1998 International Chemical Recovery Conference

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Highlights of the Florida meeting

The 1998 International Chemical Recovery Conference was held June 1-4 at the Hyatt Westshore Hotel in Tampa, FL. There were 387 attendees representing at least 16 countries. The program included 69 papers grouped into 13 sessions, plus a poster session with 37 presentations. This was the first of the international chemical recovery conferences to include a poster session, which turned out to be a popular and very productive addition to the program.

A highlight of the Conference was the presentation of a Certificate of Outstanding Merit to Thomas M. Grace, president of T. M. Grace Company. This award from the TAPPI Engineering Division recognizes Grace's exceptional contributions to the safety and productivity of the recovery boiler community. Grace received the Engineering Division's Beloit Award in 1991 and was named a TAPPI Fellow in 1987.

IS THE RECOVERY PLANT RELEVANT?

The keynote address by Richard B. Phillips, senior vice president of International Paper, provided ample material for coffee-break conversation for the remainder of the conference. Phillips noted that the pulp and paper industry is in the midst of a major profitability and investment crisis and has the lowest profitability of any manufacturing category. He questioned whether recovery boiler technology is relevant in resolving this crisis; or if it is, in fact, one of the causes.

In his opinion, poor capital management and the industry's practice of sharing technology are the major factors responsible for poor profitability of the industry in the United States. The fact that the U.S. government does not view paper as a strategic industry exacerbates the problem, as does the growth in manufacturing capacity in the Southern hemisphere.

Phillips believes that poor project selection, focused toward commodity products and large production increases, rather than poor engineering or project management, is leading to unacceptable returns on investment. He pointed out that the most profitable papermaking sector, tissue manufacturing, typically does not operate pulp mills or recovery plants and that most new capacity additions in the industry as a whole do not need recovery capacity. He questioned whether replacement of recovery boilers with new units, rather than simply rebuilding existing units, can ever be justified based on efficiency alone.

Phillips concluded that the solution to our profitability crisis lies in technology – new, innovative and proprietary technology that does not require large and expensive increments of capacity; technology that can provide incentive to risk the first installation. He believes application of such "leg-up" developments will draw the industry into the innovation necessary to achieve greater profitability.

BLACK LIQUOR GASIFICATION

The most significant current focus for long-term innovation in chemical recovery is undoubtedly development of black liquor gasification; particularly when coupled with gas and steam-turbine power generation in a so-called "combined-cycle" configuration (BLGCC). The considerable interest in black liquor gasification shown at the last international chemical recovery conference in 1995 continued unabated at this conference with a total of eight papers devoted to the subject.

George McDonald, with Union Camp, reported cost-benefit analyses showing both air and oxygen-blown BLGCC systems to have lower operating costs than conventional technology (by US$ 26 – US$ 37/ton of pulp) and air-blown systems to have the additional benefit of lower capital costs.

Craig Brown, of Weyerhaeuser, gave a status report on operation of the atmospheric pressure air-blown CHEMREC gasifier at New Bern, NC. The 350 tons/day of black liquor solids (tBLS/d) gasifier started up in December 1996. This is the first commercial black liquor gasification plant in North America .The system has had periods of reliable operation producing acceptable quality green liquor at 75% to 85% MCR, but Brown reported that challenges remain to achieve acceptable commercial operation. In another presentation, Lars Stigsson, of Kvaerner Chemrec,AB gave the history and status of CHEMREC development. Of particular note is an active project with AssiDomän to commercialize a 550 tBLS/d oxygen-blown BLGCC system at their mill in Piteå, Sweden. Startup is scheduled for the first half of 2000.

Since gas turbines are available in only a fixed set of output ranges, turbine size can rarely be matched exactly to mill black liquor capacity. The thermodynamic and financial consequences of applying a fixed-size gas turbine for BLGCC systems in mills with production rates of 500 to 2000 metric tons/day of pulp was examined by Tom Kreutz of Princeton University. Not surprisingly, the financial benefits of a BLGCC powerhouse relative to conventional technology are optimal when the gas turbine is closely matched to the mill's black liquor production rate. Kreutz suggested that his paper be viewed as a methodology template for recalculating benefits using individual mill's specific data and assumptions.

Another important issue in matching a BLGCC system to a given mill is how well the low-to-medium temperature gasifier system heat streams can be integrated with heat sinks in the mill. Niklas Bergin, of Chalmers University, used pinch analysis to identify two opportunities, in the evaporators and in the digester, to use all of the excess low-temperature heat from the particular gasification plant studied. His study provides generally applicable methodology for tailoring heat sinks in the mill to use low-grade heat from the gasifier.

Ken Nichols with Weyerhaeuser reported on a study to estimate NOx emissions from BLGCC systems. He indicated that overall BLGCC NOx can be expected to be in the same range as conventional fraft recovery furnaces, but black liquor gasification offers potential for NH_3 removal in gas cleanup and therefore potentially lower NOx. High-pressure, oxygen-blown gasification produces less NH_3 than atmospheric-pressure, air-blown gasification and hence has potential for lower NOx.

Per Ulmgren of STFI discussed an investigation of impact of pressurized black liquor gasification on non-process element accumulation in the liquor cycle. The two most critical issues are relatively high carbonate ion concentration, which could lead to calcium-sodium salt formation with potential for deposition, and relatively high liquor temperatures which could lead to reduced aluminum purge because of greater hydrotalcite solubility.

Finally, Kavin Whitty, of Åbo Akademi, reported on laboratory work to define effects of pressurized operation on char swelling, morphology and yields. Swelling was found to decrease with increasing pressure with the most dramatic decrease at lower pressures. Increased pressure led to increased char yields above 800ºC. The relative swelling difference between liquors should remain unchanged under pressurized operation.

MATERIALS AND CORROSION

According to Doug Singbeil, of PAPRICAN, corrosion will cost the pulp and paper industry US$ 24 per ton of production, or approximately US$ 3 billion, in 1998. Furthermore, he reported that boiler corrosion currently represents 50% of this cost; up from only 10% in 1974. Singbeil provided a excellent summary of the recent 9th International Symposium on Corrosion in the Pulp and Paper Industry.

ABB's field experiences with 29 non-cooled smelt spout installations over a 10-year period were reviewed by Chris Beveridge. A new cast alloy used in the last two years has exceeded expectations regarding corrosion and erosion in field tests to date. All repair or removal incidents have been thermally induced cracking or separation issues.

Hirotoshi Matsumoto, with Mitsubishi Heavy Industries, reported on new materials for recovery boilers. He showed data indicating H_2S concentrations of over 20,000 ppm near the water wall tubes, presumably due to smelt adhering to the walls. Materials that included 18% chromium were said to have excellent resistance to corrosion by this atmosphere as well as by high SO_2 concentrations. Intergranular corrosion caused by chloride ion in the ash was cited as the primary cause of austenitic steel corrosion in superheaters. A low C, low Si 25Cr-14Ni steel was found to have good resistance to this mode of corrosion.

A study to investigate differences in superheater corrosion in a recovery boiler versus a bubbling-bed bark boiler was reported by Keijo Salmenoja, of Kvaerner Pulping Oy. The study concluded that fuel analysis is misleading in predicting superheater corrosion propensity. Despite the fact that the recovery boiler fuel had order of magnitude higher Cl and K levels, corrosion associated with these elements was significantly less in the recovery boiler.

Jim Keiser, of Oak Ridge National Laboratory, summarized a large body of work done in the last few years at

Oak Ridge, PAPRICAN and IPST to investigate cracking of composite floor tubes in recovery boilers. To eliminate such cracking, the authors recommend maintaining recovery furnace beds as stable as possible and minimizing falling saltcake pieces; avoiding leaving wash water in contact with floor tubes; and using tube outer-layer alloys with thermal expansion coefficients closely matching that of the carbon steel base material. In a poster paper relevant to this issue, Tom Grace reported on calculations suggesting that debonding of the frozen smelt layer from floor tubes could provide the explanation for reported floor tube overheating episodes.

CONVENTIONAL RECOVERY BOILERS

As would be expected, the Conference included a variety of papers addressing issues relating to conventional recovery boilers. Two full sessions were devoted to fireside plugging, one session covered recovery boiler operation and design, one session addressed gaseous emissions, and one session covered recovery boiler modeling. Approximately half of the poster presentations dealt directly with recovery boiler issues.

HIGH-SOLIDS FIRING

A summary of the well-established benefits and drawbacks of high-solids firing was provided by Andy Jones, formerly with ABB and now with International Paper. The effects were conveniently broken down based on 5%-point solids increments, with solids increasing from 65% to 85%. Drawbacks are essentially limited to higher NOx and fume generation and pumping difficulties.

RECOVERY MODERNIZATIONS

Two papers dealing with recovery system modernizations were presented. Kaj Bäckman, Stora Cell, reviewed recovery system improvements at Skutskär that increased capacity by 25% and reduced COD by 20%. Of particular note was implementation of a "vertical air" system on one recovery boiler. Kjell Ljungkvist, of Kvaerner Pulping AB, described three examples of conversion of recovery boilers from two-drum to single-drum configurations. Reported benefits included increased availability (fewer leaks), increased capacity (less generating bank plugging), reduced maintenance, and increased safety (improved circulation).

COMBUSTION AIR RESIDENCE TIME

A very interesting study using helium as a tracer to evaluate combustion-air residence time in a recovery boiler was reported by Jan-Erik Gustafsson, of STFI. Data were presented showing shorter mean residence times, and therefore better mixing, for rotational firing compared with conventional firing.

BED COOLING

Tom Grace summarized the current body of knowledge regarding bed cooling following an ESP. Important points included:

1. all actions taken after an ESP should be such that they do not increase the extent of combustion in the bed;
2. most heat transfer resistance is internal, therefore efforts to increase surface heat transfer have little effect;
3. measurement of bed-surface temperature is not a good indication of the state of the bed;
4. thermoprobes inserted into the bed remain the best means for bed temperature measurement.

FIRESIDE DEPOSITION AND PLUGGING

The Conference included no less than 12 papers and eight posters on recovery boiler deposition and plugging or factors that contribute to plugging. The latter category included a number of presentations on chloride and potassium ions in the liquor cycle.

The effects of fume particles in the gas and in wall deposits on radiative heat transfer in recovery boilers were explored by Rick Wessel, of McDermott Technology. Radiation scattering and reflection by fume particles impedes radiative heat transfer and substantially increases required furnace size and capital cost. Relationships and modeling results were presented to illustrate these points.

Two papers characterized different types of deposition using large entrained-flow type reactors. Larry Baxter reported experiments performed at Sandia National Laboratories using their Multifuel Combustor or "MFC." Both fume (submicron) and intermediate-sized particles (1–100 microns) were studied. Contrary to earlier hypotheses, thermophoresis did not appear to be a controlling mechanism for deposition. Deposits from both sizes of particles collected as columns or stacks growing out from the substrate surface. Reyhaneh Shenassa presented a very popular paper reporting a study of carryover particle (40–590 microns) deposition using the University of Toronto's Entrained Flow Reactor or "EFR." She found that significant deposition occurred only when the Cl content exceeded a critical level between 2.5 and 5 mole-% Cl/(Na+K) and that the deposition rate increased as Cl content increased up to about 10 mole-%.

Another popular paper on fume chemistry and deposition was presented by Jorma Jokiniemi, of VTT Energy. This paper applied Jokiniemi's aerosol behavior in combustion (ABC) model to particle and vapor deposition in the recovery boiler superheater section. Results indicated that carryover deposition on superheater platens

was important but that vapor deposition was not even though carryover particle mass was only one-fifth of that of the fume. A number of deposition composition versus boiler location curves were presented.

In a rather controversial presentation, P.J. McKeough, of VTT Energy, reported results of equilibrium calculations to define release of Na, K, Cl and S during black liquor combustion as well as subsequent reactions to form fume. He used his results to specifically refute previously published work using laboratory data to determine sodium release during black liquor combustion. Some audience members questioned the study's dependence on equilibrium calculations when abundant rate data are available.

A novel approach for predicting dust composition and melting characteristics for a given liquor under typical furnace conditions was presented by Mikko Hupa, of Åbo Akademi. The method is based on liquor analysis, single droplet tests and equilibrium calculations. Calculated results were compared with actual dust samples from the boilers whose liquors were tested. Fume compositions and melting ranges were in good agreement. Calculated carryover deposit compositions did not agree well, however, with superheater deposit probe samples; presumably because the samples were not fresh.

Kauko Janka, Kvaerner Pulping Oy, used results of eight recovery boiler studies to expand on the enrichment factor concept as a tool to address fouling problems. He evaluated the role of furnace heat load, temperature and dust loading on first-melting, sticky, and final-melting temperatures. Furnace conditions had little effect on first-melting temperatures and no effect on final-melting temperatures but did have a significant effect on sticky temperatures with variations due to furnace conditions in the range of 100ºC.

Saied Kochesfahani reported on a cooperative project between the University of Toronto and IPST in which a laboratory char-bed reactor was used to study fume and "ejecta" formation during char bed burning. As expected, fume formation increased exponentially with increasing temperature. "Ejecta" formation, however, increased markedly up to about 1000ºC and then leveled off. The composition of "ejecta" is close to that of oxidized smelt and consistent with a mechanical mechanism of formation.

While understanding factors controlling deposit formation is critical in resolving boilers plugging, understanding the mechanisms of deposit removal is also important. Don Cormack, of the University of Toronto, discussed factors affecting sootblower peak impact pressure, cleaning radius and steam consumption and also presented an analysis of solid deposit removal mechanics. The resistance to debonding (adhesion strength) appears to control most deposit removal, particularly at higher temperatures. Tensile strength can be a limiting factor at lower temperatures.

Barry Hirtz, with Canadian Forest Products, described implementation of a new recovery boiler control strategy at the Intercon Pulp mill. An 8% increase in liquor throughput was accomplished via reduced carryover and boiler pluggage. Boiler thermal efficiency also improved via reduction in excess air.

CHLORIDE AND POTASSIUM REMOVAL

The high level of concern in the industry regarding means for removal of Cl and K from the liquor cycle was evidenced by the fact that the Conference included three papers and four poster presentations devoted specifically to this subject. The only commercial implementation was that of a fractional crystallization system for removal of K and Cl from precipitator catch, reported in a paper by Masakasu Tateishi, with Mitsubishi Heavy Industries. Their process operates by partially dissolving the saltcake at 40º–45ºC, cooling the slurry to 10º–15ºC and separating the precipitated $Na_2SO_4 \cdot 10\ H_2O$. Recovery boiler operation was extended from two months to more than six months before pluggage occurred.

Two papers proposed processes directed primarily toward Cl removal. Geoffrey Covey, of the University of Melbourne, Australia, described a scheme to facilitate bleach plant effluent recycle in a soda mill involving combustion in a fluidized bed of ferric oxide to volatilize NaCl and KCl. Michael Paleologou of PAPRICAN reviewed their precipitator dust precipitation (PDP) process and reported lab results showing 97% Cl removal.

Two poster presentations reported lab results on Cl and K removal: for leaching experiments at Lund University and for membrane electrodialysis experiments at IPST. One poster presentation reported full-scale pilot tests by Ahlstrom Machinery of an evaporation-crystallization system at a mill site. A fourth poster presentation reviewed two technologies for Cl and K removal from precipitator dust: Eka Chemical's Precipitator Dust Recovery (PDR), an evaporation/crystallation process; and PAPRICAN's Precipitator Dust Precipitation (PDP), an ion-exchange process. A WinGems™ simulation applying both technologies to an actual mill scenario indicated that both achieved manageable levels of Cl and K in the liquor cycle.

BLACK LIQUOR VISCOSITY

The Conference included several papers relating to black liquor viscosity and combustion properties. Particular emphasis was placed on controlling viscosity to maintain or increase capacity. Three papers dealt with heat treatment and one with high-intensity shearing to reduce viscosity. Two papers addressed changes in viscosity and combustion properties with addition of various bleach plant effluents.

Storage of kraft black liquor at high temperature is well known to permanently reduce viscosity, and this concept has been applied commercially. Liva Söderhjelm, Finnish Pulp and Paper Research Institute, presented results of a study to clarify the factors responsible for this effect. The viscosity reduction was found to be primarily due to alkaline degradation of polysaccharides. Esa Vakkilainen with Ahlstrom Machinery presented additional results of the same study that indicated increased swelling and decreased combustion time and sulfur and nitrogen release during combustion of heat-treated liquors. Oxidation was added an extra dimension to the heat treatment concept in a paper presented by Tom Mullen, of Air Products & Chemicals. In this case, the heat necessary for viscosity reduction is provided by reaction of the Na_2S and organic compounds in the black liquor with molecular oxygen.

Jim Smith, with Thor Technology Corporation, presented laboratory data and pilot plant results indicating that subjecting liquor to high shear rates (25,000 s^{-1}) can permanently reduce viscosity. A full-scale mill trial is planned for this year.

Per Ulmgren of STFI reported that ClO_2 and chelating stage effluents increased black liquor viscosity and that the chelating effluent had the greatest effect. Peroxide stage effluent was found to have no effect. Raimo Alén, of the University of Jyväskylä, found no changes in char swelling or burning time with addition of oxygen bleaching effluent. Addition of TCF bleaching effluent also did not affect swelling but did increase total burning time.

GASEOUS EMISSIONS

One Conference session was devoted to gaseous emissions. In addition to recovery boiler emissions, papers in this session dealt with burning non-condensable gases in recovery boilers, methanol vapor-liquid equilibria in black liquors, and sulfur distribution in TiO_2 fluidized beds burning black liquor.

Two papers were concerned with the mechanism of NOx formation in recovery boilers. Mikko Hupa, of Åbo Akademi, summarized recent research findings regarding the various NO formation paths in recovery furnaces. According to this paper, the predominate NO formation pathway, ammonia oxidation, can be minimized by burning devolatilized gases in several stages at relative low temperatures. Generation of NO from nitrogen in char residue can reportedly be minimized by insuring that char burnout occurs on the bed. Kristiina Iisa, IPST, reported on a mathematical model to quantitatively describe these same reactions. The model consists of N release during pyrolysis, NO formation during char combustion, NO formation from volatiles and from combustion air and NO destruction. Results of laboratory experiments to test the model were reported. Experiments suggested that part of recovery furnace NOx might be prompt NOx.

Two papers dealt with burning non-condensable gases in recovery boilers. Roberto Villarroel described a system developed by and installed at CELPAV Pulp and Paper to burn HCLV gases in the recovery boiler. They have been very pleased with the installation and do not believe that it has compromised the safety of recovery system in any way. Ari Tamminen, Kvaerner Pulping Oy, also described for burning HCLV gases in a recovery boiler. This system has been operating in a Finnish pulp mill since 1993 and is considered effective and safe. The caveat was added, however, that black liquor dry solids content should be above 70% and dust carbonate content must be between 5%–10% to react with the extra SO_2.

Since methanol accounts for some 90% of the VOC emissions from kraft mills, knowledge of the vapor-liquid equilibria controlling release of methanol from black liquor systems is valuable in understanding and controlling VOC emissions. J. Y. Zhu, of IPST, reported measurement of Henry's law constant for methanol in various black liquors using headspace gas chromatography. The constant was found to increase exponentially with the inverse of temperature in Kelvin and to decrease linearly with solids content.

Adriaan van Heiningen, of the University of New Brunswick, reported the distribution of sulfur among various compounds during gasification of black liquor in a fluidized bed of TiO_2. Detected gaseous sulfur species included H_2S, COS, CH_3SH, C_3H_7SH, $(CH_3)_2S$ and $(CH_3)_2S_2$.

RECOVERY BOILER MODELING

A great deal of effort has be devoted in recent years to the application of computational fluid dynamics (CFD) based computer modeling techniques to the recovery furnace. One session at the Conference focused on recovery boiler modeling. Four papers were concerned with various aspects of CFD modeling, and one paper took a completely different tack by investigating the applicability of artificial neural network modeling to the recovery furnace. Three of the four CFD papers also overlapped the gaseous emissions session by addressing recovery furnace NOx emissions.

Eas Vallilainen, Ahlstrom Machinery, described a three-dimensional simulation of a 3150 tds/d recovery boiler and compared calculated temperature and NO results to actual measured values taken throughout the furnace. Tom Grace, representing IPST, reported on a new elemental-based droplet-burning model for incorporation into overall CFD recovery furnace models. The model allows computation of parameters relating to boiler fouling and also allows prediction of TRS, CO, VOC, SO_2, and NOx concentrations in air emissions. Wolfgang Schmidl, IPST, summarized CFD model validation efforts using pilot-scale water models as well as an actual recovery furnace. Flow and temperature predictions were more successful than the predictions based on black liquor combustion modeling. Wlodzimierz Blasiak, Royal Institute of Technology, reported on a three-dimensional CFD simulation of a recovery furnace that incorporated rotational firing and double overfire air. Results indicated that rotational firing led to higher combustion and thermal efficiencies and lower droplet carryover. NOx reduction by air staging was also demonstrated.

The applicability of neural network modeling to recovery boilers was investigated in a paper given by Bob Horton, Radian International. The authors concluded that accurate neutral network recovery boiler models are possible given sufficient input data. They believe that such models can be effectively applied to on-line monitoring and optimizing control.

CLOSURE OF THE CHEMICAL RECOVERY CYCLE

In addition to the papers and posters dealing with Cl and K in the liquor cycle covered under recovery boiler deposition and plugging, the Conference included several papers dealing with liquor cycle closure and the management of other non-process elements.

Björn Warnqvist, with ÅF-IPK, reported on the recycle of TCF bleach plant effluent currently practiced by three mills in Sweden. In each of these mills, the TCF-bleached pulp is less than 40% of the total production, which allows the liquor cycle to effectively absorb the chemical elements in the effluent.

Methodology for assessing the distribution of non-process elements (NPEs) in the pulp mill was presented by Risto Järvinen, of KCL. Testing for this technique requires only the elemental analysis of white liquor, black liquor and unbleached pulp. The behavior of NPEs is then described in terms of two parameters: distribution between black liquor and unbleached pulp and reduction in the recovery cycle.

Murray Ellis, of PAPRO, reported on a study to develop mill balances for a number of NPEs in the Kawerau mill of Tasman Pulp and Paper Co. Approximately 100 process streams were sampled during an eight-hour period of stable operation. Fiberline balances for Na, Ca, Al, and K and pulp mill and recovery balances for K, Mg and Si were presented.

A study of the solubility of aluminosilicates in green and white liquors was presented by Jim Frederick, of IPST. The study involved two-day equilibrium solubility tests of Al and Si in unclarified liquors. Results indicated that efficient dregs removal is critical in maintaining low Al and Si levels. Addition of Mg salts facilitated Al and Si removal in the dregs.

Maritta Kymäläinen, of Åbo Akademi, presented results of a very comprehensive study to trace the fate of fuel nitrogen through the recovery process. A nitrogen mass balance of the entire recovery process at a Finnish mill was presented. Total N in the smelt was about 40% of that in the black liquor. Practically none of the N in the smelt was NH_3, but 20% of the N in the green liquor exiting the dissolving tank and 70% of the N entering the slaker was NH_3. It was suggested that NH_3 forms relatively slowly in green liquor by hydrolysis of cyanate (OCN^-) ion. About 60% of the N in the green liquor passed into the white liquor. A poster presentation was given by the same authors who reported further laboratory work supporting cyanate ion as the NH_3 precursor in green liquor. No cyanide (CN^-) ion was found thereby ruling out this species as a precursor.

BLACK LIQUOR EVAPORATION

The Conference included seven papers and two poster presentations concerned with black liquor evaporation. The principal focus was on evaporator fouling and scaling, but one paper had to do with a mill upgrade and one had to do with a new falling-film evaporator design.

In 1974-75, Tom Grace conducted a survey of evaporator fouling in the North American kraft pulping industry. A second such survey was conducted by IPST in 1997 and reported at the Conference by Wolfgang Schmidl. Results of the two surveys were compared in detail. An updated version of the preprint paper was handed out after the session.

Steffan Magnusson, with MoDoPaper R&D, cautioned that recycling Q-stage (chelating) bleach filtrates may result in increased calcium scaling because of greater degrees of supersaturation. Data characterizing precipitation upon heat treatment were presented. Jarmo Kaila, with Ahlstrom Machinery, described a system in operation at UPM-Kymmene's Kaukas mill for calcium deactivation through heat treatment to reduce calcium scaling.

A new method for calculating the solubility of burkite and sodium carbonate in black liquor using the NAELS (non-ideal aqueous electrolyte simulator) model was discussed by Greg Golike, of Weyerhaeuser. Calculated results were compared with experimental data.

An upgrade of the evaporator system at Irving Pulp and Paper, Ltd. was described by Farshad Piroomand. The existing five-effect LTV evaporators with a single PFR concentrator was upgraded by adding a FF #6 evaporator, new surface condenser, external preheaters, a high-solids crystallizer and a complete stripping unit.

The new TUBEL® concentrator technology was described by Lars Olausson, of Kvaerner Pulping AB.

CAUSTICIZING

Relatively little attention was devoted at this Conference to the conventional caustic plant with only four papers and two poster presentations. This compares with 12 causticizing papers at the 1995 Conference.

Formation mechanisms for H_2S, the principal lime kiln TRS constituent, and results of a twelve-month field study to assess lime mud filtering and lime kiln operation were presented by J. Kivivasara, of UPM-Kymmene. As would be expected, lime-kiln TRS emissions were found to be a direct function of mud washing and filtration as well as the kiln burning conditions.

A fuzzy logic based expert model for lime and causticizing process control was described in a paper by Lars Nilsson and Mette Dobel. The particular control strategy for STORA's Skoghall mill was presented. Results showing a 50% reduction in make-up lime and 64% reduction in the variation in residual carbonate were reported.

As part of a major modernization project, Aracruz Celulose S.A. installed a new green liquor filtration system. A paper by Marcelo Montanhese, et al, of Aracruz described the project, including results of preliminary pilot studies and documentation of industrial performance.

The physical properties of lime pellets from fluidized-bed calciners and rotary kilns were compared in a paper authored by Josefina Lindblom and Hans Theliander. Laboratory experiments were conducted to determine the reasons for differences. The higher strength properties of lime from fluidized beds are thought to be due to the relatively fast calcination and the mechanical forces associated with turbulent conditions.

NEW CHEMICAL RECOVERY TECHNOLOGIES

The Conference included one session devoted to new chemical recovery technologies. This session included six papers; four of which were concerned with various aspects of autocausticizing. One poster presentation also dealt with autocausticizing. Of the remaining two papers, one dealt with a novel recovery process for non-wood pulp mills and the other with a calcium-based sulfur recovery process for gasification systems. One poster presentation reported an electrochemical replacement for the conventional kraft recovery process.

A process using ferrite causticizing to enable a split-sulfidity scheme was described by Geoffrey Covey, of the University of Melbourne. Results of supporting laboratory experiments were included. Adriaan van Heiningen, University of New Brunswick, presented results of pilot fluidized-bed studies to investigate direct causticization of kraft black liquor solids (KBLS) using sodium titanate. A causticizing efficiency of over 90% was obtained with KBLS; much higher than that obtained with pure Na_2CO_3. Hans Theliander, Luleå University of Technology, reported results of a laboratory study to define kinetic parameters for leaching of sodium hydroxide from the sodium titanate. Honghi Tran, University of Toronto, presented a paper giving a detailed review of the basic reactions between Na_2CO_3 and sodium borates ($NaBO_2$ and $Na_2B_4O_7$). He concluded that partial borate autocausticizing is technically feasible.

A novel recovery process for small non-wood pulp mills was described by Bertel Myreen, of Jaakko Pöyry. The process involves silica precipitation with CO_2 and lignin combustion in a reactor with pure oxygen. Chris Verrill, with McDermott Technology, described a process using dry lime (CaO) to scrub H_2S from offgas from a black liquor gasifier. The resulting CaS can then be hydrolyzed to NaOH plus NaHS for kraft pulping. Laboratory results were reported showing very high conversion efficiencies. Finally, a poster presentation gave a cursory report of the patented Jernigan Kennedy Electrochemical Recovery Process (JKECRP). This process is claimed to recover pulping chemicals and lignin and to have the capability to eliminate the kraft recovery furnace and associated NOx and sulfur gases. No experimental data were reported. **TJ**

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