# A new heat recovery system for batch digester

CHAUDHURI PUNYA*

SUMMARY

The high steam consumption and variable steam demand are the main two problems in batch digesters. These can be eliminated by having enchanced heat recovery system i.e. by displacing the hot liquor inside the digester at the end of the cook by weak cold liquor from washing and utilizing heat for preheating white liquor. The system described in the article will result in 50% less heat consumption for all mills and will eliminate surge of foul gases from the digester.

The conventional batch digester method for soda and sulphate process has had two basic problems :

High steam consumption
Variable steam demand

Introduction of continuous digester, their subsequent modification and development eliminated these two above mentioned negative aspects and quickly outpaced batch digester as a viable alternative for the kraft and soda pulp industry. Nevertheless, the decreasing quality of wood, increased use of saw mill chips and variable wood quality together with high availability of a batch digester system compared to single line continuous digester tiggered a number of new and innovative development in this age old method of pulp production. The versatility of the batch sulphate process has been its main advantage, despite its inherent drawbacks.

The purpose of this article is to present a concept of heat recovery system suitable for retrofitting in an existing batch digester in order to eliminate the two said drawbacks.

Energy crisis of the 70's anp rising environmental consciousness within the pulp industry has imposed considerable demand on the pulp industry. The proposed system is devised tackle these two problems.

## CONVENTIONAL BLOW HEAT RECOVERY SYSTEM

Figure 1 shows the conventional blow heat recovery system. This system enables a pulp mill to recover approximately ten percent of the heat energy of the digester contents at the end of the cook as hot water at ~70°C.

Requirement of hot water is steadily decreasing, as the pulp mill are closing the back water system. For a modern pulp and paper mill there is often a surplus of low grade secondary heat. Unless the recovered heat is of high grade i.e. of high temperature, it is of insignificant value which merits little, if any, capital investment !

## ENHANCED HEAT REOCVERY SYSTEM

Figure 2 shows the flow sheet of the prosposed enhanced heat recovery system. The main principle of the system is to displace the hot liquor inside the digester at the end of the cook, by weak cold liquor from washing. This operation is performed by injecting cold liquor at the digester bottom cone by a high pressure pump (pressure should be 1—2 bar above the digester pressure). The amount of liquor, to be introduced to the bottom cone, should correspond to the cone volume, thereby guaranteeing a complete displacement of hot liquor in this zone. Hot liquor so displaced will be withdrawn from the digester through the suction strainers by the digester circulation pump and transfered to a hot black liquor accumulator tank. This tank should have a volume equal to twice the digester volume. The design pressure should be the same as digester pressure.

After the hot liquor in the bottom cone is displaced by cold liquor, the liquor injection is transfered to the top of the digester. Hot liquor from the digester is continued to be pumped out by the digester

*Sr. Consultant Celpap International AB.

CELPAP INTERNATIONAL AB
Consulting
PO Box 74
S-601 02 NORRKOPGIN
Sweden

FIGURE 1

BLOW HEAT RECOVERY SYSTEM

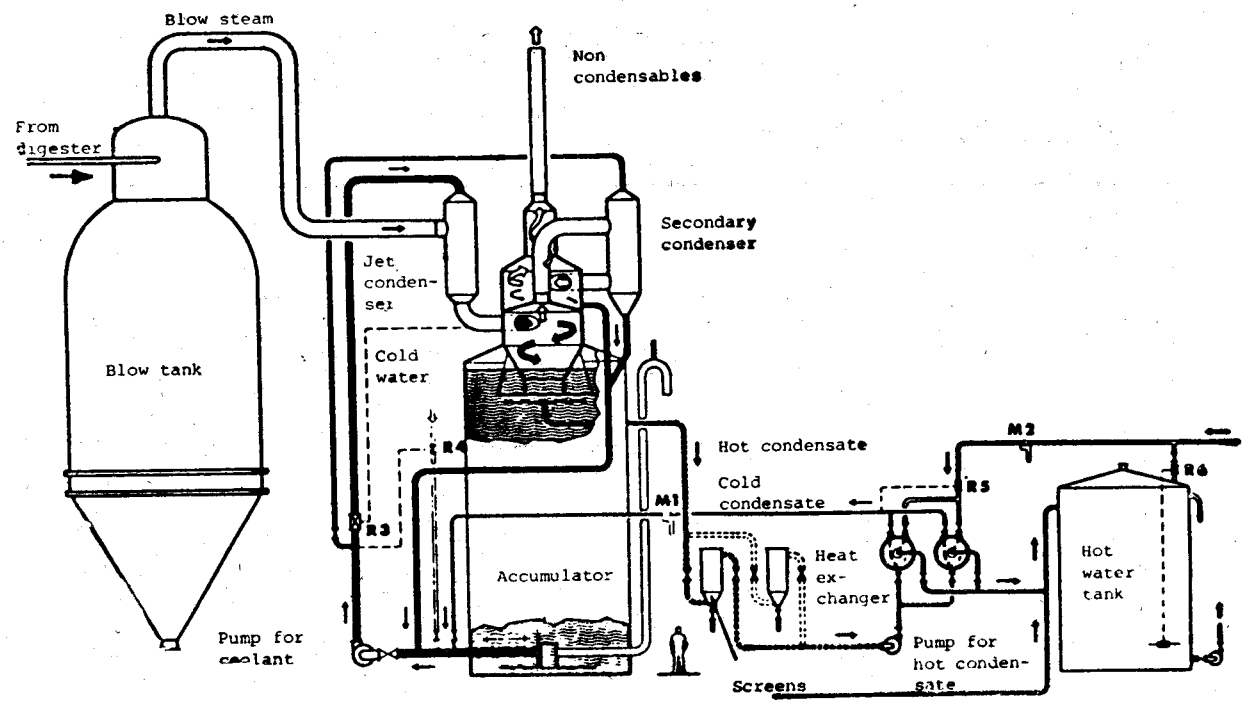
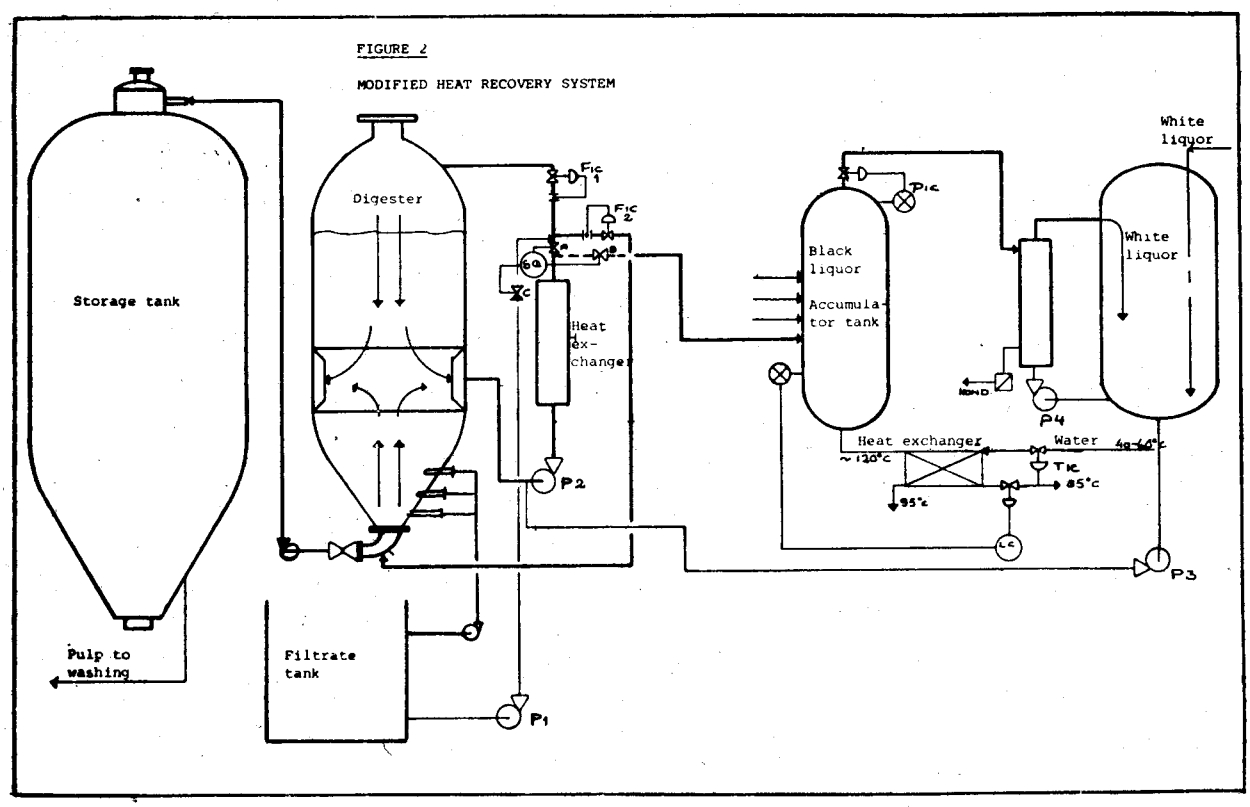



FIGURE 2

MODIFIED HEAT RECOVERY SYSTEM



circulation pump to the hot black liquor accumulator tank.

Experiments carried out in a commercial plant show that displacement pattern is very near ideal. This is interpreted from the measured temperature of the displaced liquor while the displacing liquor was injected at a temperature of ~ 40° C. The figure 3 shows the temperature time curve of a displacement experiment performed in 60 m³ digester.

It is expected that under normal operating condition the washer filtrate temperature will be around 70°C, which will mean that the final temperature after the cold liquor displacement would be approximately 100°C.

The amount of liquor to be pumped through the digester for displacing the hot liquor will be equal to mother liquor plus dilution factor. Very roughly the volume of the displacing liquor is equal to digester volume.

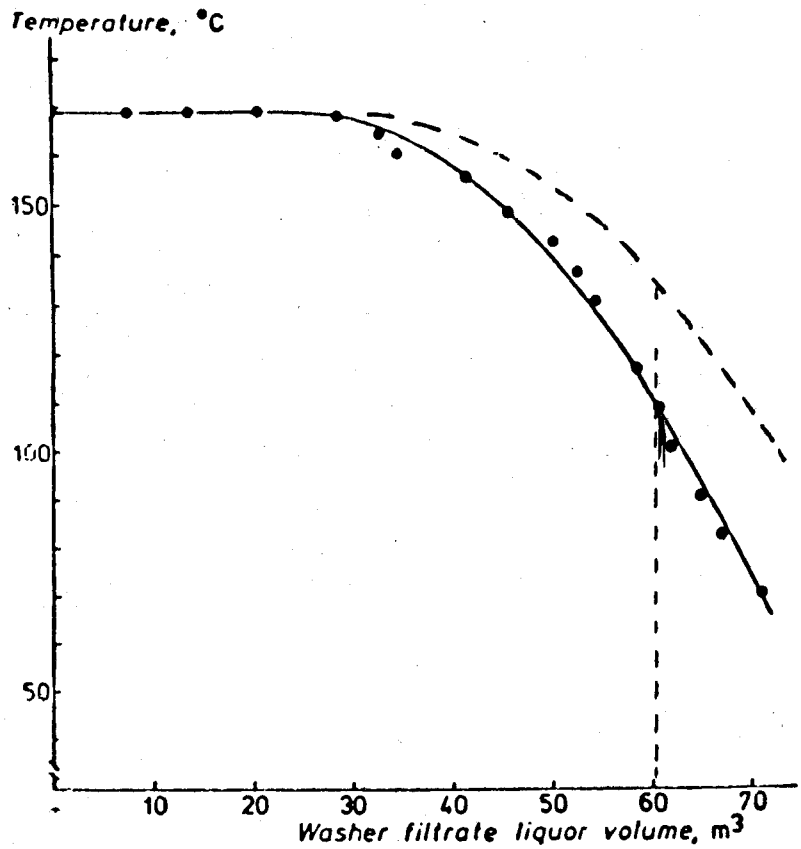
The temperature of the displaced liquor is initially 170°C, for approximately 50% of the displaced liquor. The temperature thereafter starts to fall due to mixing of the liquor inside the chips which is migrating out of the chips and the surrounding colder liquor (displacing liquor). The average temperature of the displaced liquor during the experiment was found to be 156°C.

## UTILIZATION OF HEAT

The liquor is allowed to flash at a controlled rate in the black licquor accumulator tank. The rate of flashing is proportional to the flashed steam consumption at the set pressure. The potential consumer for the steam is a three effect preconcentrator for black liquor or a white liquor preheater which ever is more suitable for the particular mill. Figure 2 shows a white liquor preheating system which will cut down the digester over all cycle.

**FIGURE 3**

Temperature curve of the displaced hot-spent liquor when displacing with washer filtrate. In this case the washer filtrate had a temperature of about 40°C. Dotted lines indicate expected temperature profile with 70°C displacing liquor.




## EMTYING OF THE DIGESTER

At the end of the liquor displacement operation, pressure inside the digester falls below the critical pressure when conventional blowing of the digester can be performed. For this reason as well as avoiding surge of foul gases coming from a digester blow, the digester contents are pumped out from the digester by a large capacity pump while simultaneously diluting the digester pulp by injecting colder black liquor from washing. The injection of liquor at the digester bottom for emptying should take place in a tangential manner to create a vortex at the cone. This method of digester emptying take away all possibility of unclean blow and ensures complete emptying of the digester contents. Mechanical action of the pump impeller also helps to defiberize the pulp for subsequent washing operation.

## POTENTIAL SAVING

By adopting the proposal system, a mill can recover as useful heat 2 GJ per ton of pulp while consuming approximately 4GJ per ton of pulp for heating. The net result is 50% less heat consumption for the mill. The system also eliminates surge of foul gases from the digester plant and gives the possibility to install special odour abatement system to take care of continuous vent.