Mixed Office Waste A Substitue For Virgin Fibres

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ABSTRACT

With the steady development of technology processing secondary fibres during the last decades, the range of application for waste paper has widened considerably.

Starting with partial replacement of mechanical pulp for newsprint, followed by total substitution, also high grade writing & printing as well as copy papers are considered to be made at least partially of recycled fibres.
The main driving forces to substitute virgin fibres with DIP stock are:

Firstly, to reduce operating costs by using a cheaper furnish and saving electric energy, as DIP systems consume less electric energy then production and preparation of comparable virgin fibers like BCTMP;
secondly environmental aspects, as the recycling of paper contributes to minimise effluent pollution.
Depending on the final paper grade, a mixture of OMG with MOW (or SOW) or pure office waste is used. Compared with the standard furnish for deinking plants, like ONP and OMG, the office paper has quite different characteristics. Therefore a different treatment is required.

The decisive difference is the type of ink and the printing process: on magazine papers, which are mostly coated papers, the ink is smoothly printed onto the coat, whereas office papers contain a lot of toner ink particles, which are fixed with heat and pressure directly on the fibres or only on a light coat.
These particles are classified as hard inks, compared to the soft inks of offset and gravure print. But it is also the different level of contaminants, especially the sticky load, which leads to different system configurations.
However, the high brightness level of office waste and the superior fibre quality allows a broad employment of this furnish: from high grade writing and printing papers to art coated paper, white top board and even copy papers and also tissue products.

Hence, the requirements of the final stock quality differ accordingly, however, special attention has to be given to dirt speck level and residual ink content. Out of various eligible system configurations, a three-loop system will meet these highest quality targets, considering flotation stages in all three loops. This system will be presented in the following paper, but also modifications regarding ash content will be discussed.

FURNISH COMPARISON

Virgin fibres are still the leading furnish for high grade papers. However, the recipe vary individually as the very final product targets also do. Following table shows a comparison of some key properties for virgin fibres versus magazine waste and office waste respectively:

The quality of virgin fibres sets the benchmark for the final qualities of DIP stock. It is the common goal of machine suppliers and paper producers to adjust or improve existing or to develop new technologies to rise DIP stock up to the same or similar quality level with economically reasonable expenses, which allows the use for high grade papers.

The main differences to standard DIP furnishes used for newsprint or SC papers (ONP / OMG) are the significant higher initial sticky load and the type of

TABLE – 1

COMPARISON OF FURNISH QUALITY PARAMETERS

Property \ Furnish	Chemical Pulp	Magazine Waste	Office Waste
Brightness [% ISO]	> 86	50 - 55	60 - 64
Tappi Dirt [ppm]	< 3		
Ash [%]	< 0.5	18 - 30	12 - 18
Resin [%]	< 0.2		
Stickies [mm2/kg]		4,000 – 7,000	6,000 – 12,000
Freeness [SRU]	26	35 - 42	33 - 38
Breaking length [m]	≥ 6,000 / ≥ 4,500	≈ 3,800	≈ 4,200

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ink particles. In office waste, they are mainly of toner origin and are fixed onto the fibres or filler compound of a low coated paper. In addition, a lot of shaded or even coloured papers can be found in the office waste, including the stickers and envelopes, which contain quite a lot of sticky material.

How does it now affect the process? One key design parameter is in respect of the method how to detach the ink particles from the surface of the office paper. Pure pulping, either by means of a drum pulper or a high consistency pulper, is not sufficient any more. Further, this process can only be partly supported by chemicals or increased temperature, but requires strong mechanical forces, which will be imposed on the stock at high consistency and high temperature. In a recycled paper line, this task can be fulfilled with two dispersers.

PAPER GRADE REQUIREMENTS

The table-2 summarizes the quality parameters and the influence of different furnishes for writing & printing paper grades.

And for table-3 Tissue paper.

Comparing the suitability of the different furnishes for the different paper grades, it will become obvious, that currently chemical pulp cannot be substituted by 100% with DIP stock.

This fact is also underlined by the figure-1, showing breaking length vs. beating degree.

The target area can easily be reached with virgin fibres just with low consistency refining. Untreated office waste has already a beating degree of the target area, but at a lower strength value. To lift this property to the same level as for virgin fibres requires again refining efforts, which become already uneconomic and leads to undesired high beating degrees, which effect already the dewatering capacity on the paper machine.

CONTAMINANTS IN OFFICE WASTE PAPER

The various types of contaminants in office waste and the related process stages to remove or to reduce them to a harmless size are put together in the table-4.

TABLE – 2

KEY QUALITY PARAMETERS FOR WRITING & PRINTING PAPERS AND THE INFUENCE OF DIFFERENT FURNISHES

Furnish / Property	Chemical Pulp	Magazine Waste	Office Waste
Strength	+ + +	o	+
Opacity	o	+ +	+
Brightness	+ + +	o	+ +
Low Dirt	+ + +	+	-
Less Ash	+ + +	- -	-
Sticky material	-	- -	- - -

Legend: influence on property: + + + positive; o neutral; - - - - negative

TABLE – 3

KEY QUALITY PARAMETERS FOR TISSUE PAPERS AND THE INFUENCE OF DIFFERENT FURNISHES

Furnish / Property	Chemical Pulp	Magazine Waste	Office Waste
Strength	+ + +	o	+
Brightness	+ + +	o	+
Low Dirt	+ + +	+	-
Less Ash	+ + +	- -	-
Sticky material	-	- -	- - -
Hand feel / Softness	+ + +	o	+

Legend: impact on property: + + + positive; o neutral; - - - - negative

FIGURE – 1

BREAKING LENGTH OF DIFFERENT FURNISH VS. BEATING DEGREE

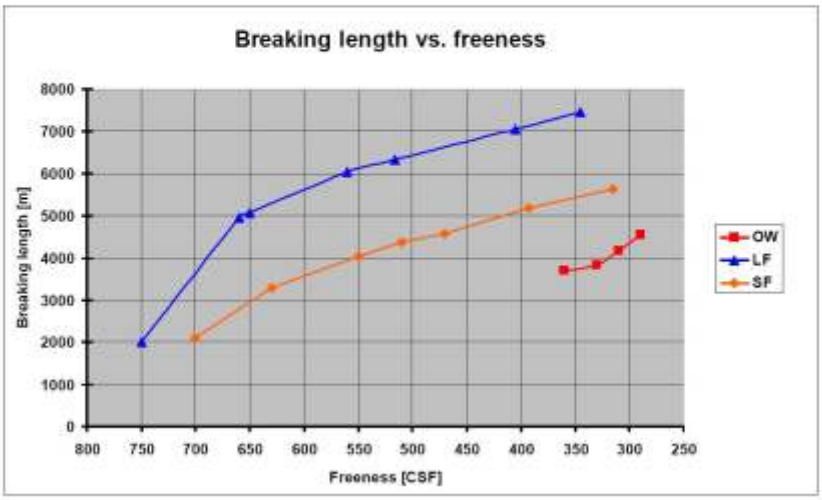


TABLE – 4

PROCESS STEPS AND THEIR SPECIFIC FUNCTION

Technological demands / Process step	Optical properties	Debris and sticky reduction	Ash content
Pulping	print ink detachment & dispersing of ink particles	saving screen ability, pre-screening	ash enrichment by process water
HD Cleaner		heavy particles	
Hole screening		flat disturbing components	
LC Cleaner	removal of dirt ink particles	fine sand and debris removal	minor reduction
LC slot screening		sticky removal	
Flotation	brightness increase, dirt speck reduction	sticky reduction	ash reduction
Washing	Dirt speck reduction, brightness increase		high ash reduction
Dispersion	Dirt speck dispersion, bleaching chemical mixing	sticky dispersion	
Bleaching (oxidative)	brightness/mottling fibers		
Bleaching (reductive)	brightness / colour stripping		

BASIC SYSTEM DESIGN

The basic DIP system for office waste can now be fixed as shown in the figure-2.

For pulping, two different technologies are available: high consistency batch pulper and continuous drum pulper. Due to the characteristics of the ink particles, the task of disintegration of the waste paper prevails over the detachment of ink. As chemicals have also only minor impact to support this process, pulping of office waste shall be done more or less in the neutral range. Less contamination of the process water system (in terms of COD, PCD) is an additional benefit.

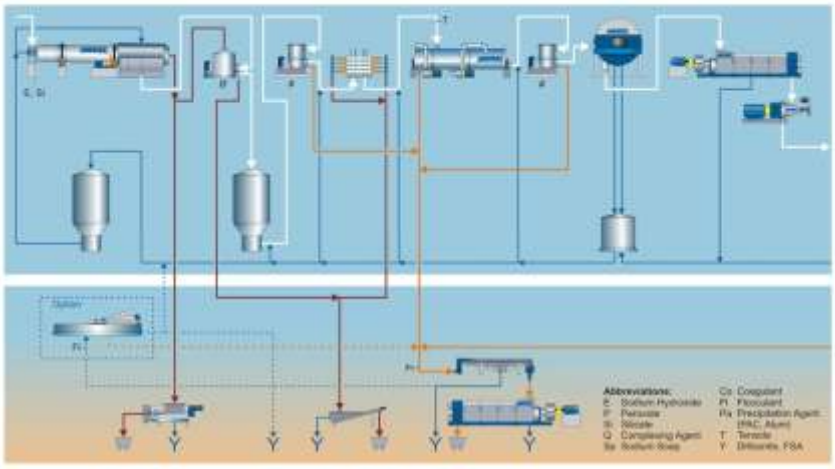
The selection of the right pulping technology shall be guided mainly by the most efficient removal of one of the most disturbing contaminants: the stickies. The extreme high level especially in office waste strictly recommends the employment of that technology, which provides the smoothest disintegration process - the drum pulper technology. This process stage can contribute to a high extent to the final quality because it sorts out contaminants already at the beginning of the whole process, so the drum pulping can be defined as one of the core technologies. This is the first equipment in the process and keeps the contaminants as much as possible in their original size, which is very important for the further process.

Before the stock is soaking in the dump tower, it shall be cleaned from heavy and light contaminants. Here, a unique technology is available to eliminate these particles simultaneously in one machine, the Moduscreen Type CR-H, which combines both requirements in one equipment. With this technology it is not only possible to eliminate separate high consistency cleaners, it also needs less energy and pumping equipment.

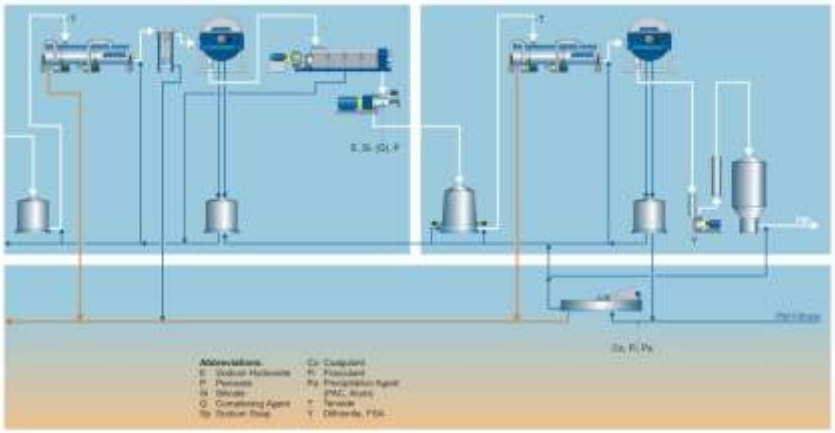
The first loop is focused on screening and cleaning technology. Two full stream slot screening stages are clearly a must for this kind of furnish, for medium consistency screening a slot width of 0.2 mm is selected, whereas for low consistency screening 0.12 mm slots are applied. This is a very economic gradation of the slot width sequences, as the screens in the MC range can be kept at a reasonable size

FIGURE – 2

BASIC SYSTEM FOR OFFICE WASTE – LOOP 1



BASIC SYSTEM FOR OFFICE WASTE – LOOPS 2+3



without any sacrifice of screening efficiency and final product quality. The minimum slot width in the low consistency screening is determined by the amount of long fibre content of office waste. It is not economic to use screen baskets with 0.10 mm slot width due to the small open area and the danger of rejecting too many long fibres. Furthermore, screening efficiency is not determined by slot width, only but by the more complex interaction of the relevant screen components like rotor design, rotor speed, casing, baskets, etc.

The cleaner plant for removal of fine heavy particles prior to fine screening is mandatory and is installed immediately after the MC screening still before flotation, providing the additional benefit of avoiding sedimentation of those heavies in the flotation tank.

Although ink detachment is not yet completed like for newsprint and magazine waste, it is still essential for the final product quality to remove free ink and dirt particles by means of a flotation already in loop 1.

The following thickening is now designed individually acc. to the needs of the final product. Conventional solution is pre-thickening by means of a disc filter followed by a screw press. If a low ash content in the final DIP stock is required, then a full stream washing device can be used instead of a disc filter or both machines can be installed operating in a parallel mode.

The disperser, located at the beginning of loop 2, operates preferable at high temperature level under atmospheric pressure and has two main objectives.

Apart from the detachment of ink particles to a high extent, all the other impurities will be downsized to a more homogeneous particle size distribution. This goal is achieved by the input of mechanical shear forces, created by the intense friction between the fibres given occurring at the high consistency in the disperser. Here, the importance of adjusting the specific energy input in a disperser has to be underlined. It must be possible to find the right balance between best ink detachment and, nevertheless, a not too aggressive operation, which might smear soft inks again onto the fibres. This process is irreversible and leads to mottled fibres. This goal can only be achieved with machines allowing a control of energy input like the dispersers.
Flotation 2 is now challenged to remove mainly the already detached laserprint ink particles (hard ink). That means the flotation equipment must provide sufficient flexibility to catch all these different particles.

Office waste also contains shives of varnished and special coated papers. Due to their specific weight and shape, these particles are difficult to float, but they can be eliminated at least partially by special low consistency cleaners, which provide high centrifugal separation forces. The position of these cleaners within the system is again given by the requirement, that the stock has to be treated by mechanical forces first. The integration in loop two after the first disperser, but still before the bleaching process, will be the most suitable position.

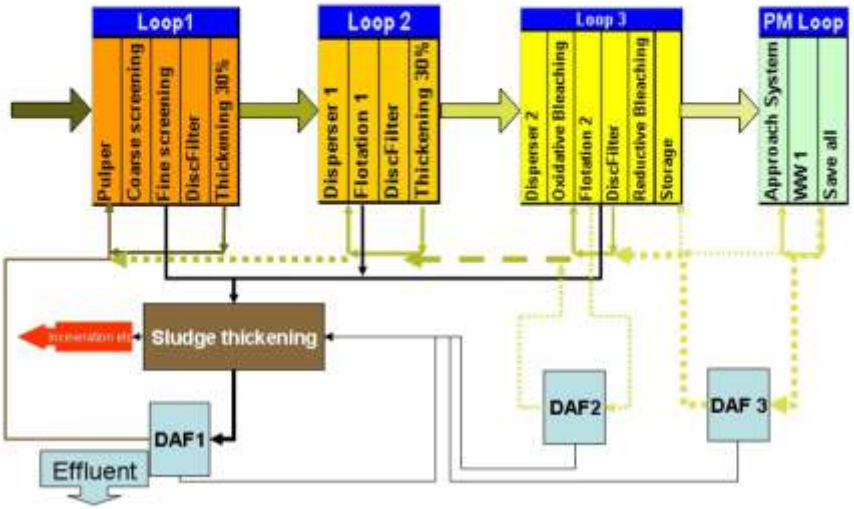
Thickeners close the second loop, and it is again the consideration of ash removal, which type of machine for pre-thickening shall be used. According to the grade of de-ashing, either speed washer, drum filter or disc filter will be used.

If DIP stock based on ONP/OMG is used for higher grade writing and printing papers, then a second disperser is installed in loop 2. For processing office waste, this disperser is located at the end of loop 2. In this position the machine has to cope with the most resistant ink particles, some remaining very small stickies and dirt particles. Cracking these particles may require a higher energy input than in disperser 1.

The third flotation has to take the remaining dirt and ink particles, and the third thickening by means of a disc

FIGURE – 3

WATER MANAGEMENT IN THE DIP SYSTEM



filter (up to 12%) is followed by the reductive bleaching, preferably with FSA. This second bleaching is important also for bleaching of coloured fibres, and at the brightness level > 78% ISO, this has become already an important factor for final brightness.

WATER MANAGEMENT IN DIP SYSTEMS

The water system has to be designed as a strict counter current flow as shown in figure - 3

All the make up water to balance the DIP process and a portion of disc filter 3 filtrate are clarified in a micro flotation. This DAF should be operated in a precipitation mode to remove colloidal substances, to a certain extent, which are causing the anionic trash. If the level of the anionic trash in the process water can be kept on a low level, then it results in a higher brightness of the final paper at a given consumption of bleaching chemicals or, on the other hand, reduces the chemical consumption for the same brightness level.

Proper water management can also help to reduce the overall fresh water consumption. Filtrate from sludge dewatering, which usually goes to the effluent, can be clarified in a micro flotation and partly be reused as pulping water in loop 1, thus reducing the effluent and consequently, the fresh water input, accordingly. However, in terms of final pulp quality, the specific effluent shall not be less than 10 m^3/ t of stock.

CARRY OVER OF ANIONIC TRASH

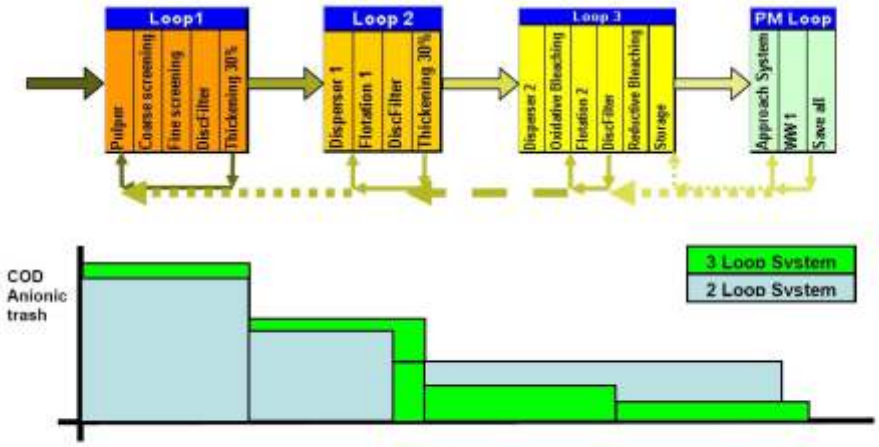
Regarding the overall water system of PM loop and stock preparation, it is a clear request to get the best water quality in the PM cycle. This means on the other hand, to transfer as less as possible of the anionic trash and COD load from the stock preparation to the PM. This can be achieved by thickening the pulp as high and as often as possible. The figure 4 shows the development of the COD load and anionic trash along the DIP system.

With the two high consistency thickening stages up to 30% at the end of loop 1 and 2 a good washing efficiency can be achieved, followed by a further slight reduction at the end of loop 3, where the pulp is thickened at least to 12% with the disc filter.

It also leads to a further advantage in the bleaching process. The anionic trash is consuming Hydrogen Peroxide without any contribution to brightness increase. Hence, the reduction of these detrimental substances also reduces the demand of bleaching chemicals to achieve the same brightness level.

FIGURE – 4

CARRY OVER OF COD AND ANIONIC TRASH



LOW ASH DIP STOCK

If the final ash content must be less than 2.5 %, de-ashing devices have to be integrated. One possibility is full stream washing preferably in loop 1. This arrangement gives the advantage, that together with fines also small sized ink particles are removed before the 1st disperser, avoiding the danger of re-attachment onto the fibres. Further, the size of the subsequent machines can be reduced. (fig - 5)

FIGURE – 5

FULL STREA WASHING LOOP 1

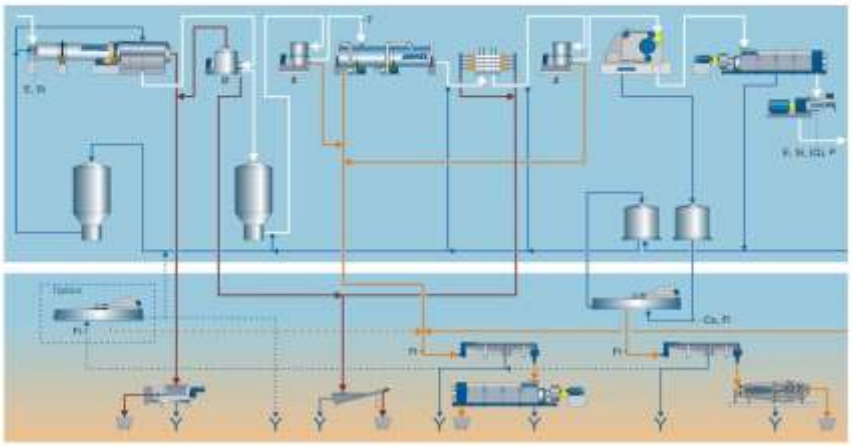
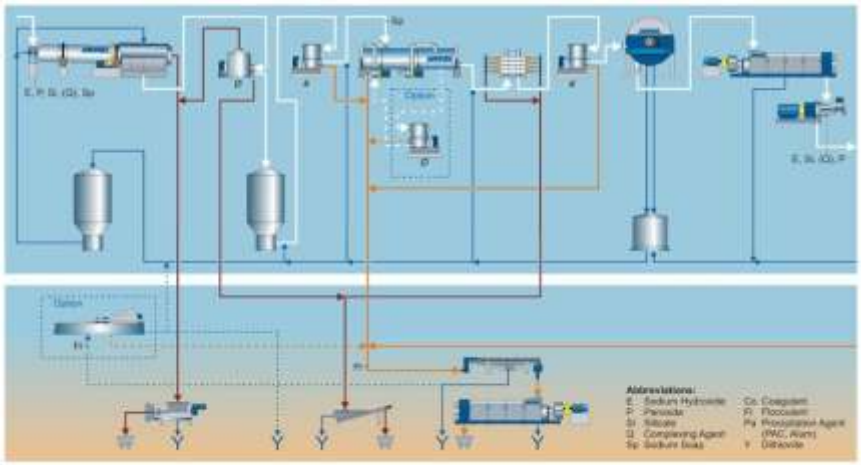


FIGURE – 6

PARTIAL DE-ASHING



However, to match the a.m. goal, further steps might be taken. Another full stream washing will not be necessary as long as the initial ash content does not increase beyond 16 - 17%. Partial de-ashing with a washer and a disc filter operating in parallel could be an alternative, however it is a very expensive solution.

In this case secondary flows with high ash load are targeted. Such flows are overflow of primary flotation cells or filtrate of screw presses. (fig - 6)

A special screen, the RotoWash, can selectively separate now residual ashes, fines and small ink particles from good fibres so reduce the ash content of the final DIP stock to the requested level.

FINAL STOCK QUALITY

The quality figures, which finally can be achieved with office waste papers in such a system, are summarized in table 5.

SUMMARY

The state of the art technology allows the use of DIP stock from office waste as a substitute for virgin fibres at least partially for high grade writing and printing papers and even copy papers. Due to the broad application range, the quality requirements will also differ and the system has to be tailored respectively. Even market pulp quality can be achieved, however much higher losses have to be calculated. Rejects, if they are carefully separated into metals, combustibles and others, can also be reused and so help to reduce deposit costs and save energy resources.

Table -6

QUALITY OF FINAL DIP STOCK

Brightness level	80 – 85 % ISO
Dirt content	5 - 10 mm^2 / m^2 (Tappi 213)
Sticky reduction	≥ 98.5%
Ash (initial 18 – 22%)	9 – 12% 3 x flotation, no washing
	3 – 5 % 3 x flotation, 1 x washing
	< 2% 3 x flotation, 2 x washing
Yield	approx. 74 – 78% no washing
	approx. 62 – 66% 1 x washing
	approx. 54 – 58% 2 x washing