Recovery and Utilities Management

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The safe and productive operation of the Chemical Recovery & Utilities portion of a kraft pulp mill is essential for the success of the economic entity. This paper will examine the economic success factors, the importance of risk management, the interdependence of unit operations and the role of effective teamwork in Recovery & Utilities management.

Economic Success Factors

The economic success of a kraft pulp mill is highly dependent upon the operation of its chemical recovery facilities. The pulp business is among the most capital intensive businesses in the world with total capital investment for a new greenfield mill being roughly four times the annual sales revenue generated. In this extremely capital intensive business, the recovery boiler is the single most expensive component, accounting for approximately 20% of the total installed cost of a new mill. When considered together with the power boiler, turbine generator, recausticizing plant and evaporation plant, the installed costs approach 50% of the entire plant investment. It is the goal then, to achieve the maximum economic benefit from the capital employed. This requires that very high capacity utilization rates be achieved. As is typical in any capital intensive business, the difference between profit and loss usually occurs within the last small fraction of production. This will be examined later in detail. Achieving high capacity utilization is one of the key responsibilities of those leading this part of the enterprise. This is an arena in which the application of the technical principles covered in this course can make a significant difference in a facility.

One of the reasons that capacity utilization requires such intense focus is the extreme difficulty in expanding the capacity of any existing recovery boiler. There are significant physical limits to what can be achieved with any given boiler. The area of the furnace hearth, the volume of the furnace cavity and the size of the steam drum set some practical upper limits to the throughput of any given unit. These parameters are well established in the industry and attempts to exceed them generally become self-defeating. Any capital project which seeks to expand the physical size of the recovery boiler firebox or contemplates the replacement of the steam drum to allow the addition of steam separation equipment, generally will be found to prohibitively expensive. Further, even if it is technical feasible to change major components of an existing recovery boiler, the regulatory permitting process often imposes such onerous obligations that it discourages such investments. Regulators often take the opportunity to impose far more stringent emission limits, or even caps, when major sources undergo significant modifications.

With this background, the only immediate and generally most influential avenue to improve capacity utilization is the improvement of the firing practices of an individual unit. Implementation of current best firing practices tailored to a given recovery boiler is the topic of much detailed discussion within this course. Application of improved operational methods can make a very significant difference. This can be seen clearly by exploring the value of incremental production from an economic perspective. The concept of economic contribution sheds significant quantitative light on this topic. Contribution is defined in all classic economic textbooks as the difference between the net revenue per unit received for a product and its unit variable cost. Economists describe it as contribution because it is this difference that "contributes" to the coverage of fixed costs and any economic profits generated by an asset. In the kraft pulping business, the only truly variable costs are wood and bleaching chemicals. All other costs (fixed costs) of the facility essential remain constant or in the case of energy, actually increase when production declines. These fixed costs include all labour, maintenance materials, energy, asset taxes, insurance, cost of capital (including interest and dividends), and depreciation.

Figure 1 outlines the contribution and break-even points for a typical 1000 ADMT/day kraft market pulp mill. As you can see from the example, slightly more than half of the costs in the facility are fixed. On a unit basis, the contribution is $300/ADMT. The total fixed costs of $90 Million/Year require the contribution of the first 300,000 ADMT of production to be fully covered. The profit is then earned with the last 50,000 ADMT of production. Our example produces $15 Million of pre-tax profits for the entity.

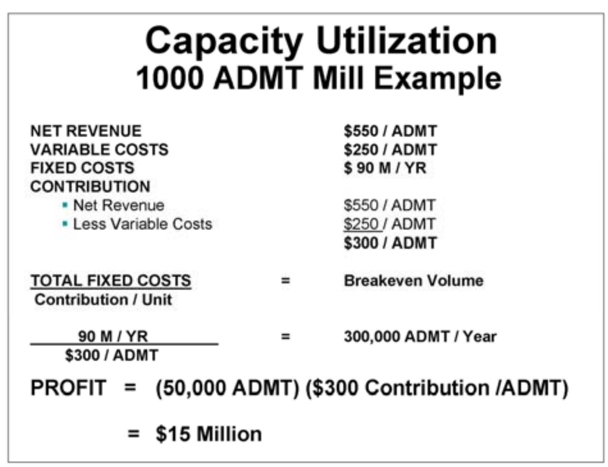


Figure 1

Figure 2 graphically illustrates this concept showing the accumulation of fixed cost coverage as the cumulative production volume builds for a year, finally reaching the break-even point where the contribution line crosses the fixed cost line. If we can achieve a 5% increase in volume in our typical mill example in *Figure 1*, we can achieve a 35% increase in pre-tax profits, as shown in *Figure 3*. This is simply derived by multiplying the new volume above the break-even point times the contribution/ADMT. In this example, our profit increases from $15 Million to just over $20 Million. This impact is typical of the profit margins and economic impact from increasing production in an existing facility.

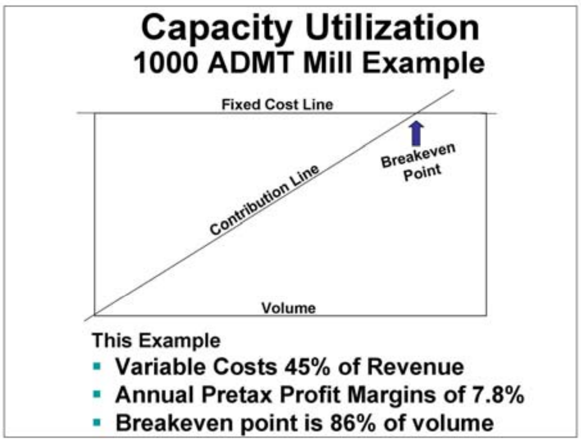


Figure 2

Capacity Utilization
Impact of 5% Production Increase

	1,000 ADMT / Day	1,050 ADMT / Day
Annual Volume	350,000 ADMT	367,500 ADMT
Contribution	$ 300 / ADMT	$ 300 / ADMT
Fixed Costs	$90 M	$90 M
Breakeven Volume	300,000 ADMT	300,000 ADMT
Volume Above Breakeven	50,000 ADMT	67,500 ADMT
PROFIT	$15 M	$20.3 M

Figure 3

The best mills are currently achieving absolute capacity utilization of 95+%. This allows for 2% annual downtime for inspection and repair and 3% losses for all other causes during the year. This requires maintaining the peak instantaneous firing rate a high percentage of the hours during the year. Since there are only two ways to increase annual throughput; 1) increasing the instantaneous operating rate, and 2) reducing the time off peak rate, it is important to manage both factors. Employing the best firing practices has the greatest influence on instantaneous rate and the team management concept has the greatest influence on the time lost due to slowdowns.

The second major economic success factor is the achievement of high thermal efficiencies in the recovery boiler operation. *Figures 4-8* outline the historic trends of energy production from kraft recovery boilers. Over the last 40 years, the thermal efficiency of this process has progressed significantly. This increase in thermal efficiency, together with reduced thermal energy consumption within the pulping process, has allowed a modern recovery boiler to produce 75% of the total steam required in new market pulp mills. At the same time, advances in steam conditions to higher final temperatures and pressure, together with improvements in turbine generators thermodynamic efficiency, have doubled the potential back pressure power generation. Modern kraft mills are now self-sufficient in electric power. They generally are able to export up to 20% of their usage rate when the bark boiler and condensing components are considered.

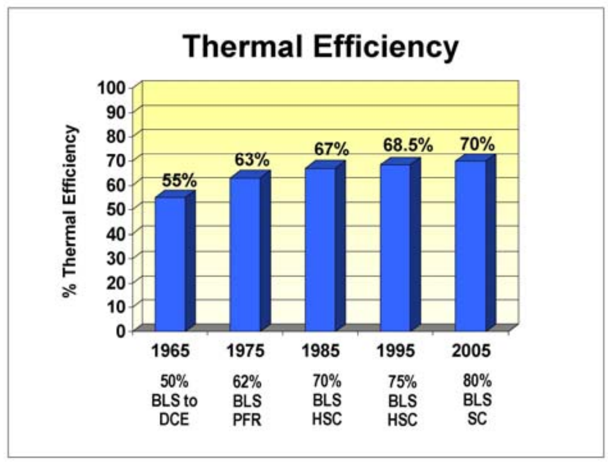


Figure 4

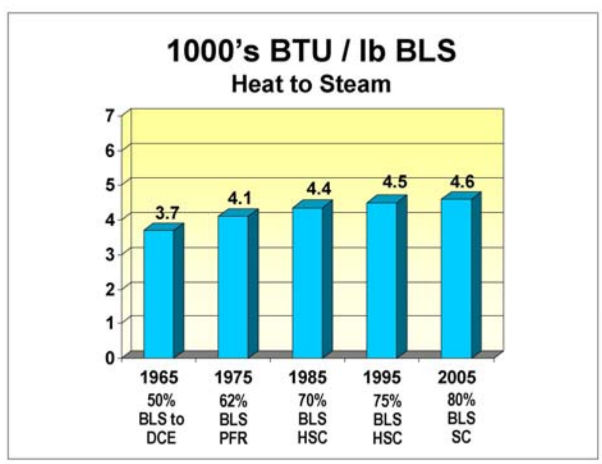


Figure 5

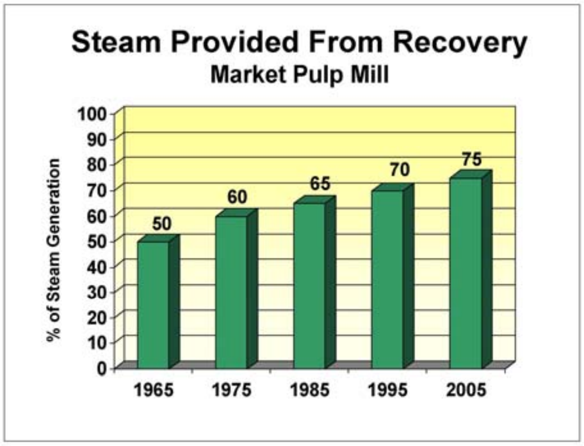
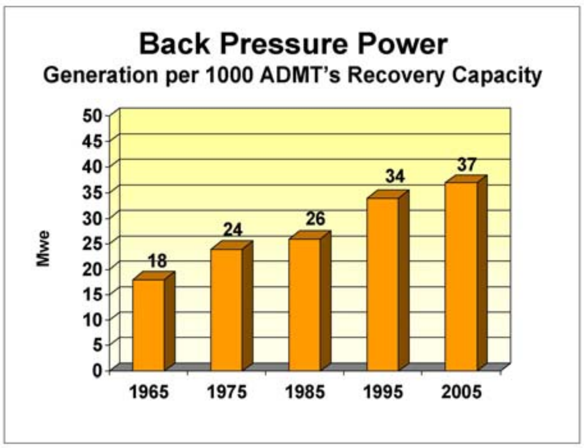
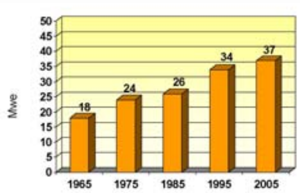


Figure 6





HP Steam Conditions

PSIG	600	900	900	1200	1500
°F	750	825	825	900	950

HP Steam Conditions

MP Extraction	60%	55%	50%	45%	35%
LP Exhaust	40%	45%	50%	55%	65%

Figure 8

Effective leaders in the Recovery & Utilities group need to have a clear understanding of where their facility lies on this continuum of technological development. In order to do this, there should be a heat & material balance developed for each recovery boiler. This should be done in conjunction with a plant-wide steam & power balance. Out of these investigations, it is then possible to formulate improvement opportunities. It is often possible to significantly increase the thermal efficiency of an existing kraft recovery unit and may be possible to increase the overall power generation potential within the plant. However, it is not sufficient to simply identify opportunities. It is the responsibility of leadership to sell the investment opportunities to upper management. This requires technical knowledge and understanding not only to identify but effectively explain the opportunities. Further, financial understanding is essential to make the economic case required. It also takes salesmanship. There are many competing demands for capital in our industry. To successfully sell identified opportunities is a major responsibility of good leadership. As a minimum, all mills should be striving to eliminate any direct contact evaporators, achieve at least 70% black liquor solids concentration, use no more than 8% of the steam production in soot blowing and have indirect final black liquor heating. Additional benchmarks include less than 2% oxygen at the furnace outlet and a maximum exit gas temperature leaving the economizer of 400^{o} F.

Risk Management

Not only is the kraft recovery boiler the most expensive capital asset within the facility, it is also the one with the most substantial inherent risks. The potential for smelt water explosions has been understood and minimized through extensive work over the last 40 years. BLRBAC has led this effort and recovery management must fully understand and comply with all their recommendations and procedures. However, smelt water explosions are only one of many economic risks associated with kraft recovery boilers. Significant downtime and very high maintenance costs are often associated with pressure part deterioration. Pressure part deterioration problems include fireside thinning, feedwater quality excursions, near drum corrosion, membrane cracking, attachment weld cracking and cold side corrosion. Proper operating and maintenance practices, together with appropriate metallurgy and design standards, can minimize these risks.

In recent history, fossil fuel explosions have been more frequent than smelt water explosions. Since recovery boilers operate for long periods of time without auxiliary fuel firing, potential problems often arise during the infrequent operation of oil and gas burners. Once again, diligent adherence to the standards developed by BLRBAC can minimize these risks. Given the complexity of a modern recovery operation, human factors are now one of the largest risk elements. Accidents are often the result of errors made due to poor training, operating procedures, or inexperience. Given the economic impact, investment in the competency of operating and supervisory personnel cannot be over emphasized. Ultimately, the economic costs of these risks are covered by insurance premiums and it is incumbent on all of us to minimize this added economic burden upon the industry.

Interdependence of Unit Operations

Excellent leadership within the Recovery & Utilities area requires the understanding of the interdependence of unit operations. These interactions occur on many levels. Three of the most important are chemical interactions in the liquor systems, thermal interactions in the steam, power & heat recovery systems, and inventory interactions in the management of the mill tankage. The chemical interactions significantly influence the quality of cooking liquor produced as well as the reliability and cost effectiveness of equipment operation. Among those factors which must be controlled to assure efficient operation of the entire kraft mill are; chemical reduction efficiency in the recovery boiler, causticizing efficiency at the slaker, white liquor total suspended solids, liquor cycle chemical make-up, non-processed element concentration control and digester residual alkali. By way of illustration, poor causticizing efficiency can quickly lead to excessive evaporator fouling, which in turn may result in lower black liquors solid concentration, reducing thermal efficiency and chemical reduction efficiency at the recovery boiler. Similarly, high digester residual alkali may result in difficult firing properties in black liquor and overloads to the causticizing unit operations. These are just two of a myriad of potential problems which may arise if the entire liquor cycle is not managed in a comprehensive manner. This requires the co-operative teamwork of all production units within the facility.

It also falls largely upon the Recovery & Utilities leadership team to effectively manage the multiple thermal interactions within the kraft mill. These include not only the overall steam power balance but the hot & warm water systems, condensate recovery, boiler feedwater pre-heating systems, as well as the effects of area maintenance outages. Careful co-ordination and thorough understanding of these interactions often result in significant reductions of fossil fuel usage. It is not uncommon for the heat recovery systems to capture and re-use 30%-50% of the heat content of the primary steam generation of the plant. Plant modifications and improvements should be carefully evaluated by recovery management personnel, in light of the complex interactions of these systems, to assure proper integration and avoid undesirable, unintended consequences.

The careful management of the inter-stage process liquor inventories is another area requiring considerable attention from the Recovery & Utilities leadership team. The positioning and control of green, white and black liquor inventories and their interaction with the unit process rates is a challenging and important responsibility. Achieving process stability, while effectively managing facility bottlenecks, can have significant economic benefits. Each of the unit processes can be more effectively optimized when their production rates are stabilized. However, this must be undertaken with a view toward always maintaining the lowest capacity unit process at its maximum rate. Optimization of the bottleneck will result in the highest final output from the facility. Once again, this requires a high level of co-operation among the leaders in all departments of the facility.

Teamwork

This brings us then to a critical question: How can the myriad of interactions be effectively managed? This can only be achieved through technical excellence together with teamwork. Both of these factors are critical. One cannot succeed without the other. There must be a sound understanding of the fundamental science involved and a commitment to manage in light of the data available on an ongoing basis. However, many leaders with outstanding technical credentials have failed because they did not foster an environment leading to effective teamwork. Who must be involved in this teamwork? The Recovery & Utilities operations require support from not only Operations & Maintenance but Engineering, Technical, Human Resources and Financial services as well. The Chemical Recovery Unit (CRU) Manager must employ expertise from all of these disciplines to achieve the maximum value for the enterprise. Getting all of these individuals and groups to work productively together is a challenge. This challenge is much like that of a head coach in a team sport. Good leaders create structures and model styles of leadership which promote teamwork. The structure must facilitate frequent and constructive interactions of the team members. Many of the tasks can only be accomplished in co-operative efforts. The structure also must assure common understanding of the goals. It must also provide a mechanism to quickly resolve conflicts which will inevitably arise. It is also important that the structure provides support and resources to those responsible. Responsibilities without the proper resources are highly frustrating and interfere with teamwork. Leadership must also demonstrate a style which promotes co-operation. Important factors include sound science and data driven decisions previously discussed, an environment which motivates each individual towards excellence, building mutual respect and trust among the team members, and a strong commitment to take care of the people.

As our industry has reduced staffing levels, it has become increasingly more important that we support and care for one another. These are demanding jobs both technically and physically. Long hours and large responsibilities can take their toll. The team needs to take all of this into account. Today's Recovery & Utilities managers must focus on the skills of leadership as well as the technical aspects of the business. Think of yourself as the head coach of an NFL team. Personnel selection, training, motivation, delegation and co-ordination are just as important as technical knowledge of the game.

Closing Comments

To be a good leader in the Recovery & Utilities area requires a solid technical background, lots of experience and refined leadership skills. Therefore, learn all you can, apply yourself to both the technical and human aspects of the business. Strive for technical excellence. It will set you apart in today's world. Study leadership with the same intensity. Think of yourself as a head coach. No one can succeed today without a quality team around them and finally, be a good team player.