### B.4 Assessment on Paper Production

Units in the papermaking process is divided into two parts, namely stock preparation units and papermachine. Operations performed on the stock preparation unit principally aimed at the development/ modification of the fiber so feasible to be made of paper. The paper machine unit aims to spread a pulp fiber with a consistency of about 0.3-1% which is sent from the stock preparation unit to the wire to form a wet sheet web and fiber sheet is separated from the water gradually. Separation of fibers from the water begins by way of gravity above the wire, followed by a pressing phase and ending with evaporation or drying stage.

Assessment on paper production focused on the Paper Machine 10, which consists of:

- Dryer head of steam Cylinders: It was observed that dryer head of steam cylinders of both paper machine and pulp sheeting machine were not insulated thereby increasing heat loss from the dryer heads. It is recommended to insulate the dryer cylinders exposed to working area to avoid convection losses.
- 2. Refiner: It was observed that refiner consume energy to modified fiber. energy used to modify the fiber is expected according to the strength of fibers obtained.

Mill data condition and observations during audit as follow :

| No | Parameter | Mill Condition |
|---|---|---|
| 1 | Grammage, g/m$^2$ | |
| | - pre dryer | - |
| | - after dryer | 58.7 |
| 2 | Final Moisture Content, % | 3.5 |
| 3 | Pre-dryer sheet temperature, °C | |
| | - in | 53 |
| | - out | 3 |
| 4 | After-dryer sheet temperature, °C | |
| | - in | - |

| | | |
|---|---|---|
| | - out | 3.5 |
| 5 | Machine speed, mpm | 1170 |
| 6 | Inlet moisture content drying unit, % | 53 |
| 7 | Main steam pressure, kg/cm$^2$ | 3.85 |
| 8 | Main steam flow, ton/day | 1212 |
| 9 | Condensate flow, ton/day | 450 |
| 10 | Hood System | close |
| 11 | Cylinder dryer diameter, m | 1.83 |
| 12 | Cylinder Dryer Number<br>- pre-dryer<br>- after-dyer | <br>28<br>16 |
| 13 | Water evaporation, ton/day<br>- total | <br>1067 |
| 14 | Pope reel production capacity, ton/day | 630 |

Table …. Mill data condition and observation

### B.4.1 Dryer System

Close hood system in drying units will utilize most of the heat goes from evaporation of water content of the paper and can reduce steam consumption compared with the open hood system. In systems of open hood often leads to high heat loss uncontrolled.

| No | Energy Consumption | Energy (GJ/day) |
|---|---|---|
| 1 | Heat for fiber drying | 89 |
| 2 | Heat for sheet water content evaporate | 276 |
| 3 | Heat for water evaporation | 2612 |
| 4 | Heating for dry air | 7 |
| 5 | Unaccounted (balance) | 170 |
| | **Total** | **3158** |

| | | |
|---|---|---|
| 6 | Steam Enthalpy | 3333 |
| 7 | Condensate Enthalpy | 175 |
| 8 | **Heat in machine** | **3158** |

Table …. Drying unit energy balance

The high heat loss uncontrolled expressed as unaccounted, this can be caused by a hood system and heat loss due to over-drying the sheet of paper. In the case of paper machines audited, unaccounted thought to be caused by heat lost through over-drying causes the water content of paper is too low so that the need for additional heat of sorption and the rate of excess steam for heating the drying air. The lower the water content of the paper (<5%), the greater the heat of sorption is required to release the bound water.

Specific energy consumption of drying unit is slightly higher than the benchmark value. Still has potential of energy saving, primarily on the moisture content of paper coming out of the drying unit. When the moisture content of paper coming out of the drying unit adjusted to benchmark value (5-7%) is expected to reduce the consumption of energy use.

| No | Parameter | Mill Condition | Benchmark* |
|---|---|---|---|
| 1 | Product Type | Coated Base Paper | Paper and board |
| 2 | Raw Material | Virgin pulp | - |
| 3 | Grammage, $g/m^2$ | 60.8 | - |
| 4 | Freeness Stock, CSF mL | 380-400 | - |
| 5 | Inlet moisture content drying unit, % | 53 | - |
| 6 | outlet moisture content drying unit, % | 3.5 | 5-7 |
| 7 | Hood System | Close | closed |
| 8 | SEC, $ton_{steam}/ton_{evap}$ | 1.06 | 1.30 |
| 9 | SEC, $ton_{steam}/ton_{product}$ | 1.92 | 1.8-2.2 |
| 10 | SEC, $GJ/ton_{evap}$ | 2.92 | 3.00 |
| 11 | SEC, $GJ/ton_{product}$ | 5.28 | 3.01-5.04 |

Table …. Drying Unit Specific Energy Consumption

(Paulapuro, 2000 (FAPET)

Steam consumption savings can be made by reducing the moisture content of paper into the drying unit from 53% to 50%, which may be implemented with an increase the pressing operation. Decreased moisture content of paper that goes into dryer can generate steam savings 6.98% from 1212 tons/day to 1127 tons/day, see table below.

| No | Operation Variable | In moisture content on drying unit* | |
|---|---|---|---|
| | | 53% | 50% |
| 1 | weight of water evaporated in the pre-dryer, ton/day | 687.96 | 607.88 |
| 2 | weight of water evaporated in the after dryer, ton/day | 459.02 | 459.02 |
| 3 | Total weight of water evaporated , ton/day | 1146.98 | 1066.90 |
| 4 | Steam consumption, ton/day | 1212 | 1127 |
| 5 | Steam saving, % | 6.98 | |
| 6 | Cost saving, Rp. | 10,154,110 | |

Table …. The influence of the moisture content of the paper into drying unit on steam consumption

Drying load can be reduced by restoring the moisture content in paper products from 3% (current operating data, see table …) to 5%. The decrease drying load is estimated to be able to provide the potential for steam savings of 14 tons/day. But raising the moisture content of paper out of the drying unit should be studied more in depth with respect to changes in moisture content and other physical properties as long as the product is stored, especially the requirement for further process, because the paper is the product of base paper for coating process.

| No | Operation Variable | Out moisture content on pre-dryer* | |
|---|---|---|---|
| | | 3% | 5% |
| 1 | weight of water evaporated in the pre-dryer, ton/day | 687.96 | 674,34 |
| 2 | weight of water evaporated in the after dryer, ton/day | 459.02 | 459,02 |

| | | | |
|---|---|---|---|
| 3 | Total weight of water evaporated , ton/day | 1146.98 | 1133,37 |
| 4 | Steam consumption, ton/day | 1212 | 1198 |
| 5 | Steam saving, % | 1.19 | |
| 6 | Cost saving, Rp. | 1,726,327 | |

Table …. The influence of the moisture content of the paper out from drying unit on steam consumption

(note: the above conditions takes place on the moisture content in drying unit 53%)

**B.4.2 Refiner System**

Energy consumption in refining unit a little higher compared with the benchmark value (35 kWh/ton (UPM Kymenee). Still has potential energy saving “kWh/ton” but the freeness and fiber development should be taken as the first priority. The intensity <<1.5 Ws/m, this is low enough and good for fiber development (another source mention should << 1.0 Ws/m).

| Parameter | Double Disk Refiner (LBKP) | Double Disk Refiner (NBKP) |
|---|---|---|
| Pattern | Curve | Curve |
| Bar width | 1.651 | 1.651 |
| Groove width | 2.29 | 3.04 |
| Disk Diameter, inch | 46 | 38 |
| Average Bar Angle, | 25° | 24° |
| RPM | 420 | 500 |
| Bar Edge Length, km/rev | 159.3 | 61.3 |
| Volumetric Flow, m3/hour | 186 | 235 |
| Consistency, kg/m3 | 44 | 43.9 |
| Quantity Flow, ton/hour | 8.2 | 10.32 |
| Consumed Power, kW | 500 | 500 |
| Idle (No Load) Power, kW | 170 | 120 |
| Effective Power, kW | 330 | 380 |

| | | |
|---|---|---|
| Specific Refining Energy, kWh/ton | 40.2 | 36.8 |
| Intensity , Ws/m | 0.3 | 0.8 |
| Recirculates refined pulp, % | 50 | 50 |

Table …. Specific Refiner Energy

Refiner is designed for a wide range of operational capacity. Capacity optimization could be done by using the whole capacity with less recirculation refined pulp, but the result of fiber development should be considered as the first priority. Recirculation refined pulp 50% is too high, 20 – 25% is enough and 10 – 15% is recommended in case for having stable supply of fiber for the next process, but taking sample of refined pulp from outlet refiner is recommended for fiber development evaluation.

### B.4.3 Summary of Observations

Dryer

- SEC = 1.01 ton steam/ton water evaporated (good)
- Steam distribution use Cascade System
- Circulated exhaust air is mixed with steam
- Air humidity increase
- Loss in-condensate return to boiler
- Sheet moisture content exit after-dryer about 3% (over drying and consume higher steam)

Refiner

- Pattern is good, so does the instensity, similar pattern better to be considered
- Specific Refining Energy is good but possible to be improved and the achievable fiber development shoud be checked / evaluated.
- ∆P indicator or pressure indicator should be installed, especially when DDR is the bottle neck of the process

## RECOMMENDATION

Dryer

- It is recommended to record the sheet moisture content in each of year.
- Saving of steam consumption with thermo-compressor (theoretically about 5%)
- By heating the circulated exhaust air with steam coil, the RH of air will decrease caused the ability to evacuate vapor will increase.
- Maximum sheet moisture content exit pre-dryer about 5-6%
- Improved techniques for moisture measurement within the press section and at the boundary between the press and dryer section.

Refiner

- Optimizes the refiner capacity with less recirculation
- Optimizes the specific refining energy, SRE –kWh/ton
- Optimizes the fiber development by choosing the correct plate pattern (high bar edge length/revolution, in order to have low intensity)
- Do evaluation to get optimal SRE
- Do this step every time you change the plate pattern.
- In case the DDR capacity still to high, may change the plate pattern diameter, so the power consumption will be less and so does the no load power.
- Major sources of energy waste are running refiners on part load and over fiberizing of pulp.