Brown Stock Washing: Dilution Factor, Displacement Ratio, Efficiency

Dilution factor, thickening factor, displacement ratio and overall dissolved-solids removal of a brown stock washer stage, by Smook's definitions (ch. 9).

Method: Smook; Handbook for Pulp & Paper Technologists; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Pulp production (oven-dry)	500.00	t/d
Shower water	4,500.0	t/d
Consistency of stock entering	1.2000	%
Consistency of the sheet leaving	13.000	%
Vat liquor solids	12.000	%
Liquor solids in the sheet leaving	4.0000	%
Wash liquor solids	0	%

Calculated results

Parameter	Value	Unit
Liquor per kg pulp entering	82.333	kg/kg
Liquor per kg pulp leaving	6.6923	kg/kg
Dilution factor	2.3077	kg/kg
Thickening factor	91.872	%
Displacement ratio	66.667	%
Overall solids removal	97.291	%

Notes for this case

- A higher dilution factor washes better but sends more water to the evaporators; 2–3 t/t is usual.

Formula and method

$$DF = \frac{\dot{m}_{sh} - W_{out}\dot{m}_{OD}}{\dot{m}_{OD}}, \quad W = \frac{1-C}{C}, \quad TF = \frac{W_{in} - W_{out}}{W_{in}}, \quad DR = \frac{C_v - C_s}{C_v - C_w}, \quad \eta = TF + (1-TF)DR$$

Variables

$\dot{m}_{OD}$	Pulp production (oven-dry)	kg/s
$\dot{m}_{sh}$	Shower water	kg/s
C_{in}	Consistency of stock entering	-
C_{out}	Consistency of the sheet leaving	-
C_v	Vat liquor solids	-
C_s	Liquor solids in the sheet leaving	-
C_w	Wash liquor solids	-
W_{in}	Liquor per kg pulp entering	kg/kg
W_{out}	Liquor per kg pulp leaving	kg/kg
DF	Dilution factor	kg/kg
TF	Thickening factor	-
DR	Displacement ratio	-

η	Overall solids removal	-

Method and standards

Smook's washer definitions.

Assumptions and limits

- Liquor density 1 kg/L; solids by mass.
- The dilution factor and the displacement ratio are independent inputs here; a negative dilution factor gives a note. The sheet liquor solids must lie between the wash and vat liquor solids.

References

- Smook
- Handbook for Pulp & Paper Technologists
- 3rd ed. (Angus Wilde, 2002)
- ch. 9.3 (brown stock washing: DF, DR, TF and % efficiency = [TF + (1 − TF)DR]100)

Report details

Report reference	FCC-XQSZ-DEAQ (the same inputs always give the same reference)
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Calculator	Brown Stock Washing: Dilution Factor, Displacement Ratio, Efficiency
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Release checks	2 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/chemical/pulp-paper/brown-stock-washing-efficiency

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.