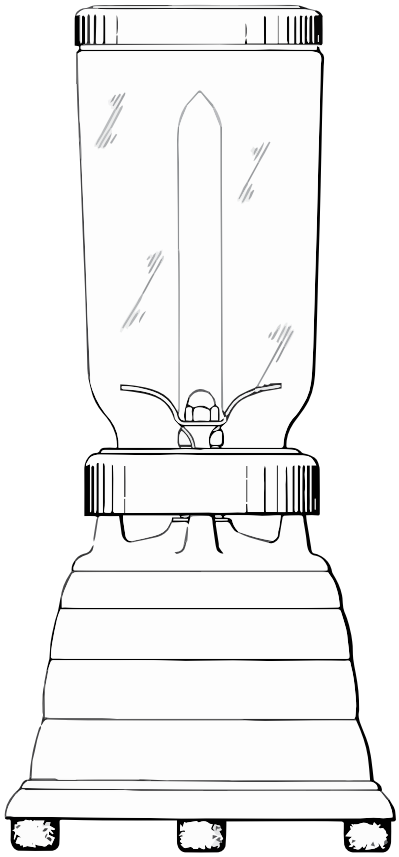
Determinate Hand Papermaking

V

Processing Paper Fiber

with an inverted blade blender



Text and illustrations by
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2017

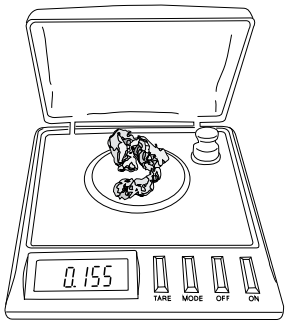
Pulp & furnish preparation

1. As described in *Determinate Paper No. III*, it is possible to **predetermine the grams of raw material** needed to make a specific weight (gsm) paper. For example, to make a 60 gsm sheet for a 5.7cm diameter paper (2.25 inch) we can calculate using this method that 0.15 grams of dry fiber will be needed. (i.e., processed abaca, flax, or cotton linter, or a combination of the three). Dry half-stuff fibers are best if hydrated for an hour or more before blending. Also, prior to blending add a few grams of CaCO3 and/or MgCO3 as buffering agent and antioxidant. For a more **opaque** and harder paper, add kaolin, (aka China clay) and or white pigment (titanium dioxide). Retention aid can be added at the end of blending to attract clay to fibers, thereby losing less of your additives in the "white water."

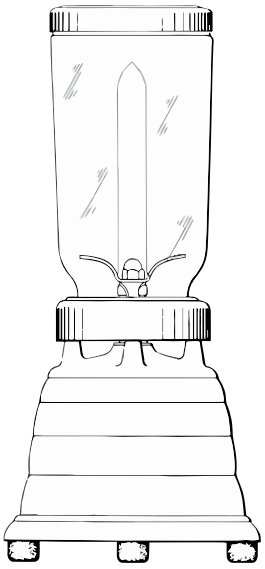
Blend for 2 to 3 minutes in a blender with blades reversed (see next page). After blending, add 10 ml to 25 ml of tororo-aoi (PNP formation aid) for slower drainage, smoother paper formation and a well-formed sheet. Briefly blend again with added formation aid (1 second), decant, and stir or shake vigorously to break up the knots settle air bubbles caused by blending.

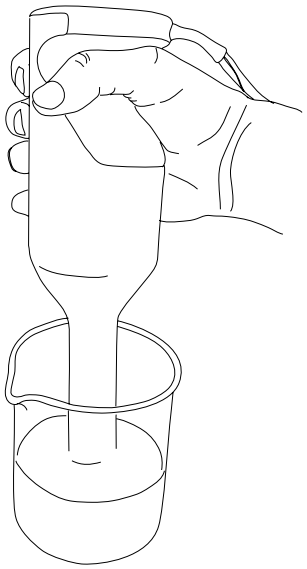
2. For the AeroPress, use from 100 to 150 ml of furnish per sheet.

1 **Select & weigh fiber**. Use the *PaperWeight* app to calculate the weight of fiber needed for a specific gsm paper.



2 **Add water and any additives, then blend until fibers are separated.***





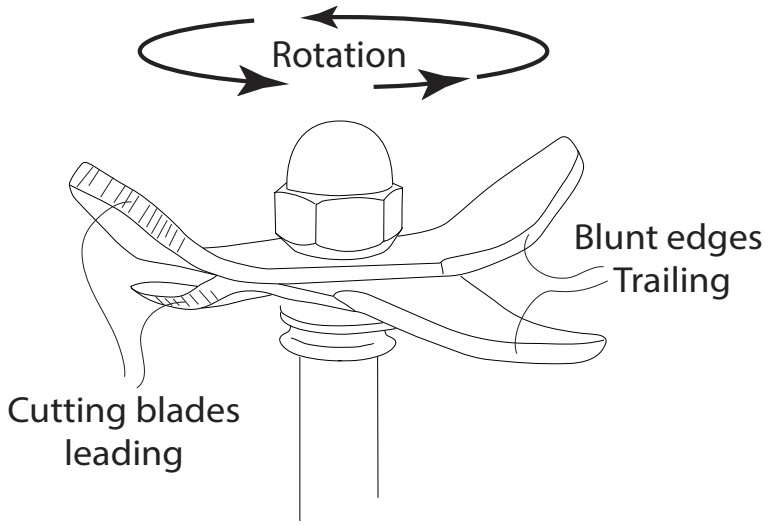
Use caution and be safe with the spinning blades of mixer.
Use a GFCI outlet (Ground Fault Circuit Interrupter) to avoid electrocution.

****Blender Notes:** In a freeness test of flax and abaca pulp processed in a kitchen type blender, we found that 5 minutes of blending (whipping) reduced freeness from 400ml to 350ml and another 5 minutes blending (total 10 minutes) reduced freeness another 50ml to 300ml. Folding strength rose in the first 5 min and then diminished after 10 min of blending. One strategy to make a kitchen blender more like a commercial hydropulper is to change out the blades for a flat plate with pulp impeller vanes for more hydration and fibrillation with less cutting (see p. 4) or if the blender model design permits, detach, invert the blades and reassemble (see opposite page).*

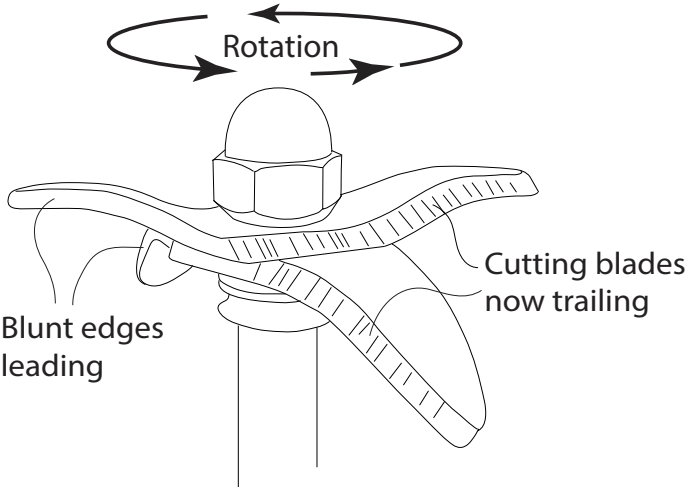
Hamilton Beach blade reversal

By design, kitchen blenders are made to cut, pulverize, whip and chop ingredients for our culinary pleasure. Their sharp cutting blades are always the leading edge of their (counter-clockwise) rotation. A simple modification to the blender blade assembly of a Hamilton Beach commercial blender disables this cutting edge: simply disassemble, invert, and reassemble the blades so that the cutting edge is the trailing edge and the blunt edge is the lead edge. This easy switch (brought to my attention by artist Guy Diehl) produces more "beating" and less cutting during processing. Freeness tests done with this inverted blade produce results comparable to the Hydropulper blade (p. 4).

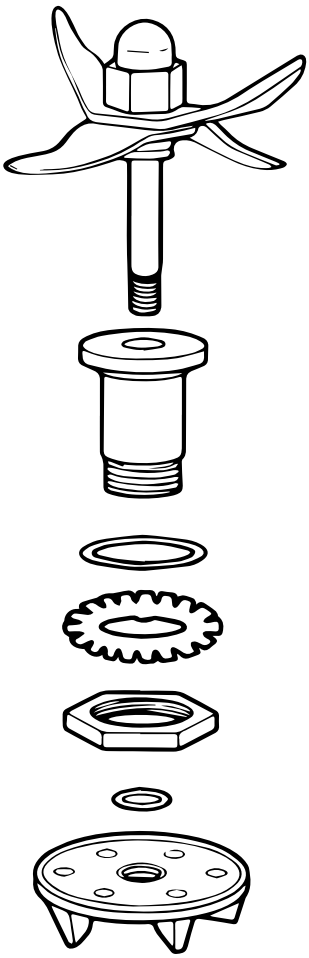
Standard, default assembly:

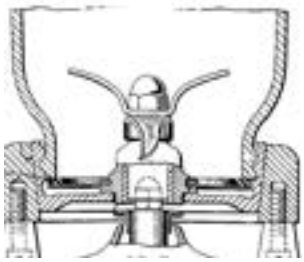


Reversing blade orientation: Inverted blades make the blunt edge the leading edge:



Hamilton Beach commercial blender blade assembly

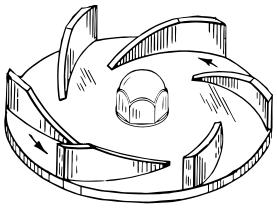




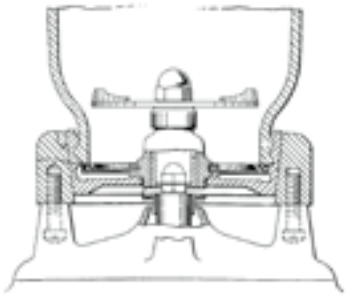
Invert blender blades for less cutting action

Hydropulper-inspired blender blade

Hydropulper modified blender blade



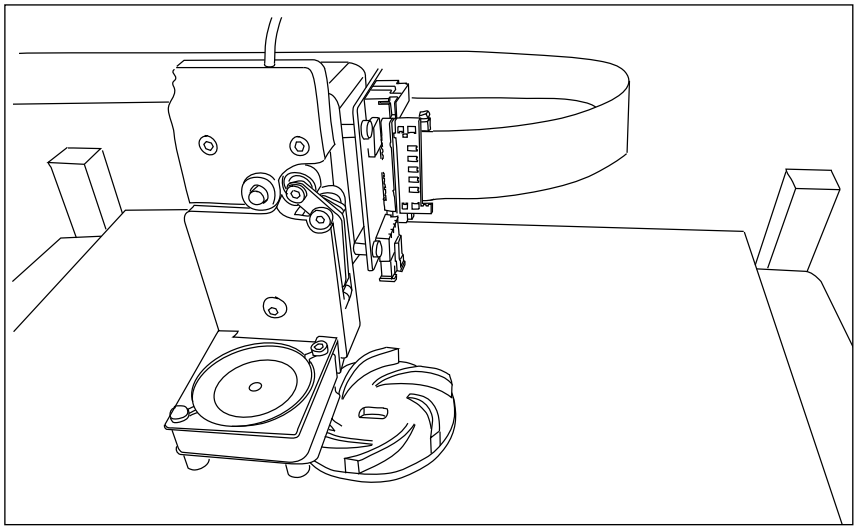
hydropulper style blade (detail)



Blender modification with pulp impeller vanes

Hydration and fibrillation occur during fiber processing, when the heavy hammers of a stamper and the beater blades of a beating engine smash into wet shards of linen and hemp rags, causing the fibers of the cloth to stress, fray, and swell with water. Various degrees of hydration and fibrillation are responsible for producing the wide variety of papers we have come to enjoy. Expertise and experience at the processing stage will confirm the axiom that "paper is made in the beater" rather than during sheet formation at the vat: it is at this stage, as fibers are hydrated, fibrillated, separated and made shorter in the beating engine, where the characteristics of the finished sheet are actually determined. While shorter fibers articulate laid lines and are desirable in some watermarked paper, folding endurance and tear strength are eventually diminished by prolonged processing.

Not always having access to laboratory beaters or stamper mills, most small-scale paper studios rely to some extent on kitchen and commercial food processors and blenders. Unfortunately, the standard thin, sharp blades of this type of equipment catch the fibers, creating knots and tangles; they can also harm cellulose fibers by shortening and cutting the fibers, thereby exposing oxidation sites which weakens the paper and shortens its life expectancy. In a series of experiments, I substituted the knife-sharp blades of a commercial blender for a bladeless device with hydropulper-inspired vanes. This durable plastic rotary propeller, created using a 3-D printer with PLA filament, hydrates and fibrillates without noticeably cutting or entangling the fibers.



Series links:

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No. II: Retting: lignin removal using mycelium
No. III: Calculating paper weight with a smartphone app
No. IV: Finding the surface area of an irregular sheet
No. V: Blender processing paper fiber
No. VI: (Next:)**Formulating pulp for color and content**
No. VII: Making small paper with 3D printed deckle box and an AeroPress
No. VIII: Techniques for forming laid and wove paper without a vat
No. IX: Drying handmade paper
No. X: Sizing and burnishing

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