Water Consumption Reduction Strategies in Recycled Paper Production Companies in Iran

Omid Ramezani[1], Hossein Kermanian[1], Zahra Razmpour[1], Mehdi Rahmaninia[2]

[1]Department of Cellulose and Paper Technology, Faculty of New Technologies and Energy, Zirab Science and Technology Park, Shahid Beheshti University, Zirab, Savadkoh, Mazandaran, Iran, e-mail: O_Ramezani@sbu.ac.ir, Kermanina_h@yahoo.com, Parisa_Razmpour@yahoo.com

[2]Department of Wood and Paper Science and Industry, Faculty of Natural Resources, University of Tarbiat Modares, Noor Campus, Noor, Mazandaran, Iran, e-mail: mrahmaninia@yahoo.com

Abstract. A close relation exist between Forest products industries and water cycle. Water as a natural resource is assumed to be a necessary and vital element in pulp and paper manufacturing and power generation in the related power plants. The objective of the current study is to determine the main factors affecting the water consumption in recycled paper manufacturing companies using analytical hierarchy process (AHP). Several questionnaires and related tables were forwarded to selected recycled paper manufacturing companies to evaluate the water reduction criteria in different sectors including manufacturing process, final product, raw material, human resources, costs and expenditures, environmental regulations and technical modifications. The results were analyzed by Expert Choice 2000 software. The results indicated that 'final product" criterion was ranked first following by manufacturing process, human resources, costs and expenditures, environmental regulations and technical modifications, respectively. Also among alternatives, final product, cooling water network, and water storage tanks were categorized in the first three priorities. The specified priorities would assist the managers and production experts to achieve the optimized water consumption with minimum possible cost.

Keywords: Analytical Hierarchy Process, Water Consumption Reduction, Pulp and Paper Industry, Paper Recycling Technology.

1 Introduction

Paper is a network of fibers and chemicals affecting its properties and quality. Large amount of water and energy in form of steam and electricity other than the raw

---

In: M. Salampasis, A. Matopoulos (eds.): Proceedings of the International Conference on Information and Communication Technologies
for Sustainable Agri-production and Environment (HAICTA 2011), Skiathos, 8-11 September, 2011.

materials are essential for paper manufacturing. Therefore, the most important environmental concerns in pulp and paper industry are the contaminants emission to water and air as well as energy consumption. Moreover, the wastes and residuals resulted by production are increasingly affecting the environmental concerns (1).

There is a close relation between the forest products industry and water cycle as shown in figure 1. Water is a vital and essential source in pulp, paper and paperboard manufacturing. A major part of water required in the factories is supplied by surface water resources such as rivers and lakes and the remaining is fed by water wells with the depth ranging from very shallow to more than 1000 meters.

In Iran, the water consumption standards in industry has not been determined correctly and no extensive study has been dedicated to clarification of water consumption condition and the water saving potentials in the capital industries (2).

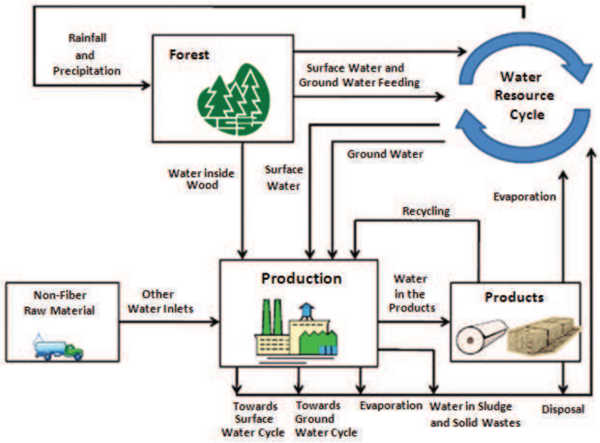

Fig. 1. Forest Products Industry and Water Cycle (NCASI, 2009)

Similarly, Iranian pulp and paper industry lacks a definite standard for water consumption. Besides, the situation is more severe which is due to the increasing grow in the number of small manufacturing plants of recycled paper products supplying the packaging industry including test liners and corrugating medium as well as a non-existence of supervision in water consumption. On the other hand, in a recent study (3), the water consumption in pulp and paper industry in Iran has been reported to be above 20 m^3/ton (m3 water/ton paper) which is significantly higher than the global standards as summarized in table 1.

Table 1. Water Consumption Standards in Paper and Paperboard Plants (4)

Types of Paper	Cubic Meter Water per Ton of Paper (m^3/ton)
Newsprints	6-12
Light Weight Coated Paper (LWC)	10-20
Fine Paper	5-10
Supercalendered Paper (SC)	10-15
Tissue Paper	10-15
Liner Board	2-10
Corrugating Medium	2-10
Multiply Board	8-15

Water reduction in papermaking companies have attracted many studies and research projects (5- 8). By now, different process integration methods including linear models, non-liner models, pinch analysis, genetic algorithms, cleaner production strategies, benchmarking, water re-use and recovery methods and waste water and effluent treatment methods have largely contributed to water reduction in industrial plants. Each of the mentioned methods has definite advantages and drawbacks but generally, implementation of modification or alternation procedures for water reduction in process requires a substantial financial costs and expenditures which is the main obstacle in practical application of the methods (9-11). The situation in small and medium-size plants with weak management, low technical capacity, limited access to technical data and unstable financial situation is more unsatisfactory. Therefore, priorities determination and proper strategic decision making is of great importance.

One of the qualified tools in the similar situations is Analytical Hierarchy Process (AHP) which has been used in ranking and categorization of many sciences including marketing, architecture, energy resources scheduling as well as social and economical analysis. AHP is the most popular method in Multiple Criteria Decision Making (MCDM) methods which was first introduced by Thomas L. Saaty (12). When the AHP logic hierarchical structure is formulated, one should first yield the judgment matrices based on pair-wise comparison of all elements in each hierarchy with respect to the higher hierarchy according to certain criteria of comparison within certain scales. The basic idea of AHP is that the factors in a complex system are grouped on different logic levels, forming a chain, or hierarchy, whereby the lower-level elements can be compared in pair-wise matrices with respect to the higher level, and so on, so that finally the composite priorities of all levels are achieved (13-15).

As described in the foregoing paragraphs, the water consumption in Iran is far above the global standards and therefore requires a careful attention. On the other hand, the solutions suggested by some of the available techniques and methods involve high financial expending which is not fully justifiable for industry. The objective of this paper is to apply the Analytic Hierarchy Process (AHP) as a decision making tool for selecting the most prior decision for water reduction in Pulp and Paper manufacturing companies in Iran enabling them to obtain remarkable saving by the most prior approaches.

2 Methodology

2-1 Questionnaire and preliminary data collection

Based on the similarity in product and manufacturing process, 20 companies producing packaging paper and paperboard (Test Liner and Corrugating Medium) were selected. The reason for selection of this particular type of manufacturing plants was the increasing number and the lack of technical supervision on their operation. In the first stage of this research, a preliminary questionnaire was designed asking several questions about the manufacturing process, water supply resources of the company, water consumption estimates as well as the main locations of this consumption and major production costs. This data were used in the company selection and design of the hierarchy tree by which 9 companies representative for their capacity, water supply source and major water consumers were selected. Table 2 summarizes the list of selected companies and their response to some of the questions.

Table 2. The selected Companies for Studying Water Reduction Strategies

Company Name	Nominal Capacity (Ton/year)	Type of Product	Water Supply Source	Water Treatment Plant	Major Water Consumers*	Major Production Costs*
Namiran	4000	Testliner	Urban Pipeline-Well	No	Pulping, Water Nozzles for Wire and Press Section	Recycled Paper, Personnel Salary, Water, Electricity and Fuel
Saghe Cellulose	3300	Corrugating Medium and Testliner	Industrial Complex Pipeline	No	Dryers	Personnel Salary, Electricity and Fuel, Wire and Felt Change, Depreciation of Machineries
Behsaz Shargh	9000	Testliner	Well	Yes (DAF)	Pulping, Washing Nozzles, Cooling Water	Raw Material, Personnel Salary, Fuel, Maintenance
Nil Garmsar	15000	Corrugating Medium and Testliner	Urban Pipeline	Yes (not active)	Boiler and Dryers	Electricity, Personnel Salary
Tehran Kaghaz	15000	Testliner	Industrial Complex Pipeline	Yes	Pulping, Washing Nozzles, Boiler, Sanitary and Drinking Water	Raw Material, Spare Parts, Fuel
Kimia Kaghaz	1000	Testliner	Well	Yes	Pulping, Washing Nozzles	Raw Material, Electricity, Fuel, Personnel Salary
Omid Kaghaz	4000	Testliner	Urban Pipeline	No	Pulping, Washing Nozzles	Water, Electricity
Kaghaz Alamot	4000	Corrugating Medium and Testliner	Well	Yes	Sanitary and Drinking Water, Washing Nozzles, Chemical Preparation, Boiler	Raw Material, Fuel, Electricity
Kahrizak	60000	Corrugating Medium and Topliner	Well	Yes	Washing Nozzles	Raw Material, Spare Parts

*according to rough estimate and experience of operating Staffs

2-2 Analytical Hierarchy Process

Utilization of Analytical Hierarchy Process involves four major levels as followings:

a) Modeling and the Hierarchy Tree Development

In this step, the objective and problem of decision making is derived from the decisions ' elements which are related to each other. The elements of decision include decision making criteria and alternatives. The hierarchy process requires the breakdown of a complex decision problem in a logical manner into many small but related sub-problems in the form of level of a hierarchy. The top level indicates the main objective of the decision making process. The second level comprises the main criteria which can be broken into subcriteria in the following levels. The last level presents the decision alternatives. Based on the data collected from the companies, The Training Resource Package published by United Nations Environment Program (16), Technical Guidelines published by European Community (17) and the pre-assumption of the following white water cycle in the paper machines as figure 2 shows, the hierarchical tree developed.

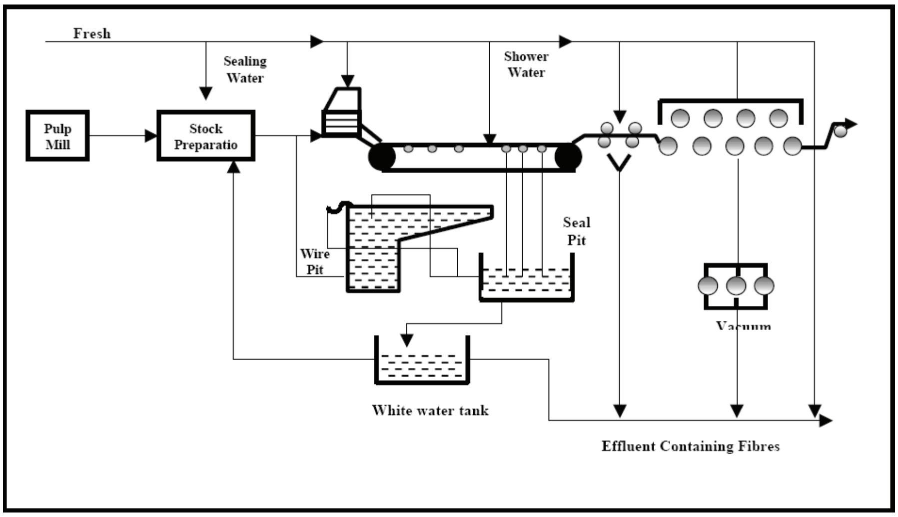

Figure 2. Typical White Water Cycle in Pulp and Paper Companies

The hierarchy tree for determining the water reduction consumption potentials was structured into tree levels as figure 3 shows. The effective factors were divided into manufacturing process, product, raw material, human resources, costs, environmental regulations and technological aspects. Subsequently, the criteria were extended to sub-categories (figure 3) from which the comparison tables are derived.

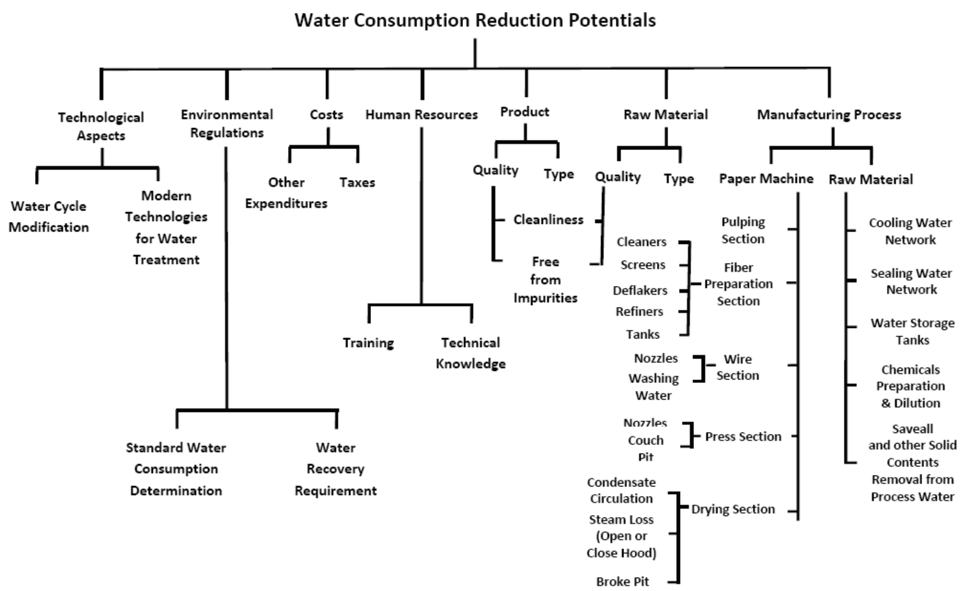

Figure 3. The hierarchy tree of the criteria and sub-criteria effective in water consumption rates.

b) **Developing the questionnaire and pair-wise comparisons**

The next step in AHP is data collection. This was done through a systematic series of pair-wised comparisons among the specific criteria and sub-criteria. AHP provides unique features for criteria weight and subjective evaluations by pair wise comparison and the 1-9 ratio scale in Table 3. The pair-wised comparison matrices were completed with the aid of 10 experts from industry and academia. The AHP then converts these comparisons to criteria weights using a matrix algebra-based algorithm while also checking for consistency in the results.

Table 3. Saaty's 1-9 scales for pair wise comparison in AHP

Importance intensity	**Definition**
1	Equal importance
3	Moderate importance of one over another
5	Strong importance of one over another
7	Very strong importance of one over another
9	Extreme importance of one over another
2,4,6,8	Intermediate values

C) Determining the normalized weights

With the completion of the pair-wised comparisons, mathematical computations were conducted. The first step in the evaluation is to normalize each matrix by adding the values of each b_{xy}. So a matrix (B) can be normalized:

$$B = \begin{pmatrix} b_{11} & b_{12} \cdots & b_{1n} \\ b_{21} & b_{22} \cdots & b_{2n} \\ \vdots & \vdots & \vdots \\ b_{n1} & b_{n2} \cdots & b_{nn} \end{pmatrix} = \begin{pmatrix} 1 & b_{12} \cdots & b_{1n} \\ 1/b_{12} & 1 \cdots & b_{2n} \\ \vdots & \vdots & \vdots \\ 1/b_{1n} & 1/b_{2n} \cdots & 1 \end{pmatrix}$$

Then the local weight W_{Bi} was calculated according to the formula:

$$W_{Bi} = \frac{\left[\prod_{j=1}^{n} b_{ij} \right]^{1/n}}{\sum_{i=1}^{n} \left[\prod_{j=1}^{n} b_{ij} \right]^{1/n}}$$

After determining the local weights, the global weights of each criteria and sub-criteria are calculated. To avoid misdirection analysis affected by interviewees' incompatible judgments, AHP establishes a consistency indicator as the standard judgment if the values are incompatible. The questionnaires involved in incompatible judgments were normally discussed with their answerers. Only the matrices that passed the consistency test were included in the final analysis.

d) Aggregating the weights and Expert Choice Software

To prioritize the decision alternatives, the weights of each element were multiplied by the weight of prior element to reach to the final weight. The implementation of this method for each stage would lead to final weight. The Expert Choice Software (http://www.expertchoice.com/) was applied for weight calculations. Expert Choice is a multi-attribute decision support software tool based on the analytic hierarchy process (AHP) methodology. Expert Choice poses a series of pair-wise comparisons of each of the alternatives identified in relation to each of the criteria and objectives. Expert Choice's five Sensitivity Graphs enables taking some of the uncertainty out of the decision making by quickly and easily testing the results using "what if" scenarios. A full range of reports - either printed in hard copy or pasted into other Windows applications - can be customized to individual needs for presenting results or documenting the decision making process through this software. Reports may include the entire decision hierarchy in sideways or tree view, specific segments of the hierarchy, details of the synthesis process, or sensitivity analysis.

3 Results and Discussion

As indicated in table 2, except Kahrizak the other companies are categorized in small-scale and medium-scale papermaking plants (lower than 5000 and between 5000 to 15000 tons annual production, respectively). Highlighted in table 2, despite the considerable water consumption by papermaking plants, only two companies of Namiran and Omid Kaghaz mentioned the cost of water consumption as their major production costs while the other 7 companies did not refer to the costs due to water utilization from water wells and the industrial complex and pretty likely the water consumption reduction is not considered as their challenge. On the other hand, although 6 out of 9 companies in this study stated the existence of water treatment plant in their factory, it should be noted that other than exceptions the only available technology for water treatment in this sort of companies is Dissolved Air Flotation System (DAF) which is responsible for fiber recovery and presents less effects on reducing the pollution of the wastewater to the required environmental standards.

3-1 Water Consumption Reduction Criteria Results

As shown in figure 4, the "Product" category is the most prominent water reduction criteria with a normalized global weight of 0.250 followed by manufacturing process, raw material, human resources, costs, environmental regulations and technological aspects, respectively. In the Product category, the "Type" of the product gained more global weight than the "Quality" of the product.

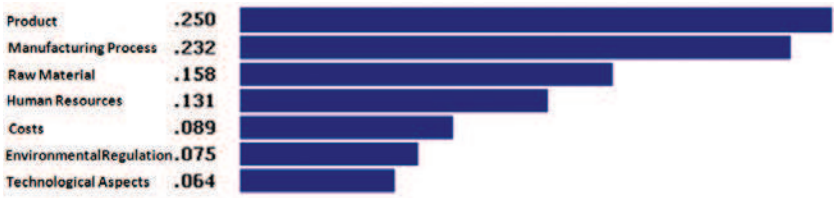

Figure 4. The prioritization of the main criteria in water consumption reduction

As table 2 indicates, the companies in this research manufacture three products of Topliner, Corrugating Medium and Testliner ordered from lower quality to higher quality. To produce the higher quality products, more complex manufacturing process and unit operations and application of new chemicals are indispensible and essential. The increase in the number of wastepaper processing stages and chemical preparation requires more water consumption implying the result signified by figure 4. Also, the raw material in all of these companies is mixed wastepaper. Despite, the higher quality of Old Corrugated Container (OCC) due to source sorting practices for this material compared to other types of wastepaper, OCC contains several process contaminants including Pressure Sensitive Adhesives (PSAs), low molecule weight extractable polymeric materials like styrene butadiene rubber (SBR), Copolymers, Polyvinyl Acetate (PVAc), Polyvinyl Alcohol (PVOH) and etc. (18-19) which pollute the process water and limit its re-use. As a rule of thumb, the amount of contaminants in raw material directly affects the fresh water utilization in recycled paper companies. The technical knowledge of human resources and training would indirectly influence the reduction of water consumption in the factories. The knowledge of fiber line potential to decrease water consumption and identification of major water consumers in the process and optimization of manufacturing process through training of personnel and operators can significantly affect the water consumption.

The environmental regulations and technological aspects were ranked in the lowest weighting levels. This result is expected because no water consumption standard has been defined yet for papermaking companies in Iran. On the other hand, since no wastewater and effluent discharge legislation or permit has been issued for recycled paper companies, the environmental regulations do not seem to be an effective factor in water consumption reduction in Iranian papermaking companies.

As figure 5 shows, in the manufacturing process criteria, the process design sub-criteria is regarded as more prominent than paper machine and in process design sub-criteria, the tanks and vessels of water storage are weighted more.

Figure 5. Prioritization of manufacturing process criteria

Figure 6 indicates that the sub-criterion of Type has more priority than Quality sub-criterion in Raw Material criteria. And in the Quality sub-criterion, the "Cleanliness" was superior to "Free from Other Impurities".

Figure 6. Prioritization of Raw Material criteria

The judgment of the experts about Human Resources criteria implies the priority of Technical Knowledge than Training as figure 7 shows.

Figure 7. Prioritization of Human Resources criteria

Figure 8 indicates that the Taxes sub-criterion is more prominent than Other Expenditures sub-criterion in Costs criteria.

Figure 8. Prioritization of Costs criteria

Figure 9 indicates that the Standard Water Consumption Determination sub-criterion is more prominent than Water Recovery Requirement sub-criterion in Environmental Regulations criteria.

Figure 9. Prioritization of Environmental Regulations criteria

Figure 10 indicates that the Modern Technologies in Water Treatment sub-criterion is more prominent than Water Cycle Modifications sub-criterion in Technological Aspects criteria.

Figure 10. Prioritization of Technological Aspects criteria

Decision alternatives in the prioritization of 30 criteria effective on Water Consumption Reduction Potentials have been summarized in figure 11.

According to figure 11 and as indicated before, the Type of Product directly affects the water consumption. Considering this priority, the selection of final product and setting the process variables in a way to optimize the production of the selected product would significantly influence the water consumption. The other major alternatives affecting the water consumption included cooling and sealing water network in the factories.

Other research projects have confirmed the importance of water cycle network in the manufacturing plants (20-21) in which the recovery of the water used in cooling and sealing of pumps, vacuum pumps and other equipment has been emphasized. Also, they have reported that in the case of water loops separation and use of white water from each section in the previous section, the suspended and organic solid content would reduce 2 to 4 times.

The significance of storage tanks and vessels and leaks control in water cycle network have been emphasized elsewhere (17, 22) in which storage capacity of process water tanks and broke pulp should be adjusted in a way to contain the maximum water discharge in the accidental shut downs preventing the overflows and leaks.

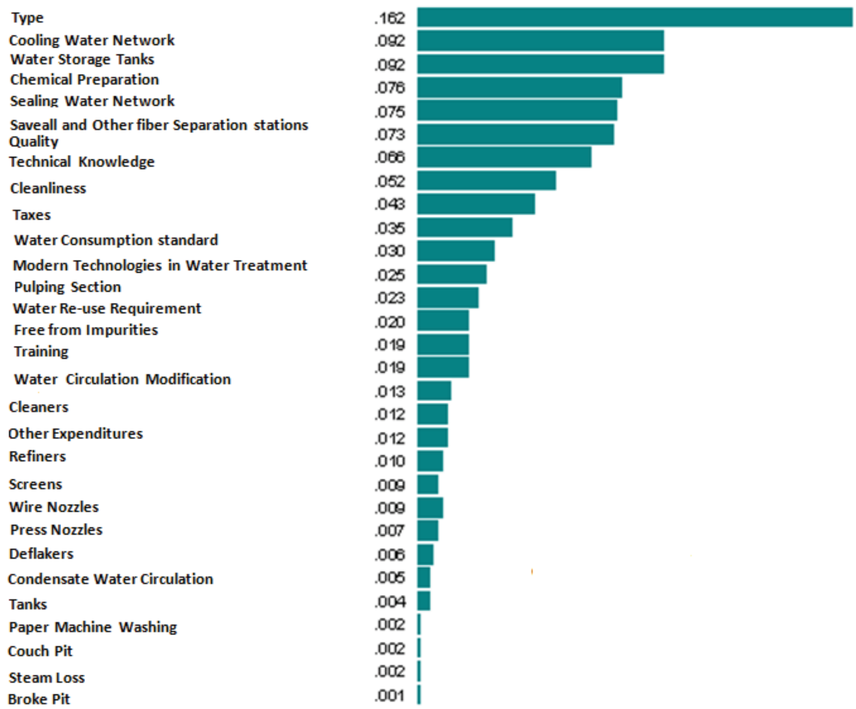

Figure 11. Decision alternatives in the prioritization of 30 criteria effective on Water Consumption Reduction Potentials

Despite that wire nozzles, press machine nozzles and steam loss in the dryers were placed in the lower levels of decision alternatives in the present research, others (23-24) have stated the remarkable loss of water in the mentioned sections and some practical approaches have been outlined.

Acknowledgment The authors would like to thank the assistance and collaboration of the companies taking part in information and data providing in form of the questionnaire and comparison tables. It is hoped that the results of this research can lead to a significant improvement in the manufacturing productivity.

Conclusion

Recycled paper production companies in Iran consume water far beyond the global standards and therefore require a careful attention. On the other hand, the solutions suggested by some of the available techniques and methods involve high financial expending which is not fully justifiable for the industry. The present project applied the Analytic Hierarchy Process (AHP) as a decision making tool for selecting the most prior decision for water reduction in Pulp and Paper manufacturing companies in Iran to enable them to obtain remarkable saving by the most prior approaches. The results indicated that 'final product" criterion was ranked first following by manufacturing process, human resources, costs and expenditures, environmental regulations and technical modifications, respectively. Also among alternatives, final product, cooling water network, and water storage tanks were categorized in the first three priorities. Regarding the results in the present paper, it is stated that reaching to optimized water consumption in the factories requires significant modifications as well as cooperation and partnership of the manufacturing personnel and management of the company. Considering the high costs and expenditures related to some alternations and modifications in the manufacturing process, the specified priorities in this paper can considerably help the decision makers in the companies to have more intended and prioritized decisions in water consumption reduction with minimum possible costs.

References

1. Hynninen, P., 1998, Environmental Control, Pulp and Paper Book Series, Fapet Oy.
2. Tajrishi M., Abrishamchi A., 2004, Management of Water Resources Supply in Iran, First Annual Conference of Prevention Methods of Water Waste, The Academy of Sciences of Islamic Republic of Iran, Tehran.
3. Ghornannezhad, P., 2008, "An integrated approach to pollution prevention for the forest industry: A Case Study of Kaveh Paper Mill", Master of Science Thesis submitted for the Department of Wood and Paper, Natural Resources Faculty, University of Tehran.
4. Bryant, Patrick S., Clark P. Woitkovich, and Earl W. Malcolm. 1996. “Pulp and Paper Mill Water Use in North America.” In Proceedings of the TAPPI 1996 International Environmental Conference and Exhibits, 451-60. Atlanta, Ga.: Technical Association of the Pulp and Paper Industry.
5. Gune, N.V., October/December 2000, "Total water management in pulp & paper industry with focus on achieving 'zero effluent discharge' status", : IPPTA: Quarterly Journal of Indian Pulp and Paper Technical Association, v 12, n 4, p 137-142.
6. Hirosh A., July 2004, "Effluent minimization in european and North American pulp and paper industries - Major incentives for mills to reduce water consumption", Kami Pa Gikyoshi/Japan Tappi Journal, v 58, n 7, p 3-18.
7. Faleiros M., May 2009, "Despite still plentiful, water resources demand for good management", O Papel (Brazil), v 70, n 5, p 32-35.
8. Feng W., January 2009, "New initiatives for environmental protection and energy saving in the Chinese paper industry", Appita Journal, v 62, n 1, p 10-12.
9. Shi, H., Peng, S.Z., Liu, Y., Zhong, P., 2008, "Barriers to the implementation of cleaner production in Chinese SMEs: government, industry and expert stakeholders’ perspectives", Journal of Cleaner Production, Vol. 16, pp: 842-852.
10. Ghazinoory, S., 2005, "Cleaner production in Iran: necessities and priorities", Journal of Cleaner Production, Vol. 13, 755-762.

11. Ghazinoory, S., Huisingh, D., 2006, "National program for cleaner production (CP) in Iran: a framework and draft", Journal of Cleaner Production, Vol. 14, 194-200.
12. Satty, T.L., 1980, "The analytic Hierarchy Process", McGraw-Hill international, New York, RWS publications, Pittsburgh.
13. Satty, T.L., 2000, "Fundamentals of Decision Making with Analytic Hierarchy Process", paperback, RWS publications, 4922 Ellsworth Avenue, Pittsburgh, PA 15213-2807.
14. Saaty T.L., 2001, "Decision Making with Dependence and Feedback: The Analytic Network Process", RWS publications, Pittsburgh, PA, pp 376.
15. Saaty, T.L., 2007, "Time dependent decision-making; dynamic priorities AHP/ANP: Generalizing from points to functions and from real to complex variables", Mathematical and Computer modeling, 46:860-891.
16. Svenningsen N., Radka M., Berkel R.V., 1998, "Cleaner Production in Pulp and Paper Mills: A Training Resource Package", United Nations Environment Program (UNEP) Publication, ISBN 92-807-1712-X.
17. CTP: Centre Technique du Papier, 2002, "PAPERBREF, Technical guidelines (Water Management Concept) for paper makers in European Regions with difficult boundry conditions on how to operate mills with minimum water use", Project funded by the European Community under the "Energy, Environment and Sustainable Development" Program (1998-2002).
18. Holbery J. D., Wood D. L., Fisher R. M., JULY 2000, "Analysis and characterization of contaminants in OCC recycle furnishes", TAPPI JOURNAL, VOL. 83: NO. 7.
19. Kortmeyer, J.; Yordan, J. L.; Lasmarias, V.; Anderson, L., 2004, Identication and quantification of process water contaminants from paper mills using old corrugated containers, Research Forum on Recycling, Proceedings, p 125-132, 7th Research Forum on Recycling.
20. Albert, M. Beaudet, J.-F. Hurley, R. Tomney, T. Glasgow, R. Arsenault, P. , 2006, "Recycling vacuum seal water using the actiflo® process for reduction of water consumption and for improvement of energy recovery", Annual Meeting of the Pulp and Paper Technical Association of Canada (PAPTAC), v A, p A273-A278, PAPTAC 92nd Annual Meeting Preprints.
21. Wirth, B.; Kosse, J.; Welt, T.; August 2005, "Importance of water loops in production of corrugated board raw paper", Wochenblatt fuer Papierfabrikation, v 133, n 16, p 974-978.
22. Kroushl, Paul W., Nov 1984, "Demand reduction: conservation through leak detection", Canadian Water Resources Journal, v 9, n 3, p 48-50.
23. Akaike, Hideki; June 2009, "Reduction of steam consumption rate by heat recovery of turbine condenser cooling water", Kami Pa Gikyoshi/Japan Tappi Journal, v 63, n 6, p 41-44.
24. Matsushita, Makoto; Numata, Yoshiharu, 2008, PVDF emblem/micro filter water recycling system, Kami Pa Gikyoshi/Japan Tappi Journal, v 62, n 6, p 60-63.

Reduction and Recycling of Industrial Waste. Achieved â€œZero Landll Wasteâ€ Target at All Plants Chart 6. In response to an imminent shortage of capacity at landll waste.Â Reducing Water Consumption and Recycling Water. Water Consumption per Vehicle Manufactured Reduced by Approximately 30% Compared with FY 1996 Graph 12, 13. Toyota Industries has strived to control and reduce the amount of water consumed at every plant.Â To further reduce water consumption, we will start to recycle wastewater in line with the completed refurbishment of the wastewater treatment facility at the Nagakusa Plant in FY 2006. Through such efforts, we expect the recycling rate of used water* will rise from 2% in FY 2005 to 9%. This strategy lays the foundations to a new plastics economy, where the design and production of plastics and plastic products fully respect reuse, repair and recycling needs and more sustainable materials are developed and promoted.Â By 2030, all plastics packaging placed on the EU market is either reusable or can be recycled in a cost-effective manner. â–ºâ–º Changes in production and design enable higher plastics recycling rates for all key applications.Â Outside Europe, plastics consumption per capita is growing quickly, most notably in Asia.59 Plastics value chains are developed across entire continents and plastic waste is traded internationally: in the EU about half the plastic waste collected is sent abroad, where uncertainty remains over its treatment.