Microbial Control in Paper Mills

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Abstract :

Water is the fundamental to many industries including pulp and paper industries. Otherwise sterilised, water presents a fertile land for microbial growth. The amount of water used in pulp and paper industry is huge and practically poses microbial problems in all segments in one form or other. Due to microbial growth pulp and paper industries faces multiple problem like –

1. Chocking in seizing and filters due to slime production by the action of slimy bacteria and fungi.

2. Cracking or holes in paper

3. Smell issues

4. Fungal issues on paper

5. Coloured spot on paper

6. Operational defectives due to MIC in pipelines

The quality of paper is hampered because of bacterial growth which can reduce the fibre strength these problems can be controlled by using various chemistries. Various treatment programs are in place by different service providers to control the microbial problem but still it remains in place forcing the industries for regular shut down of the plant for manual cleaning. These unwanted shutdowns are adding ups the cost of manufacturing per square meter to significant levels. In this paper we present case studies showing various levels of microbial problem specifically in seizing area, starch tanks, filters and spray nozzles and back water. We tried to address the microbial diversity in this area at species level and efficacy of treatment regime taken in trail runs in different areas in few paper mills.

Introduction :

Paper industries are highly susceptible to microbial contamination due to use of water in hugh quantities. Microorganisms can enter in these industries through number of means like process water, raw materials and air. The processes and raw material used in the production paper provide favourable condition for variety of microorganism. The pulp which is a lignocellulosic material made from wood cellulosic fibres or waste paper, upon combining with starch forms slurry which itself is very good source for the growth of bacteria and fungi. Here microorganism utilize organic carbon sources and lead to the formation of Biofilms. Once biofilm formation occurs then it is very difficult to remove microbial contamination from the system. Worker safety is also a prime concern in the paper mills if the aerosol generated contains pathogens. Previous studies has shown a variety of organisms found in the paper mill slimes, majorly found are *Burkholderia cepacia, dienococcus geothermalis*, *Meiothermis spp.* Modern paper mill is divided into several sections and chances of contamination has also increased. It is very important to prevent microbial contamination in system by using proper doses of Biocides in the every step of the process. In addition to biocide use, plant hygiene and quality raw material can also add in the better product quality. In present study we have collected samples from two different paper industries. Samples

included for the microbial testing were collected from different processing points, water samples, and raw material samples. At the end of the complete microbial analysis we found heavy microbial contamination in all the samples. This enumerates the level of contamination in Paper industries.

EXPERIMENTAL METHOD

SAMPLE COLLECTION

Paper industry samples were collected in sterile vessel (Himedia) from stored water, settling tank, fan pump area, mould section, vacuum separator, and wet end backside other samples were collected in sterile vessel (Himedia) from starch service tank and percol xylo under aseptic conditions.

MICROBIOLOGICAL ANALYSIS

Bacterial cultivation

For CFU counts samples were serially diluted and plated on R2A media. Plates were incubated for 72-96 hours at 30 ˚C.

Fungal cultivation

For CFU counts samples were serially diluted and plated on PDA media. Plates were incubated for 72-96 hours at 25 ˚C.

SRB cultivation

For SRB count, samples were inoculated in Sulphate Reducing Medium. The vials were incubated for 24-72 hours at 37°C.

Microscopic examination

Microscope BX 52 was used to determine the structure of the microbes. Gram staining was performed for tentative identification of bacteria. For this examination the pure cultures (wherever possible) were wet by adding one drops of sterile saline (0.85% NaCl solution) and smeared on the clean glass slide for each sample. After air drying the slide was visualised at 10X, 20X and 40X and 100X magnifications.

H2S gas detection

The presence of H2S gas in the medium was tested using lead acetate strip which turned black or brownish from white in 2-3 minutes.

Starch degradation

Starch agar was prepared and bacterial cultures isolated from starch solution were inoculated separately on starch agar. After incubation the plates were flooded with iodine solution. A against clear zone around the colonies violet background was formed in those plates where bacteria could degrade the starch.

OBSERVATIONS AND RESULTS

CASE-1

All the samples were showing heavy growth of bacteria and fungi upon incubation. CFU count for aerobic bacteria from the entire sample was found to be in the range of 105 and CFU count for fungi was found to be 103 (table 1). Three/four types of various aerobic bacterial morphotypes were found on the Petri plates (Fig 1). Colony morphology suggested that these bacterial colonies were slime producing. Microscopic analysis suggested that these bacteria mostly belong to slime producing bacteria belonging to Gram positive Bacillus and Gram negative CFB group (*Cytophaga*, *Flavobacteria* and *Bacteroidetes);* (Fig 2). Samples from fan pump area, mould section, vacuum separator -wet end backside indicates presence of Sulphate Reducing Bacteria (Table 2).

Table 1 Total aerobic count

S.No	Samples	Total Bacterial Count (CFU/ml)	Total Fungal Count (CFU/ml)
1.	Stored water 1 x 103	1.2×10^5	1×10^3
2.	Settling tank water	3×10^5	4.4×10^3
3.	Fan pump area swab	Heavy growth	Heavy growth

Table 2 Sulphate Reducing Bacteria (SRB) count

S.No.	SAMPLES	Sulphate Reducing Bacteria (SRB)	SRB/ml Count
1.	Mould section	+	$>10^5$
2.	Wall	+	$>10^5$
3.	Vacuum separator –Wet end backside	+	$>10^5$
4.	Fan pump area A1	+	$>10^5$

+ Positive, - Negative

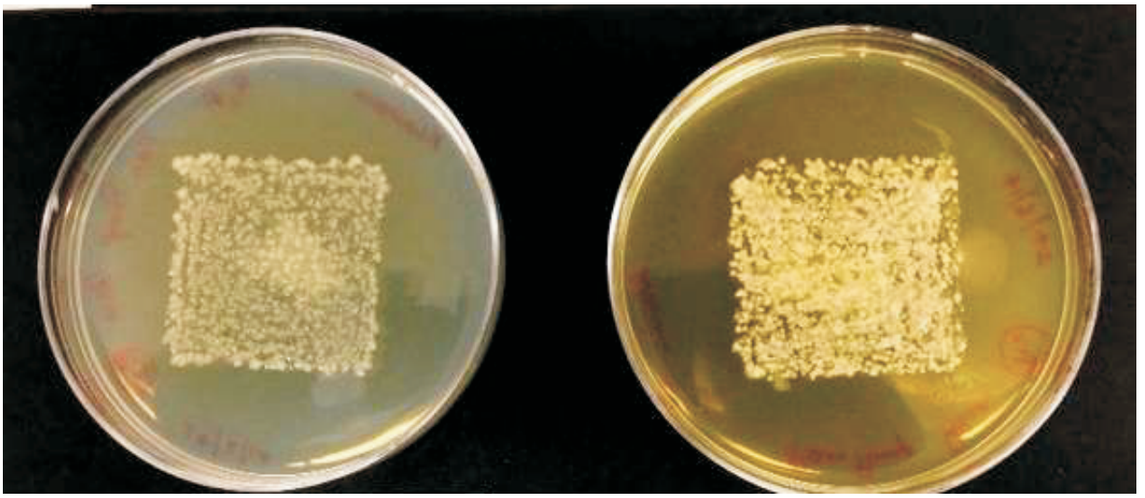

Fig 1 Bacteria And Fungi Recovered From Fan Pump Area

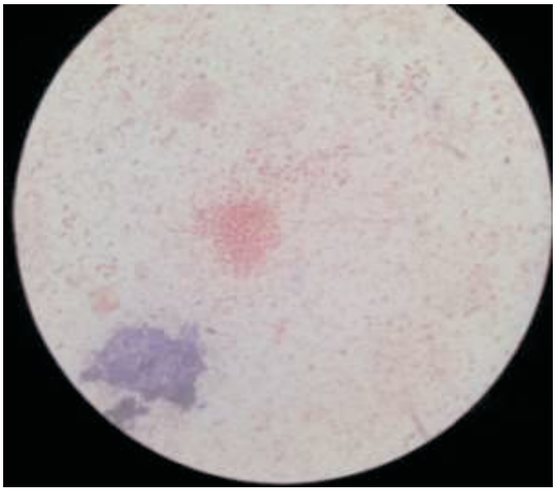

Fig 2 Microscopic view of bacteria recovered From fan pump area

Fig 3 Growth of SRB and H2S detection

CASE-2

CFU for Starch sample was found to be 7.2 x 10^8 and CFU count for Percol was found to be 4.8X10^8. Three/four types of various bacterial morphotypes were found on the Petri plates (Fig 1). Colony morphology suggested that these bacterial colonies were slime producing and mostly yellow pigmented. Microscopic analysis suggested that these bacteria mostly belong to slime producing starch and cellulose degrading bacteria belonging to Gram positive Bacillus and Gram negative CFB group (*Cytophaga*, *Flavobacteria* and *Bacteroidetes*; Fig 3). Clear halos were observed around the colonies where starch was completely hydrolysed thus indicates presence of starch degrading bacteria (Fig 2). No halo or no zone around the colony indicated negative test. Please refer Table 1.

Samples	CFU Count/ml	Bacteria Isolated	Strain Identification (Gram +ve / Gram-ve)	Starch Hydrolysis Test (After 72hrs)
Starch Sample	7.2 x10^8	1A	Gram –ve	Zone observed
		1B	Gram +ve	Zone observed
		1C1	Gram –ve	Zone observed
		1C2	Gram –ve	No Zone
		1D	Gram –ve	Zone observed
Percol sample	4.8x10^8	2	Gram –ve	No Zone

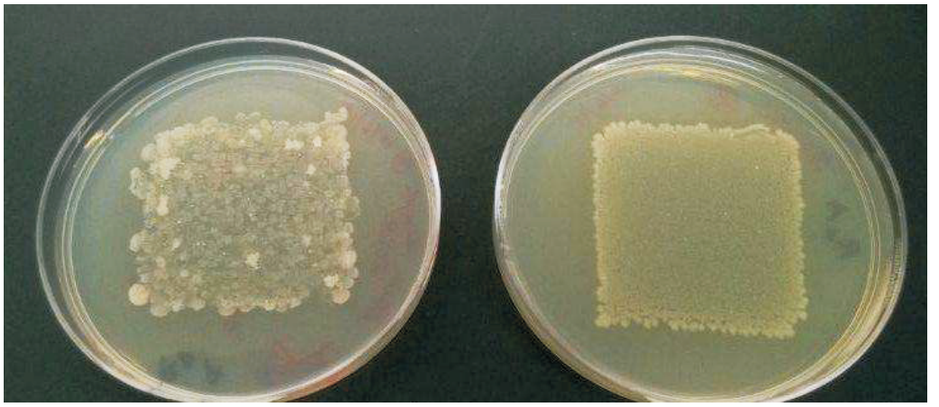

Fig 1 Bacteria recovered from Starch service tanks and Percol service xylo

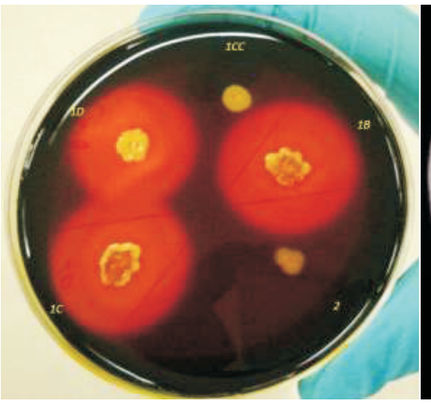

Fig 2 Starch degrading bacteria recovered from Starch service tank sample

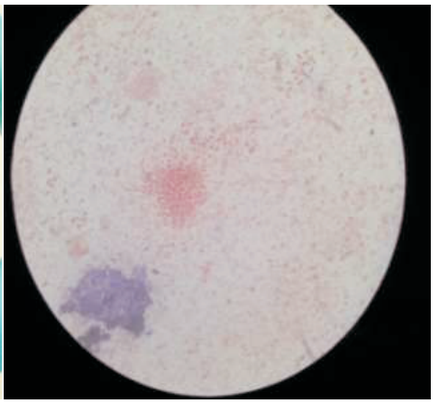

Fig 4 Microscopic view of bacteria recovered from Percol sample

Conclusion:

Paper mill proposes highly conducive environment for microbial growth. If microbial growth is not controlled well, it poses all form of fouling starting from foul smell to slime that challenges smooth operations, witness production loss and decreases efficiency. The type of microorganism isolated in this study highlights the presence of those microbes that are directly or indirectly responsible for multiple issues that paper industry is facing year on year like foul smell, yellow patches on paper, black patches and holes on finished paper, nozzles blocked which requires frequent shut down, corrosion of pipelines leading to damage and frequent boil outs leading to profit compromises. A better microbial control strategy can definitely help. The use of un-conventional biocidal products can improve the paper making process and also can impact on commercial gains.