Statistical Validation of Makeup Water Requirement in a Recycled Fibre Based Kraft Paper Mill Operating on Zero Liquid Discharge

By

Mohd Salim, *Nitin Endlay, Shivaker Mishra, M. K. Gupta, B. P. Thapliyal*

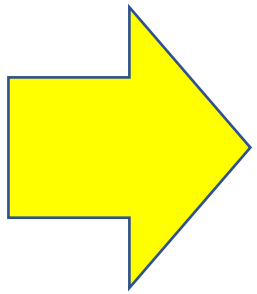
Environmental Management Division

Central Pulp & Paper Research Institute, Saharanpur – 247001 (U.P.) INDIA

Introduction: Major Drivers and Benefits of ZLD

Major Drivers of ZLD

- ❑ Stringent norms /regulations on effluent discharge quality
- ❑ Increasing cost of effluent treatment
- ❑ Freshwater scarcity
- ❑ Increased environmental awareness



Benefits/Advantages

- Compliance of environmental regulation
- Fresh water conservation
- No treatment cost
- High pulp yield

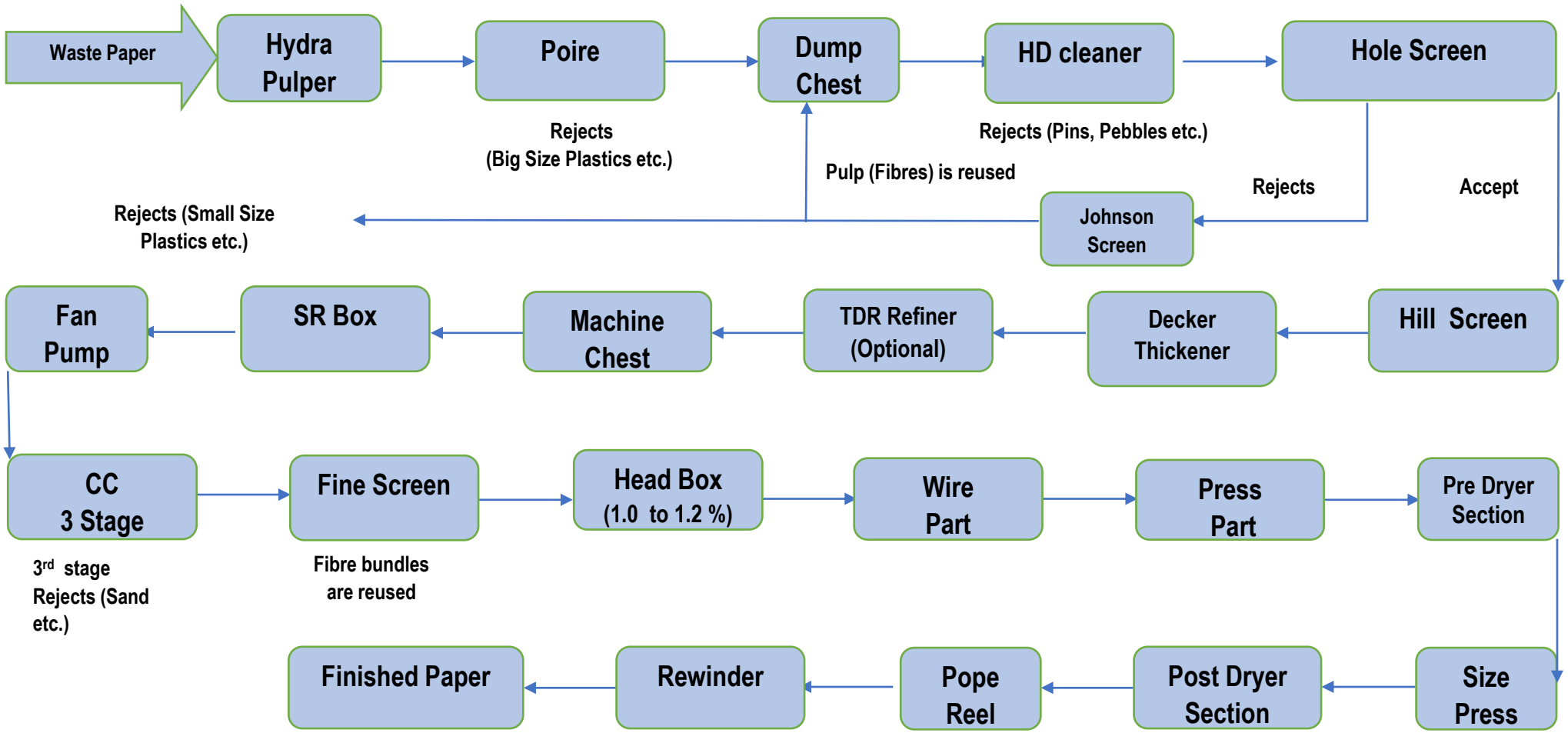
Case Study

A Recycled Fibre Based Kraft Paper Mill Operating on Zero Liquid Discharge (ZLD) since 2018 Was Taken Up for the Study

Case Study: Profile of the Mill

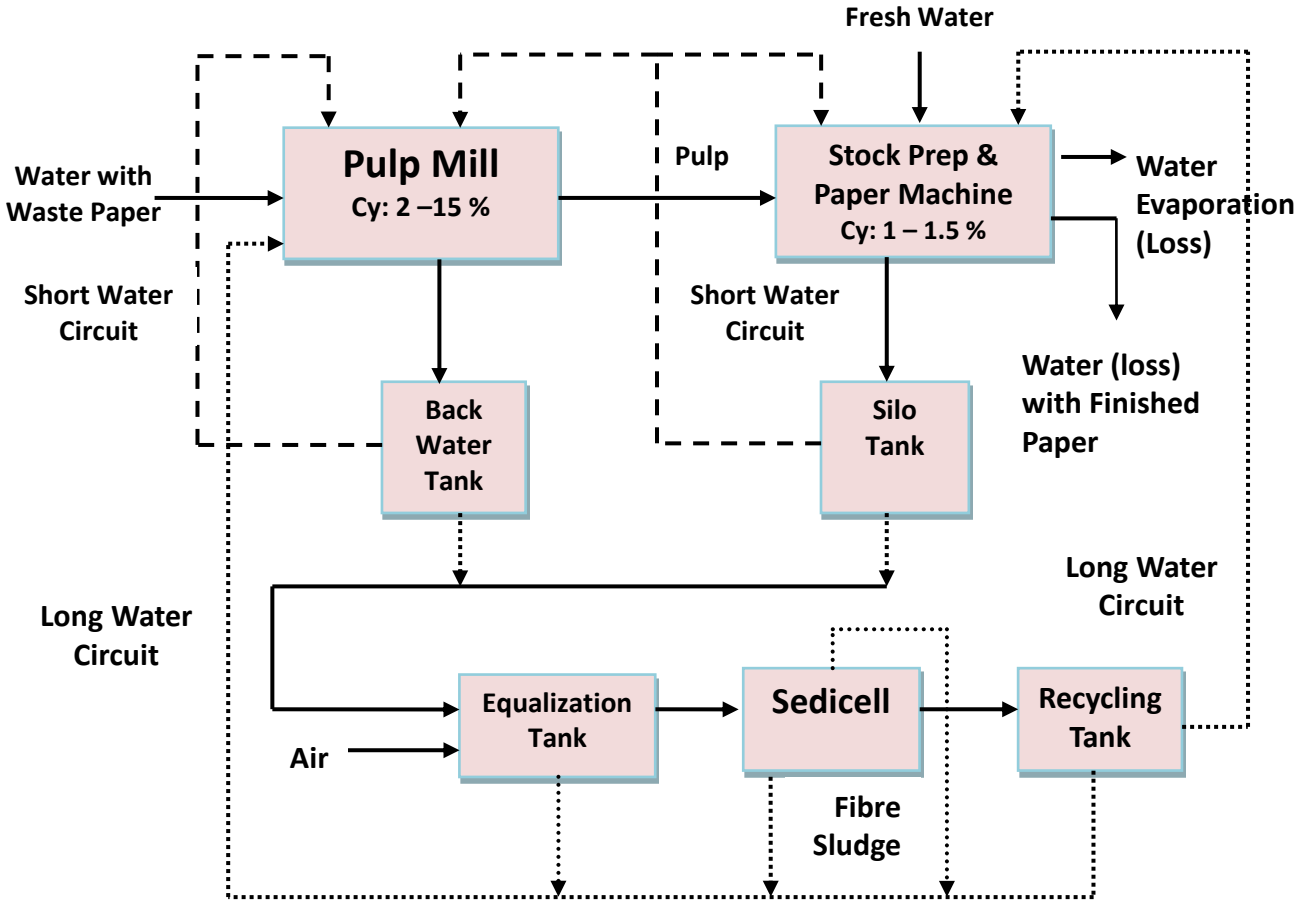
Category	C_2- RCF & Market Pulp Based Paper Mill Producing Unbleached Grades of Paper & Paperboards
Production Capacity	120 tpd
Raw Material Used	Mix Waste Paper (60 % Indian OCC +10 % Indian DMC + 30 % Imported OCC)
Grades of Paper Produced	Kraft Paper (Grade 3)
Wet End Chemicals Used	Retention Aid & Filler (Internal Sizing- Not employed)
Dry End Chemicals Used	Surface Sizing (Native Starch, Enzyme, Surface Size)
Freshwater Consumption	~ 2.0 m^3/tonne of paper as makeup water only
Backwater Treatment System	Partiallly treated through sedicall based on dissolved air flotation (DAF) for reuse in showers and vacuum pumps sealing
Volume of Effluent Discharge	No Discharge, Operating on Zero Liquid Discharge (ZLD)

Case Study: Process Flow Chart



Case Study: Backwater Reuse/Recycling Practice

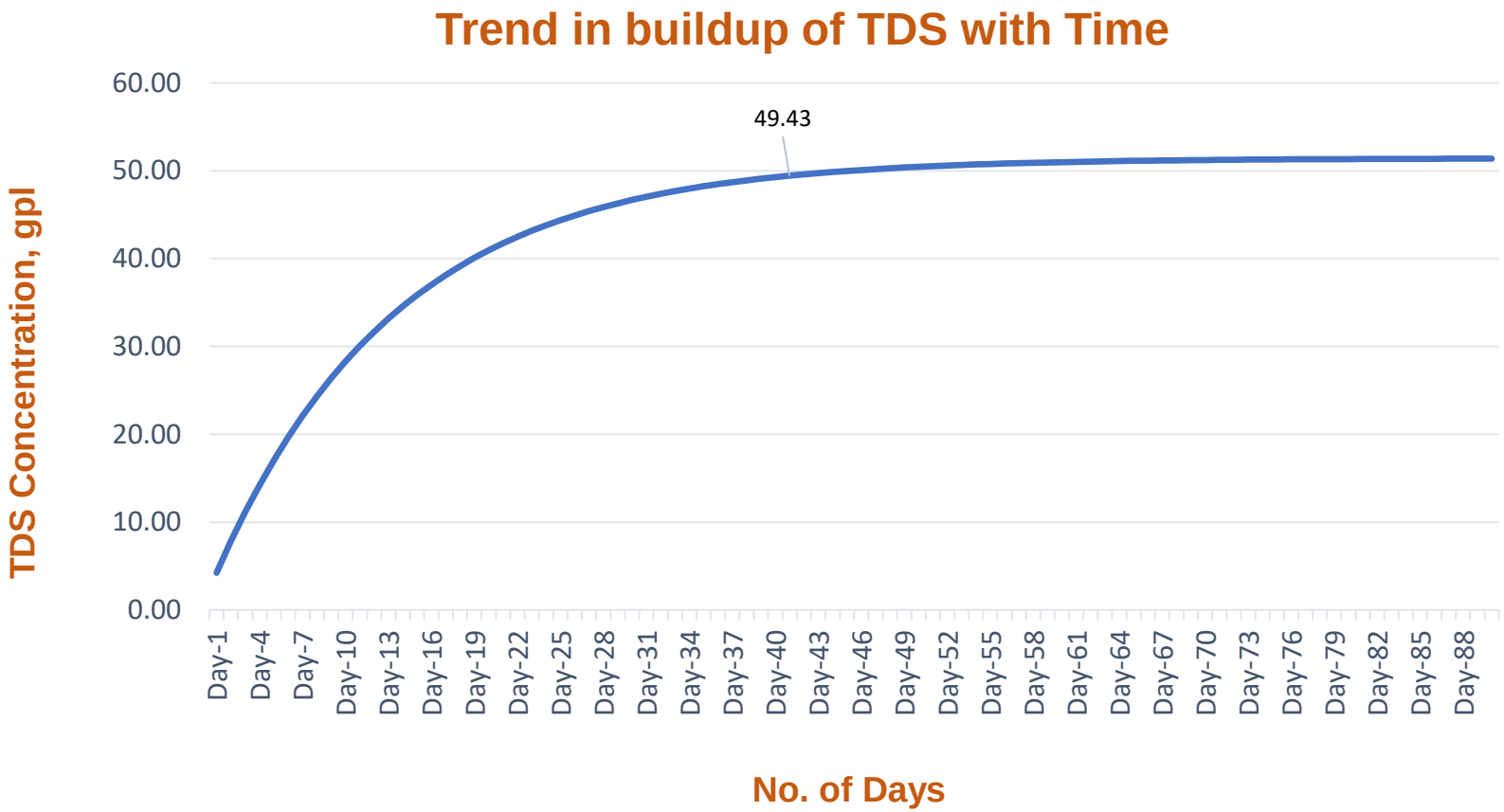
All the unit operations like pulp dilution, stock preparation, consistency levelling etc. are carried out mainly with backwater and fresh water is reported to be used as makeup water only for clearing of wire & felt at paper machine, sizing chemical preparation and boiler feed makeup water



Case Study: Characterization of Backwater Samples

Parameters	Paper Machine Backwater	Combined Backwater
pH	6.27	5.23
TSS, mg/l	3,840	5,658
TDS, mg/l	48784	46915
TDS (Organic), mg/l	28490 (58.4 % w/w)	26648 (56.8 % w/w)
COD (Soluble), mg/l	38366	36156
BOD (Soluble), mg/l	27012	26448
TDS (Inorganic), % w/w	20294 (41.6 % w/w)	20267 (43.2 % w/w)
Calcium as Ca^{++}, mg/l	5,992	6,119
Magnesium as Mg^{++}, mg/l	438	451
Chloride as Cl^{-}, mg/l	3,748	3,891
Sulphate as $SO4^{--}$, mg/l	1,725	1,846
Conductivity, µS/cm	13,254	12,776
Cationic Demand, µEq/l	11,412	10,779

Case Study: Estimation of TDS Buildup in Backwater- Buildup Trend Until Equilibrium



Challenges in Maintaining ZLD

Challenges in Maintaining ZLD without Major Technological Intervention for Treatment of Backwater Generated

- Buildup of TDS & Conductivity resulting in scaling, corrosion and deposits
- Buildup of colloidal and suspended solids concentration resulting felt/wire blinding and shower nozzles blockages
- Problem in internal sizing due to buildup of anionic trash in the closed system
- Buildup of inorganic TDS can affect paper strength properties
- **Increased biological activity and slime formation as well as odor problem**
- **Regular Maintenance of backwater volume circulating in closed loop**

Makeup Water Requirement in a Recycled Fibre Based Kraft Paper Mill Operating on Zero Liquid Discharge (ZLD)- Statistical Validation/Estimation

Sources of Water Losses during Paper Making

- ❑ Paper machine pre-dryer Section
- ❑ Paper machine post-dryer Section
- ❑ Steam boiler (makeup water)
- ❑ Water carryover with solid rejects
- ❑ Water carryover with finished paper
- ❑ Domestic loss
- ❑ Open losses (Uncountable)

Methodology Adopted

Following samples were collected at different time intervals

- Waste paper used
- Paper sheet after press part (Inlet to pre-dryer Section)
- Paper sheet after pre dryer Section (Inlet to size press)
- Paper sheet after pope reel (finished paper)
- Paper machine backwater from wire tray
- Starch solution used at size press
- Solid waste generated

Statistical Analysis of Data Generated

Particulars/Variables	Unit	Average Value	Std. Dev.	Coef. Var.	Confidence Limit	
					Lower	Upper
Moisture in waste paper	% w/w	9.21	0.66	7.19	7.89	10.54
Dryness of paper sheet after press part	% w/w	48.25	0.89	1.85	46.46	50.04
Dryness of paper sheet after pre dryer section	% w/w	89.81	0.77	0.85	88.28	91.34
Moisture in paper sheet after pope reel (finished paper)	% w/w	6.75	0.31	4.66	6.12	7.38
Dissolved solids in paper machine backwater	**% w/w**	**4.88**	**0.42**	**8.70**	**4.03**	**5.73**
Starch solution concentration	% w/w	12.60	0.82	6.52	10.96	14.25
Dryness of solid wastes generated	% w/w	29.39	4.22	14.36	20.95	37.84

Major relevant data collected from the mill

Particulars/Variables	Unit	Range	Average Value
Starch consumption	% w/w of finished paper	4 - 7	5.5
Filler consumption	% w/w of finished paper	2 – 4	3
Solid waste generation	% w/w of waste paper	4 – 6	5
Steam consumption	tonne/tonne of finished paper	1.5 – 2.0	1.75
Steam condensate recovery	w/w % of steam generated	80 – 90	85

Material Balance

Particulars/Variables	Quantity (t/t finished paper)	
	At lower Confidence Limit	At Higher Confidence Limit
Moisture content in finished paper	0.061	0.074
Starch carryover with finished paper	0.055	0.055
TDS carryover with finished paper	0.043	0.053
Filler in finished paper	0.030	0.030
Pulp (fibre content) in finished paper	0.811	0.788
Waste paper requirement (AD)	**0.980**	**0.996**

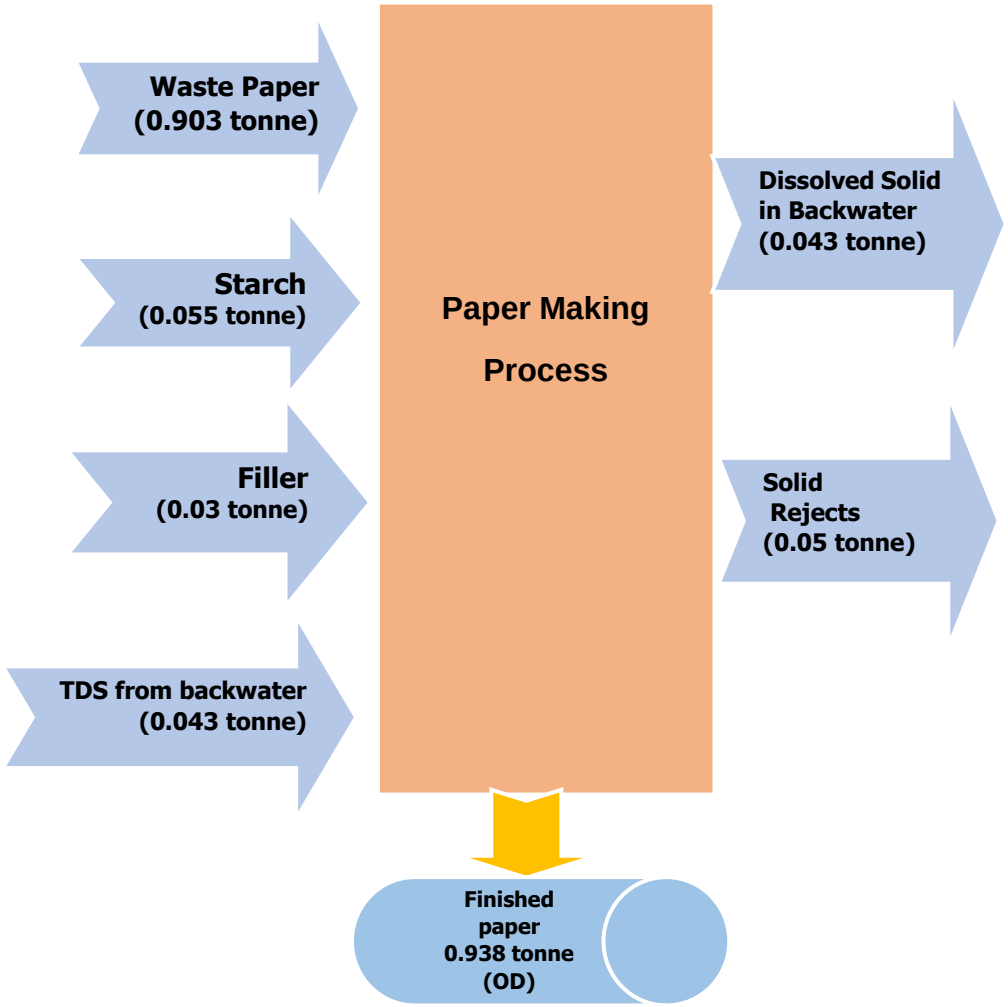
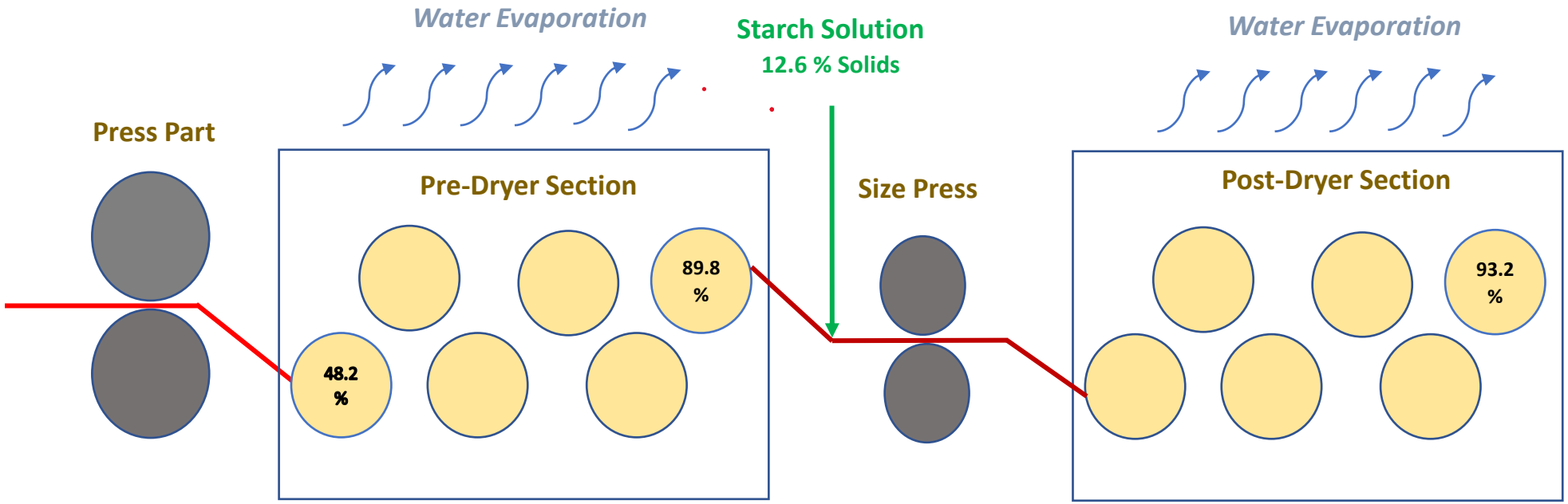


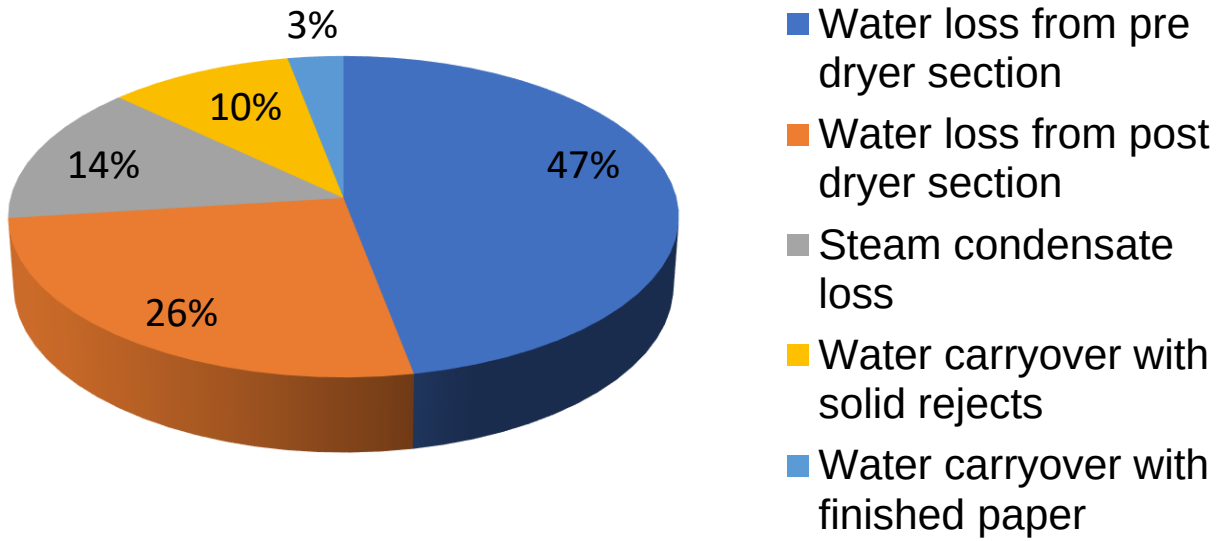
Illustration of Water Loss from Paper Machine during Paper Making



Water Loss During Paper Making

Particulars/Variables	Quantity (t/t finished paper)	
	At lower Confidence Limit	At Higher Confidence Limit
Water evaporation (loss) from pre dryer section	0.901	0.787
Water evaporation (loss) from post dryer section	0.503	0.340
Water carryover (loss) with finished paper	0.061	0.074
Water carryover (loss) with solid rejects	0.189	0.082
Steam condensate loss	0.263	0.263
Total water loss during paper making	1.916	1.545
Water addition from waste paper	0.077	0.105
Nett water loss (Makeup water requirement)	**1.839**	**1.440**

Percentage Share of Water Loss



Conclusion

The study on estimation of water loss during paper making has established the optimum fresh water consumption range from from**1.44 – 1.84 m^3/tonne** of finished paper as makeup water in RCF based Kraft paper mills operating on ZLD

- ❑ Regular Maintenance of the backwater level in closed system
- ❑ Facilitate to reduce backwater storage capacity in closed loop in order to reduce biological activity, slime formation and odor problem
- ❑ This study can also be used as a benchmark to validate the ZLD status of similar category of paper mills

Thank You