Sixty Years Of Deinking

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ABSTRACT

Deinking history, practice and theory has been traced through the examples of a few deinking mills in the western world. The advances made in difibering technology and contaminate removal are touched upon. It is suggested that a national laboratory should test the equipments available in the country for waste-paper processing and should also establish the norms which the industry could follow. Capital cost for putting up deinking pulp street is compared with that of an agricultural residue pulp street for the same tonnage. Finally a suitable deinking system is suggested for this country.

The recycle of printed waste-paper through deinking was done 250 years ago in 1695 at George Illy, Denmark. By 1925 large amounts of rag and chemical wood pulp waste paper were deinked. Sorting was resorted to restrain mechanical pulp to less than 10%. The use of sodium hydroxide was common in deinking plants because it saponified the resinous base of the inks and retarded the redeposition of carbon pigment back onto the fibres.

By 1930 's large quantities of mechanical pulp papers in the form of telephone directories and books were deinked. One mill used sulphor dioxide dissolved in water as dispersing agent and used wash deinking. This process also increased the brightness of pulp. Sodium peroxide, and sodium silicate gradually displaced this process.

A block diagram is given for a 1932 typical deinking system below. It uses breaker-beater to break the furnish sufficiently to make it pumpable. The furnish was pumped to paddle agitated cooking tanks, where soda ash was added and the batch held at 70° C for three hours before bleaching, After bleaching the furnish was washed in four stage washers with counter current flow system. The pulp was then passed through riffler and then thickened. The mistake made in this system was that bleaching was attempted with the ink still present.

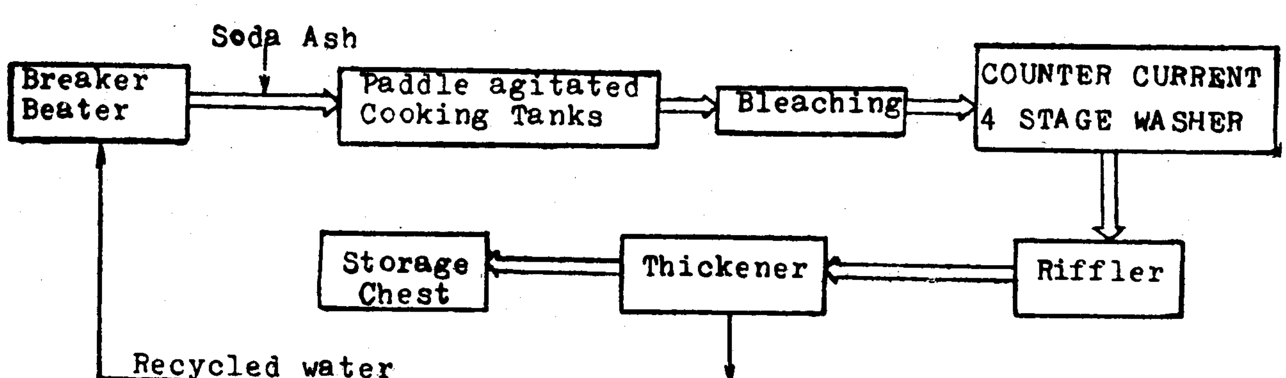

Figure 1

Typical Deinking System of 1932

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In order to cope with the demaned on dinking systems to handle all sorts of trash and non fibrous materials, by 1935 one mill had progressed to a point that they considered it necessary to remove by dry dusting and manual sorting such imputities that could be visualy recognised. This was done by a conveyor system. The waste-paper thus sorted was cooked in digestors for 4 hours and then put in retention cooking chest. The pulp was then passed through a riffler, screening, and three stage washer. Bleaching was done in bleaching chest, (Figure—2). Following are average requirements for one ton b. d. deinked pulp.

Labour for Sorting..................48 man hours

Power requirement............... 331 H. P. hours

Heat requirement.................12,000 B. T. U.

Soda Ash..............................60 lb.

Caustic Soda..........................60 lb.

Bleach..................................36 lb.

Water....................................42,500 gal.

Shrinkage in deinking 18%

At the prevailing costs it was still economical to deink. The cost margin over virgin pulp was nearly 40%. The system could however not produce pulp of very good quality, nor could it cope with large quantities of non fibrous material.

By 1965 there were 20 Flotation deinking installations in Europe. Dr. Herbert Ortner has suggested that Flotation process was mentioned by Herodot as far back as the fifth century B.C. In the process sorted,

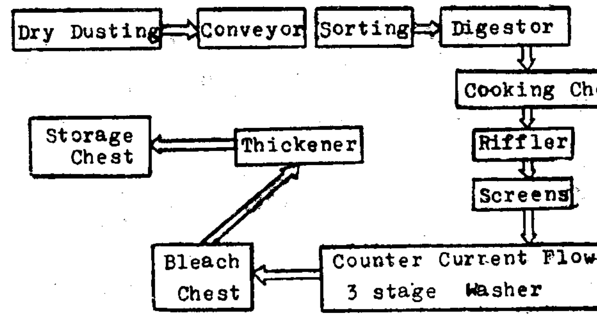
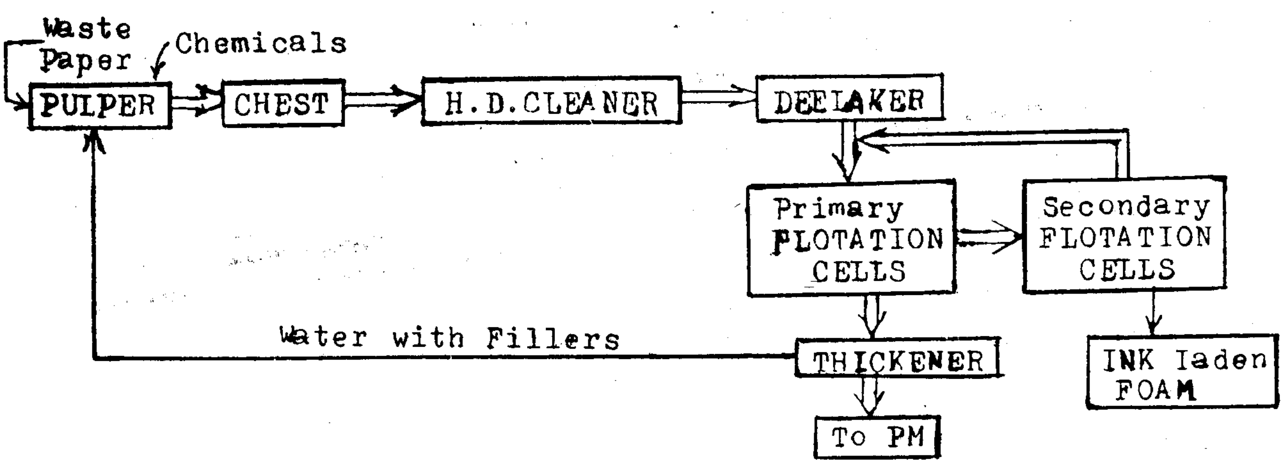


Figure 2-Deinking System of 1935 using manual sorting

printed waste paper (Fig. 3) is flushed in the pulper for about 30 minutes at 45° C or higher with a stock consistency of 5-7% and is then pumped to a chest, where the slushed stock is allowed to soak for 1 to 2 hours. Impurities such as staples and paper clips are removed by high consistency purifier. A high speed deflaker is used for despecking. The stock is then diluted to 0.8% and passed through the flotation cells where the printing ink particles are removed. The accepted stock is thickened to 4-6% and is ready for further processing in the paper mill. Important is the reuse of water. The waste water originating from the thickener is reused for diluting the stock at flotation cell stage. Surplus waste water is pumped to a water storage chest and then used for the slushing of the waste paper in the pulper. To keep the fibre losses to a minimum the flotation froth from the primary cells is collected and refloated in secondary cell, where the ink was discharged in fairly concentrated form, and accepts lead back to primary cells.



Fi3ure 3—Flotation Deinking of 1965 to replace groundwood

Mostly groundwood was replaced by deinked wastepaper by the system shown. For deinking of groundwood paper, 2% sodium peroxide, 5% sodium silicate and 3.5% soft soap were added at the pulper stage. The insoluble calcium soaps formed act as agents for flake flotation, whereas the other chemicals detach ink particles from fibres. The synthetic flotation agents were not succesful in closed cycle operation as they tend to concentrate leading to impaired flotation action. The whiteness could be increased by hypochlorite bleaching stage after the flotation process. A power consumption of 450 kwhr/ton of finished stock and water consumption of 4750 gal/ton was observed.

Developments in secondary fibre stock preparation systems

The breaker-beater dominated secondary fibre preparation systems from 1925 to 1950. It could be combined with a classifier with 1/8" perforations and also fitted with a junker, ragger and backfall extraction plate with 3/4" perforations.

The hydrapulper invention in 1939 made braker beater obsolcte. Further inventions like vokes roter in 1958 became standard in defibering technology in the western world, because it operated in combination with an extraction plate with 1/8" perforations, helping pulper to both screen and defiber. This development, however, bypassed India, and 1/8" extraction plate in pulper brings a look of dis-belief on the faces of most Indian parer makers.

In the meanwhile the Western world has marched ahead with several more developments, like high consistency enclosed pressure screens, horizontal centrifugal cleaner cum secondary pulper, Flotation purge system, two stage high consistency pulping system, single stage high consistency system using pressure screen, high-low consistency system etc. The emphasis has been in reducing the energy requirements, initial capital outlays, and at, the same time increasing the cleanliness of the pulp produced. Espenmiller and Root in Vol. 59, No. 3 March 1976 Tappi have given a good cross section of these developments.

Deinking systems using Vokes type Hydrapulper were designed to separate the polythene from polythene coated boards and papers for milk cartons, locker papers, frozen food containers etc. The crux of the entire operation depends on

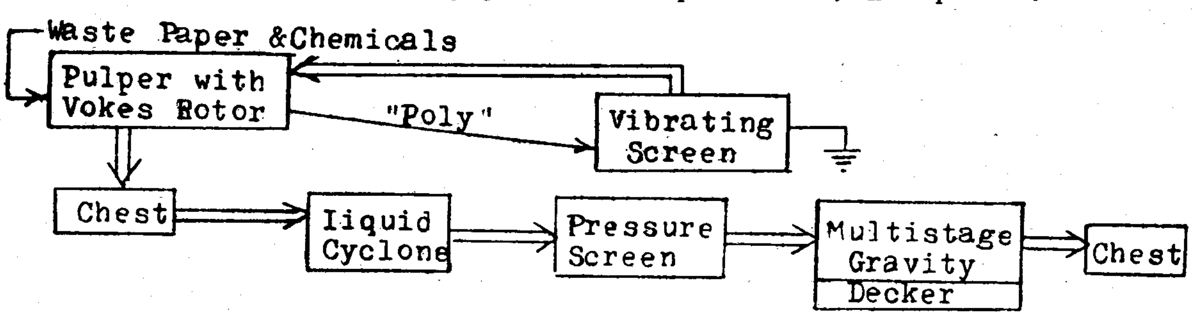
(a) initial separation of "poly" from paper fiber.

(b) removal of the fiber from the "poly" by extraction through 1/8" diameter perforations underneath tha Vokes Rotor in the pulper during the washing cycle, when after 15 minutes of defibering, wash water is added continously and the fibre is extracted continously to a dump chest. Such wash deinking system using pulper in batch operation is shown in figure 4.

WASHING DEINKING

After defibering, screening and cleaning, the ink removal can be said to be a laundering process. Washing is a mechanical process that rinses ink, ash, and dirt particles from the pulp. Froth Flotation, on the other hand, is a chemical-mechanical process that selectevily floats ink particles from a dilute suspension.

Removal of ink by washing is affected by operating characterstics of a particular washer. For example, ink connot be removed effectively at 8-10 consistency of discharge using a vacuum filter, because a tight structured fiber mat is formed, which impedes and filters suspended solids, like in particles.



Figure—4
Deinking System Capable of getting rid of Rolythene

The following classification can be applied to washers :

1. Low consistency : upto 8% (sidehill screens and gravity deckers).
2. Intermediate consistencty : 8–15% (Inclined screw extractors and vacum filters)
3. High Consistency : above 15% (screw press and belt filter press).

Typical Commercial washer performance is given in a table from (fig. 5). Source : Horaceck and Dewan, Vol. 65, No. 7 July 1982/Tappi.

WASHER TYPE	INIET % CY	QUTLET % CY	1st STAGE FIBER LOSS	DILUTION FACTOR	1st STAGE % INK REMOVED %
Sidehill Screen	0.6–1.4	3–4	12–18%	124	74 0%
Gravity Decker	0.7–1.2	4–6	6–12%	124	84 7%
Inclined Screw Extractor	3.0–4.5	8–12	8–12%	32.2	72.1
Screw Press	3.5–4 5	20–28	3–5%	24	89.3%

Fig.—5

Belt Filter Press would be expected to perform similarly. The belt filter press uses a twin wire to press the stock.

Much discussion has accured throughout paper industry as to whether full stream flotation deinking or washing deinking is superior. Neither has a clear advantage over the other, and each system and its respective requirements must be studied separately to determine whether flotation or washing or a combination of both will yeild the best results in terms of brightness, pulp quality, and costs.

CONTAMINATES OR CONTRARIES

The purpose of a well designed deinking system is also to effectively deal with the contaminates in waste—paper as these can lead to many specks. Let us classify them into four distinct groups.

1. Ultra heavy such as nuts, bolts, bottle caps, sheet metal, packaging wire, large stones etc.
2. Heavy such as sand, staples, metal particles, glass paper clips and stiches etc.
3. Light such as styrofoam, rtrings, threads, rubber, threads, synthetic fibre reinforeed adhesive tapes, book splines etc.
4. Ultra light such as hof melts. glue, waxes, synthetic particles.

The presence of these contaminates will dictate the design of cleaning system various equipment that can be used and their rough guide to contaminate removal efficiency is given in the table below. Surce : David S. Rao June 1984/Tappi.

Equipment	Contaminates			
	Ultra heavy	Heavy	Light	Ultra Light
Pulper Junker, 5/8"	50	10	5	—
Pulper Junker, 3/16"	80	10	5	—
Junk Tower	50	10	5	—
Ragger	—	—	70	5
Float Purge	—	—	80	5
Medium density Cleaner	—	60-90	—	—
Horizontal Cleaner	—	3	60	15
Pressure screen (holes)	—	40	60	30
Pressure screen (slots)	—	60	85	40
Forward Cleaners 2%	—	90	—	—
Forward Cleaners 1%	—	95	—	—
Reverse Cleaners, *1%	—	—	80	80
Reverse Cleaners, 0.6"	—	—	90	90

Stickies are a problem as they affect the felts and considerably impair the good operation of the paper machine. It has been confirmed that floatation process to some extent eliminates these plastic particles and sticky fragments.

Special Chemicals

On the basis of the experience gained in the dispersion of resin with dispersing agents and solvents, special chemicals have been available with the aim to swell the synthetic adhesives on their surface and to vary their properties to such an extent that the production losses can be substantially reduced.

Specks on Paper

The decrease in specks on finished paper is propotional to the number of cleaning stages the waste-paper is passed. This is illustrated by a graph (fig. 6) prepared by Institut fur Papierfabrikation, Technische Hochachule, Darmstadt, West Germany.

above normal, and abnormal quantities, with equipment available in our country to eatablish industry norms.

The practice of deinking is illustred by a few random examples, of mills established in western world between 1974 and 1984.

***150 TPD Deinking Mill in U.S.A. established in 1974**

The Mill produced bleached hardwood substitute from ledger grades of waste-paper. The deinking process is a continous hot caustic process. (fig. 7). Wastepaper is slushed continuously in a 16 foot hydrapulper with Vokes rator and 3/8" extraction plate. Coarse screening is done by three Jonsson screens having 3/16" holes. Coarse centrifugal cleaners are three 7" Bird HDC type. This is followed by two deflakers of Model E2K from Escher Wyss.

Wash deinking is done in three stages of Baker screw extractors. Heat and chemical economy is

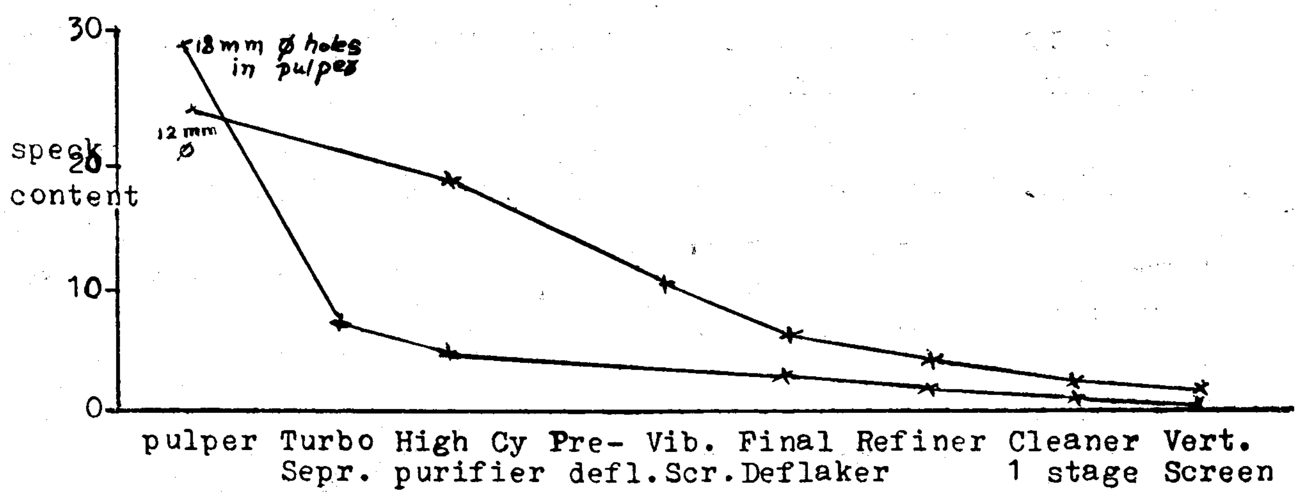


Fig.—6

System design for contamination revolves around usage of the various cleaning equipments being optimised w. r. t. to type and quantity of contraries expected. A A logical system can be built aronnd specific mill conditions. Efficiency of contamination removal and adequacy of throughput tonnages should be established. A post-appraisal of efficiency should also be part of preliminary design criteria. It is also necessary to establish laboratories where extensive testing can be carried out. These laboratory tests should be performed on three levels of contaminate inputs : normal,

improved by taking the extraeted water to Voith-Morden dispersed air floatation cells to remove ink and sending the clarified water back to pulper.

Fine screening is done in three stages of Bird Centrisorter pressure screens with 0.012" slotted plates. The stock is then double cleaned by centrifugal cleaners including one stage or core bleed, and then bleached using Hooker 2 stage bleach plant after thickening in Beloit Jones disc thiciner, having 15 discs, 12'6" in diameter.

Steam requirements were 16 million BTU's per hour make up at the pulper for 180°F operating temperature plus 0 to 16 million BTU's per hour seasonally to keep bleach plant at 95°F. Electrical power requirements 2500 KVA. Shrink about 18%. Brightness between 78 and 80 G. E. Tappi dirt count averages around 3 ppm.

comparable with Flotation deinking plants, popular in Europe. Average Power Consumption is 410 KWH/ton, water consumption 20 cubic meters/ton, steam 900 Kg/ton. The chemicals used are caustic, DTPA, Hydrogen Peroxide, Silicate, and proprietory dispersants. (The above figures and chemicals are only approximate).

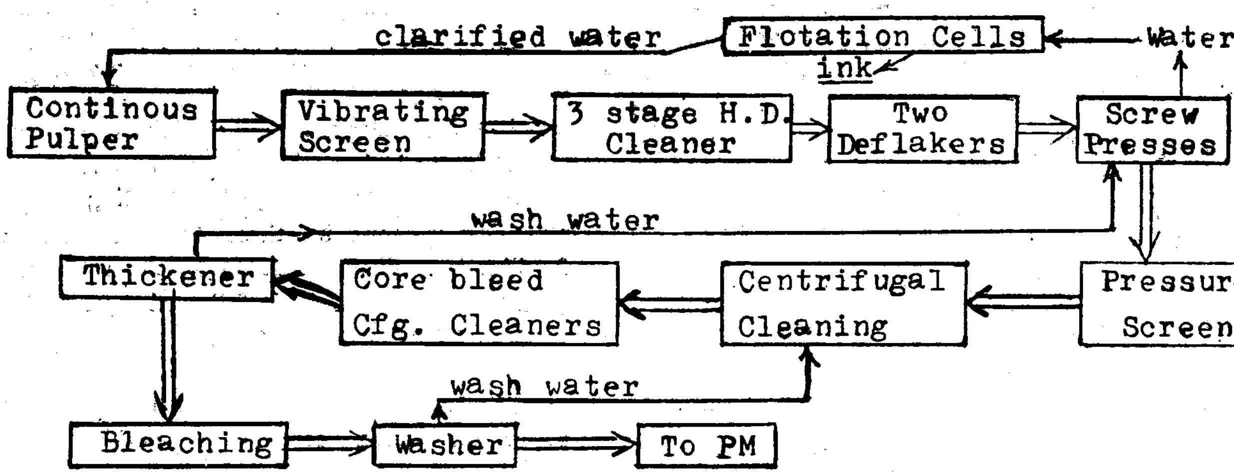
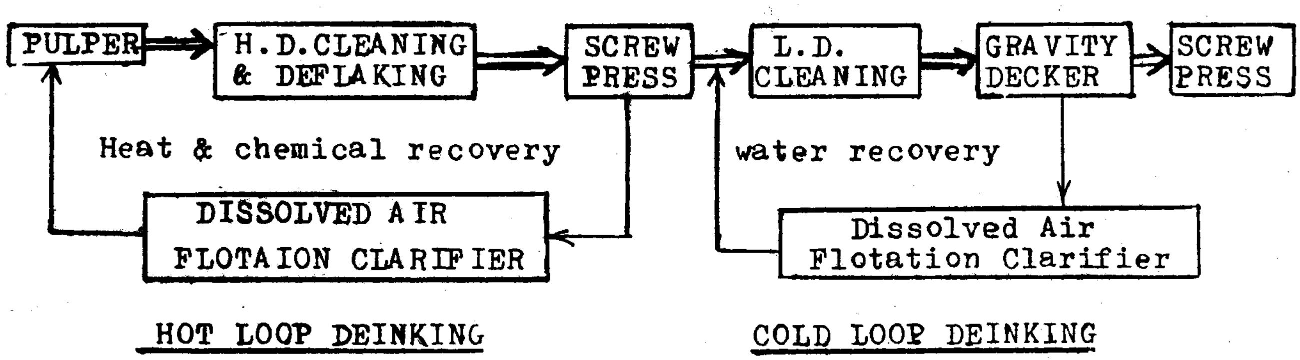


FIG.—7

DEINKING PLANT 150 TPD USING SCREW EXTRACTORS AND FLOTATION CELLS FOR HEAT AND RECOVERY.



HOT LOOP DEINKING

COLD LOOP DEINKING

Deinking Mills in Holland Producing Newsprint with Market Pulp and Deinked Newsprint and Magazine Waste paper, using the concept of Heat and Concept of Heat and chemical recovery through Hot Loop and reducing water consumption through the concept of cold loop.

FIG.—8

Fig. 8 shows a wash deinking plant executed by Beloits in Holland and elsewhere. Dissolved air Flotation in used to recover heat and water in Hot Loop and water in Cold loop The strength properties, cost of chemicals, power, water and steam consumption is

60 TPD DEINKING PLANT USING FLOTATION DEINKING AND HOT DISPERSION SYSTEM IN FRANCE STARTED IN 1984.

The deinking plant produces pulp at 85 G. E, brightness from woodfree papers, CPO, white ledger, white printing and writing and brochures. The plant uses pulper with helical screw with pulping consistency of 17%. The ultra heavy contiminants are removed in a second pulper operating at 5%. After coarse screening the deinking is done in vertical flotation cells. This is followed by low density cleaning and thickening. Water recovery is by dissolved air flotation. The stock is further thickened in screw press and taken to hot dispersion system at 75-80°C. The dispersion system contributes to good quality of pulp by separation and disintegration of all types of stickies that remained in stock Temperature is kept below 100°C to prevent irreversible deterioration of processed hemicellulose. The steps are illustrated in fig. 9. The shrinkage is about 17%.

extensive testing, and set norms for the Industry to follow.

One other problem is changing quality of waste-paper. The papermakers are unable to influence the buying decision because of various market forces in operation and have therefore to exert greater effort to produce uniform quality of deinked pulp.

ECONOMY FOR PUTTING A DEINKING PULP STREET

Most paper mills in India are thinking in terms of expanding their produclion capacity by either running existing paper machines faster or addin a paper machine to existing.

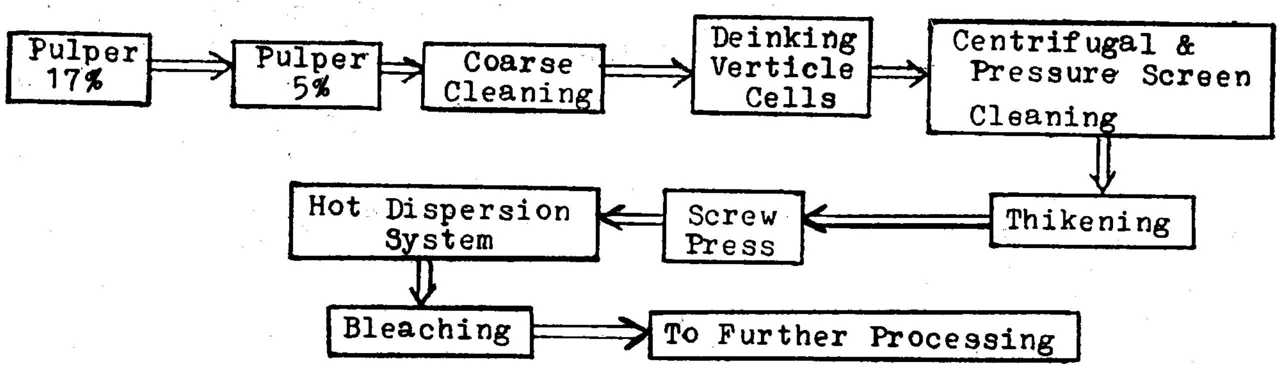


FIG.—9
60 TPD Deinking System of 1984

PROBLEMS OF DEINKING IN INDIA

Various paper mills in India are attempting to deink waste-paper. Some are following the digestion route followed by drum wasthers. The yeild is around 75%. Yet others are trying to follow the pulper route, but are hampered by synthetic materials/contraries and improper defiberisation, for which they ultimately rely on refiners'. Some are trying to bleach with the ink still present. Also seems to be absent the need of classifying the contraries and the aproach to eliminate them scientifically.

The mills also do not have a proper guide to the efficiency and effectiveness of various equipment being manufactured and sold in India. It has been suggested earlier in this paper that some national laboratory should take upon itself to subject these equipments to

To enhance pulp production, a pulp street based on wood or imported pulp is rather hazardous. The alternatives are either establishing a pulp street based on agricultural residues or deinked wastepaper.

Rough estimates of capital investment for putting Rough estimates of capital investment for putting up either from scratch, for both bleached and unbleached pulp are given in fig 10.

COMBINED FLOTATION AND WASHINGDEINKING SYSTEM

A Block diagram is given (fig. 11) for a combined flotation and washing deinking system. The capital cost for the system is comparitive to ammounts given in fig. 10.

	Agricultural Pulp Street TPD			Deinking Pulp Street TPD		
Unbleached Pulp Production	10	20	30	10	20	30
Street...........	Not	85	100	18	24	30
Bleaching Eqaipment	Viable	40	50	6	8	10
Building, piping & accessories	,,	25	30	9	12	15
Effluent Treatment	,,	40	40	3	4	5
Total Capital Invest. (Rs. in Lacks)		190	220	36	48	60

FIG.—10

Comparitive Capital Investment for establishing Pulp Streets

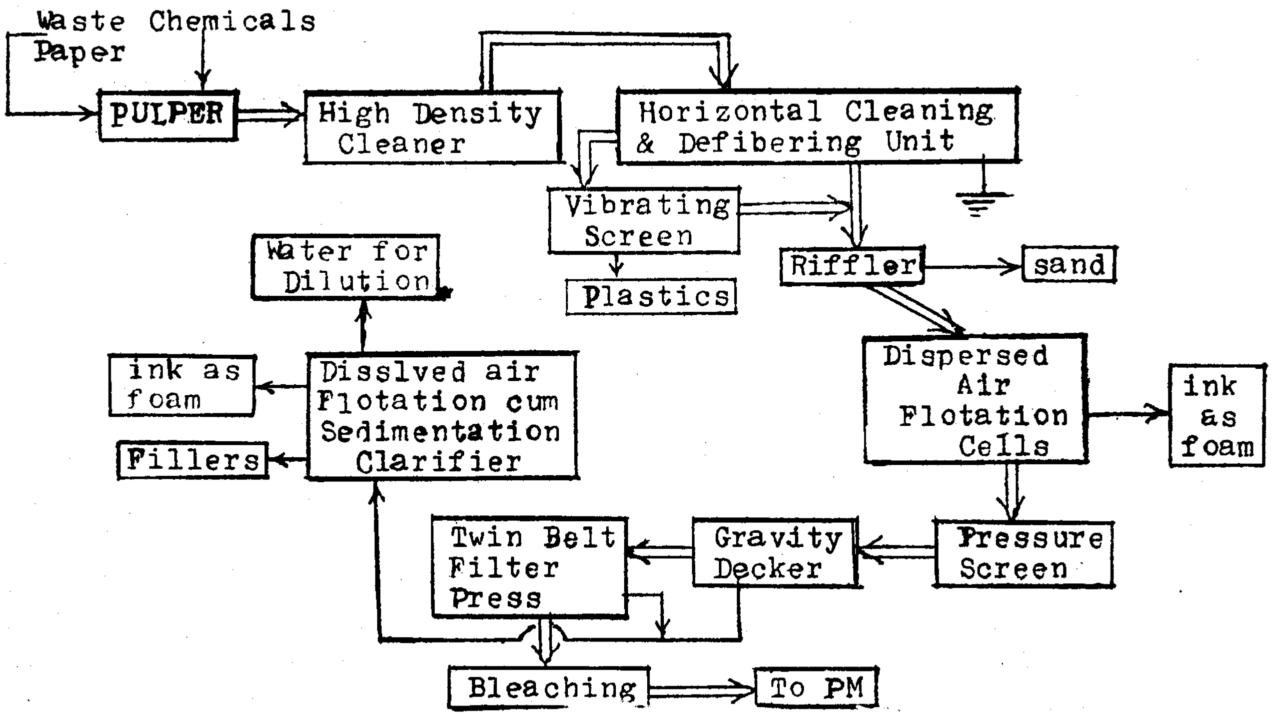


FIG.—11

Combined Floation & Washing Deinking System with the Possibility of Using it as Either, or Combined Depending on Waste-Paper Quality and Results Desired

The system is specially adapted to varying quality of input (waste-paper), and can produce several qualities of Deinked pulp. For example if high yeild is desired, the dissolved air flotation cum sedimentation clarifier can be bypassed. This will bring all the fillers back into circulation. The ink would then be removed by dispersed air flotation cells and discharged in fairly concentrated form, which can be taken to sludge bads drying. The recycling of fillers would, however, bring down the strength and brightness by a few points.

For some grades of waste-paper, where the fillers have to be removed, but ink is not present in large particle size, such as in photostat papers, and stikies are low, then some cost of chemicals in the form of soft soap can be saved by by-passing the dispersed air flotation cells. Then the dissolved air flotation cum sedimentation clarifier will be used to remove ink and fillers both in the floated form and sedimented form. To produce high quality of deinked pulp with maximum strength and brightness, from most grades of waste paper, both flotation and washing deinking are reccomended to be employed Most ink will be discharged from dispersed air flotation cells, but some will also be discharged as foam from dissolved air flotation cum air flotation cum sedimentation clarifier,

Effluent Treatment

The exciting thing about this system is that the ink will be discharged in fairly boncentrated form and can be straight away dried in sludge betheds, eliminating the need for expensive biological treatment effluent system. Most of the water is re-circulated so water recquirements are low. The twin wire belt filter press concentrates the discharge consistency to 30%, thus helping to keep the maximum water of deinking recirculating in deinking system. Generally a single stage of bleaching will suffice. Connected Electrical Load for a 30 TRD plant would be about 630 KW, and shrinkage depending on various factors would vary between 8 to 18%.