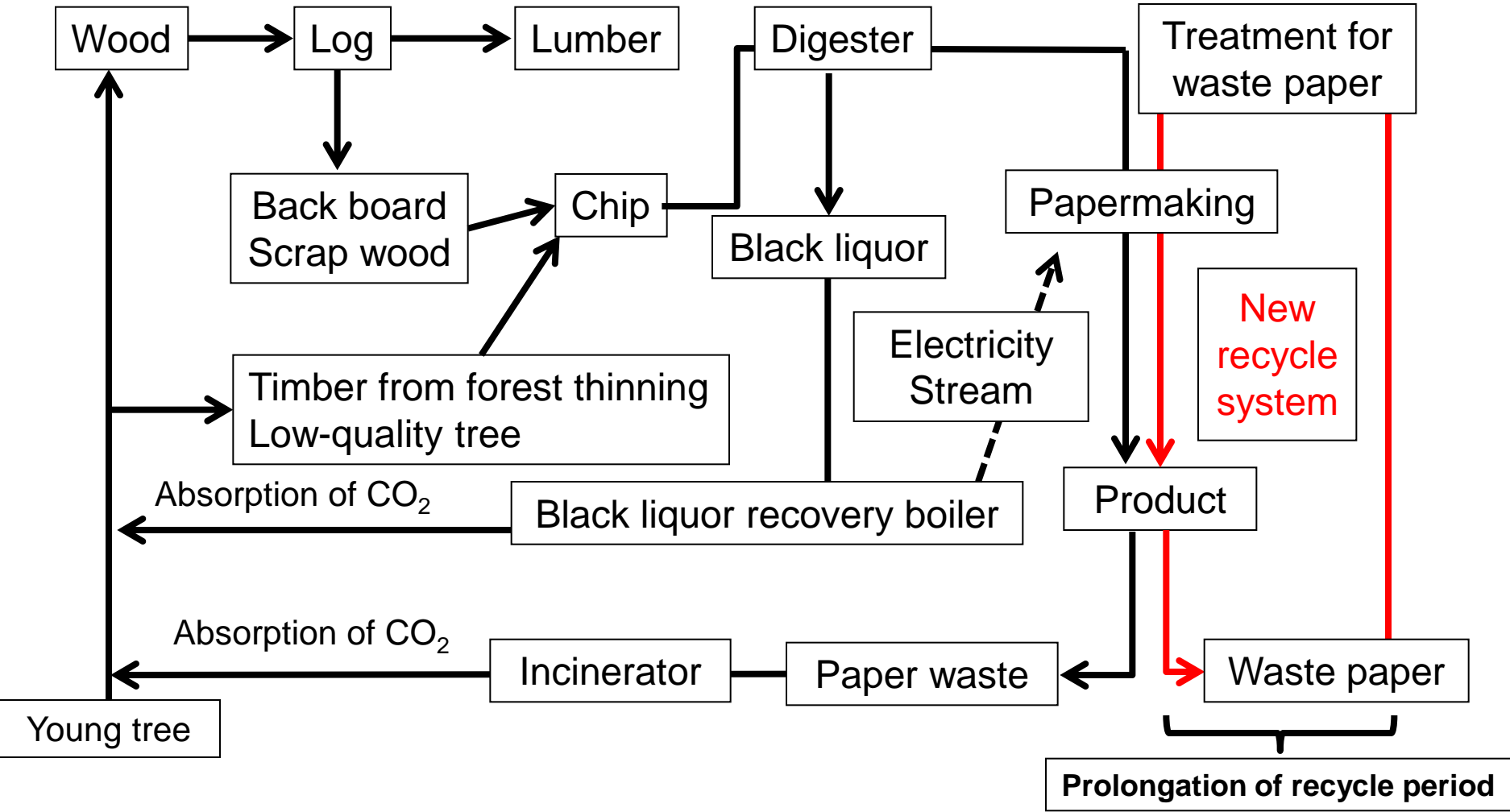


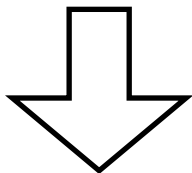
Position of new recycle system for waste paper in material cycle system



Reference: Oji Paper Co., Ltd., In "Knowledge of paper 100", pp218-219, Tokyo Shoseki Co., Ltd., Japan (2009)

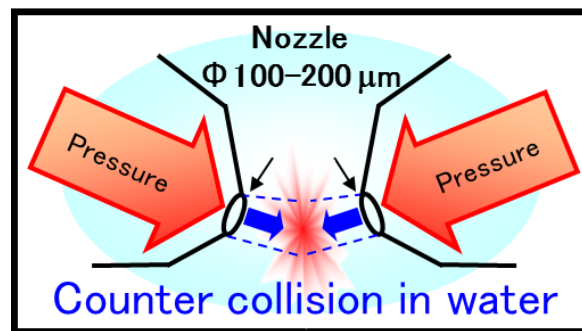
<< Development of new system for waste paper >>

Waste paper

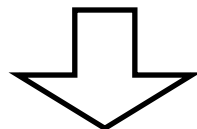


Aqueous counter collision method (= ACC)

Cellulose nanofiber



Miniaturization by rapid water stream

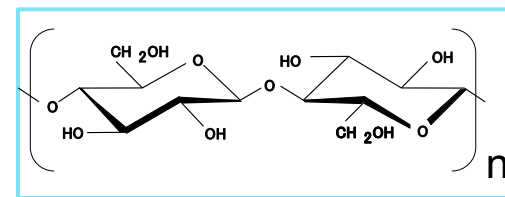


Ordered structure at micro-scale



Nanofiber-aligned material

Cellulose molecule



Nanofiber =
molecule-aligned material

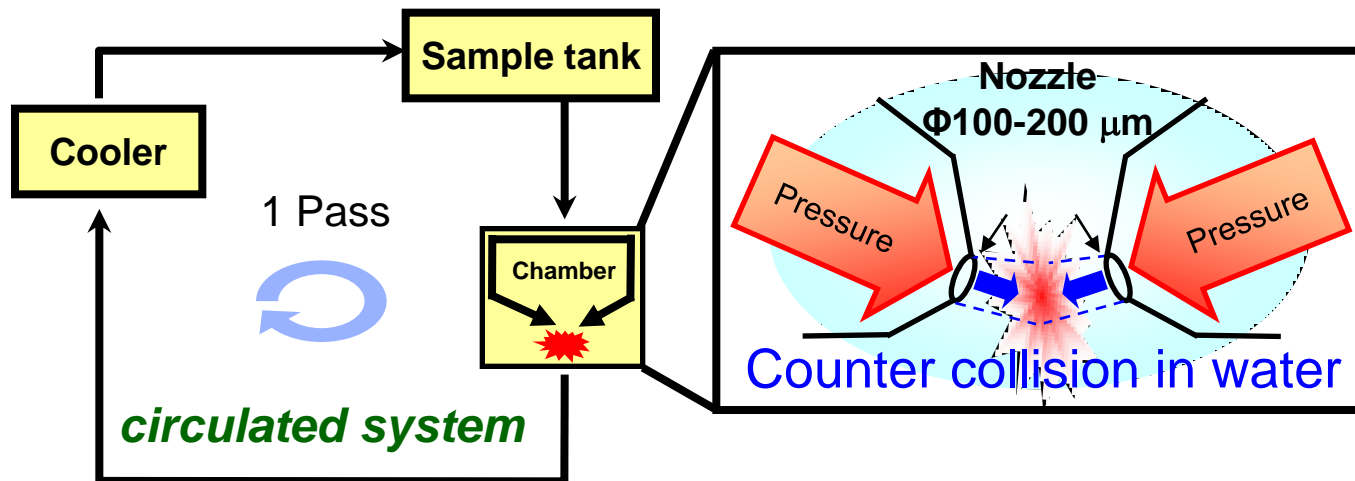
< Recycle >
Separation and
Refinement of
impurity by ACC

Agent strengthening
paper

Water-resistant material
High-intensity material

New form of waste paper

Aqueous Counter Collision system (= ACC)¹⁾



Each bonding energy

Type of bond	Bonding energy / kJ mol ⁻¹
H-OH (covalent bond)	499 ²⁾
H-H (covalent bond)	436 ²⁾
ion-ion	250 ³⁾
Medium hydrogen bond	21 – 62 ⁴⁾
Weak hydrogen bond	4.2 × 10 ⁻¹ - 4.2 ⁴⁾
London dispersion force	2 ³⁾
dipole-dipole	0.6-2 ³⁾

Properties of ACC

- **Cleavage of only intermolecular interactions** without chemically modifying molecules
- Liberating nano-fibers from raw materials
- A rapid process to provide nano-fibers
- Chemicals-free (using water alone)

Maximum bonding energy cleaved by ACC (Theoretical value)

18.1 kJ/mol⁻¹

1. Kondo T., Morita M., Hayakawa K., Onda Y., U.S. Patent 7,357,339.
 2. K.P.C.Vollhardt, N.E.Schore, In "Third edition organic chemistry structure and function", p99, Kagaku-Dojin Publishing Company, INC, Japan (1999)
 3. P. W. Atkins, In "Physical chemistry sixth edition", p716, Tokyo kagaku dojin Ltd., Japan (2001)

4. H. Uedaira, In "Molecular engineering of water", p7, Kodansha Scientific Ltd., Japan (1998)

Important natural phenomena in new recycle system for waste paper

