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Paper machine clothing cleaning and conditioning for recycled fiber use

Scope

The objective of this Technical Information Paper is to recommend specific guidelines for maintaining the efficient running of paper machine clothing when recycled fiber is utilized in the process. The paper also discusses reasons for the recommended cleaning and conditioning techniques and explains mechanisms of contamination from recycled furnish constituents.

Safety precautions

As with any mechanical or chemical system, hazards are inherent and manufacturer guidelines must be followed to ensure safe operation. MSDSs for chemical treatments should always be available, and referenced in advance of starting any new treatment program.

Introduction

A common concern of papermakers is the dewatering of new furnishes with increasing recycled fiber and contaminant content while maintaining sheet properties. Recycled fibers, primarily chemical pulps, are less able to swell by the absorption of water. When voids in the cell wall become irreversibly closed, an increase in the crystalline structure of the cell wall is also likely to occur. This unswollen, stiffer fiber cannot come close enough to other fibers to develop good bonding. Consequently, further refining is necessary to reach paper strength properties, which in turn stresses the formerly dried fiber. Additional fines production from this process scenario is typical. Due to their unhydrated fiber origin, these fines act like filler. Recycled fines and fiber cause drainage difficulties on a paper machine, and increase contamination of clothing.

In addition to changes in fiber properties, recycled furnishes bring with them increasing amounts of contaminants such as glues which tend to fill paper machine clothing in new and increasingly insidious ways. These glues are also responsible for one of the more colloquial technical terms in our industry: “stickies.”

Papermaking strategies must change to compensate for these new furnishes. Table design, vacuum application and wear surfaces need to be examined to maintain machine efficiency. Formation and retention levels can be negatively impacted by the addition of recycled fiber to the papermaking system.

Paper recycling raw materials interact with the chemical and physical characteristics of the recycling and papermaking process to produce a finished product. Deficiencies in either the raw material or the design and operation of the process will result in either an inefficient process, inferior product, or both. Contaminants impact the paper machine by affecting runnability, product quality or both. Contaminants from recycled fiber can be traced to adhesives (hot melt glues and contact adhesives); waxes, inks, and other materials contained in the wastepaper furnish. These materials are generally hydrophobic (water-hating), and are highly attracted to similar energy surfaces such as the polymers used to make paper machine clothing.

The physical size of the contaminant is most important. Large stickie particles (roughly greater than 200 microns in diameter) are not problematic; these can be removed through properly designed recycling and stock

preparation systems. Similarly, colloidal sized particles (roughly less than 2 microns in diameter) do not represent a problem if they remain small. However, they can and will often aggregate to a larger size and cause deposits. The mid-sized particles (2-200 microns in diameter) represent the real problem to the papermaker. They are too small to be removed by screening and cleaning equipment and too large to pass through the system unnoticed. Particles from 2 – 20 microns generally do not pass impact quality directly, but can still contribute to problems such as press fabric filling.

Contaminant problems begin with the wastepaper supply to the recycling plant. The most effective means to eliminate a contaminant situation is to remove the problematic material from the wastepaper supply. This is usually easier said than done. Once into the recycling process, the rule of thumb is to remove contaminants as early in the process and in as large a form as possible. Both of these situations are outside the scope of this paper, but should always be investigated in the early stages of dealing with any paper machine contamination problem.

Due to the current high use of recycle fiber furnish, additives which were previously used in a virgin system are contributors of contamination when used the second time around. Approximately 1% to 50% of recycled furnish consists of noncellulosic contaminants, such as:

- Fillers (clay, titanium dioxide, calcium carbonate and talc)
- Sizes (rosin and synthetic)
- Dyes and pigments
- Hot melts, plastics, and asphalt
- Styrofoam
- Tapes and other sources of contact adhesives
- Waxes
- Coating binders such as polyvinyl acetate (PVAC) and styrene-butadiene (SBR)

Important considerations are the surface energy, electrochemical charge, and size of contaminants such as PVAC, SBR, polyethylene, wax, and hot melts. Surface energy phenomena can explain why contaminants adhere to fabrics and other surfaces, causing problems. Surface chemistry can thus become an important consideration in resolving deposition problems.

Machine approach flow and overall process considerations

This section is intended to serve only as an overview. Several excellent references are listed which give more complete information.

Screening system

Tailings management is extremely important in dealing with recycled fiber contaminants on the paper machine. Many virgin fiber systems, especially those using mechanical pulp, collect screen tailings and refine them for eventual reintroduction to the paper machine system. This is an effective strategy for wood shive reduction, but not for elimination of plastics and stickies. If a significant amount of recycled fiber is used, these screen tailings must be eliminated from the process. Secondary or tertiary screening stages may be required in order to make the process yield loss acceptable. Lower screening stage barrier sizes should generally be the same used in the primary stage, or cycle-up of contaminants will occur. If the tailings are not removed from the process, or the screening system is not designed and operated properly, stickie contaminants simply cycle up in the system and eventually either exit with the sheet or deposit on paper machine clothing and other surfaces.

Changes in screen reject rates, basket sizes, and basket type (i.e. – switching to slotted stock approach screens) may all have to be considered in order to optimize the removal of hydrophobic contaminants before they reach the paper machine. The stock approach screening system should be audited or surveyed for contaminant removal efficiency on a scheduled basis (i.e. – weekly or monthly) to assure that it is operating as intended.

Centrifugal cleaning system

The forward centrifugal cleaners in common use on stock approach systems will only remove contaminants which have specific gravities significantly higher than water (greater than 1 g/cc). The majority of stickie contaminants have specific gravities slightly less than water. Forward cleaners will not effectively remove these

materials. Throughflow and reverse cleaners are designed to remove lightweight contaminants, but are not commonly found in stock approach systems.

The paper machine cleaner system is an important site for removal of other tramp materials (sand, dirt, glass, metal, and some inks) found in recycled fiber. Optimized operation of the cleaning system is essential when recycled fiber is used on the machine. In many mills, these cleaners may be one of the most ignored sections of the paper machine. The system should be visually checked for plugged cones on each shift. Any plugs should be removed immediately. Reject rates may have to be increased to accommodate recycled fiber use. The system should be audited or surveyed for contaminant removal efficiency on a scheduled (weekly to monthly) basis.

Most modern paper machine cleaning systems are designed to minimize fiber loss. This often involves the use of a fiber recovery unit as a last cascading cleaning stage. Improper operation of the fiber recovery stage often allows heavy recycled fiber contaminants to cycle up in the upper cleaning stages and eventually reach the paper machine. In some cases, the fiber recovery unit may need to be shut down to allow greater purging of contaminants from the system. In all cases, the cleaner system rejects need to be removed from the process.

System chemistry

A number of chemical treatment programs are used in stock preparation systems to minimize the effects of stickies contaminants on the paper machine. The nature and severity of the contaminant problem will determine the program(s) which should be used. Program choice(s) will also be influenced by the mechanical aspects of the paper machine system and the grade(s) being produced.

Many types of dispersing systems are currently in use. The objective of these treatments is to keep the contamination particles in as small a form as possible. "Dispersion" may be a misnomer with respect to stock preparation systems, as there is rarely enough mechanical, chemical, and thermal energy to break up large stickies particles into smaller ones. Most stickies size reduction, if desired, needs to occur in the recycling plant. The primary objective of dispersing treatment in stock preparation systems is to keep microscopic material from agglomerating to the point where its size becomes a problem.

Contaminant particles can be "detackified" through the use of nonionic polymers, talc, or other inorganic compounds. The objective of these treatments is to create a hydrophilic layer of material on the stickie particle surface. The particle is then more likely to be retained in the paper, and less likely to absorb onto a low energy surface such as a paper machine forming fabric.

Another common stock preparation treatment technology is cationic fixation. This approach uses polymeric retention aid technology to retain the contaminant particles in the sheet. Both stickie particles and papermaking fiber have negative surface charges. A cationic polymer is used to "fix" the stickie particle to the sheet.

A relatively recent technological advancement involves aggregating stickies particles early in the recycling process. A hydrophobic interaction allows the stickies particles to attach to one another. Subsequently, there are fewer but larger contaminant particles present in the pulp. These larger particles can then be efficiently removed through conventional screening and cleaning technology.

Finally, enzymatic treatments are starting to be used to break chemical bonds in stickies. These treatments reduce the molecular weight of the particles and make them more innocuous.

System temperature

Contrary to normal good papermaking practice, cooler wet end temperatures are often better for stickie contaminant control. Many contaminants become more deformable and tackier at higher wet end temperatures. They become more difficult to screen out and are more likely to deposit. Some waxes melt at temperatures as low as 120°F (50°C). Running a paper machine wet end at a cooler temperature may not be advisable or even possible, due to sheet dewatering and paper property development concerns. Of course, cooling the wet end only postpones the inevitable. The sheet must eventually be heated to be dried. Some of the retained contaminants will be drawn from the sheet by heat later in the machine. Some data suggest that running the wet end at greatly elevated temperatures (above 140°F or 60°C) may help solubilize and disperse some types of stickie contaminants. Sustainable operation at these very high temperatures is unlikely for most mills.

Exposure of the pulp to significant temperature or pH shocks should be minimized. Sudden changes or swings in either temperature or pH can greatly increase the severity of contaminant deposition problems. This also applies to paper machine showering systems. Wet end shower water should always be the same approximate temperature as the stock/whitewater system.