

Fibre and Water Reclaiming in Waste Paper Recycling System

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ABSTRACT

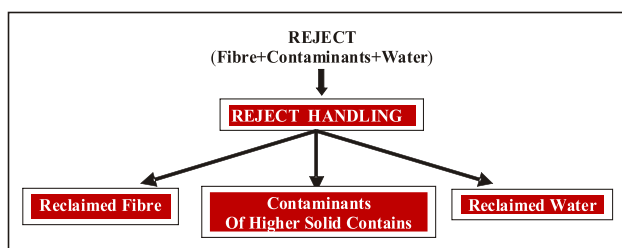
Removing contaminants from a Waste Paper Recycling system is a complicated process that can involve many steps, e.g., pulping, high-density cleaning, coarse screening, fine screening, flotation and washing, low density cleaning etc. Each step removes certain sizes and types of ink and contaminants, along with some fibre and water. The weight of incoming contaminants can vary from less than 0.5% of total furnish weight for some grades to 5.0% or more for mixed office waste. Proper rejects-handling equipment and procedures can significantly reduce the cost of waste disposal and recover fibre/water at initial stage itself. The proper handling of rejects also reduce labor requirements, improves housekeeping and safety.

Sludge pressing has become increasingly important due to enhanced environmental awareness, stricter guidelines concerning the disposal of effluents, and limitations of landfills. Dewatering technology and equipment are essential to meet the requirements of environmental- protection legislation.

Introduction

Contaminants vs. Rejects

Contaminants are materials that should not be present in the stock sent to the paper machine. Rejects are the materials that are actually discharged and must be disposed of after the stock has been processed. Ideally, all contaminants, and only contaminants, would be discharged as rejects.



Equipment for handling rejects must convey, compact, and dewater them to reduce handling and disposal costs. It is not usually possible to recover the usable fibers once they have been rejected and mixed with other rejects without risking the reintroduction of previously removed contaminants. The best way to control final fiber loss is by the proper selection, operation, and maintenance of equipment rather than by trying to recover fibers after they have been rejected.

Types of Contaminants

Contaminants can be broadly classified as heavy or light.

Heavy rejects such as metal, rocks, ceramics, wire, sand, and grit are discharged from the high- density cleaners and low density cleaners. These contaminants are generally non compressible and highly abrasive, with no fuel value if burned. Heavy rejects will self-drain to a solids concentration of 40-80% if allowed to do so in the absence of fiber. Heavy rejects are normally landfilled after free draining. The largest discharge points for heavy rejects are the ragger (wires) and pulper detashing unit.

Light contaminants such as plastics, polystyrene foam, wax, and hot-melt adhesives are discharged from the coarse screens, fine screens, and reverse cleaners. These contaminants are highly compressible and generally nonabrasive and have a substantial fuel value if dewatered sufficiently before burning. Light contaminants will self-drain to a solids content of 10-20% in the absence of fiber, particularly during up-sets.

Other contaminants in a deinking system include ink and ash. They are removed and disposed of by flotation cells, clarification of washer filtrate, and sludge-thickening technology.

Most discharge points also discharge some fiber, and many discharge both heavy and light contaminants. Also, it is common practice to discharge rejects from several sources into the same dump bins or rejects-handling equipment. Thus, rejects handling is much more complicated than it first appears and must be customized to some extent for each installation.

Rejects Conveying

Rejects discharge points should be arranged so that the heavy rejects fall by gravity into a dump bin or dewatering device. Geographic restrictions sometimes require the use of conveyors to minimize the number of dump bins and make it possible to locate

them in more accessible area. Normally, either belt or screw conveyors are used to convey rejects.

Flat belt conveyors are usually limited to near- horizontal straight runs and can convey only materials that contain very little free water.

Screw conveyors are normally more compact than belt conveyors

The screw and trough can be easily cut to length in the field, or sections can be welded to produce lengths of 100 ft or more. Because it has no bearing, the nondriven end can discharge out of its end into the side of the next section of the conveyor at the same level, i.e., without a gravity drop into a feed trough.

Ragger

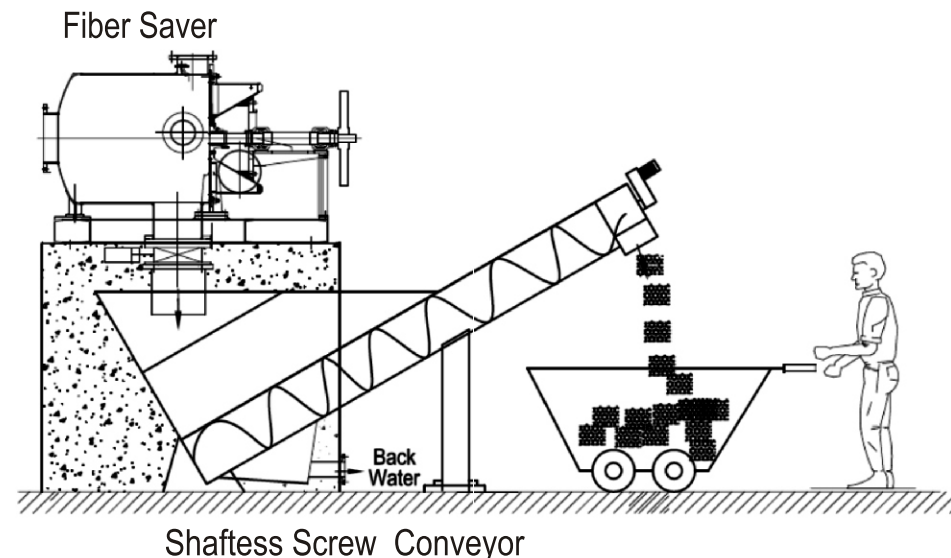


Figure 1.1 Typical Shaftless helical screw conveyor

and can convey fairly wet solids on straight, near-horizontal runs. Angled screw conveyors can be used to drain free water from rejects. Under the right conditions, free, drained rejects can be conveyed at angles up to 40 degrees from the horizontal.

A modified screw conveyor consisting of a shaftless, helical screw in a plastic-lined or metal- splined trough is shown in Fig. 1.1. Because it has no shaft, the non-driven end has no bearing to maintain, and alignment is not as critical. Intermediary support bearings, which are often a maintenance problem and can encourage jamming, are also eliminated.

Continuous tub-type pulpers often use a ragger or “rag rope” to remove the wires continuously as the bales are processed in the pulper. Rag ropes present a problem for many mills. The discharged wire rope is often 20-30 cm in diameter and can be run continuously to unwieldy lengths of 3-10 m.

Many secondary fiber mills have installed shredders to shred the rag rope into individual wires or small bundles of wires about 10-25 cm long. After shredding, the pieces can easily be conveyed with a belt or screw conveyor, or they can tumble down a chute into a dump box, which can then be filled completely to level. Shredders

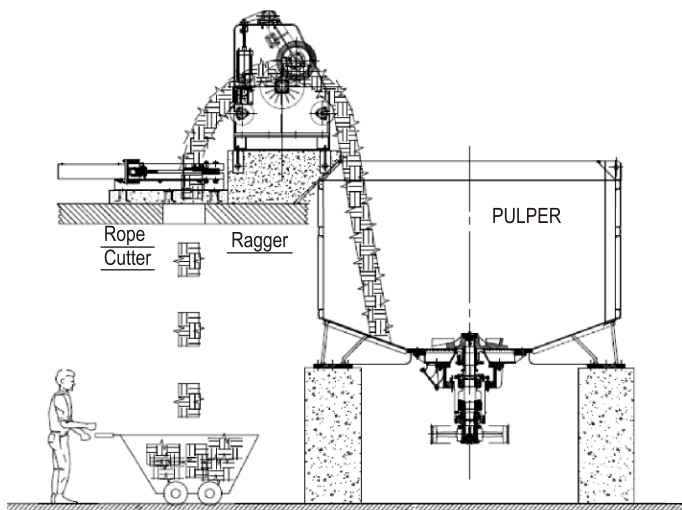


Figure 1.2 Typical Rag rope cutter

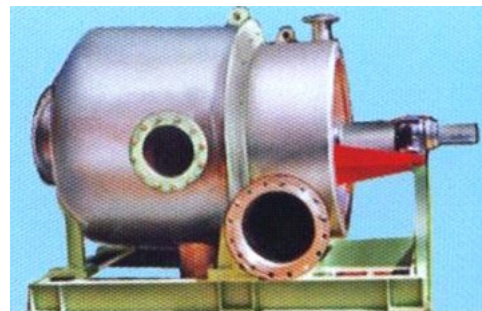
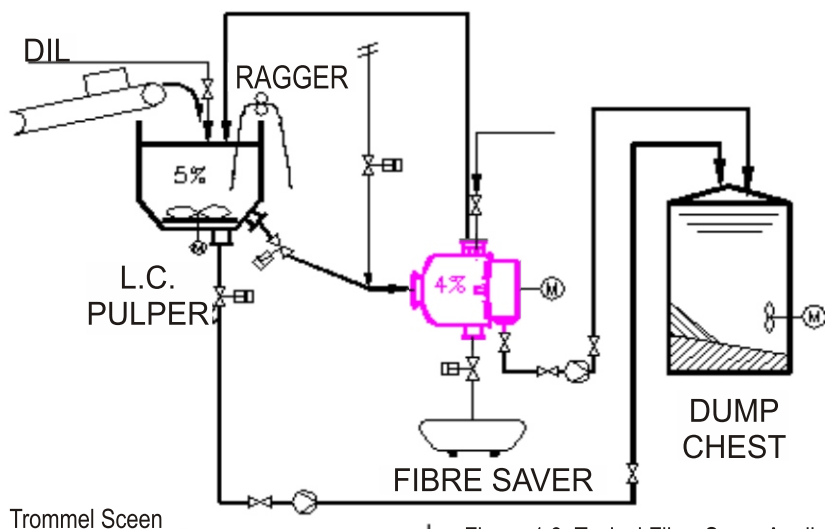


Figure 1.3. Typical Fibre Saver Application

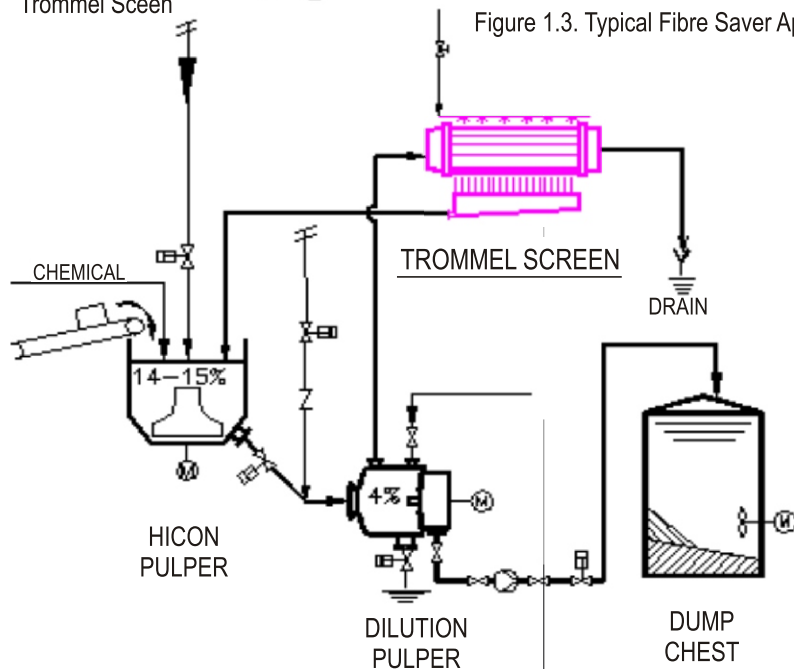


Figure 1.4 Typical Trommel Screen

are competitive in price with guillotine cutters and can often be mounted over existing dump boxes.

They can be started by the same automatic timer that is used to advance the ragger and so require on special attention from the operation. Fig 1.2 shows a typical rag rope cutter.

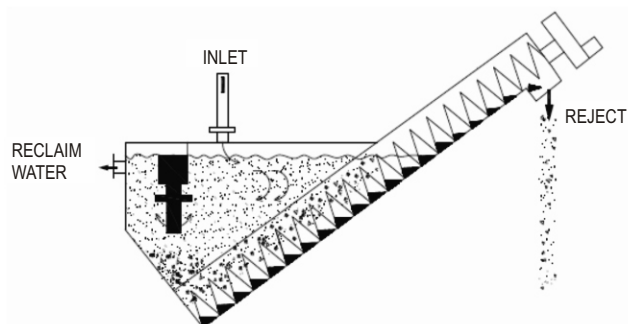


Figure 1.5 Typical Sediment Separator

Rejects Dewatering

Recently, there has been considerable interest in compacting and dewatering rejects before landfilling them. Dewatering rejects from approximately 10% water content to 40-50% can reduce hauling and landfill costs by 50-80%. In addition, the dump boxes do not drip on the way to the landfill.

Many mills are currently burning thickened rejects in bark burners, hogged fuel boilers, or special fluidized-bed incinerators. At 35% solids, the rejects have at least a break-even fuel contribution, and, except for the ash, the landfill charge is eliminated. Although not every mill has the capacity to burn rejects, those that can should consider this alternative to landfilling.

Rejects dewatering devices are well known in the paper industry. The most appropriate type depends on the quantity and drainage characteristics of the rejects and on the intended means of

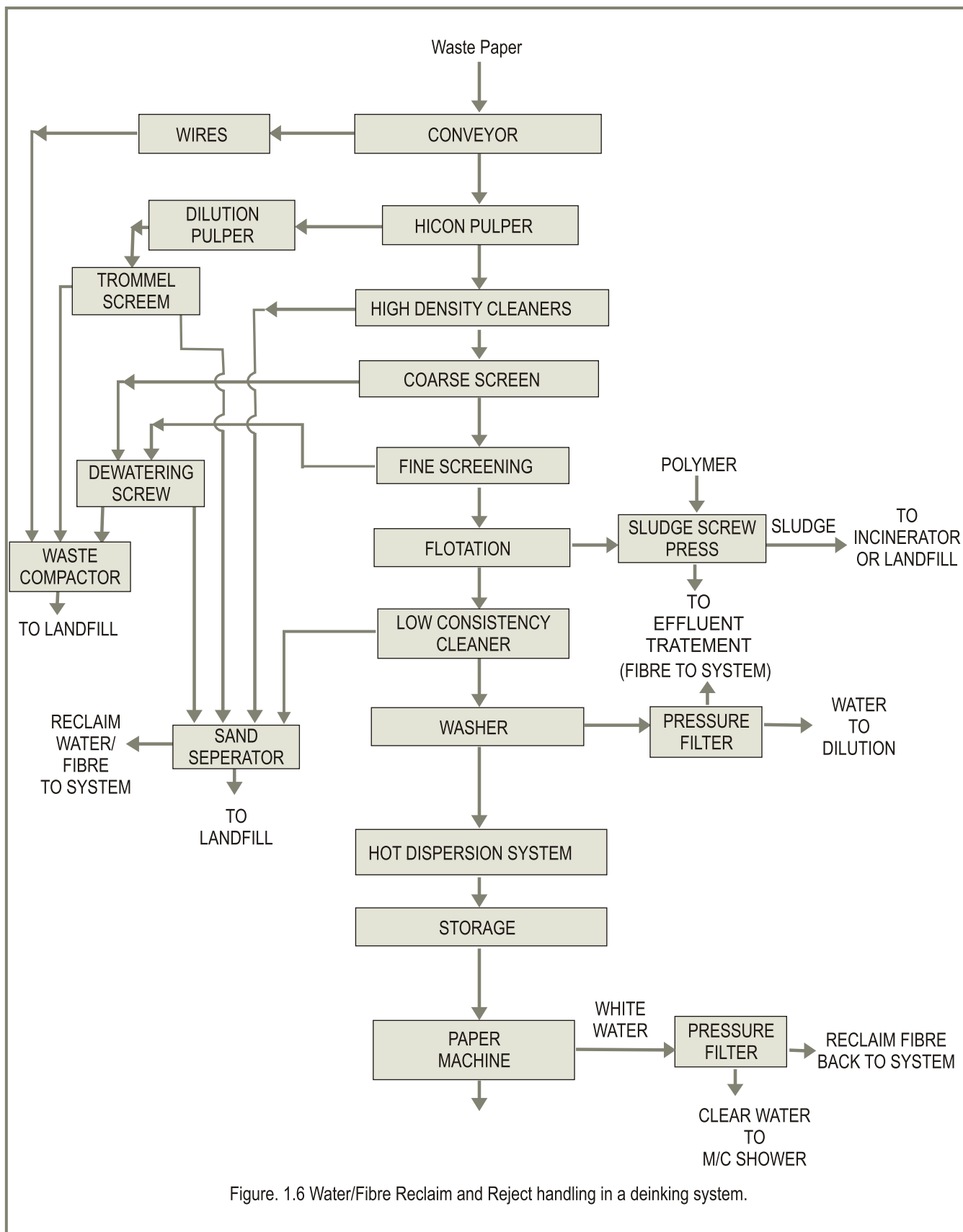


Figure. 1.6 Water/Fibre Reclaim and Reject handling in a deinking system.

disposal. Some of the more commonly used devices are described below.

Fibre Saver

Fibre saver such as the one shown in Fig.1.3 are normally used to

recover fibres from reject of Low Consistency Pulper.

Advantage of Fibre saver are

- Reduce Fibre Loss
- Increase capacity of Pulper
- Reduce down time of Pulper for cleaning
- Eliminate tedious labour work of removing reject from LC Pulper.

Trommel Screen or Drum screen such as the one shown in Fig. 1.4 is useful for recovering fibre from the reject of dilution pulper Unit, water from the reject also can be reclaimed. Increase capacity of Hicon Pulper by reducing discharge time of Pulper. Trommel screen in combination of fibre saver is normally used for waste paper with large amount of plastic like Pepsi Cup, tretapack etc. .It is economical to use with very less power consumption.

Dewatering Gritty Rejects

Gritty rejects, e.g., those from high or medium density cleaners, presents a special problem. Although they settle readily, they are highly abrasive and are often discharged with a considerable quantity of flush water into a dump bin, which quickly fills with water. As additional rejects are added, the rejects eventually displace the water. When the box is to be dumped, the free water must first be decanted, which often spills grit. As an alternative, some mills discharge into a perforated dump box, which often leaks grit through its perforations until they plug. When this happens, the problem are the same as those of the unperforated box.

Some smaller mills discharge their cleaner rejects into a settling trough and allow them to accumulate until a convenient shutdown, when they are manually shoveled out of the trough. Although this method is simple and effective, it is too inconvenient and too labor-intensive for mills that have large quantities of cleaner rejects and for mills that shut down infrequently.

Sediment Separators

Mills with large amounts of gritty rejects often use an inclined screw conveyor to drain free water from them. Typically, the lower end of the conveyor is submerged in a receiving pond, and the upper end is well above the water level, so that well drained rejects discharge at the height of the dump box. In such applications, the screw can be rotated very slowly or even intermittently by means of a timer. A sediment separator such as the one seen in Fig. 1.5 can be used to avoid submerging equipment that uses lubricated bearings in a wet, gritty environment.

The same type of inclined screw conveyor can be used to dewater rejects from the low consistency cleaner, although large amounts of water must be added to separate the fiber from the grit. For proper settling, the consistency must be 0.2% or less, and the fibers must be kept in suspension using velocity or turbulence until they can overflow out of the receiving pond.

Configuration of Rejects - Handling

Equipment in a Deinking Facility

Figure 1.6 is a flowchart representing simplified rejects handling in a typical deinking plant.

Sludge Pressing

The pulp and paper industry produces approximately 1 million tonnes of sludge each year. Conventional disposal methods such as landfills are coming more and more restricted. Consequently, sludge must be dewatered to higher levels than ever before to allow the use of innovative and environmentally friendly disposal methods.

The Past 10 years have ushered in an era of increased environmental awareness. More stringent guidelines for effluent discharge have forced more and more pulp and paper mills in India to install both primary and secondary wastewater treatment. Effluents high in biological oxygen demand (BOD) and total suspended solids (TSS) must now be clarified to a level that, in some cases, is cleaner than 90% of the ink and contaminants in the

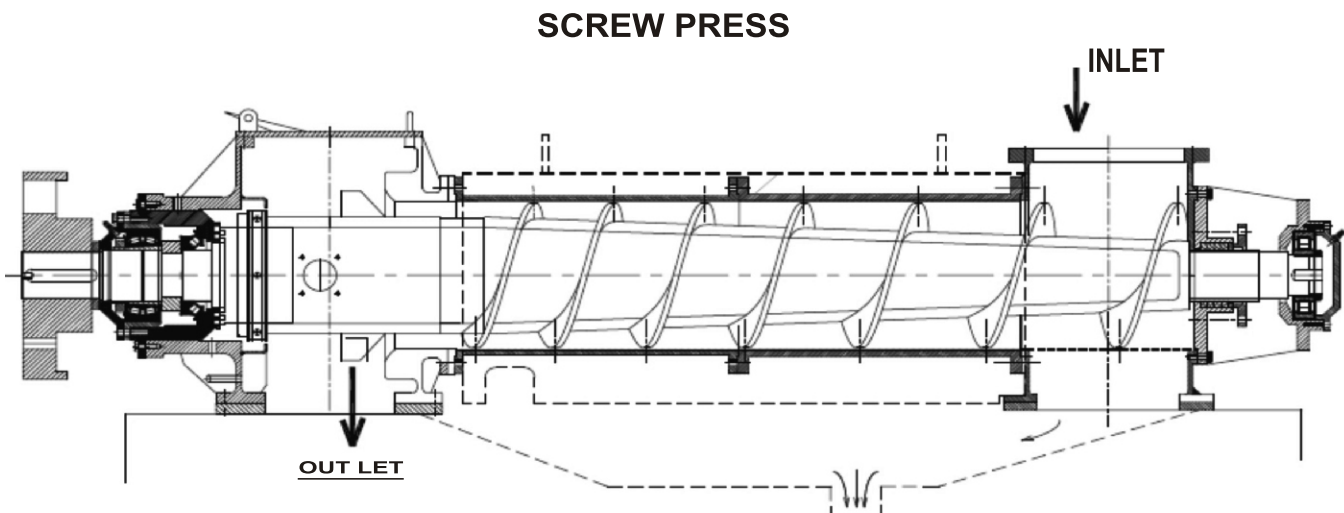


Figure 1.7 Typical Horizontal Screw Press

recovered paper furnish. Primary clarifiers typically remove more than 90% of the suspended solids and 20-30% of the BOD, while secondary treatment removes another 80-90% of the BOD. Because policies concerning conventional methods of sludge disposal such as landfills are changing rapidly and there is growing concern about groundwater contamination, sludge must now be dewatered to levels that are often twice as high as those seen in the past.

Dewatering Parameters

After discharge from a deinking system or clarifying and treatment devices, sludge is low in consistency, ranging from 0.5% to 5.0% total solids (TS). It must be dewatered and thickened to facilitate storage and disposal.

Dewatering is defined as separating liquids and solids by filtering large amounts of liquid from the slurry mechanically to concentrate the solids. The goal is 100% separation of solids and liquids.

The term "cake dryness," which is expressed as percent total solids, is used to quantify the amount of moisture in the sludge after it has been dewatered. To evaluate the efficiency of dewatering equipment further, the solids lost in the filtrate or press can be measured to determine the "solids capture" or "capture rate."

Water or liquid in sludge may be present in three basic forms: free water, capillary water, or intracellular water.

Free water drains easily and has no adhesive or cohesive forces to overcome before separation can be achieved.

Capillary water is trapped between the solid particles in the sludge or slurry. External force must be applied to achieve separation. Capillary water may be changed to free water by using polymeric flocculants, which attract the solid particles to as long, chained carbon molecule that has a specific charge and charge density. This chemical flocculation increases particle size and thereby increases dewatering efficiency.

Intracellular water is contained inside a cell wall. Removing this water mechanically would require extremely high mechanical forces, which are impractical. The amount of intracellular water present in a sludge sets the theoretical upper, limit for cake dryness.

Sludge Composition

The main constituent of most sludges is cellulose fiber, along with different amounts of ink and ash. Sludges also vary because of differences in treatment facilities. Ash content can range from zero to 60-70%, depending on the type of recovered paper used.

Sludges with ash contents higher than 50% generally come from coated paperboard or coated fine papers. Sludges drainability is affected by both ash content and fiber length. A higher ash content usually result in high final dryness, because the ash particles displace water that would normally occupy the space between the fibers. Because BTU values decrease with increasing ash content,

a sludge that is high in ash attains high dryness in a particular machine but is not suitable for incineration unless the purpose is solely to reduce volume.

Equipment Review

Dewatering equipment has continued to evolve over the past 30 years. Equipment that once yielded a cake dryness of 20-30% is now being replaced with machines that are capable of attaining as high as 50-55% total solids. Sludge blends with high ink and ash contents are now dewatered to much higher levels than ever before, and equipment selection is based on suitability for end use. These high levels of final dryness do not come without a price. Each sludge must now be individually evaluated with respect to disposal method as well as attainable vs. economically feasible cake dryness.

There are six commonly recognized types of dewatering devices, although some are no longer economically attractive due to low final cake dryness or high operating costs. They include the plate and frame press, centrifuge, vacuum filter, V-belt press, belt filter press, and screw press etc.

Disposal Alternatives and Equipment Selection

The sludge disposal methods currently in use include landfilling, incineration, landfill ash, landsprading, composting, and reuse in process. Local ecological, economic, and regulatory conditions generally dictate which one is most cost effective.

Dewatering equipment is selected based on factors such as disposal method, sludge type, ash content, and proximity to the disposal site. Incineration may be chosen for its volume reduction and energy value. Maximizing final cake dryness is very important to obtain maximum BTU value. Recently, screw presses have been the equipment of choice, because they can achieve the high (i.e., above 45%) cake dryness required if the ash content of secondary sludge is kept low. For sludges with a high ash content, which dry easily but have relatively low BTU values, high pressure belt presses are attractive, because they can produce a cake dryness of 35-40% at a much lower cost than that of screw presses. A typical horizontal screw press is shown in Fig. 1.7

Landfilled sludge must be dry to prevent water from leaching out of it and to minimize transportation and tipping charges. It require a minimum consistency of 50%, adequate cake dryness can be economically achieved using Screw Press.

Landsprading and composting resemble landfilling in term of final dryness requirements, which often makes belt pressing the most economical solution.

Sludge can be reused by reintroducing it into the papermaking process (e.g., as filler for certain grades of board) or creating value added products such as animal feed or fillers for construction materials. Other promising products based on sludge include concrete filler and gravel substitutes in road bases.

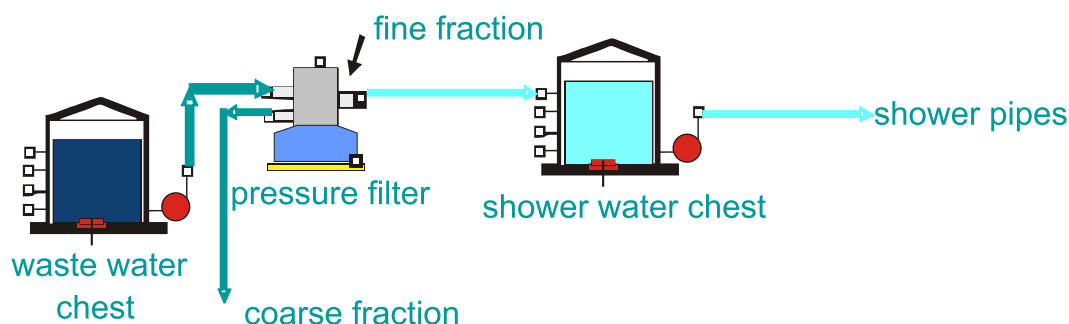


Figure 1.8 Typical Pressure Filter Application

Pressure Filter

The operating principal is based on a pressure screen and operate in similar manner. Pressure filters are most efficiently used for recovering fiber from the back/white water and reuse of cleaned filtered water for showers, sealing water etc.

According to the relevant application the pressure filter can be fitted with screen baskets of diverse perforation with hole ranging from 100 to 200 microns and slot size from 80 to 100 microns. The rotor of Pressure filter is designed to produce only light pulsation, gentle enough to allow a fine fibre mat to form on the filter basket surface. This fibre mat aids filtration and thus improves the function. A typical Pressure filter application is shown Figure 1.8 .

Conclusion

Removing contaminants from a secondary fiber system is a complicated process that requires several steps. Proper rejects handling can reduce fiber losses, water consumption, landfilled, thus cutting disposal costs.

Careful process analysis is required to determine the suitability of different types of equipment for the operating parameters of each mill. Type of rejects, disposal method, and economic limitations will ultimately determine the technology selected.

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