K. Venkatramanan V. M. Mahagaonkar

Introduction :

The climate for Research and Development has improved and matured considerably and the Indian Paper and Pulp Industry has geared up for indigenous development and innovation. There has been good work done in the maximum use of locally available raw material sources for pulping and paper manufacture.

L and T as a company is actively involved in development efforts for the Paper and Pulp Industry. In this paper, however, we are only highlighting and sharing our exterience in development efforts on "Black Liquor Evaporation".

Scope of R & D in Evaporation Technology

Evaporation as a science is fairly old. But, up till now, most of the plants in India have been based on foreign know-how and expertise. Larsen and Toubro has been fortunate in that, over the years, we have been associated with a number of leading firms of evaporation, viz. Wiegand, W. Germany, for milk and heat sen-

K. Venkatramanan,

V. M. Mahagaonkar, Research and Development GR. II. Larsen and Toubro Ltd., Bombay-400072.

Recent Developments in Black Liquor Evaporation "Reference to Indian Industry"

sitive products; Kestner France, for aluminate liquor and Swenson, USA, for black liquor and applications to the fertilizer and chemical industry.

We have, therefore, accumulated know-how and experience for a wide variety of products, process applications and needs. In particular, we have geared ourselves (as explained later) to assimilate the know-how of our collaborators and relate the technology and experience to typical Indian raw material peculiarities and circumstances.

Furthermore, recent multifold increase of energy cost and large capacities of individual plant have made it imperative that the evaporation system be optimally designed with respect to operating efficiency and fuel economics.

The optimisation can be possible only if these new plants are designed to suit exactly the rawmaterial specifications and process conditions present during operation under Indian conditions. Previously, facilities and the knowledge base for conducting these trials did not exist to any professional scale with Indian design firms and as such the plants were basically based on foreign know-how with suitable empirical adaptations.

Let us now examine the type of Research and Development activities that are important if we have to be self-reliant and optimum in our design of Evaporation Systems :

- 1. Understanding of the characteristics of Indian Liquor from various Indian raw material sources.
- 2. Pilot plant trials to obtain seale-up data and understanding of the operational difficulties.
- 3. Computerisation of the design procedure for optimisation of cost.
- 4. Modification and trouble shooting of existing plants through detailed study and optimised simulation.
- 5. Innovation and new design for better efficiencies and reduced cost.

Our development efforts are in total product range of evaporation application. However, in this article, we will stress only on Black liquor Evaporation.

Investigation on Indian process liquors :

Paper industries in India are based on the use of alkaline processes for making pulp from various fibrous raw materials,

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such as, Bamboo, grasses, bagasse, mixed hardwoods, etc. The proportion of the major constituents like cellulose, hemicellulose, lignin, extraneous compounds and inorganics, such as, silica, depend largely upon the raw materials Physico-chemical and used. like characteristics rheological viscosity, scaling and foaming tendencies. specific gravity, specific heat have been determined at various process conditions for various raw material combinations. As illustration, a graph of an viscosity variation with respect to concentration for some Indian liquors is given in Fig. 1.

These physico-chemical properties play an important role in the selection of the type of evaporator and its design.

Pilot plant investigations :

Our Research and Development Powai has a Laboratory at carefully designed flexible pilot plant set-up (suitable for commercial scale evaluation) with evaporation capacity of an 500 kg/hr. The plant can simulate climbing film, falling film and forced circulation arrangements for various process conditions. To-date, we have done over 50 sets of experiments with Black Liquors on this pilot plant.

generate the The pilot plants and give basic scale up data enough insight into the operational problems to improve the design accordingly.





Computerised Design

We have now computerised our procedure for multiple design effect evaporation plants. With the help of the program we can now offer an optimum evapor-

ation system in each specific case after considering various process cost alternatives criteria and been which would not have design manual possible in approach. Some of the salient

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features of this computer program are given in Annexures I and II

For every specific case, the program automatically chooses the optimum flow routing through the heat recovery units like product flash tanks, condensate flash tanks and internal preheaters to give minimum steam requirements.

Modification and trouble shooting of existing plants

It has been our experience that older evaporator plants operate on a low efficiency because of either change in process conditions or certain operating problems. Such plants can be considerably improved after a detailed study and optimisation.

We are presently doing an assignment for an Aluminium factory in India, where our scope is "Modification of existing evaporator system to improve capacity and performance". To be able to offer such services on a larger scale to the Indian industry, we are now developing a computer oriented simulation program. This program will be specifically for evaluating and improving the existing plant performance. Another advantage of this simulation program will be to give a "Dynamic" cost optimisation of existing plant operation. This is important because when a new plant is installed, an optimisation

is arrived at between fixed cost and operating cost to obtain minimum total cost. Since the basic costs have changed in various proportions over the years, what appeared an economic proposition when the plant was installed may not be a satisfactory condition today. With this program, which has a cost element built in, we can help, evaluate and suggest methods of improving existing evaporation plant operation economics.

The soft-ware data and computer oriented simulation program will be suitable for similar improvement to the paper industry. We have noted after detailed survey of the paper and pulp industry in most of the older plants, we can achieve substantial improvement in their operating efficiency through detailed investigation and recommendation.

We look forward to the industry taking maximum advantage of this facility. We can say from experience that it takes more ingenuity to evaluate, trouble shoot and improve an existing evaporation system.

New Designs

Paper plants using bagasse or eucalyptus as a raw material give rise to high viscosity black liquor. This black liquor because of its high viscosity at high concentrations cannot be evaporated in

evaporators. Similarly normal bamboo black liquors at high concentrations and high temperature gives rise to severe scalling. We have now developed a forced circulation design which can concentrate the black liquor upto 50-55% TS. A novel feature of our design is the improvement of hydrodynamics of the fluid whereby the power consumption of our concentrartion system is 25 to 40% lower than the conventional system. A modern concentrator system of this type is now being supplied to a paper factory in central India.

Conclusion

A detailed design of a commercial systems evaporation requires of the integration the phenomenon transfer heat hydro-dynamics with the and physico-chemical characteristics of the liquor. We are presentperforming experiments to lv determing the optimum operating cycle of a black liquor evaporation plant under the most severe conditions to Indian raw material sources.

We look forward to serving the paper industry better through these innovations and to closer participation with the Industry.

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Annexure I SALIENT FEATURES

- 1. The number of effects that can be handled by the program is in the range 2 to 10.
- 2. In addition the program is capable of handling a concentrator (an unit which is used as the finisher in an evaporating system handling the product in its maximum concentration).
- 3. Along with the concentrator, the program handles a product vaporiser (liquor flash tank LFT).
- 4. Following five situations can be allowed in the program :
 - i) Two LFTs in series
 - ii) One concentrator and one LFT.
 - iii) One concentrator only
 - iv) One LFT only
 - v) No concentrator or LFT. In each case the pressure of vapour existing in the concentrator/LFT can de obtained using the computer.
- 5. The steam condensate can be flashed in two effects such that the economy is maximised.
- 6. Each effect may or may not have an integral heater.
- 7. There can be a preheater before each effect.
- 8. The optimising variables are the temperature differences existing in each effect (ΔT).
- 9. Properties of the process liquor are incorporated in the program as subroutines.
- 10. Size of each effect (i.e. the number of tubes and the dimensions of the evaporator are obtained by subroutines).

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Annexure II MEEVOPT





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