stock washing system for dilution purposes. Weak liquor fractions from NSSC may be utilised for washing of Kraft pulp Water may subsequently be applied for displacement of NSSC waste liquor.

c) WBL storage tanks ahead of evaporation system.

d) At the cascade evaporator and before the Soda boiler.

e) At the Soda boiler — separately evaporated NSSC waste liquor may be burned together with kraft waste liquor.

Before deciding as to the place for mixing the two liquor the following considerations should be given a thought :

i) Kraft lignin is liable to be precipitated at lower pH. As a result pH control is required and when NSSC and kraft spent liquors are mixed, pH is generally kept around 11.

ii) The NSSC spent liquor contains small fragments of fibre so this liquor should be filtered through before mixing.

Evaporator Problems

With the association of NSSC waste liquor in the kraft cycle following problems can be encountered :

i) Tube fouling — more frequent clea ning water boil out, acid cleaning.

ii) Increased corrosion — Stainless steel tubes.

Furnace Problems

Lowering of calorific valve and the related problems are encountered. On the basis of the high yield the solids calorific valves is low and the net heat available is just enough for evaporating the liquor to burning consistency.

Normal Kraft — 3200-3400 Keal/kg.

NSSC — 2900-3100 Keal/kg. of dry solids.

Material balance calculations for a cross recovery system :

In Fig. 3, an imaginary case of 110 tons/day kraft mill has been taken. Calculations have been made to show the losses of Na and S compounds in the various sections of the pulp mill. Total make up is by Na_2SO_4.

In Fig. 4, the same kraft mill has been converted into a combined Kraft/NSSC mill. Since the losses were too high so the make up by Na_2SO_4 has not altogether been given up. It will be noted that more NSSC pulp could have been made on this system. This is a typical case of unbalanced cross recovery.

GENERAL

In recent past several processes have been developed for the recovery of NSSC and the NSSC cooking liquor is regenerated for reuse in process in the sulphite mill. The most important among them are :

i) The Institute of Paper Chemistry Process

ii) Stora Kopparberg process

iii) Sivola — Lurgi processes

iv) Tampella process

v) Copeland process.

These processes in general have a kraft like furnace and the resulting green liquor is treated with CO_2 gas and carbonated to convert Na_2CO_3 and Na_2S to $NaHCO_3$ and free H_2S which is recovered and burned to SO_2 and which in turn is used to convert Na HCO_3 to Na_2SO_3. However, these processes differ greatly in details and operations.

All these processes installed cost is very high, included are the cost of evaporator and recovery boiler very similar to kraft process. A rough cost estimate for only recovery section and liquor prepa ration for such process will vary from Rs. 4,500 to Rs. 6,500 per yearly ton in the range of (50,000 tons NSSC per year) whereas a hole Kraft pulp mill cost will be around Rs. 5,000 per yearly ton in the same range. The investment cost of a recovery plant calculated per unit capacity of the mill is lower for a large plant than for a small one. This indicates that a small independent NSSC will be too expensive to build but if coupled with Kraft a very easy recovery and liquor preparation system can be thought off.

Actually recovery of NSSC spent liquor should have come into the wide spread

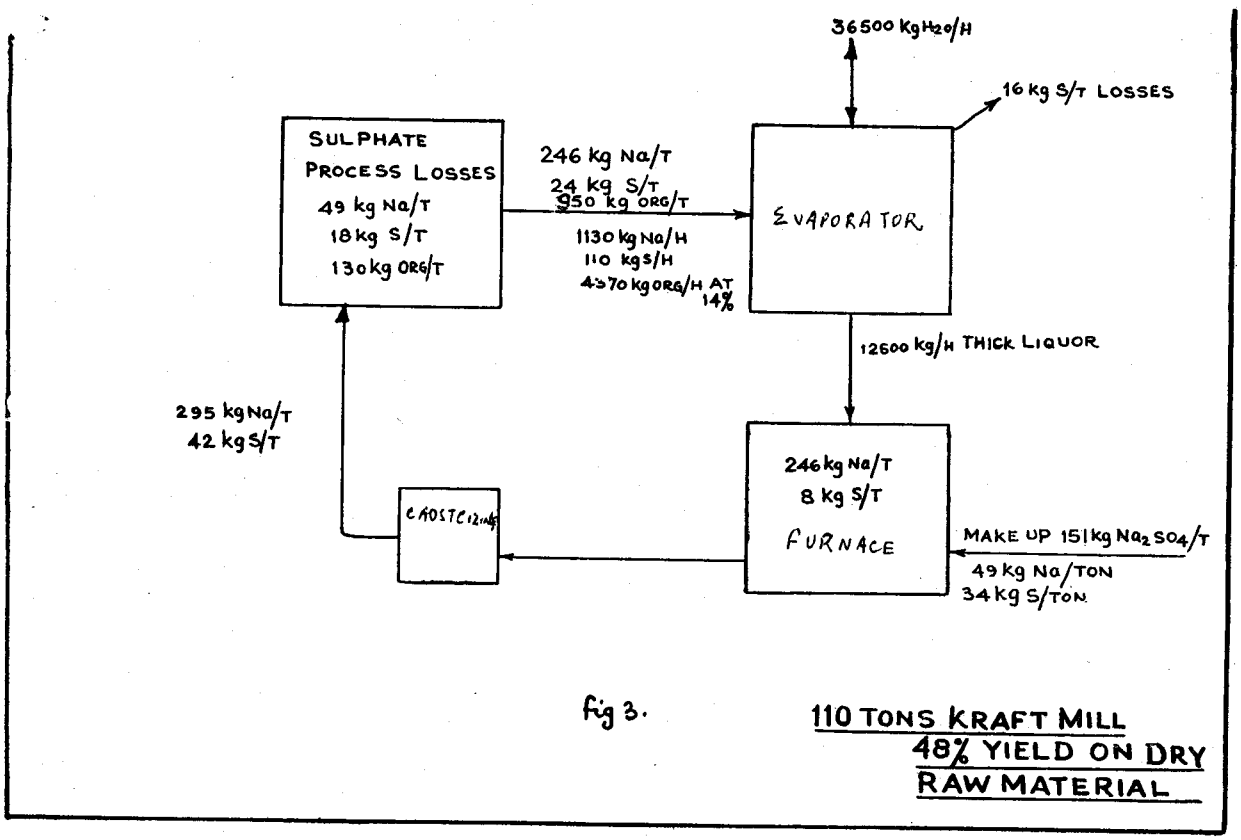


Fig 3.

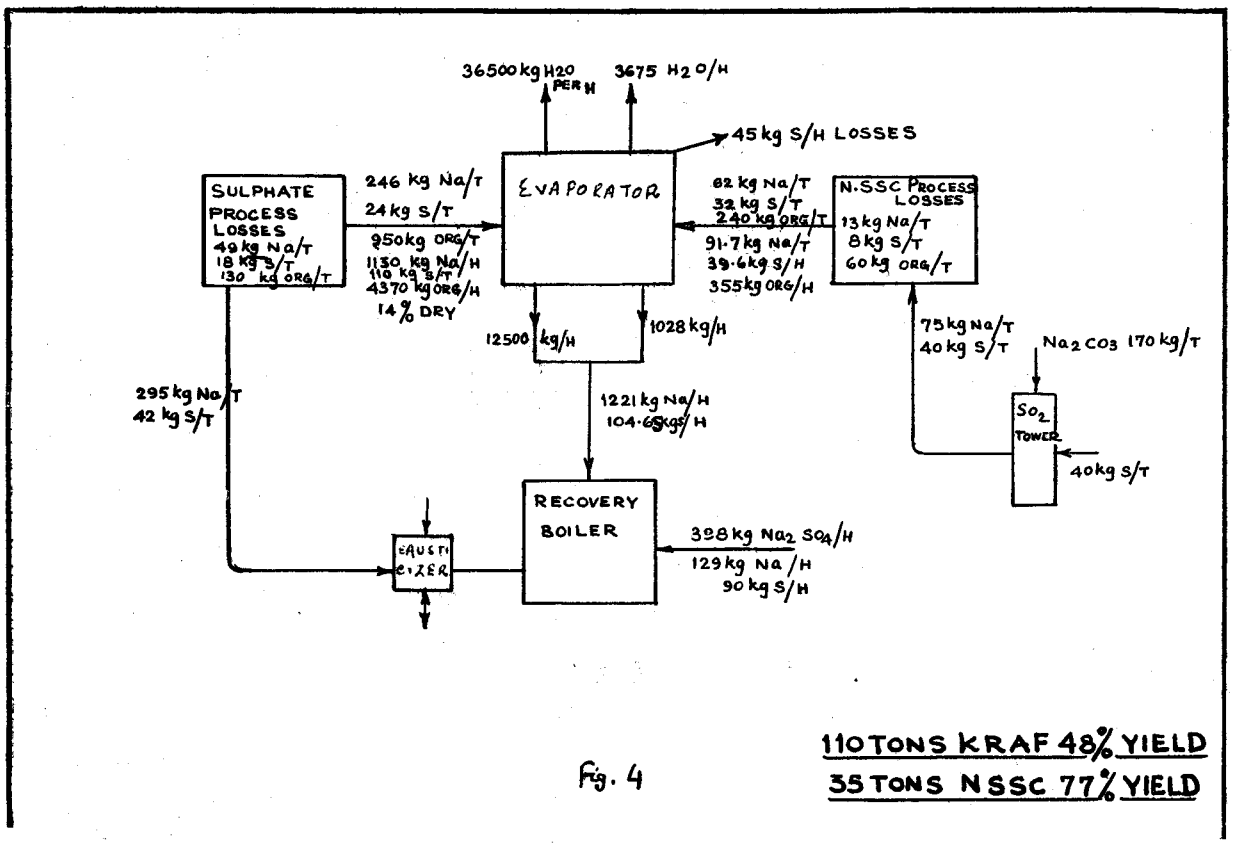


Fig. 4

use. A possible explanation might be found in the unfavourable steam balance.

REFERENCES

1. Experiences in Semi-Chemical Pulping — Arne Asplund of Defibrator AB.
2. Kraft process liquors for Na base sulphite pulping — By Nils Mannbro Svensk Papperstidning 66 (1963) 2, 25.
3. The use of green liquor as cooking liquor in the production of Semi-Chemical hardwood pulps for fluting — By stainar Vardheim Papper Och TRa No. 9, 1967.
4. Kemikalieatevinmingvid Cross recovery NSSC — Sulpat. Driftserfarenhetn vid Fiskeyby AB — By Av Lennart Ivnas Fiskeyby AB. Skarblacka.
5. The Kraft process chemical equilibriums and possibilities for cross recovery — By Bengt Arhippainen Ekono, Helsinki, Finland.
6. Recovery of Chemicals in Combined Kraft and NSSC pulp mills — by D. F. Williamson G. W. Hongh and F. I. Mason — Tappi/Nov. 1969 Vol. 52 No. 11 page 2105.