ENTELA PINGULI[1]
LULJETA XHAGOLLI[2]

Scientific paper
UDC:628.316.7

Alginate treatement of yeast slurry discharges a simple and eco-friendly method in minimisation of organic pollution of brewery waste waters

1. INTRODUCTION

The brewing process requires a significant amount of water and produces wastewater with high biochemical oxygen demand and suspended solid content. Brewery wastes are extremely variable due to variation in production activity by season, by day of the week and by the time of day.

Organic and inorganic adsorbents are used in treatment of water and industrial effluents. Polymeric flocculants, natural as well as synthetic, because of their natural inertness to pH changes, low dosage requirements, and ease of handling, have become popular in water and wastewater treatment. In this paper alginates have been used in water purification and yeast immobilization. The main advantages are related with faster processing, lower content of insoluble solids, and a much smaller sludge volume. Alginates are a useful option since they have no adverse impact on human or environmental health.

1.1. Aims and background

Yeast can be collected from fermentation and storage tanks, the yeast storage plant and from the filter line. The yeast collection system may include a centrifuge [1], yeast storage tanks, pipes and pumps. The yeast slurry contains a large amount of beer. A brewery loses about 1 - 2% of the beer production with the yeast. The beer can be recovered and recycled using centrifuges. On the other side brewery filtration process (candle filtration and PVPP filtration) produces a considerable amount of slurry [2]. If water treatment is not used at the brewery, centrifuging the beer prior to filtration can reduce kieselguhr consumption. Implementation of a centrifuge will have the following effects:

- Reduction in the amount of kieselguhr that needs to be dosed during filtration
- Reduction in water consumption for back-washing of filter
- Minimisation of problems with handling of wet kieselguhr and dry kieselguhr [5]
- Possibility to collect more surplus yeast [6]

Water effluents contains many compounds, which can be classified in three categories [7]: **Suspended solids.** These products in waste water effluents are organic in origin (kieselguhr, polyphenols, proteins etc) or mineral (osmoses reverse effluents). Added to these compounds there are microorganisms such as yeast, bacteria, etc. **Colloidal particles** (less than 1 micron). These are Suspended Solids of the same origin as the above but of smaller size and with a settling rate that is extremely slow. **Dissolved substances** (less than several nanometers). These are part of the organic matter dissolved or cations or anions. Gases are also present (O_2, CO_2, H_2S, etc.). Organic and inorganic adsorbents are used in treatment of water and industrial effluents. Sodium alginates are obtained from alginic acid, which itself is extracted from seaweed [8]. The main components of this polymeric structure are mannuronic acid and glucuronic acid. These products are particularly effective as flocculent aids with ferric and aluminums salts. The treatment rate is between 0.5 and 2 $mg.l^{-1}$.

2. EXPERIMENTAL

Yeast and filter slurry can be removed by waste waters using alginates. Alginate could be dosing in line. Alginate treatment can be done simply for flocculation or for yeast immobilization. Alginate beads must remain for 3 - 4 hours in $CaCl_2$ solution. After rinsing for 2 - 3 min they can remain in water for 6-9 hours.

Address authors: [1]Regional Environmental Centre, [2]University of Tirana. Faculty of Natural Sciences. Department of Industrial Chemistry, Contact: lulipinguli@yahoo.com

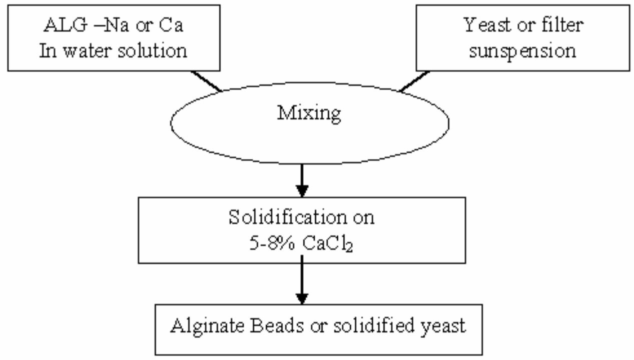

Figure 1. Alginate treatment procedure for organic matter entrapment

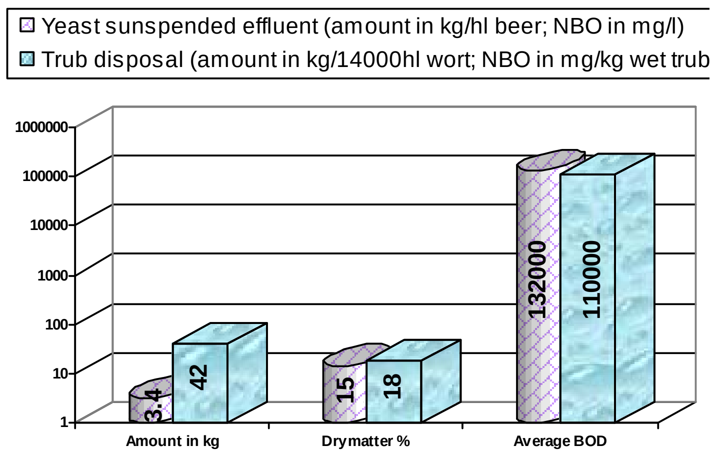

Figure 2. Slurry characteristics in brewing process

Table 1. Amount of yeast removal from inoculation to the end of filtration.

Sample Measurements	Yeast amount (cell/ml)
Yeast inoculation in-line	10×10^6 - - 20×10^6 *
Beer in the end of fermentation	$1 - 25 \times 10^6$
Beer after centrifugation	$1 – 5 \times 10^5$
Beer after kieselguhr filter	0 – 5
Beer after sheet and kieselguhr filter	0

Figure 3 - In the left slurry from filter effluent, in the right gel entrapment of the slurry in alginate

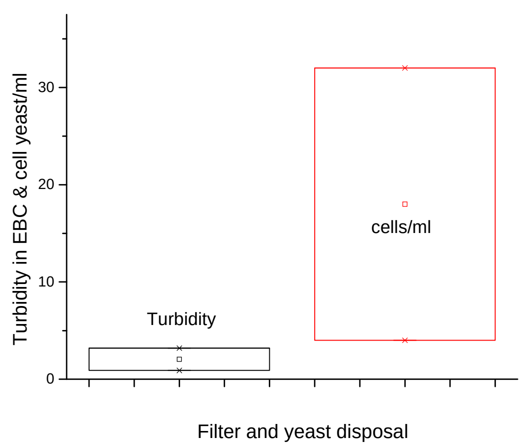

Figure 4. Turbidity of spent yeast effluent after alginate treatment (4%) and cell yeast number in slurry

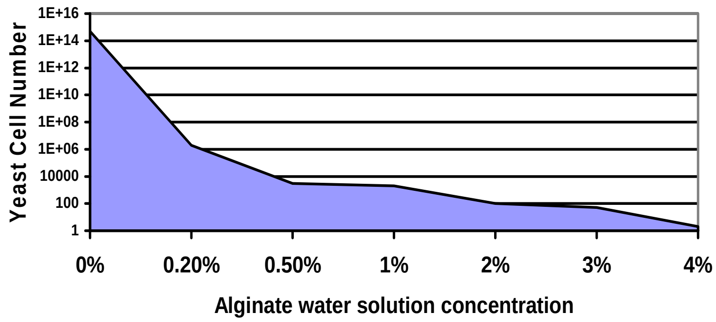

Figure 5. Yeast cell number after spent yeast treatment

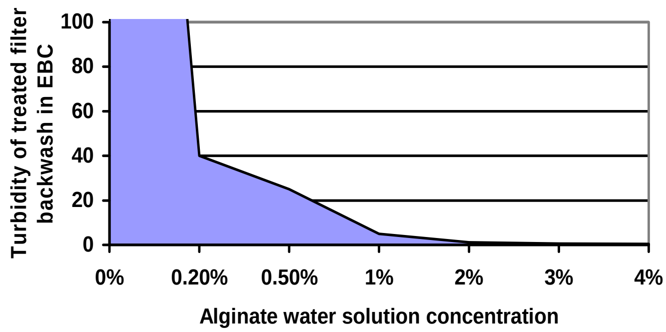

Figure 6 - Water turbidity after filter backwash treatment

Table 2 - Detailed consume of water in different filter used in the brewery.

		Water Consumtion	Recovery water
Candle Filter	Filter Run + First run	15	15
	Filter-aid dosing	3	3
	Last Run	10	10
	Filter discharges	3	-
	Filter cleaning	20	10
	Sterilization	20	-
	TOTAL(Hl water/100Hl beer/h)	**71**	**38**
Plate Filter	Filter Run	10	10
	Oxygen Removal with deoxygenated water	50	50
	Last run	10	10
	Filter Cleaning	20	-
	Sterilization	20	-
	TOTAL(Hl water/100Hl beer/h)	**110**	**70 Hl**
Regenerable PVPP Filter	Air Removal	6	6
	PVPP coat formation	2	2
	Water removal from filter	3	3
	First Caustic cleaning	4	-
	First Rinse	4	-
	Second Caustic cleaning	4	4
	Second Rinse	4	4
	Cool water filling	4	4
	Acidic cleaning	4	4
	Final Rinse	8	8
	TOTAL(Hl water/100Hl beer/h)	**43**	**35**

In function of further using purposes yeast can be entrapped in different manner. This can influent significantly treatment time and cost of the process. For water treatment procedures it is recommended to use a concentration up to 2%, because the alginate beads swells and yeast escapes from gel structure.

Figure 7 - In the left continuous dosing and in the right small beads dosing

Figure 8 - Treatment of waste waters using 100 g of yeast beads with different dimensions. The dimensions of these beads as shown in the figure are:1-2 mm; 1-2 cm; 5-7 cm; filamentous

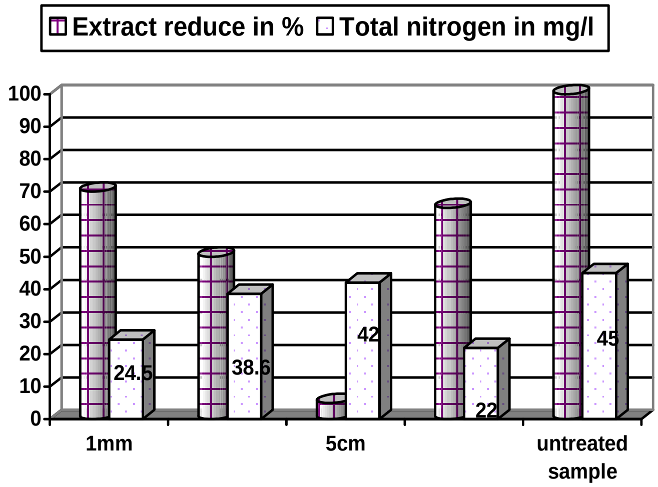

Figure 9 - Extract reduction and total nitrogen for different beads used in weak wort treatment procedure

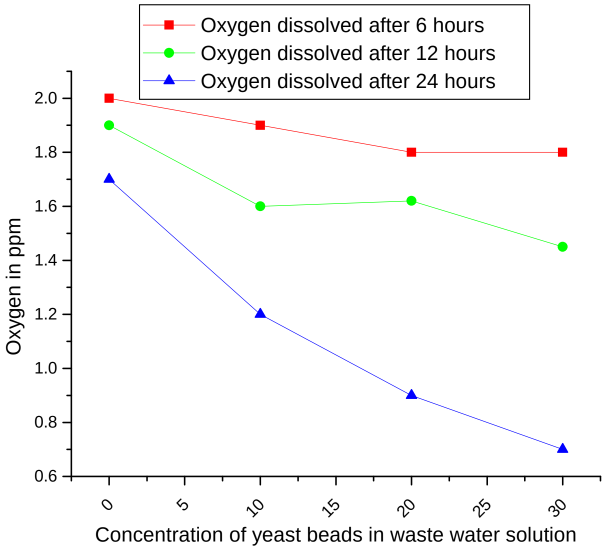

Figure 6 - Oxygen content in waste waters after treatment of 1000 ml water effluents with continuous mixing 100 rpm in aerobic conditions. Time of measurements after 6, 12 and 24 hours with concentration of yeast beads respectively 0%; 10%; 20% dhe 30%.

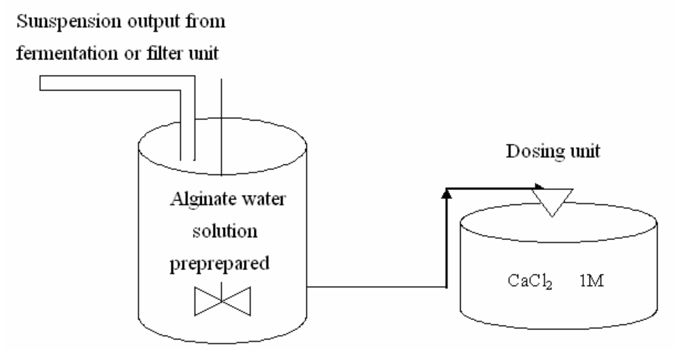

Figure 10 - Industrial proposing scheme for alginate treatment of yeast slurries

3. CONCLUSIONS

Excess yeast is produced during the fermentation process. Only part of the yeast can be reused as new production yeast. It is important to collect as much surplus yeast as possible to avoid high COD discharge to the sewer system. Yeast can be collected from fermentation and storage tanks, the yeast storage plant and from the filter line.

The backwash filter effluent contains a high concentration of spent diatomaceous earth (kieselguhr), yeast and beer residue. It is one of the most severe and concentrated waste streams generated by the plant. The filter backwash cycle consists of three distinct fill-and-drop steps; the volume of water used in each step is equal to the capacity of the filter. The 1st backwash step washes most of the contaminants out of the filter (kieselguhr, yeast, BOD, and foam). The effluent generated by the following steps is significantly cleaner and carries mainly settleable suspended solids.

It is strongly recommended to separate the filter backwash flow from the rest of the plants effluent. The best method is to send the first of the backwash flow to a storage tank for high strength wastes. This flow contains a large amount of dense foam and BOD which could not be eliminated through a simple settling operation. This procedure results in reduce content BOD and SS. It is estimated that the proposed recommendation will reduce by 90% the discharge of spent kieselguhr to the river.

To control these slurries we can use biodegradable polymers such as alginates. The main advantages are; inertness to pH, faster processing, lower content of insoluble solids, and a much smaller sludge volume, low dosage requirements, and ease of handling. They represent truly renewable resources and are a useful option since they have no adverse impact on human or environmental health. After this process immobilized yeast can be used for treatment of waste waters. The yeast can be used also for animal feeding or organic concentrated wastes could disposal also on agricultural land.

4. REFERENCES

[1] E.B.C. Manual of Good Practice. Beer Filtration, Stabilization, 1999, 156, 49-60.

[2] E.B.C. Manual of Good Practice. Fermentation & Maturation, 2000, 187, 60-89.

[3] European Brewing Chemists. Analytica EBC; Methods of Analysis, 1992, 40 - 45.

[4] Europian Brewing Chemists. Analytica-EBC Microbiologica, 1992, 87-99.

[5] The brewers of Europe. Guidance Note for estabilishing BAT in the Brewing Industry. October 2002. Brussels. Belgium, 2002, 12-32.

[6] UNEP, Environmental Management in the Brewing Industry, UNEP Technical Report, United Nations, ISBN: 1995, 92-807-1523-2, 22-34.

[7] Brewery Wastewater. EBC Manual of Good Practice 2006, 76-34.

[8] Rajani, S; Agarwal, M; Vankar, P.S; Mishra, A. Synthesis, characterization and flocculation efficiency of sodium alginate –g - Polyacrylamide in textile waste water. Asian Textile Journal. 2002, 11(2-3), 48-52

[9] K. Vaso, M. Dema, J. Marku, Improvement of the physico-chemical characteristics of sunflower oil through thermo-chemical processing and its use in the anticorrosive paints, Časopis „Zaštita materijala“ broj 2, str. 71-76, 2010. godine, Beograd

[10] J. Marku, K. Vaso, Optimization of copper slag waste content in blended cement production, Časopis „Zaštita materijala“ broj 2, str. 77-80, 2010. godine, Beograd

[11] L. Xhagolli; E. Pinguli, E. Gjergjndreaj, Minimization of waste waters discharges from albanian breweries, Časopis „Zaštita materijala“ broj 2, str. 81-86, 2010. godine, Beograd

[12] K. Vaso, M. Dema, Preparation of the anticorrosive paints with long oil alkyd resins modified with maleic anhydride and phthalic anhydride, Časopis „Zaštita materijala“ broj 2, str. 87-93, 2010. godine, Beograd