BEST: Journal of Recent Trends in Business &
Human Resources Management (BEST: JRTBHRM)
Vol. 1, Issue 1, Dec 2016, 5-14

THE CIRCULAR ECONOMY CONCEPT APPLIED TO NON-PRODUCTIVE STRUCTURES: CASE OF THE WASTEWATER PROCESSING STATION OF A TANNERY ALGERIA

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ABSTRACT

Leather industry on the one side boosts the local economic development, on the other side; it leads to the tremendous environment pollution and biological chains destruction. The goal of this paper is to underscore the necessity of implementing a model of circular economy (EC) in order to achieve sustainable development for developing country industries. While reviewing the reasons for the need to adopt the strategy of circular economy thus, to adopt cleaner production for the industries of developing countries, the special features of Algerian society which makes the use of circular economy necessary were also reviewed. It is important to develop a method for developing a priority for industrialists to work with in initiating best available practices, taking into accounts all of the company subsystems. It is important to broaden the application of the concept under the EC to business systems that have long been considered unproductive (wastewater treatment plants), in this case not taken into account by the traditional scheme EC as well as waste from other polluting industries. Companies have great opportunities to minimize economic losses and preserve the natural environment by getting rid of its waste resulted from tanning and also from external companies to operate the works known by their management difficult.

KEYWORDS: Model economy, Tannery, Waste, Sulfur

INTRODUCTION

Circular Economy

Circular economy focuses on resource-productivity and eco-efficiency improvement in a comprehensive way, especially on the industrial structure optimization of new technology development and application, equipment renewal and management renovation. The concept of a circular economy (CE) has been first raised by two British environmental economists (Pearce and Turner, 1990). In Economics of Natural Resources and the Environment, they pointed out that a traditional open-ended economy was developed with no built-in tendency to recycle, which was reflected by treating the environment as a wasted reservoir. Yet, the open-ended system could be and should be converted to a circular system when considering the relationship between resource use and wasted residuals. In the same order, facing existing environmental problems and resource scarcity, they called for a need to contemplate earth as a closed economic system: one in which the economy and the environment are not regarded by linear inter-linkages, but by a circular relationship (Bounding, 1966).

The fundamental law for establishing a recycling-based society came in 2002 (Trade and Industry, 2004). It provides quantitative targets for recycling and dematerialization of Japanese society (Van Berkel et al., 2009). One common feature of both countries' CE policy is to prevent further environmental deterioration and to conserve scarce resources through effective waste management; especially integrated solid waste management. The CE model has been implemented as a new way of raw materials, water and energy consumption and reduction in the leather industry. Reduce, Reuse, Recycle and Recover of the tannery effluents have our interest in a system considered until now as unproductive (effluent treatment plant) processes.

Effective analysis approach with analysis of the aspects such as wastewater, and sulfide of the leather tannery with CE model provides guidance for the sustainable development of leather industry in the future. On the other hand, environmental benefits will be obtained not only by minimizing the amount of discharged waste, but more importantly by minimizing the use of virgin materials for economic activity (Andersen, 2007).

The essence of an ecological economy is the one that would bring fundamental changes to the traditional way of development. Three aspects, which are economic, social, and environmental dimensions, need to be considered in this model (Zhu, 2005). The circular economic model (CE) helps to strengthen national security due to the importance of sustainable energy supply. Additionally, the positive environmental effects help to improve the overall well-being in the society and advance a nation's modernization (Heck, 2006).The enacted plan (2010-2017) for Algeria's economic and social development suggests the continuous implementation and further development of the best available practices, in this case the EC model. It is not surprising to see that the Algerian government spares no effort to push this economic model into practice for a number of companies and reasons. First, Algerian faces serious and severe environmental challenges due to rapid industrialization and urbanization as well as poor environmental oversight. Striking problems include water depletion, and pollution, degradation of water resources and non-renewable Martial, desertification, deforestation. This increase is due to the vulnerability of the Algerian industrial fabric, and to the technological advancement of the exporting country which does not guarantee the success of technology transfer (broken link after turnkey), in addition to acquiring some polluting factories and consumers of water and energy. In response to serious environment problems, mitigation of wastewater, toxic and reversal of environmental degradation have become urgent. (Wang et al., 2007) suggested and regarded that the CE is the fundamental resolution to remove green barriers and expected that through its implementation, all companies of all countries would gain enhanced national competitiveness in international trade. The successful enforcement of the circular economy regulation can help tackle both environmental degradation and resource scarcity issues.

This study aims to contribute to the rapidly growing literature on the CE in general and serves for implementation and effectiveness of Algerian CE's policy in particular. In order to achieve the goals, we first present the CE concept and explain why it is imperative for Algeria. In order to achieve the goals, we first present the CE concept and explain why it is imperative for Algeria. Second, we introduce the current practices in Algeria companies (only the tanneries) and discuss the vision of integration of the EC concept in the field of leather (tanning). Our main focus is to provide the overall vision of the EC integration concept in polluting industries so that a more holistic picture of circular economy practices in Algeria. Then, based on other literature, we identify the underlying problems for this national strategy in the Algerian context. Finally, we provide the conclusion of the circular economy development.

CE model and Current CE Implémentation

(Geng et al., 2002) bring for waste management and encourages the development of companies that can play a role of scavengers (feeding the waste resources of other companies in the economic system) and decomposers (using the waste resources from both producers and consumers and then transform or recycle them back into the system) in order to build up an industrial ecosystem. By last, in the waste management area, the regulating and expending of the waste trade market and building a venous industrial park aims to increase the productivity and economic benefit of the resource recovery industry.

The main wastes focused in tannery process are shown in Figure 1. Generally 6840 kg fresh hides need 3-4 kg sulfide. The first wastes are certain amount of sulfide and lime which are not absorbed by the pelts in the liming process. Secondly, the broken hair and epidermis in the liming and non structural protein in soaking and liming increase the COD and BOD content in the water, which leads to water pollution.

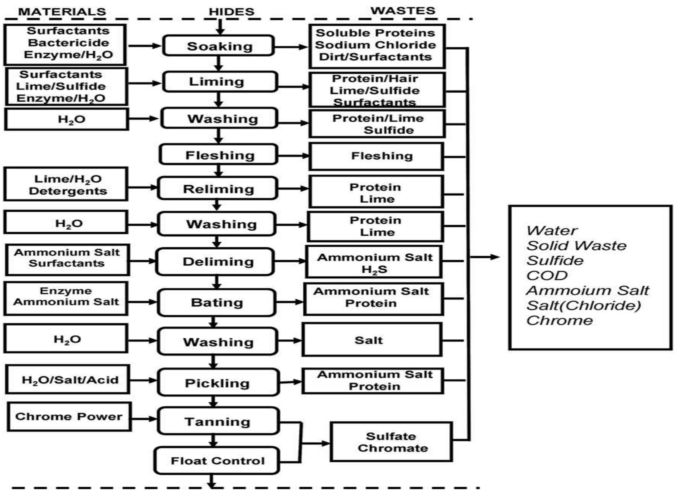


Figure 1: The Material Flow Chart during Leather Tannery

According to (Jing et al., 2011), the CE model is demonstrated in Figure 2, where the process refers to all activities of resource /energy productions and consumptions. The span between process A and process B is determined by the scope of CE. For example, process B can follow process A or antecede process A. The arrangement of both processes is flexible based on the output, their intrinsic properties and the following recycling network systems.

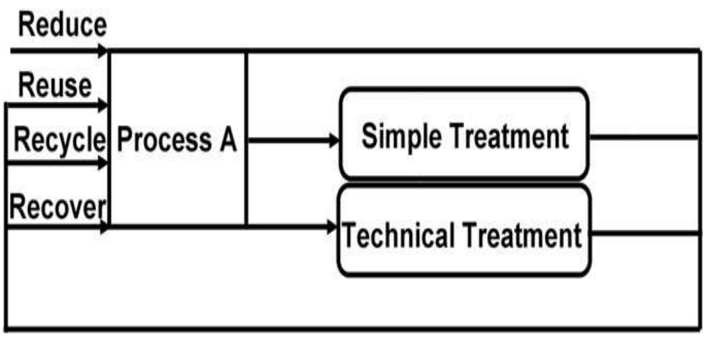


Figure 2: Special Circular Economy Model (Jing et al., 2011)

Normally, process B differs from process A. In the case that process B is the same as process A, this model can be transferred to Figure 3.

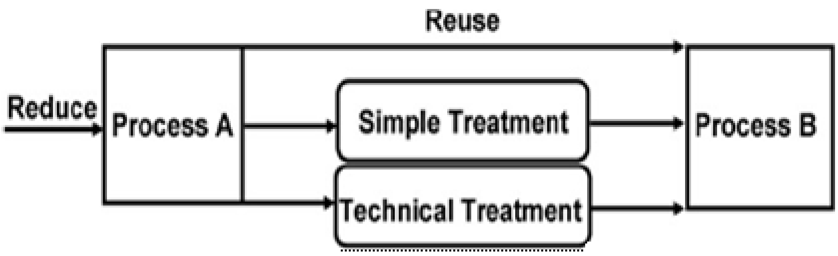


Figure 3: Recycling Economy Model (Jing et al., 2011)

In our case the process B is different than process A, respectively the process B is the installation of wastewater treatment of tannery and A is the Dehairing process (Figure 4)

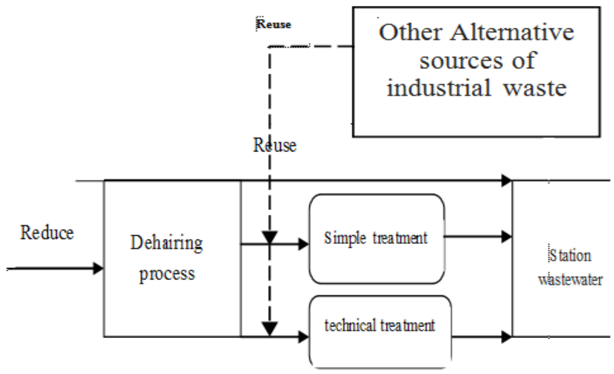


Figure 4: Special Economic Model 'waste'

Overview of Leather Tannery Waste

Tannery is an industry with strong potential of pollution.

Water is charged with organic matter (proteins, peptides, amino, acid acids fatty, sulfides and chrome trivalent). They are highly polluted (Tunay, 1996). The majority of the used operations consume several chemicals. The animal skin is subjected to deferent process to eliminate the meat, the lipids and the hairs. This stage uses deferent chemicals (in particular: the hydroxide of sodium, the hypochlorite of sodium, the dichromate of potassium, the lime, chlorides, the sulphuric acid, the acid formique, tensioactifs, sulphide of sodium, salts of sodium and ammonium, etc.) (R.suthanthararajan. et al 2004) Dehairing is a process which aims to separate hair and epidermis from the hide. Chemicals used for this process are lime and sulfides. Thus, sulfur in dehairing wastewater occurs as sulfide and it has to be converted into sulfate in order not to produce hydrogen sulfide when alkaline and acidic wastewaters are mixed (R.suthanthararajan et al., 2005).

The used product ends in waste water with a clear contribution in polluting load. These operations are carried out in aqueous environment. Therefore generates water pollution.

The tannery waste water pollution has two sources:

- Skin,
- Chemical reactive used in the various operations.

Table I gives consumption of the chemicals for treatment, agents of tanning and auxiliaries (R. suthanthararajan et al., 2005). Vulnerability caused by the transfer of technology more than ever felt in Algeria, because the technological advancement of the exporting country does not guarantee the success of such a transfer. Without purification of water (dysfunction of the installations) and in the absence of effective technology of recovery, the unit loses annually

- 140 kilogram /day of chromium with their prices with 1.22 € /kg, are equivalent to 51879.77 €/year;
- 162, 4 kilogram/days of sulfides with their prices with 0.3€/kg, are equivalent to 16577.76 €/year.

On one hand in front of this heavy heritage of industry consuming water and chemicals of export, the managers are forced to exert a responsible management, that implies, for example, to know well the chemicals implemented in the process (including the very prepared products), to take the safety measures for the protection of people and of the environment and finally optimizes the operation of the installations of waste water treatment in order to answer the multiple requirements and stakes environmental, social and economic) (R.suthanthararajan et al., 2005). Waste management and environmental protection are mandatory requirements of modern society.

Nevertheless these installations of treatments of polluting water represent an unbearable because of the high cost of operation (chemical, energy, etc.), and of the maintenance and talks.

On the other hand, in Algeria, the steel mill of El-Hadjar (ANNABA), and because of its activity, it generates an important production of industrial waste (slag) which raises a problem of storage and pollution. Following the example of industrial nations this product, presents a plentiful raw material to low cost. Which must be exploited on a large scale in operations ' sometimes without interest for the administrators ' for example the operations of waste water treatment.

The aim of this research is to develop a waste coming from another polluting industry which is the iron and steel industries (refer to figure 5). One will be interested particularly in:

- To count in a no exhaustive way the range of waste generated by this industry which considered rich in ferrous and nonferrous waste?
- To choose the waste which answers bests our problems of substitution and valorization possibly for the industry of having leather.
- This research between thus within the framework of the application of the clean technologies of which the goal is triple:
- Substitution and beyond a saving in expensive chemical ($MnSO_4$) for the tannery;
- To consider new exits for a waste (ferrous waste) of another polluting company (iron and steel industry).

All this is carried out in a preoccupation of continuous environmental of sustainable development (figure 3).

Statistically the study by L.NT.PB H; dey Algiers effluent flow are:

- Acid effluent flow 170 m3 / day;
- Basic flow of effluent from 200 /day to 350 m^3 / day.

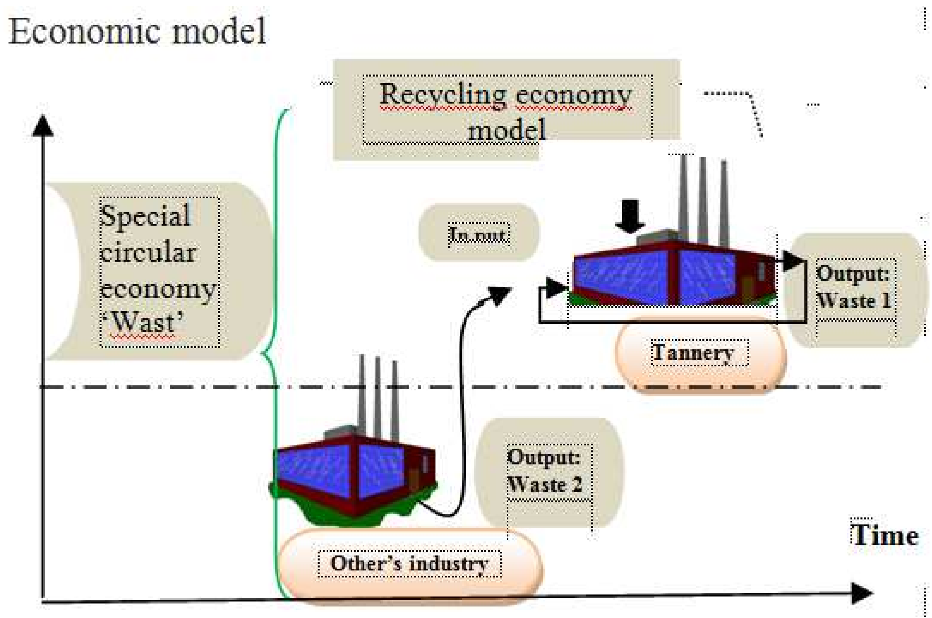


Figure 5: Conception of a Future Vision of the Economy Circular Vision of Industrial Waste

MATERIALS AND METHODS

Objective

In order to mitigate the high cost of operating the treatment plant MEGA by the use of chemicals used in the operation of the treatment plant, we perform tests of substitution of a catalyst (manganese sulfate $MnSO_4$) by a first recovery and waste from the steel industry of Algeria, then a second waste recycling in situ, basic chromium sulphate. Based in part on the chemical characteristics or almost similar iron sulfate ($FeSO_4$) with manganese sulfate $MnSO_4$, and secondly on the degree of oxidation of $FeSO_4$ and basic chromium sulphate, which oxidants to become very strong oxidant.

Hypothesis

Waste recovery used for the substitution of $MnSO_4$ is:

- First waste in situ recovery: As a second alternative substitution MnSO4, basic chromium sulphate, from the tannery itself.
- Second waste recycling ex site as an alternative first substitution MnSO4, iron sulfate (FeSO4) from the steel industry in eastern Algeria (availability);

Diagrams species distribution of $FeSO_4$ and basic chromium sulphate (Cr (OH) SO_4) can be very informative for a possible substitution.

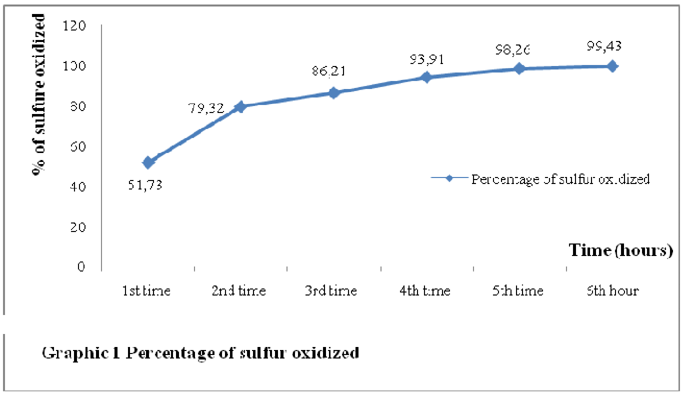
Note: In addition to the test of substitution by various wastes from the tannery itself and the steel sector, parameters such as the air intake, the air distribution in the effluent to be treated and the amount catalysts (substituent) are also modified to better understand their influence on the performance of effluent treatment.

EXPERIMENTAL RESULTS OF SUBSTITUTION ACCORDING TO THE MODEL (EC)

For the oxidation of sulfur with use of the $MnSO_4$ catalyst

Table 1: Results of Desulfurization -2ml $MnSO_4$ (with Variation of the Parameters)

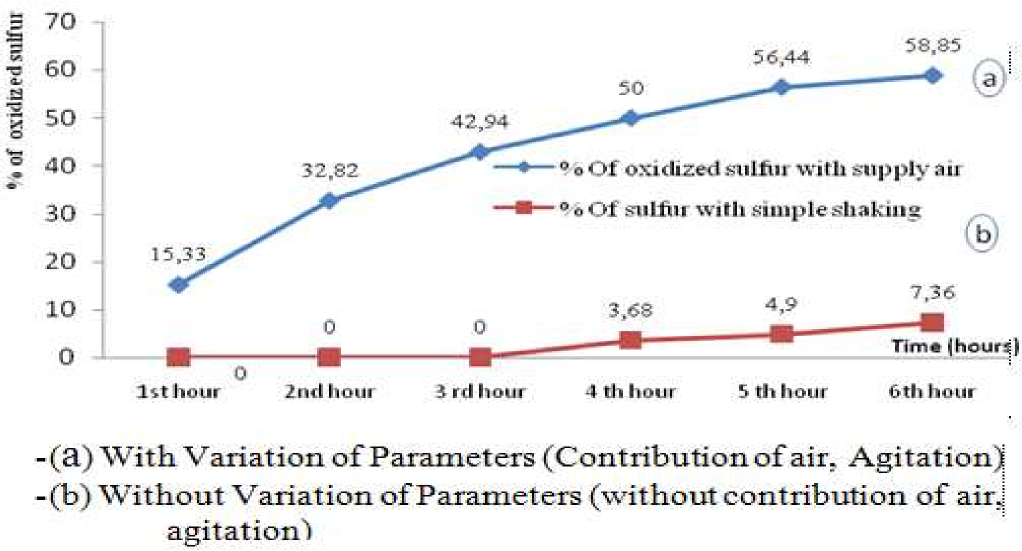
Time (Hours)	Percentage Oxidized Sulfur (with Variation Parameters)
1st hour	51,73 %
2nd hour	79,32 %
3rd hour	86,21 %
4th hour	93 ,91 %
5th hour	98,28 %
6th hour	99,43 %



Graphic 1: Sulfur Oxides as a Function of Time

Table 2: Percentage Oxidized Sulfide with and Without Variation of Parameters

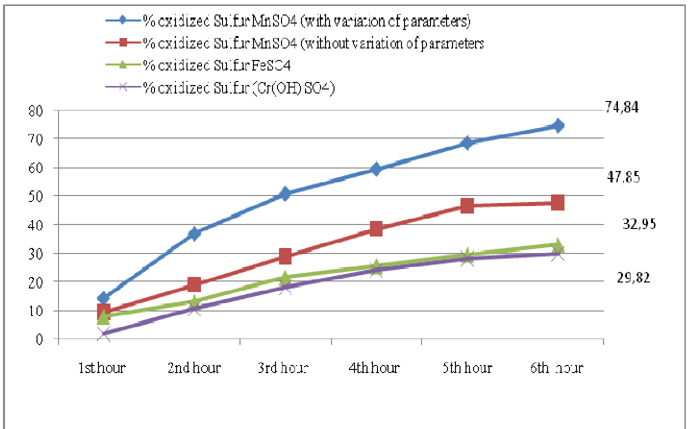
Time (hours)	Percentage Oxidized Sulfur (With Variation Parameters)	Percentage Oxidized Sulfur (Without Variation Parameters)
1st hour	51,73 %	00
2nd hour	79,32 %	00
3rd hour	86,21 %	00
4th hour	93 ,91 %	03 ,68
5th hour	98,28 %	04,90
6th hour	99,43 %	07,36



Graphic 2: Comparison of the Results of Desulfurization (2 ml $MnSO_4$)

Table 3. Results of Oxidation with Waste to Compare in Catalyst $MnSO_4$

Time hours	% oxidized Sulfur $MnSO_4$	% oxidized Sulfur $MnSO_4$	% oxidized Sulfur $FeSO_4$	% oxidized Sulfur $(Cr(OH)SO_4)$
1st hour	14,11	09,20	07,95	01,75
2nd hour	36,81	19,02	13,07	10,53
3rd hour	50,92	28,83	21,59	18,13
4th hour	59,50	38,65	25,57	23,97
5th hour	68,71	46,62	29,54	28,07
6th hour	74,84	47,85	32,95	29,82



graphic. 2 Comparison of catalyst MnSO4 with differents wastes substitution (Fe 2 + and Cr3 +)

Graphic 3: Sulfur Oxides as a Function of Time

DISCUSSIONS

From the tests on pilot, it arises that the $MnSO_4$ catalyst used for the oxidation of sulfur definitely more effective and in conformity than the ferrous sulphate $FeSO_4$ compared here to ferrous waste of the iron and steel sector. That could be the consequence proportion of iron which precipitates neighbors pH from 4, 6 to 6 and thus it does not take part that has the oxidation of sulfur, whereas that sulfur which takes part has close pH has 8. The Pourbaix curves also inform us about this aspect of appearance of new species according to the pH (Zhu, 2005).We agree to also say that better results can be obtained by increasing the concentration of the substituent (ferrous waste) in the effluent of the tannery and by increasing the reaction time of desulfurization as well. The solution proposed could be used as springboard for possible reflection for the complex problems of companies which note that their sustainability is threatened because of the loads which can be relieved by rational solutions.

The companies has great possibilities of preserving the natural environment and of minimizing the economic losses, on one hand, by the application of the concept of substitution and, or, recycling of ' valuable waste, and on the other hand by a responsible management for all under systems for the company (station of purification for example).

Finally, at least as far as general environmental management systems, is concerned, the environmental policy of an enterprise must include a commitment to preventing pollution. In the United States, the common term for the body of knowledge, approaches, techniques, practices, and technologies aimed to minimizing the creation of pollution, which is "pollution prevention," or "P2." The terms often used as near synonyms for P2 are "waste minimization» and "clean production." These terms sum Together (Cheremisin off et al., 2001).

INTERPRETATION OF THE RESULTS

The test and the proportioning of sulphides by ferricyanides of potassium show us that the elimination of sulphides by oxidation to the air in the presence of catalyst MnSO4 gives excellent results. Removing of 99, 43 % of sulfur (graphic1). These results will be taken as means of comparison with the results of the substitute (ferrous waste resulted from the activity of iron and steel industry).

The results obtained, show us that the treatment of desulphurization envisaged is very effective. However the reaction of time and the operating conditions must be well controlled (parameters).

The study on pilot of the influence of these parameters with use of MnSO4 like catalyst, gives us the results

(Graphic 2):

Indeed the results obtained, show us clearly and allow us to say that the best desulfurization is carried out by oxidation with contribution of air, and that simple agitation without contribution of air will not be enough to any case with the desulfurization of the effluent ensures. The validity of the parameters (air agitation, air distribution, and the time of the oxidation reaction) is well established

CONCLUSIONS

Stricter legal limits on sulfur levels require measures to reduce their value in the wastewater of final tannery. Removal wastewater is containing high sulfur concentrations that contribute significantly to the overall effluent. However, the final sulfate concentration in the tannery wastewater is still too high to meet future standards. Separate results remain low, 32% for waste from the tannery, and 30% for the waste from the steel industry. But the sum of the results of the two wastes gives better results desulfurization, 60% of oxidized sulfur. The companies has great possibilities of minimizing the economic losses, and to preserve the natural environment by, on the one hand, the application of the concept of substitution or the one of recycling the 'waste valuable of other factory’s site which they find difficulties that has to manage their waste, and on the other hand by a responsible management for all under systems of the company (station of treatment) even if this one is not directly profitable for the company.

ACKNOWLEDGEMENTS

The authors would like to thank Kamel Eddine BOUHIDEL and Hamel Benmoussa for their support and contribution to the work.

REFERENCES

1. Pearce DW, Turner RK, (1990).Economics of Natural Resources and the Environment. Harvester Wheats heaf, London.
2. Boulding KE, (1966). Economics of the Coming Space ship Earth. In environmental quality in a growing economy. Resources for the Future. Washington, D.C.
3. Ministry of Economy. Trade and Industry (2004): Handbook on Resource Recycling: legislation and trends in 3R. METI, Tokyo, Japan.

4. Van Berkel R., Fujita T, Hashimoto S, Geng, Y, (2009). Industrial and urban symbiosis in Japan: analysis of the eco-town. Journal of Environmental Management 90, 1540-1566.

5. Andersen MS, (2007). An introductory note on the environmental economics of the circular economy. Sustain Sc (2007) 2: 133-140.

6. Zhu DJ. (2005). Circular economy: new economy for 21 century. Empirical Reference 8, 25-40 (in Chinese).

7. Jing Hu, Zuobing X, Rujun, Z, Weijun D, Mingxi W, Shuangshuang Ma, (2011). Ecological utilization of leather tannery waste with circular economy model Journal of Cleaner Production 19 (2011) 221e228.

8. Heck P, (2006). Circular Economy Related International Practices and Policy Trends: Current situation and Practices on Sustainable Production and Consumption and International Circular Economy Development Policy Summary and Analysis. World Bank Report.

9. Wang YJ, Liu H.H, (2007). Green barriers from the standpoint of sustainable development. Journal of Economic Policy Reform 10 (3), 238-240.

10. Geng Y, Cote R, (2002). Scavengers and decomposers within an eco-industrial park. International Journal of sustainable 9 (4). 335

11. Tunay OI, Kabdasli D, and Orhon E. (1996). Ates.1996. Characterization and pollution profile of leather tanning industry in Turkey. Water Sci. Technol., 32(12) 2-7.

12. Suthanthararajan R., Ravindranath E, Umamaheswari B, Ramesh T, Rajamam S, (2004). Membrane application for recovery and reuse of water from treated tannery wastewater. Désalinisation, 2004, pp. 164, 151-156.

13. Galiana-Aleixandre M.V, A. Iborra-Clar A, Bes Pifi JA Mendoza-Roca, (2005). Nanofiltration for sulfate removal and water reuse of the pickling and tanning processes in a tannery. Desalination 179 (2005) 307-313

14. Cheremisinoff NP, Bendavid-Val A, (2001). Green Profits: The Manager's Handbook for ISO 14001 and Pollution Prevention. Butterworth-Heinemann, Boston. p. 219