FJS MODELS

The goal of any energy conservation program is to minimize both energy conversion loss as well as transmission loss. A detailed design analysis can unearth all the potential areas of energy conservation. Flow Joule System (FJS) supports the following design analysis models and provides a generic version that a user can modify, customize as per individual application.

- Rankine Cycle (Energy generation using pressurized steam from fossil fuel-fired-boilers)
- HVAC Cooling Cycle (Optimize system parameters with cooling load)
- HVAC Heating Cycle (Optimize system parameters with heating load)
- Fluid Circuits (Pressure energy losses in pipe network systems for Water, Air, Steam and any process specific fluids)

For details, please refer to the web site www.flowjoule.com and click on the graphical models that gives all the implementation features.

__Flowjoule V.3.1__

Program Highlights:

- Energy Conversion Models
- Thermodynamic, and Transport Properties of Air, Water and Steam.
- Custom Library for Process Specific Fluids
- Flow Energy Losses in Pipes, Valves and Fittings
- Fluid Circuits and Pump Design Specs
- Rankine and HVAC Cycle Analysis
- Integrated Liquor and Vapor cycle Analysis in Chemical Pulping Process
- Custom Library for Fuels used in Boilers
- Combustion Modeling and Flue Gas Analysis

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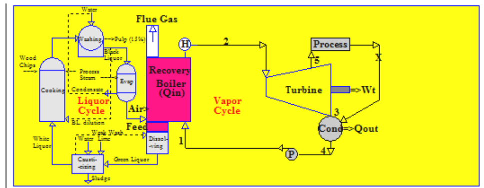
INTEGRATED LIQUOR AND VAPOR CYCLE ANALYSIS IN CHEMICAL PULPING PROCESS



State Properties

State	Pr (kPa)	Temp (°C)	Quality	h (kJ/kg)	s(kJ/kg.K)	v (m^3/kg)
1	3.250e+003	8.133e+001	-	3.438e+002	1.091e+000	1.029e-003
2	3.250e+003	3.700e+002	1.000e+000	3.159e+003	6.778e+000	8.646e-002
3	5.000e+001	8.133e+001	8.744e-001	2.356e+003	6.778e+000	2.833e+000
4	5.000e+001	8.133e+001	-	3.405e+002	1.091e+000	1.030e-003
5	8.000e+002	1.917e+002	1.000e+000	2.819e+003	6.773e+000	2.552e-001

Vapor Cycle Performance Summary

Steam (Tonne/hr)	Qin (kJ/sec)	Qout (kJ/sec)	Net Power (kW)	Process Steam (kg/hr)	Thermal Efficiency	Boiler Efficiency
1.000e+002	7.820e+004	6.048e+004	1.527e+004	5.400e+004	28.5%	62.9%

Liquor Cycle Material & Energy Per Air Dry Tonne (ADT)

Process	Water In (m^3/ADT)	Dissolved Solid (kg/ADT)	Water Exit* (m^3/ADT)	Solids Lost (kg/ADT)	Steam (kg/ADT)	Ele. Energy (KWH/ADT)
Cooking	6.43	1576	0.95	7	1485	20
Washing	12.95	1569	5.10	18	-	15
Evaporation	7.45	1473	6.16	6	1360	20
Furnace	1.27	1457	1.27	2	80	21
Dissolving	6.01	750	1.50	4	-	12
Custicizing	7.18	725	4.66	7	-	16

Evaporator Steam Economy: 4.53

Liquor Cycle Performance

Air Dry Pulp (Tonne/hr)	Fresh Water (m^3/ADT)	Na2O In (kg/ADT)	Water Loss (m^3/ADT)	Na2O Loss (kg/ADT)	Process Steam (kg/ADT)	Ele. Energy (KWH/ADT)
18.93	3.23	376	1.62	14	2925	104

Using
Flow Joule V3.1

(Design and Analysis of Flows in Energy Systems)

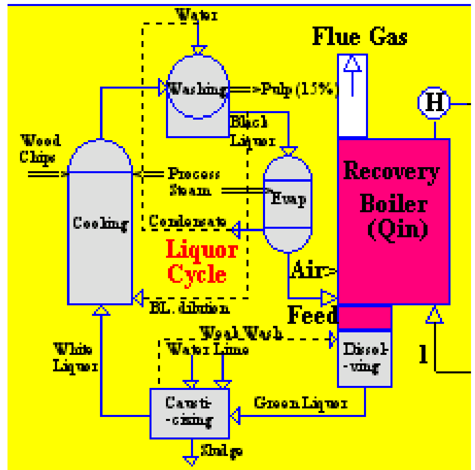
INTRODUCTION

Chemical recovery is an important part of the chemical pulping process with a potential to generate energy by burning all non-cellulose wood compounds. Hence, energy conservation in both liquor and vapor cycle needs an integrated approach. Any variation in parameters of the pulping process can influence both chemical recovery as well as energy generation. Therefore, it is necessary to evaluate material balance primarily water and total solids at every stage of liquor cycle in order to identify all potential areas and to boost conservation efforts. Furthermore, combustion heat availability and thermal efficiency of the vapor cycle is direct reflection of the liquor cycle performance.

The Flow Joule Analysis program addresses these issues and present an executive summary of both liquor, and vapor cycle. For liquor cycle, stage wise material balance and energy consumption per ton of air-dry pulp (ADP) is provided for better comprehension. This normalized data helps compare and monitor all processes irrespective of the individual plant size and helps identify all areas of energy loss. For vapor cycle, over all thermal and boiler efficiency is analyzed that helps set realistic goal for energy conservation measures.

LIQUOR CYCLE

The graphical representation of liquor cycle model is shown below.



User can edit or modify any data but only in a sequence such as Cooking, Washing, Evaporation, Dissolving and Causticizing.

Executive summary for the liquor cycle comprises of process wise material balance and energy consumption per ton of ADP and performance summary that gives the total solids and water loss per ton of ADP, as shown below.

Liquor Cycle Material & Energy Per Air Dry Tonne (ADT)

Process	Water In (m^3/ADT)	Dissolved Solids (kg/ADT)	Water Exit* (m^3/ADT)	Solids Lost (kg/ADT)	Steam (kg/ADT)	Ele. Energy (KWH/ADT)
Cooking	6.42	1576	0.95	7	1475	20
Washing	12.94	1569	5.10	18	-	15
Evaporation	7.46	1474	6.16	6	1358	20
Furnace	1.30	1468	1.30	2	80	21
Dissolving	5.90	745	1.38	4	-	12
Custicizing	7.22	715	4.65	7	-	16

Evaporator Steam Economy: 4.53

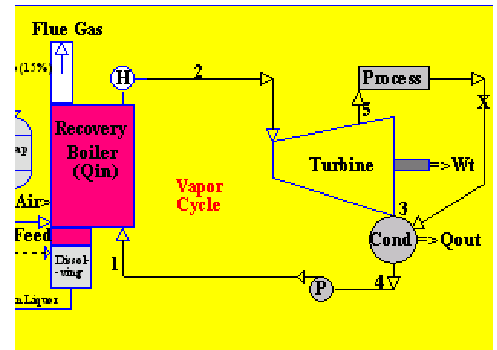
Liquor Cycle Performance

Air Dry Pulp (Tonne/hr)	Fresh Water (m^3/ADT)	Na2O In (kg/ADT)	Water Loss (m^3/ADT)	Na2O Loss (kg/ADT)	Process Steam (kg/ADT)	Ele. Energy (KWH/ADT)
18.93	3.23	376	1.65	14	2913	104

File : generic *Exit from the liquor cycle Date: Dec 6, 2007

VAPOR CYCLE

The graphical representation of vapor cycle is shown below.



Executive summary for the vapor cycle consists of Rankine cycle state properties followed by vapor cycle performance summary. Performance summary covers quantity of steam generated, net power generated, process heat delivered, thermal and boiler efficiency, as shown below.

State Properties

State	Pr (kPa)	Temp (°C)	Quality	h (kJ/kg)	s(kJ/kg.K)	v (m^3/kg)
1	3.250e+003	8.133e+001	-	3.430e+002	1.091e+000	1.029e-003
2	3.250e+003	3.700e+002	1.000e+000	3.159e+003	6.778e+000	8.646e-002
3	5.000e+001	8.133e+001	8.744e-001	2.356e+003	6.778e+000	2.833e+000
4	5.000e+001	8.133e+001	-	3.405e+002	1.091e+000	1.030e-003
5	8.000e+002	1.917e+002	1.000e+000	2.819e+003	6.773e+000	2.552e-001

Vapor Cycle Performance Summary

Steam (Tonne/hr)	Qin (kJ/sec)	Qout (kJ/sec)	Net Power (kW)	Process Steam (kg/hr)	Thermal Efficiency.	Boiler Efficiency
1.000e+002	7.820e+004	6.048e+004	1.480e+004	5.760e+004	28.5%	62.5%

Thus, the above summary tables provide different indices needed for a well-organized energy management and conservation program.