Benefits of Process Simulation in Conservation Projects

57th Appita Annual Conference

Melbourne Victoria

Forum on Water and Energy Conservation

7 May 2003

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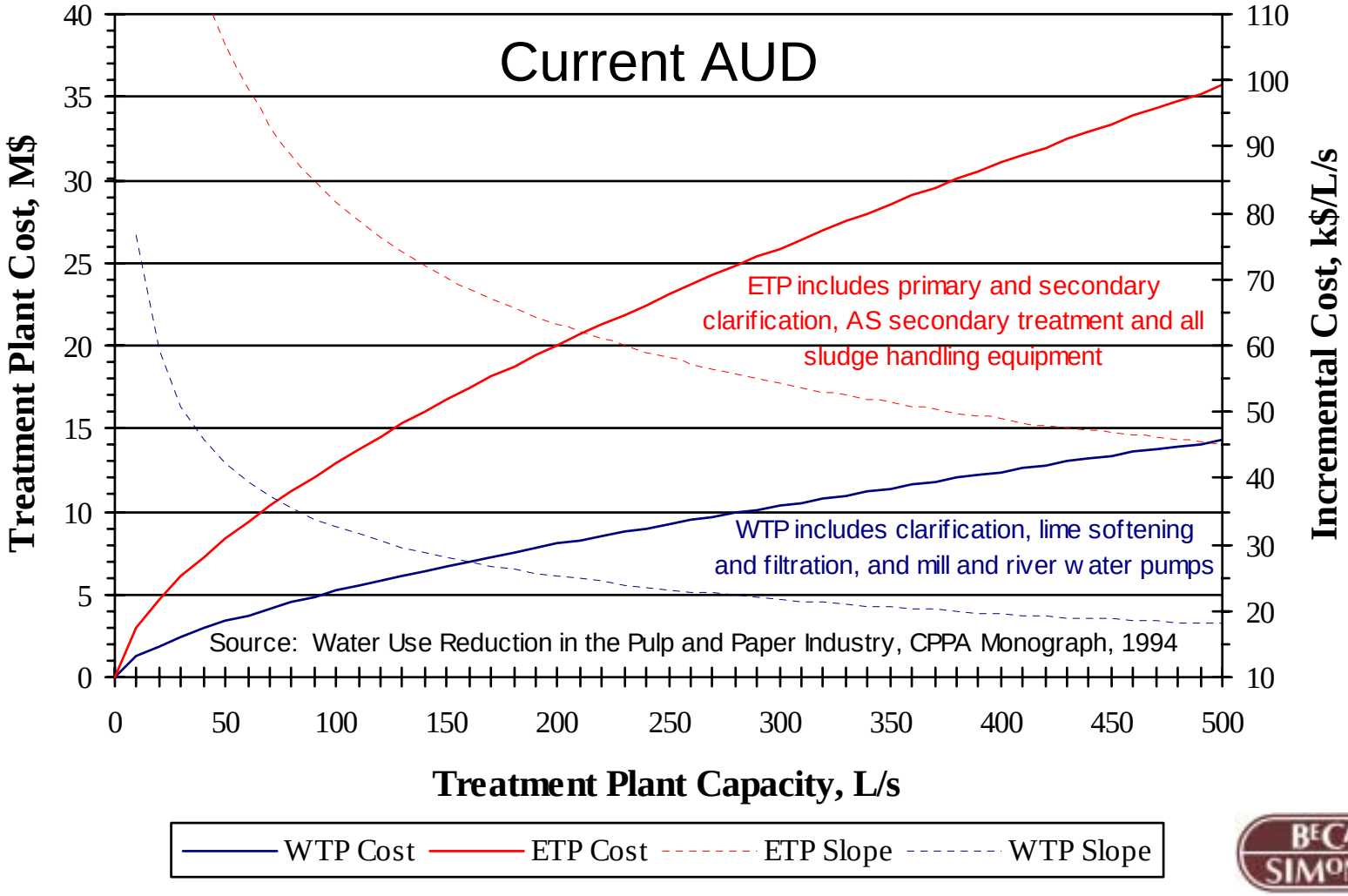
Outline

- Drivers for conservation
- Methodology for conservation audits
- Process simulation sizes and tools
- Conservation project case studies

Drivers for water conservation
New installations

- Lower investment costs for water supply/ treatment and effluent treatment
- Choice of location not dictated primarily by abundant water supply

Water and effluent treatment plant costs



Drivers for water conservation
Existing installations

- Expansion while remaining within EPA limits for water and effluent
- Lower SS to/ higher HRT in ETP
- Decommissioning or reallocation of redundant ETP equipment due to < flowrate

Drivers for water conservation Existing installations

- Water conservation has ecological merit
- Operating cost savings (site specific)
  - Water treatment $50-300/ML
  - Effluent treatment $500-1,000/ML
  - Pumping $10-20/ML
  - Fibre $300-400/t
  - Chemicals $300-1,500/t
  - Heat energy to bring cold fresh water to system temperature

Drivers for water conservation
All installations

- May be dictated by local conditions
  - LWRS at Norske Skog Albury
  - Shallow lake at Millar Western Meadow Lake
- Economies of emerging technologies (e.g. evaporation, RO, NF) are contingent on reduction in water use

Drivers for energy conservation

- Mill specific
  - Electricity cost in high yield pulp mills
  - An old kraft mill may have no electrical generation capability whereas a new kraft mill may be an exporter of electricity
- Expansion plans
- Energy savings

Methodology for conservation audits

- Mill visit
- Review of operating data with mill staff
- Base case process modelling (millwide mass & energy balances (MEB) - steam & power balances (SPB))
- What-if scenario modelling

Methodology for conservation audits

- Validation of the accuracy of the results consistent with the objectives (i.e. we built the right model)
- Verification of the accuracy of the specifications (i.e. we built the model right)
- Review of models with mill staff
- Conclusions and recommendations

Process simulation sizes

Type	Streams	Variables (Comps)	Total Variables
Three-stage cleaning system	15	4	60
Paper machine	150	6	900
Complex steam balance	950	5	4,750
Millwide water balance	1,100	5	5,500

Source: Introduction to Process Simulation, TAPPI Press (1992)

Process simulation sizes

Total Variables	Economical Way to Simulate
< 30	Electronic Spreadsheet
30 - 75	Either Electronic Spreadsheet or Process Simulator[1]
> 75	Process Simulator

1. Simulators are sophisticated graphic software packages which represent the behaviour of a real system with a model

Source: Introduction to Process Simulation, TAPPI Press (1992)

The tools

- MS Excel for small projects (seldom used)
- CADSIM^{R} Plus
- IDEAS^{TM} (Integrated Design Engineering with Advanced Simulation)
- Models are usually steady-state although CADSIM Plus and IDEAS are dynamic simulators

Conservation project case studies

- Kraft / TMP mill
- CMP / TMP mill

Project 1
Kraft / TMP mill

- 585 ADt/d UBKP and SBKP
- 545 ADt/d BKP
- 1 350 ADt/d TMP
- 4 PMs
- 2 RBs / 5 PBs / 1 - 25 MW TG / 21 steam drives / 4 steam pressure headers / 2 separate BFW and condensate systems

Project 1
The objectives

- Develop a millwide SPB (405 equipment units and 1530 streams) to carry out a benefit analysis of the proposed energy conservation projects
- Model to consist of a single flowsheet

Project 1
Summary of conservation projects

- Evaporator combined condensate HRU
  - Project cost: $320K
  - Steam savings: $530K/a
    - For heating water to steam plant demins
    - For heating water to paper machine hotwells
  - Payback: 7 months

Project 1
Summary of conservation projects

- Steam use by pulp machine
  - Steam addition was required to increase drainage of an old decker
  - As part of an overall upgrade of the pulp machine, a new, larger disc thickener replaced the decker
  - Project cost: Nil
  - Steam savings: $395K/a

Project 1
Summary of conservation projects

- TMP plant HRU
  - Project cost: $4M
  - Steam savings: $2.5M/a
    - To produce hot water for the bleach plants
    - To heat water to paper machine hotwells
  - Payback: 19 months
- Two paper machine steam turbines replaced with DC drives for lower mill steam usage

Project 1
Study stats

- Duration: 2 months
- Study cost: $60K
- Conservation projects cost: $4.3M
- Average annual operating cost savings: $3.4M

Project 2
CMP / TMP mill

- 280 ODt/d soda CMP
- 450 ODt/d TMP
- 2 SNP and INP PMs
- 1 PB

Project 2
The objectives

- Propose fibre and water conservation measures aimed at minimising loads to and cost of a future secondary ETP
- Propose energy conservation measures
- Lower the net mill gate cash cost
- Maintain or improve pulp and paper quality

Project 2
Summary of conservation projects

- Increase DOC of the soda CMP plant
  - Project cost: $5M
  - Operating cost savings: $1M/a
    - Energy conservation
    - Lower effluent flow
    - Lower effluent SS
    - Lower peroxide usage
    - Lower water use
  - Payback: 60 months

Project 2
Summary of conservation projects

- Increase DOC of brightening plant
  - Project cost: $3.1M (including water block)
  - Operating cost savings: $4.9M/a
    - Higher PM speed
    - Lower effluent flow
    - Lower effluent SS
    - Lower retention aid usage
    - Lower kraft use
  - Payback: 8 months

Project 2
Summary of conservation projects

- Increase DOC of TMP plants
  - Project cost: $1.9M
  - Operating cost savings: $0.9M/a
    - Lower effluent flow
    - Lower effluent SS
    - Lower water use
  - Payback: 25 months

Project 2
Summary of conservation projects

- Increase DOC of PMs
  - Project cost: $570K
  - Operating cost savings: $340K/a
    - Lower effluent flow
    - Lower effluent SS
    - Lower water use
  - Payback: 20 months

Project 2
Study stats (in-plant)

- Duration: 6 months
- Study cost: $240K
- Conservation projects cost: $10.6M
- Savings:
  - Average annual operating cost savings $7.2M

Project 2
ETP cost savings details

Cost savings after conservation measures for an activated sludge secondary ETP:

Capital cost savings, M$	6.0
Operating cost savings, M$/a	1.0
Chemical cost savings, M$/a	0.25