Dr. LULJETA XHAGOLLI[1];
Msc. ENTELA PINGULI[2];
ELIBJONDA GJERGJNDREAJ[3]

Scientific paper
UDC:628.312.2 :663.48(496.5)

Minimization of waste waters discharges from albanian breweries

The objective of this paper is to provide information on identification of potential generated waste waters from Albanian breweries and to develop a strategy for minimization of their discharges. Pollution prevention waste water strategy consist on continuous examination of the operations at a facility with the goal of minimizing all types of waste waters.
Pollution prevention and control of waste waters is based on Best Management Practices (BMPs) which emphasize the source control of all waste waters generated at a facility through relatively inexpensive adjustments to process or operating procedures. This plan seeks to integrate environmental benefits and economic impact without any influence in product quality and industrial safety. Optimization of water consume through conservation and recycling is the best technique to fulfill this goal. The inefficient use of water as a raw material in a brewery can have environmental impacts. Therefore, minimization of waste water should not only include the improved management and control of water discharges, but also an optimization of process water input.
Key words: *Waste water, discharge, water consume, Best Management Practices.*

1. AIMS AND BACKGROUND

In breweries to produce 1 hl of beer it needed a lot of water ranged from 5 to 10 Hl [2]. The reduction in the amount of water consumed in a brewery will have several environmental and economic benefits without compromising plant sanitation or safety considerations [1]. The effluent from a brewery is generated from the brew kettle, fermentor, storage, and various cleaning operations [5], and may contain residues such as trub, spent grains, kieselguhr, and yeast. As a result, the wastewater from these processes has a high COD (3,000-5,000 mg/L), high temperature (30-35°C), high TSS, and high pH [6].

Water conservation intend to reduce the pollutant loadings in the effluent, such as resource and by-product recovery, and waste loadings reduction. There are some critical point to optimise water consume and effluents releated with:

1. Water reduction procedures in production section
2. Water reduction in cleaning procesess
3. Water Recovery in every point or process [5].

2. EXPERIMENTAL

2.1 Monitoring and reporting

Monitoring of the final effluent for the parameters listed in this document was carried out at least twice per month, or more frequently if the flows vary significantly. Monitoring data were analyzed and reviewed at regular intervals and compared with the operating standards. The required legislative standards are applied managed and controlled based on HACCP, Occupational Health and Safety, ISO 14001-2000 and ISO 9001. The reported average results are the "Stefani & Co" data, taken during 2006-2009 period and publicates to the responsible authorities and relevant parties, as required.

2.2 Waste water characteristics in "Stefani & Co" brewery

The main pollutants generated in the brewery process include wastewater discharges, solid waste and air emissions. Water volume discharge depends on total water volume used for beer production.

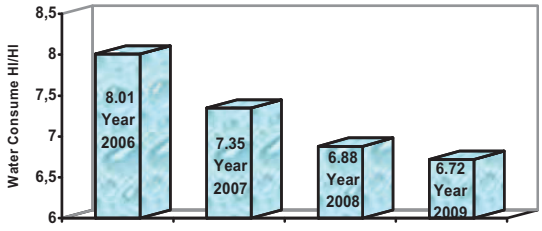

Figure 1 - Brewery Water Consume in years

For 2009 the total water consume was 6.72 hl/hl beer from which 1,3 hl is water as raw material and 0,7 hl/hl is the volume of water used for cooling process. The amount of water entering the brewery equals the amount of water leaving it. Drawing up a water balance is a powerful technique for identifying waste. It can be applied to both the whole brewery and individual processes.

Address authors: [1]University of Tirana. Faculty of Natural Sciences. Department of Industrial Chemistry, [2]Regional Environmental Centre, [3]*"Stefani & Co" Company*

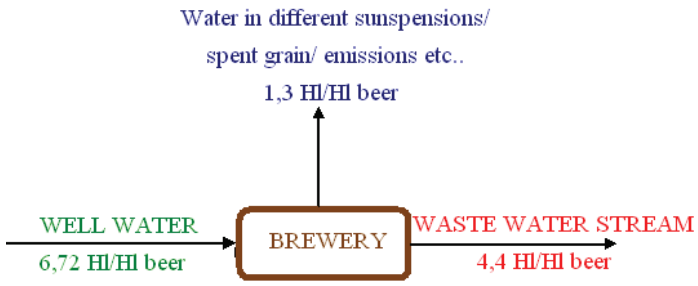

Figure 2 - Water balance in the brewery. Specific consume and specific discharges for 2009.

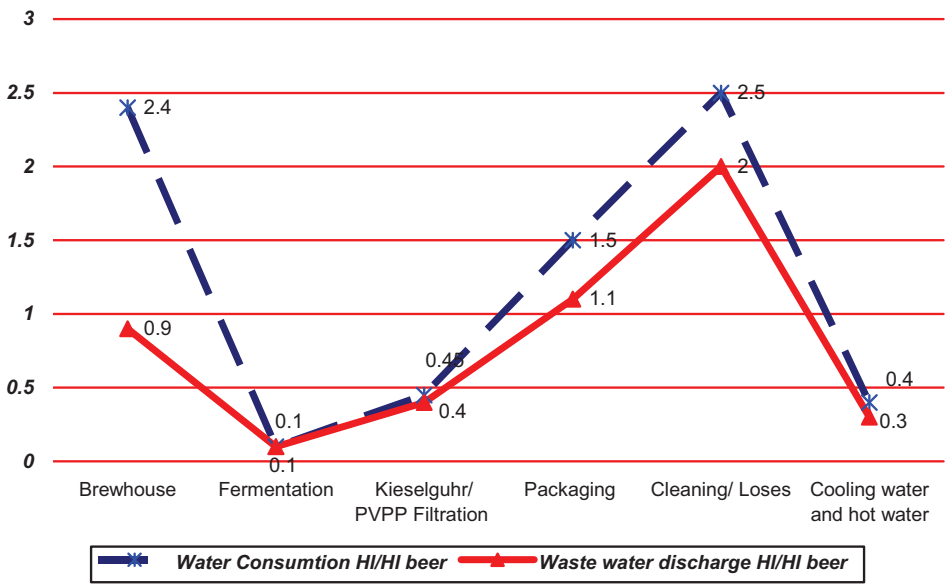

Figure 3 - Specific consumption and specific waste water effluent in different sections of beer production

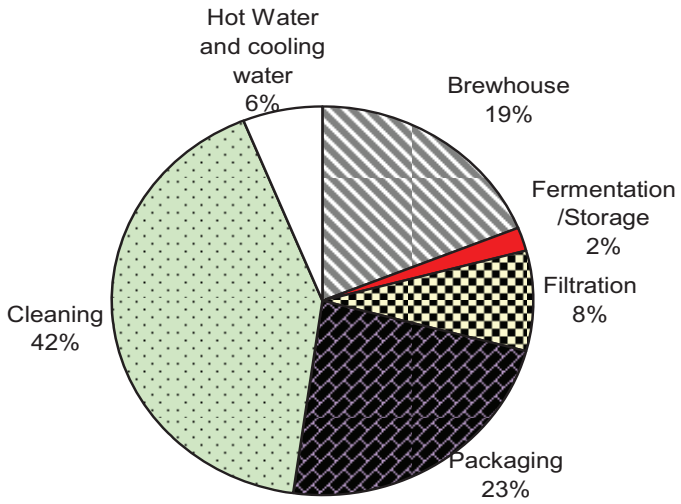

Figure 4 - Waste water discharges distribution in the brewery

Table 1 - Water analyses in different sectors of beer production

Sector	Waste water charasteristics	Amount
Brewhouse	Weak wort Steam Water leaving the brewery with spent grains and trub.	Weak wort is recycled. A part of steam is condensed. 1.1 hl/hl beer
Fermentation/ storage/filtration	Residual beer during empting tanks Pre-runs and after-runs in the kieselguhr filter (mixture of beer and water) Water in yeast and filter-aid suspensions.	0.01 hl/hl beer 0.02 hl/hl beer 0.4 hl/hl beer
Packaging and other auxilary processes	Beer rejected in the packaging area due to wrong filling height, quality defects, or incorrect placement of labels. Cleaning and rinsing waters, housekeeping waters.	0.04 hl/hl beer 4.73 hl/hl beer

Effluent charges are based on both the volume of effluent discharged and its strength. To measure the strength of trade effluent, we used chemical or biological oxygen demand (COD or BOD) and total settleable solids (TSS). Brewery effluent tends to have a high COD content due to the presence of soluble sugars, starches, alcohol and proteins in the wort, beer and yeast. The COD of these products is typically over 100 000 mg/litre. The main sources of undissolved solids in brewery effluent are trub, yeast and filter aids.

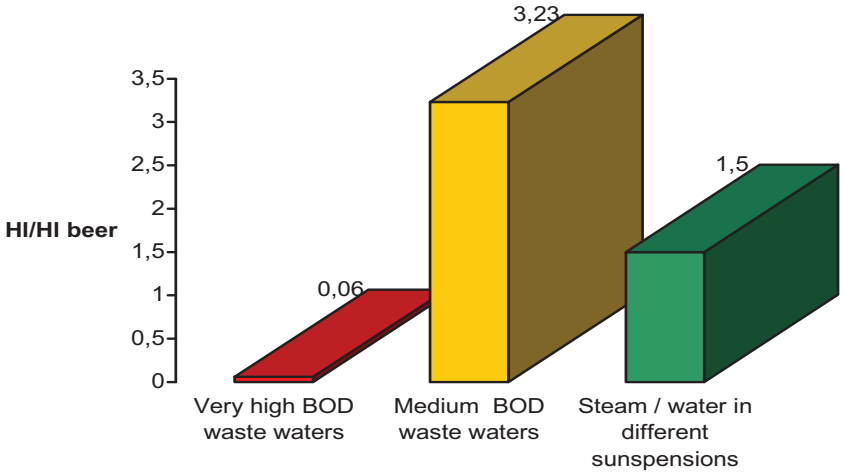

Figure 5 - The quality of waste water streams produced at a brewery in terms of their loadings

Table 2 - Water effluent parameters of waste waters

Parameter	Analyses method	Value	Limit value
pH	ISO 10523-Water Quality	5.8 – 7.7	6-9
Suspended material	S.SH.EN 872-Water Quality	113 - 300 mg/l	50 mg/l
COD	S.SH.EN1558 Water Quality	1500 -3000mg/l	250 mg/l
BOD	S.SHEN15586Water Quality	> 60 mg/l	50 mg/l
NH_4	ISO 7150 - Water Quality	0,02 mg/l	
NO_3	ISO 7890 - Water Quality	0,9- 3,6 mg/l	
P-tot	ISO/DIS 6878/1	< 3 mg/l	5 mg/l
Oils/Fats	EPA 1664	< 2 mg/l	10 mg/l

Table 3 - Physical-Chemical Water effluents in dfifferent point of discharge reservoirs

Parameters	Effluents at Reverse Osmose	Rinsing tank water	Effluents at fermentation reservoir	Effluents at packaking line reservoir	Effluents at overall reservoir
pH	6,72	6,01	7,51	6,35	7,69
Alkalinity	11mlNaOH	7,8 ml	7 ml	4,7 ml	8,9 ml
Hardness	56,1 ^{0}G	35,9^{0}G	34 ^{0}G	7,3 ^{0}G	28 ^{0}G
Ca^{2+}	210 mg/l	208mg/l	190 mg/l	16 mg/l	176 mg/l
HCO_3^-	671 mg/l	475mg/l	481mg/l	186 mg/l	496 mg/l
Cl_2	-	-	Trace	-	Trace
NO_3^-	1,6	1,1	1,5	1,1	1,53
Turbidity	0,7 EBC	1,2EBC	22 EBC	1,4 EBC	14,5 EBC

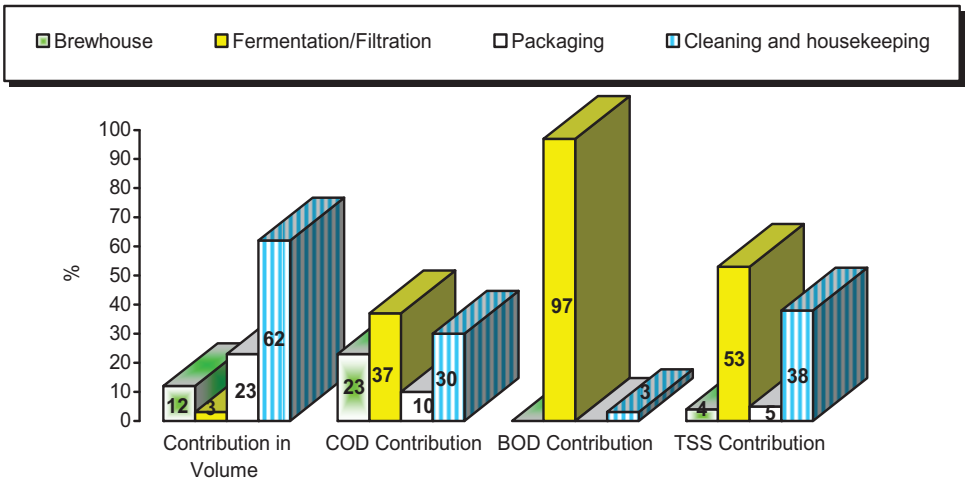

Figure 6 - Water effluent parameters in different sectors of beer production

Table 4 - Some preventive actions to minimize waste water effluents

PROCESS	Water discharges	Recommendations
Lauter Tun	Weak wort	Recycling to the mash
Hot water in brewhouse 75^{0}C	Clean hot water	50% recovery in pasteurization unit and as much as possible in housekeeping
Cleaning process in brewhouse	Cleaning cycles each 5 -7 days	Reuse of caustic and acid solutions & reuse final rinse waters for manual cleaning or CIP process.
Cleaning process in fermentation	CIP Cleaning	Effective separation of yeast and reuse as above.
Cleaning process in Conditioning	CIP Cleaning	Reuse final rinse waters for manual cleaning or CIP process.
Pasteurization	Process Water	Reuse in bottle washing machine and cleaning.

Weak wort can be used for mashing in the next brew. It reduces the organic load in the wastewater and will save raw material and water. The COD value of weak wort is around 8,000 – 11,000 mg/kg. The final extract is 0,7 – 1 ^{0}Plato. Collection of the weak wort reduce the wastewater load with 20 - 60 g/hl wort produced. The trub can be returned to lauter tun and utilised as animal feed. The COD value of trub is around 130,000 – 160,000 mg/kg wet trub. The amount of trub from a well-functioning whirlpool is 1 – 4 % of the wort volume. The reduction in wastewater load by returning the trub is therefore 150 - 450 g COD/hl wort.

Yeast suspension contains yeast and beer and has a very high COD value 180,000 - 220,000 mg/litre. The total COD load for the brewery will therefore be reduced with approx. 160 - 550 g COD/hl beer.

Residual beer is lost through the different production stages such as beer rejected in the packaging area, returned beer, emptying of beer tanks, first runs and last runs at kieselguhr filter, during transportation in the pipes etc. The COD value of beer is around 100,000 130,000 mg/kg. The total amount of residual beer will be in the area 1 - 7% of the total production.

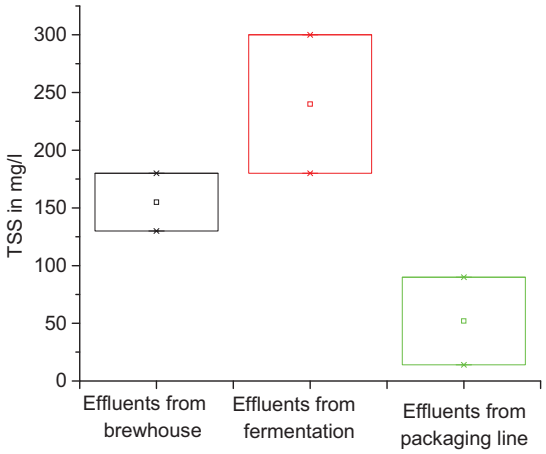

Figure 7 - Water high suspended solids effluents TSS.

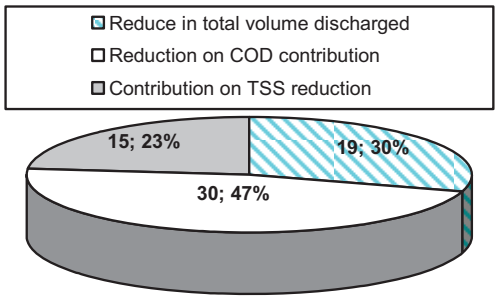

Figure 8 - Reduce of pollution contribution after preventive actions.

Table 5 - Filter Cleaning Water parameters

Parameters	Unit	Amount
COD	mg/l	5665 - 6700
BOD	mg/l	2600 - 5300
TRUB	EBC	80 EBC – not measured
TSS	g/l	4 - 8
pH		5.4 - 7
Total Nitrogen	mg/l	25-50

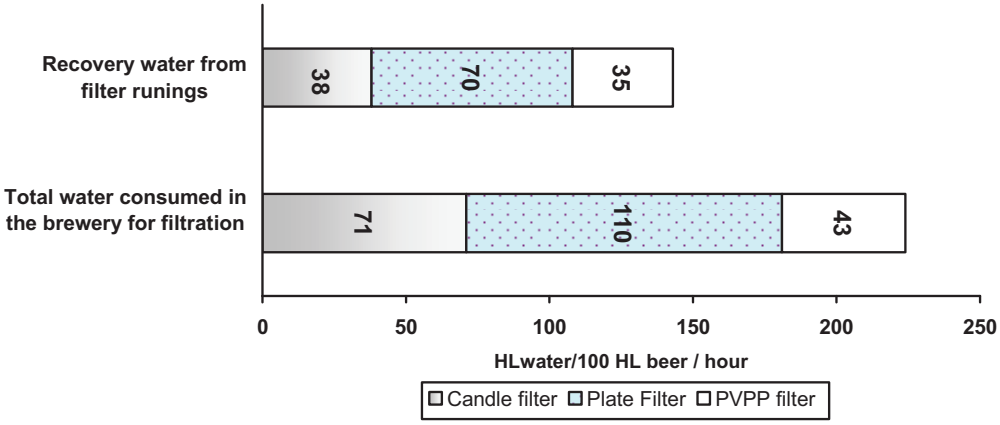

Figure 9 - Consummation ratio for different filters used in the brewery

3. CONCLUSIONS

Minimization of waste waters discharges consist on keeping in control:

1. The quality of waste waters produced at a brewery in terms of their loadings. The reduction of effluent pollutant loadings is an important consideration that consist on (1) separation of pollutants from water and wastewater in order to minimize the amount of suspended contaminants, (2) separation of high- and low-strength waste streams, allows less contaminated waste streams to be discharged.
2. The quantity of waste waters produced at a brewery . There exist a lot of methods to reduce waste volume.
3. Waste water treatment and disposal in an environmentally manner. Wastewaters from breweries are pretreated through solids removal by using screens, wastewater neutralization and pH control in production areas, using acid or caustic

to neutralize spent detergent in central neutralization tanks.

4. Optimisation of processes, maintenance and redisign (CIP system) that results in potencial consume reduction. Modifying current production processes to improve materials use and reduce waste generation.
5. Improvement of management practices used

4. REFERENCES

[1] ISO (International Organisation for Standartisation) 2004a. ISO 14001: 2004. *Environmental Management Systems – Requirements with guidance for use. Geneva: ISO*. (Accessed on 09-05-2006).

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

[3] HSC (Health and Safety Commission) 2005a. *Food Manufacture – Beer, Spirit and Soft Drink Manufacture. Injury Rate Comparison. London: National Statistics*. Available at http://www.hse.gov.uk/ food/ drink.htm (accessed on 20- 10-2005).

[4] EC (European Commission). *Integrated Pollution Prevention and Control.Reference Document on Best Available Techniques in the Food, Drink and Milk Industries. Seville: EC.* 2006, http://eippcb.jrc.es/ pages/FActivities.htm (accessed on 20-10-2005).

[5] UNEP (United Nations Environment Programme), *Environmental Management in the Brewing Industry, UNEP Technical Report, United Nations, ISBN*: 1995, 92-807-1523-2, pp108.

[6] Brewery Wastewater. *EBC Manual of Good Practice* 2006, 46-78.