Deinking - The Right Choice

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ABSTRACT

Deinked waste is a well established source of raw material usable in many paper grades and often in high proportions.

There has long been a battle for supremacy between the two major methods of deinking, washing and flotation, which appeared to reach a compromise with the development of combination systems.

Recent experience has shown however that choice of system technology can be rather complex and that there are still applications for pure washing and pure flotation as well as the various combination options.

Reflecting the continuing high level of interest in deinking systems, chemical formulations are being constantly improved. Similarly the machinery manufacture continues to strive for improved performance and new techniques.

One thing is certain, deinking is here to stay and for most mills it is definately.

"the right choice"

Recycled fibre has played a part in paper manufacture since the earliest days, providing the paper maker with a low cost readily available substitute for a proportion of his virgin fibre and often improving the properties of his product.

Whilst the manufacturer of the lower grades of paper and paper board could accept almost any kind of waste paper, the manufacturer of fine papers had to be content with his own broke and clean converters waste he was to maintain the quality of his product.

Printers waste is of course essentially clean, if one can get rid of the ink, and inevitably paper makers experimented with this cheap and relatively plentiful supply of raw material.

As early as 1890 printed waste was being effectively processed to allow inclusion in small quantities in fine paper finishes. The treatment appears to have involved only a simple caustic treatment in a beater followed by a thorough washing in a bleach washer.

From these ealy beginnings the practice of deinking gained in momentum, chemical formulations were improved and the range of deinkable wastes increased accordingly.

Advancement of the process in Europe however had one major drawback, the huge volumes of water involved in washing the loosened ink from the fibre.

America with its large rivers and low population density had no such problem and deinking by the washing process became established as the norm.

European paper makers found the answer to their problems in the flotation cell technology used by mineral processers which utilised air bubbles as the ink removal agent and produced a concentrated inky effluent which was relatively easily disposed of.

By the 1950's these two basic deinking methods, washing and flotation, were well established in America and Europe respectively and Japan, on joining the deinking scene, opted for the flotation system also.

During the 1970's after a long period of stability, virgin pulp prices started to rise and shortages occurred. A paper industry slump followed and the combination of these circumstances triggered the search for less expensive paper making fibre.

An increase in recycling was inevitable and many

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paper manufacturers began to think seriously of waste paper as a raw material for the first time.

Between 1977 and 1979, worldwide deinking capacity had increased by a spectacular 30%, with 148 deink plants in operation with a combined production capacity in excess of four million tonnes per annum.

Such activity naturally prompted a great deal of Research and Development by Paper Mills and Machinery and Chemical suppliers, resulting in significant technological advances. Systems were made more efficient and capable of dealing with waste papers containing contaminants and difficult inks which would previously have been rejected as unsuitable for deinking

Since 1979 a further 131 deink plants have been established, bringing the combined capacity to more than seven and a half million tonnes per annum and it seems likely that steady growth will continue for some years to come.

TABLE 1 = WORLDWIDE DEINKING INSTALLATION TO 1985

	NUMBER OF INSTALLATIONS	INSTALLED CAPACITY (MT/D)	AVERAGE CAPACITY (MT/D)
UPTO 1979	148	12,523	84.4
1980-1985	131	10,617	80.8
TOTAL	279	23,140	82.6
AVERAGE GROWTH RATE 11.1% PER ANNUM			

There are three major areas in the world which account for some 99% of all deinking systems, namely Europe. The Americas and Asia and Table 2 shows the distribution.

TABLE 2 = GEOGRAPHIC DISTRIBUTION OF DEINKING PLANTS

	Europe	Americas	Asia	Total
UPTO 1979	55	56	37	148
1980-1985	60	19	50	129
OVERALL INCREASE	109%	34%	135%	87%

It is interesting to note that Asia (primarily Japan) shows greater increase in the number of deink plants than the othet areas but further study shows that the actual tonnage inerease is less than in Europe.

TABLE 3—GEOGRAPHIC DISTRIBUTION OF DEINKING CAPACITY (MT/D)

	Europe	Americas	Asia	Total
UPTO 1979	3,310	6,374	2,848	12,532
1980-1985	4,728	2,155	3,748	10,631
OVERALL INCREASE	143%	34%	132%	85%

The comparatively small increase in the American figures reflects the lesser commercial and environmental, pressures on the American paper maker though the last twelve months has been a period of tremendous interest in deinking in that area.

Whilst it is true to say that the majority of pure washing systems are located in the Americans and the majority of pure flotation systems are in Asia such categorisation has become rather difficult since, increasingly, elements of each are being included in the other as the merits of the combination system are recognised.

WASH ? FLOAT ? OR BOTH ?

Any deinking system is basically a waste processing system with a facility to add chemicals to aid ink removal from fibre and a facility to then remom ink particles from the fibre suspension.

In the case of the washing system the chemical formulation is arranged so that the ink is well dispersed and this is then removed from the system in a series of thickening operations.

Flotation on the other hand depends upon collector chemistry which ensures the formation of large ink particles which will respond well to air bubble flotation techniques.

In general however, ink removal can be regarded as having three basic phases :—

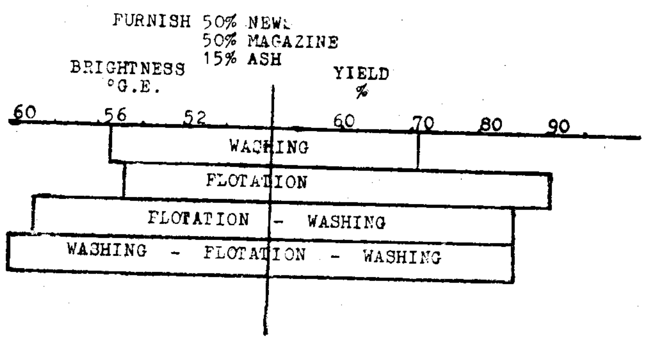
1. INK REMOVAL FROM FIBRE
   Dispersion Chemicals
2. INK REMOVAL FROM PULP SLURRY
   Washing or Flotation
3. INK REMOVAL FROM FILTRATE
   Clarification

In the case of the pure flotation system phases 2 and 3 occur together. Pure washing requires a clarifier in order to conserve water.

Combination systems may employ either washing or flotation chemistry according to type, but increasingly hybird chemistry is being offered which contains bath dispersants and collectors sketches I to IV show the basic elements of a washing, a flotation and two combination systems.

Table 4 shows the performance characteristics of these alternatives in terms of Brightness and yield when used to process a typical European waste furnish for newsprint.

TABLE 4 SYSTEMS COMPARISON



The results in this instance were perhaps much as one would expect.

The washing' system was low i. yield, because it got rid of most of the ash, and not too good on brightness because it didn't get rid of all the ink.

The flotation system was very good on yield, because it retained most of the ash but was actually lower in brightness. Probably, since some of the ash retained was of a low brightness filler variety.

The flotation washing system did much better on brightness by removing more ink and sacrificing a little yield in lost ash.

The best overall performance however was by the wash-float-thicken system by exploiting the merits of both washing and flotation to greatest advantage.

But, what if we were to change the furnish to say 70% news 30% mags 2% Ash originating from the U.S.A.? Actually, we haven't done the experiment, because the flotation chemistry just wouldn't work. This could explain 'why flotation deinking is not popular in the U.S.A. where the majority of deinking is for newsprint manufacture from furnishes similar to that mentioned above.

The problem is well illustrated by a report from a mill operating both washing and flotation systems which says :—

"Both plants were installed with the intention that they should use over issue newspapers as their raw material".

"the flotation plant often experienced difficulty in maintaining the flotation of ink and the consumption of soap rose to an unacceptable level without much improvement",

"We tried using magazines and solved the problem overnight".

The "problem" is ash, or rather the lack of it, which is a source of calciumious. Flotation chemistry depends upon the formation of large, insoluble calcium soap floccs and if there is not sufficient calcium carbonate present in the system (usally from the ash content) then poor ink removal is the result with calcium soap/ink complexes being carried over with the accepted stock.

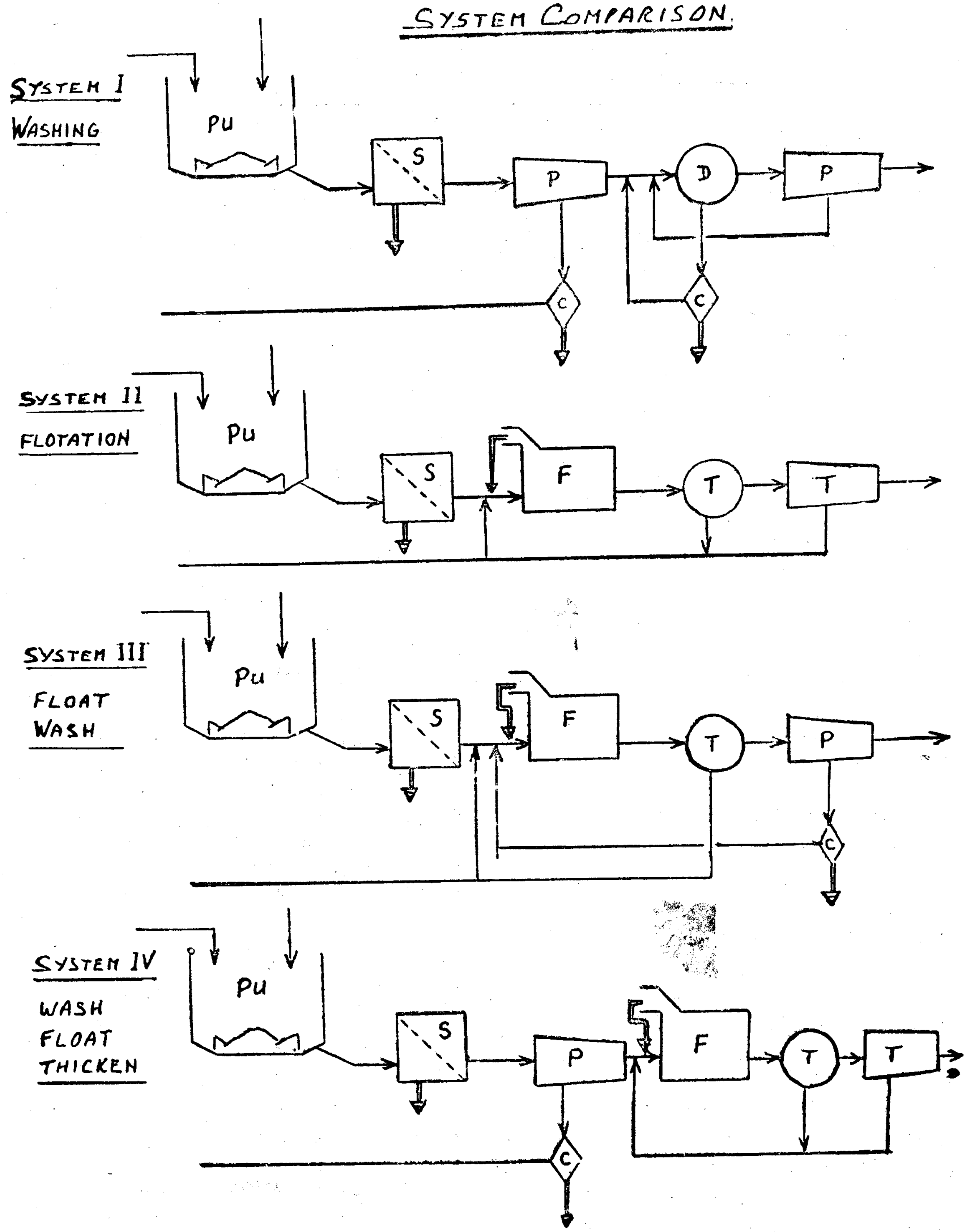
This effectually means that where the raw material contains little ash the system calcium ion level must be maintained artificially if flotation chemistry is to succeed.

In fact the problem is more serious than it may appear at first glance because the actual calcium ion concentration is critical and variations in the balance between calcium ion level and collector addition will result in either a loss in deinking efficiency on the one hand or carry over of collector into the accepts stock on the other.

In practice the tendency is to err on the side of excess calcium. due to the difficulty of accurate control, the result being the presence of sticky collector agglomerates in the deinked stock which can seriously affect paper machine runnability and hence efficiency.

Any deinked stock can of course carry potentially troublesome materials into the paper machine system and table 5 illustrates the types of problems which can occur when running significant levels of deinked stock and shows that wash deink stock is not without its problems also,

SYSTEM COMPARISON.



TABLE—5

PAPER MACHINE PROBLEM AREAS

	WATER CIRCUIT	WIRE PART	PRESS PART	DRYERS
Flotation Deinked Stock	Buildup of ash ink/ sticky deposits	Slower drainage on wire	Plugging of felts with ash/ink stickies	Doctors Required on more cylinders
	Water becomes dirty with ink carry over	Ink/sticky deposits on wire	Lower felts life	Picking at breaker stack
	Water becomes contaminated with chemicals	Pin holes & other defects due to deposits More frequent wash UPS,	Picking & crushing at Nips	More frequent cleaning
Wash deinked stock	Water becomes dirty with ink carryover Possible forming with detergent carryover	Wires can become dirty with dispersed ink coloration	Felts can become dirty with dispersed ink coloration	Picking can occur if pitch becomes excessive

Generally flotation type chemistry appears to be potentially more troublesome than wash type chemistry, particularly in terms of machine runability problems.

This is borne out to some extent by the apparent unwillingness of users of float deinked stock to add more than 40 or 50% of deinked stock to their fibre furnish excepting for a few particular instances.

On the other hand, wash deink stock is being successfully utilised upto 100% in some cases without apparent problems.

We could continue pursuing this line of argument, but the pros and cons of wash versus Float deinked stock are well known and well documented.

The eventual result would be to reach the conclusion, like many before us, that the optimum is a combination system employing one of the modern hybrid wash/float type chemistries now available.

Such a conclusion would however be based upon balance of observed overall advantages rather than on appraisal of particular requirements.

Such a system may be an admirable choice for a mill needing the versability to accept virtually any grade of deinkable waste, deink it efficiently and feed it as a 100% furnish component to a sophisticated, high speed twin wire paper machine.

The fact is though, that the other mill wanting to deink a few Tonnes per day of office waste or computer print out to blend in small amounts with his virgin furnish would simply not require such a system. His needs would best be served by a simple flotation system which could be operated for maximum ink removal with little risk of problems at the paper machine.

There is of course also the other end of the scale where a mill may wish to deink a constant and unvarying quality of North American West Coast overissue news to make typical North American quality Newsprint. For them a straight flotation system could be the most practical proposition.

Each particular variety of deinking system would appear then to have its place in the order of things and by carefull evaluation of all the relevant information appertaining to a particular proposed deinking situation it is possible to choose approximate technology. Table 6 is an indication of the types of factors which need to be considered.

Factor	:	Implication
Final Product	:	Choice of Furnish Brightness Required Cleanliness Required Surface Properties Required Physical Properties Required Tonnage Required
Type of Paper Machine	:	Speed Drainage Characteristics Sensitivity to Contaminants Runnability.
White Water System	:	Tolerance of Deink Chemicals Ability to Resist Sticky/Clay Deposits.
Additive System	:	Compatibility with Deinked Stock and Chemicals Carried Over.
Effluent System	:	Ability to Deal with Chemical Carry Over. Arrangements for Inky Effiuent Disposal.
Deinking. Bleaching and Water Treatment	:	Compatibility, Availability And Cost of Chemicals Compatibility of Process Water.
Waste Paper	:	Grade (s) Required/Available Source (s) Ash Content/Type Degree of Contmination Types of Contraries Age of Waste Moisture Content Ink Type (s) Waste Quantities Available Assurance of Supply Alternative Sources Cost.

The list is not exhaustive but if answers could be produced to all of the above then a very good choice of suitable process and plant could be made.

It is not necessary to consider the factors s rictly in the order shown and in fact frequently many factors must be considered together since they are interdependent

One consideration is paramount and overrides all the rest. The deinkplant, Paper Machine and associated systems must be treated as an integral whole as any degree of incompatibility will inevitably effect efficiency and product quality.

THE HARDWARE :

The drive for greater efficiency of ink removal has been primarily in the area of chemical formulation but the machinery manufacturers have played their part in ensuring that the chemicals are used to best advantage.

Much work has also been done in the field of contaminants removal and revised techniques of operating existing equipment have been supplemented by redesigned and in many cases, completely new machines.

A great deal of the deinking operation takes place in the pulper and it is in this area that the ink removal is initiated, and most of the potential problems begin.

Pulper development has resulted in the appearance of new high efficiency rotors such as the Tridyne. These offer power and chemical economics, through higher operating consistencies, coupled will gentle treatment. This ensures minimum fibre damage and contrary size reduction. Power temperatures of operation have assisted in this direction also, particularly where the formation of small stickie particles is concerned.

Present day philosophy is to keep contraries large and keep them in the pulper. If the quantities are fairly small then periodic discharge from the paper tank into a container of some sort is all that is required. If, however the quantities present are large then a range of course screen type devices is available for operation either on a parge loop or main line. The Trommel screen is a good example of this type of equipment and lends itself to a number of different modes of operation.

Some contraries inevitably do find their way out of the pulper tank with the stock and arrangements are commonly made to remove these progressively through the system by combinations of screening and cleaning devices, A proportion are removed also by the wasting or flotation units.

First in line after the pulper dump chest is usually a high density hydrocyclone cleaner which deals with the heavier contraries such as wire, stones etc, and this is typically followed by a course high consistency pressure screen such as the Bird Barrier screen.

This makes sure that downstream equipment is protected from any oversize partieles and these are commonly passed to a vibrating type screen to ensure minimum loss of good fibre.

Screen accept stock is now ready to be passed to the first deinking device possibly after deflaking with a unit such as the Dispersal. Development in the area of deinking devices is of course intense with manufacturers stiring to make equipment more efficient and competitive.

First stage washing is commonly achieved with some sort of dewatering press and both the Beloit PSOC pressmaster and the CDC thickner have been developed for this type of work. The accent here is on gentle dewatering without forming a thick 'cake' too early which would trays ink particles and present their removal with the filtrate.

Both first and second stage flotation, where necessary, is carried out in flotation cells in which air bubbles are introduced. Ink/collector agglomorates attach themselves to these and are thus floated to the surface for removal as an inky froth.

A variety of these cells in available but Beloit Fineacell is unique in its rectangular slope and mode of operation which is the result of several years of intensive Research and Development effort.

This unit combines efficiency with reasonable cost and lends itself to space saring arrangement.

Second stage washing is usually carried out with a drum type washer and the Beloit drum washer is an excellent example of such a device developed specifically for deinking work. Relationship between the drum and the interior tank shape is critical to ensure that washing takes place rather than simple thickening

Careful control at this stage and proportioning of underflow to recycle or clarification gives a useful measure of control over system ash removal.

Where inky effluent clarification is used it is typically by flotation clarifier. This allows discharge of an inky sludge to a centrifuge or belt press thickener for disposal, whilst ensuring optimum recovery of process water within the plant.

After first stage deinking it is likely that small contaminants, both light and heavy, will be present and it is customary to subject the stock to firescreening and cleaning before further treatment.

Typically the fire screens could be Bird Contrisenter Pressure screens operated at low consistency with fire slotted baskets, probably in a two or three stage cascade.

Fine heavy contraries would be taken care of by a three or four stage system of Bird cyclean centrifugal stock cleaners, whilst the fire light contraries including some stickies and ink would be dealt with by the revolutionary Beloit Uniflow cleaner in one or two stages.

The Uniflow cleaner was developed to deal exclusively with lightweight contraries and displays very high efficiencies coupled with economic operation. Several thousands of these units are in use in mills throughout Europe and America and are producing very satisfactory results.

The final stage of the Deink plant will have some form of thickening device such as the very well known Beloit Polydisk filter thickener. This has recently undergone a major re-design and appears as the 5000 series with many improved features.

Alternatively there may be a final stage washing thickening device which once again could be the Beloit Pressmaster or CDC thickener.

Dependent upon end use requirements there could of course be a bleaching stage normally involving peroxide addition or the somewhat more complicated Hydrosulphite based process. Choice of appropriate type is dictated by the type of fibre present in the furnish and to some extent by availability of suitable chemicals.