T.R.
MINISTRY OF AGRICULTURE AND FORESTRY
GENERAL DIRECTORATE OF WATER MANAGEMENT

Water Efficiency Campaign

Water Efficiency Guidance Documents Series

FRESHWATER FISHING

NACE CODE: 03.12

ANKARA 2023

It was commissioned by the Ministry of Agriculture and Forestry, General Directorate of Water Management to the Contractor io Çevre Çözümleri R&D Ltd. Şti.

Table of Contents

Abbreviations

WTP	Wastewater Treatment Plant
EU	European Union
SSM	Suspended Solid Matter
BREF	Best Available Techniques Reference Document
EMS	Environmental Management System
MEUCC	Republic of Turkey Ministry of Environment, Urbanisation and Climate Change
NOC	Natural Organic Matter
EMAS	Eco-Management and Audit Programme Directive
EPA	United States Environmental Protection Agency
IPPC	Industrial Pollution Prevention and Control
ISO	International Standards Organisation
BET	Best Available Techniques
NACE	Statistical Classification of Economic Activities
GDWM	General Directorate of Water Management
RO	Reverse Osmosis
MAF	Republic of Turkey Ministry of Agriculture and Forestry
TSI	Turkish Statistical Institute
NF	Nanofiltration
MF	Microfiltration
UF	Ultrafiltration
GW	Groundwater
SW	Surface Water

1 Introduction

Türkiye is located in the Mediterranean basin, where the effects of global climate change are felt intensely, and is considered to be among the regions that will be most affected by the negative effects of climate change. Projections on how our water resources in our basins will be affected in the future due to climate change show that our water resources may decrease by up to 25 per cent in the next hundred years.

For the year 2022, the annual amount of water available per capita in Türkiye is 1,313 m^3, and it is expected that the annual amount of water available per capita will fall below 1,000 cubic metres after 2030 due to human pressures and the effects of climate change. If the necessary measures are not taken, it is obvious that Turkey will become a country suffering from water scarcity in the very near future and will bring many negative social and economic consequences. As can be understood from the results of future projections, the risk of drought and water scarcity awaiting our country necessitates the efficient and sustainable use of our existing water resources.

The concept of water efficiency can be defined as *"using the least amount of water in the production of a product or service"*. The water efficiency approach is based on the rational, sharing, equitable, efficient and effective use of water in all sectors, especially in drinking water, agriculture, industry and household use, in a way that protects water in terms of quantity and quality and takes into account not only the needs of humans but also the needs of all living things with ecosystem sensitivity.

With the increasing demand for water resources, changes in precipitation and temperature regimes as a result of climate change, increasing population, urbanisation and pollution, fair and balanced allocation of usable water resources among users is becoming more and more important every day. For this reason, it has become a necessity to create a road map based on efficiency and optimisation in order to protect and use limited water resources through sustainable management practices.

In the vision of sustainable development set by the United Nations, *Goal 7: Ensuring Environmental Sustainability* from the Millennium Development Goals and *Goal 9: Industry, Innovation and Infrastructure* and *Goal 12: Responsible Production and Consumption* from the Sustainable Development Goals include issues such as efficient, fair and sustainable use of resources, especially water, environmentally friendly production and consumption with the concern of future generations.

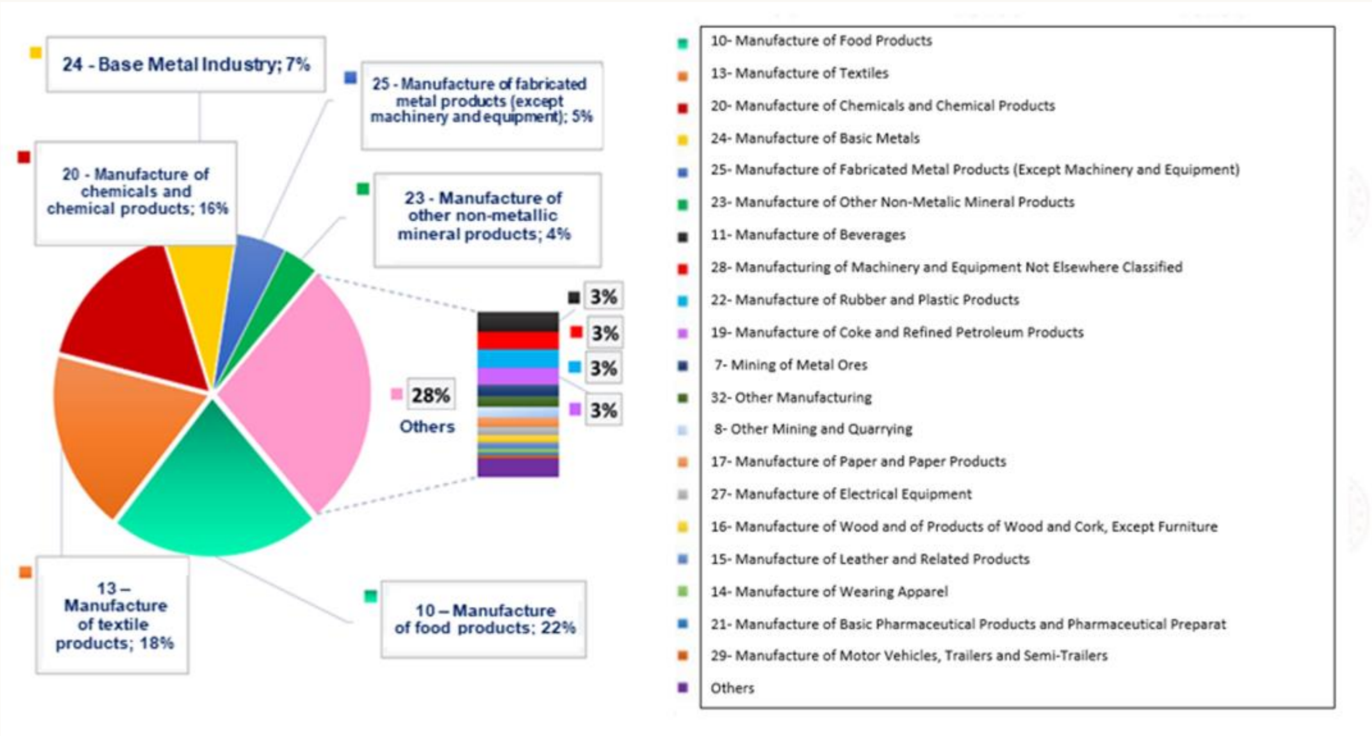
In the European Green Deal Action Plan prepared by our country within the scope of the European Green Deal Action Plan, in which member countries agreed on the objectives such as implementing a clean, circular economy model with a carbon neutral target, expanding the efficient use of resources and reducing environmental impacts, actions emphasising water and resource efficiency in production and consumption in various fields, especially in industry, have been determined.

The "Industrial Emissions Directive (EED)", which is one of the most important components of the European Union environmental legislation in terms of industry, includes measures to be taken for the control, prevention or reduction of discharges/emissions from industrial activities to the receiving environment, including air, water and soil, with an integrated approach. In the Directive, Best Available Techniques (BAT) are presented in order to systematise the applicability of cleaner production processes and to eliminate difficulties in implementation. BATs are the most effective implementation techniques for a high level of environmental protection, taking into account their costs and benefits. In accordance with the Directive, Reference Documents (BAT-BREF) have been prepared for each sector in which BATs are explained in detail. In BREF documents, BATs are presented in a general framework such as good management practices, techniques as general measures, chemical use and management, techniques for various production processes, wastewater management, emission management and waste management.

The Ministry of Agriculture and Forestry, General Directorate of Water Management carries out activities aimed at disseminating efficient practices in urban, agricultural, industrial and individual water use and raising social awareness. Water efficiency action plans addressing all sectors and stakeholders were prepared within the scope of ***the "Water Efficiency Strategy Document and Action Plan (2023-2033) within the Framework of Adaptation to a Changing Climate"***, which entered into force with the Presidential Circular No. 2023/9. In the Industrial Water Efficiency Action Plan, a total of 12 actions have been determined for the period 2023-2033 and responsible and relevant institutions have been assigned for these actions. Within the scope of the Action Plan, the General Directorate of Water Management is responsible for carrying out studies to determine specific water use ranges and quality requirements on the basis of sub-sectors in industry, organising technical training programmes and workshops on sectoral basis and preparing water efficiency guidance documents.

On the other hand, with the ***"Industrial Water Use Efficiency Project by NACE Codes"*** carried out by the General Directorate of Water Management of the Ministry of Agriculture and Forestry, the best sectoral techniques specific to our country were determined within the scope of studies on improving water efficiency in industry. As a result of the study, sectoral guidance documents and action plans categorised by NACE codes, including the measures recommended for improving water use efficiency in sectors with high water consumption operating in our country, were prepared.

As in the world, the sectors with the highest share in water consumption in our country are food, textile, chemical and basic metal sectors. Within the scope of the studies, field visits were carried out in enterprises representing 152 sub-sectors in 35 main sectors, especially food, textile, chemical and basic metal industries, which represent production areas with different capacities and diversity within the scope of NACE Codes operating in our country and with high water consumption, and data on water supply, sectoral water use, wastewater generation, recycling were obtained and information was provided on best available techniques (BAT) and sectoral reference documents (BREF), water efficiency, clean production, water footprint, etc. published by the European Union.



Sectoral distribution of water use in industry in Türkiye

As a result of the studies, specific water consumption and potential saving rates for the processes of enterprises for 152 different 4-digit NACE codes with high water consumption were determined, and water efficiency guidance documents were prepared by taking into account the EU best available techniques (BAT) and other cleaner production techniques. Within the guidelines, 500 techniques (BAT) for water efficiency;
(i) Good Management Practices, (ii) General Measures, (iii) Measures Related to Auxiliary Processes and (iv) Sector Specific Measures.

Within the scope of the project, environmental benefits, operational data, technical specifications-requirements and applicability criteria were taken into consideration during the determination of BATs for each sector. In the determination of BATs, not only BREF documents were not limited, but also different data sources such as current literature data on a global scale, real case analyses, innovative practices, reports of sector representatives were examined in detail and sectoral BAT lists were created. In order to evaluate the suitability of the BAT lists created for the local industrial infrastructure and capacity of our country, the BAT lists prepared specifically for each NACE code were prioritised by the enterprises by scoring them on the criteria of water saving, economic savings, environmental benefit, applicability, cross-media impact and the final BAT lists were determined using the scoring results. Water and wastewater data of the facilities visited within the scope of the project and the final BAT lists, which were prioritised by sectoral stakeholders and determined by taking into account the local dynamics specific to our country, were used to create sectoral water efficiency guides on the basis of NACE code.

2 Scope of the Study

- The guidance documents prepared under the water efficiency measures in the industry include the following main sectors:
- Plant and animal production, hunting, and related service activities (including 6 four-digit NACE codes representing sub-production areas)
- Fishing and aquaculture (including 1 four-digit NACE code representing a sub-production area)
- Extraction of coal and lignite (including 2 four-digit NACE codes representing sub-production areas)
- Support activities for mining (including 1 four-digit NACE code representing a sub-production area)
- Mining of metal ores (including 2 four-digit NACE codes representing sub-production areas)
- Other mining and quarrying (including 2 four-digit NACE codes representing sub-production areas)
- Food product manufacturing (including 22 four-digit NACE codes representing sub-production areas)
- Beverage manufacturing (including 4 four-digit NACE codes representing sub-production areas)
- Tobacco product manufacturing (including 1 four-digit NACE code representing a sub-production area)
- Textile product manufacturing (including 9 four-digit NACE codes representing sub-production areas)
- Clothing manufacturing (including 1 four-digit NACE code representing a sub-production area)
- Leather and related product manufacturing (including 3 four-digit NACE codes representing sub-production areas)
- Manufacturing of wood, wood products, and cork products (excluding furniture); manufacturing of items woven from rushes, straw, and similar materials (including 5 four-digit NACE codes representing sub-production areas)
- Paper and paper product manufacturing (including 3 four-digit NACE codes representing sub-production areas)
- Manufacturing of coke and refined petroleum products (including 1 four-digit NACE code representing a sub-production area)
- Chemical and chemical product manufacturing (including 13 four-digit NACE codes representing sub-production areas)
- Manufacturing of basic pharmaceutical products and pharmaceutical preparations (including 1 four-digit NACE code representing a sub-production area)
- Rubber and plastic product manufacturing (including 6 four-digit NACE codes representing sub-production areas)
- Manufacturing of other non-metallic mineral products (including 12 four-digit NACE codes representing sub-production areas)
- Basic metal manufacturing (including 11 four-digit NACE codes representing sub-production areas)
- Manufacturing of fabricated metal products (excluding machinery and equipment) (including 12 four-digit NACE codes representing sub-production areas)

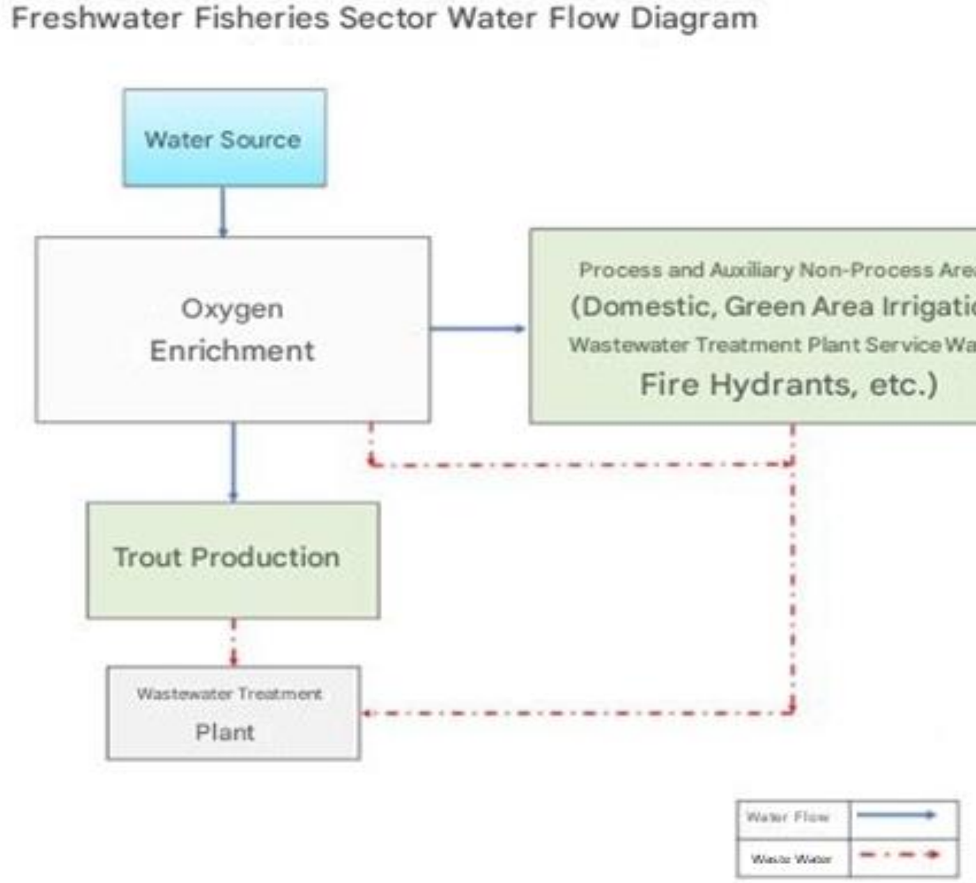
- Manufacturing of electrical equipment (including 7 four-digit NACE codes representing sub-production areas)
- Manufacturing of machinery and equipment not elsewhere classified (including sub-production area represented by 8 four-digit NACE codes)
- Manufacturing of computers, electronic, and optical products (including 2 four-digit NACE codes representing sub-production areas)
- Manufacturing of motor vehicles, trailers, and semi-trailers (including 3 four-digit NACE codes representing sub-production areas)Water Efficiency Guidance Document
- Manufacture of other transportation equipment (including sub-production area represented by 2 four-digit NACE Codes)
- Other manufacturing (including sub-production area represented by 2 four-digit NACE Codes)
- Installation and repair of machinery and equipment (including sub-production area represented by 2 four-digit NACE Codes)
- Production and distribution of electricity, gas, steam and ventilation systems (including sub-production area represented by 2 four-digit NACE Codes)
- Collection, treatment and disposal activities of waste; materials recovery (including sub-production area represented by 1 four-digit NACE Code)
- Construction of external structures (including sub-production area represented by 1 four-digit NACE Code)
- Storage and support activities for transportation (including sub-production area represented by 1 four-digit NACE Code)
- Accommodation (including sub-production area represented by 1 four-digit NACE Code)
- Educational Activities (Higher Education Campuses) (including sub-production area represented by 1 four-digit NACE Code)
- Sports activities, entertainment and recreation activities (including sub-production area represented by 1 four-digit NACE Code)

Fisheries and aquaculture

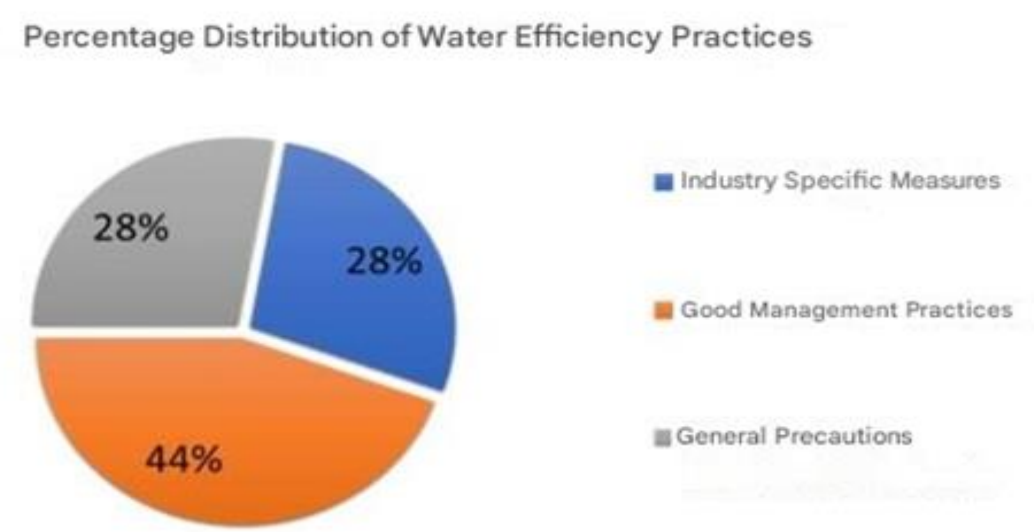
Under the sector of fisheries and aquaculture and related service activities, the sub-production branches for which guidance documents have been prepared are as follows

03.12Freshwater fishing

2.1 Freshwater Fishing (NACE 03.12)



	Minimum	Maximum
Specific Water Consumption of Facilities Visited Within the Scope of the Project (L/kg)	140,786	
Reference Specific Water Consumption (L/kg)	10	200



Within the scope of freshwater fisheries, cold, clear and oxygenated rivers, lakes and spring waters are preferred for trout farming. It is extremely important that the area where freshwater fisheries will be cultivated is close to the water source, since the temperature of the water along the way increases as it moves away from the source, and the risk of turbidity and pollution increases. During the production process, necessary precautions should be taken to ensure that the dissolved oxygen concentration in the water does not decrease.

The reference specific water consumption in the freshwater fishery sector is in the range of 10 - 200 L/kg. The specific water consumption of the production branch analysed within the scope of the study is 140.786 L/kg. With the implementation of sector-specific measures, good management practices and general measures, it is possible to achieve water savings of 27 - 42% in the sector.

03.12 Priority water efficiency implementation techniques recommended within the scope of Freshwater Fishing NACE code are presented in the table below.

NACE Code	NACE Code Description	Prioritised Sectoral Water Efficiency Techniques
03.12	Freshwater	**Sector Specific Measures**
		1. Application of well-graded soils to the bottom to prevent seepage loss from the pond bottom Application of techniques such as adding bentonite or dispersing agents to the soil applied to the bottom or placing flexible membranes on the bottom
		2. Production and use of highly digestible protein-based feeds, thereby reducing fish faeces
		3.Daily, monthly and annual maintenance of the pools
		4. Construction of ponds lined with clay or plastic to prevent leakage loss from ponds in aquaculture facilities
		5. More efficient use of existing water through oxygen integration
		Good Management Practices
		1. Use integrated wastewater management and treatment strategy to reduce wastewater quantity and pollutant load
		2. Establishment of environmental management system
		3. Preparation of water flow diagrams and mass balances for water
		4. Preparing a water efficiency action plan to reduce water use and prevent water pollution
		5. Providing technical trainings to personnel for the reduction and optimisation of water use
		6. Good production planning to optimise water consumption
		7. Determination of water efficiency targets
		8. Water used in production processes and auxiliary processes and the resulting monitoring of wastewater in terms of quantity and quality and adapting this information to the environmental management system

NACE Code	NACE Code Description		Prioritised Sectoral Water Efficiency Techniques
03.12	Freshwater		**General Water Efficiency BATs**
		1.	Minimising spillages and leakages
		2.	Shower/toilet etc. will provide water saving at water usage points use of automated hardware and equipment (sensors, smart hand washing system, etc.)
		3.	Identification and minimisation of water losses
		4.	Documented production procedures are kept and used by employees to prevent water and energy wastage
		5.	Prevention of mixing of clean water flows with polluted water flows
		6.	Implementation of time optimisation in production and arrangement of all processes to be completed as soon as possible
		7.	Separate collection and treatment of grey water in the plant and high water quality in areas that do not require (green area irrigation, floor, floor washing, etc.)
		8.	Collecting rainwater and utilising it as an alternative water source in facility cleaning or in suitable areas
A total of 21 techniques have been proposed in this sector.			

For Freshwater
Fishing NACE Code;

(i) Sector Specific Measures,
(ii) Good Management Practices,
(iii) General Precautions
are given under separate headings.

2.1.1 Sector Specific Measures

- ***Prevention of possible leaks on the pool floor***

  In aquaculture, leaks at the bottom of the ponds cause significant water losses. Techniques such as applying well-graded soils to the bottom, adding bentonite or dispersing agents to the soil applied to the bottom, or placing flexible membranes on the bottom can be applied to prevent seepage at the bottom. A less expensive but less reliable way to reduce seepage is to incorporate organic matter such as manure, plant residues or scrap paper into the application of well-graded soil at the pond bottom (Boyd & Gross, 1994).

- ***Construction of pools lined with clay or plastic to prevent leaks***

  Depending on climatic conditions, the need for water replenishment of open-top ponds varies. In order to prevent seepage loss, it is generally recommended to construct ponds excavated with an excavator and lined with clay or plastic (Günerhan, n.d.).

- ***Daily, monthly and annual maintenance of the pools***

  Inspection, maintenance and repair of the water inlet-outlet, water discharge weir grates, canal and pond walls, and daily, monthly and annual maintenance aimed at increasing pond efficiency provide control and reduction of water losses. Short-term maintenance of ponds includes checking water inlet and outlet, discharge weir grates, channel and pond walls and fish mortality. Annual maintenance includes repair of ponds after the fish harvest in autumn and efforts to increase yield. The necessary maintenance and repairs of the empty ponds are carried out during the winter and preparation is made for the next production period (Korkmaz, n.d.).

- ***Reducing pollution in the pond by using highly digestible protein-based feeds***

  By using highly digestible protein-based feeds, fish faeces can be reduced and the pollution rate in the pond can be reduced. Although the technique is not a direct water reduction technique, it provides environmental benefits as it reduces the pollution load in the receiving environment.

- ***More efficient use of existing water through oxygen integration***

  The oxygen level in the water not only ensures growth, but also supports the health, appetite and general welfare of the aquatic organisms and reduces the effects of temperature-induced stress. In this context, it is aimed to provide more efficient production by using the same amount of water with oxygen integration.

Oxygenation Application in Fish Farming

Oxygenation Application in Fish Farming by Making Water Fall

2.1.2 Good Management Practices

- ***Establishment of environmental management system***

Environmental Management Systems (EMS) include the organisational structure, responsibilities, procedures and resources required to develop, implement and monitor the environmental policies of industrial organisations. The establishment of an environmental management system improves the decision-making processes between raw materials, water and wastewater infrastructure, planned production process and different treatment techniques. Environmental management organises how resource supply and waste discharge demands can be managed with the highest economic efficiency, without compromising product quality and with the least possible impact on the environment.

The most widely used Environmental Management Standard is ISO 14001. Alternatives include the Eco Management and Audit Scheme Directive (EMAS) (761/2001). It was developed for the assessment, improvement and reporting of the environmental performance of enterprises. It is one of the leading practices within the scope of eco-efficiency (cleaner production) in EU legislation and voluntary participation is provided (TUBITAK MAM, 2016; TOB, 2021). The benefits of establishing and implementing an Environmental Management System are as follows:

- Economic benefits can be obtained by improving business performance (Christopher, 1998).
- International Standards Organisation (ISO) standards are adopted to ensure greater compliance with global legal and regulatory requirements (Christopher, 1998).
- While the risks of penalties related to environmental responsibilities are minimised, the amount of waste, resource consumption and operating costs are reduced (Delmas, 2009).
- The use of internationally recognised environmental standards eliminates the need for multiple registrations and certificates for businesses operating in different locations around the world (Hutchens Jr., 2017).
- Especially in recent years, the improvement of the internal control processes of companies is also considered important by consumers. The implementation of environmental management systems provides a competitive advantage against companies that do not adopt the standard. It also contributes to the better position of organisations in international areas / markets (Potoski & Prakash, 2005).

The above-mentioned benefits depend on many factors such as the production process, management practices, resource utilisation and potential environmental impacts (TOB, 2021). Practices such as preparing annual inventory reports with similar content to the environmental management system and monitoring inputs and outputs in terms of quantity and quality in production processes can save 3-5% of water consumption (Öztürk, 2014). The total duration of the development and implementation phases of the EMS takes an estimated 8-12 months (ISO 14001 User Manual, 2015).

Industrial organisations also carry out studies within the scope of ISO 14046 Water Footprint Standard, an international standard that defines the requirements and guidelines for assessing and reporting water footprint. With the implementation of the relevant standard, it is aimed to reduce the use of fresh water required for production and environmental impacts. In addition, ISO 46001 Water Efficiency Management Systems Standard, which helps industrial organisations to save water and reduce operating costs, helps organisations to develop water efficiency policies by conducting monitoring, benchmarking and review studies.

- ***Use integrated wastewater management and treatment strategy to reduce wastewater quantity and pollutant load***

  Wastewater management should be based on a holistic approach from wastewater generation to final disposal and includes functional elements such as composition, collection, treatment including sludge disposal and reuse. The selection of the appropriate treatment technology for industrial wastewater depends on integrated factors such as land availability, desired treated water quality and compliance with national and local regulations (Abbassi & Al Baz, 2008).

  On-site reuse of treated wastewater not only improves the quality of water bodies, but also reduces the demand for freshwater. It is therefore very important to identify appropriate treatment strategies for different reuse objectives.

  In integrated industrial wastewater treatment, different aspects such as wastewater collection system, treatment process and reuse target are evaluated together (Naghedi et al., 2020). For industrial wastewater recovery, methods such as SWOT method (strengths, weaknesses, opportunities and threats), PESTEL method (political, economic, social, technological, environmental and legal factors), decision tree can be combined with expert opinions to determine the integrated wastewater management framework (Naghedi et al., 2020). The integration of Analytic Hierarchy Process (AHP) and CoCoSo techniques can be used to determine priorities based on multiple criteria for industrial wastewater management processes (Adar et al., 2021).

  The implementation of integrated wastewater management strategies can lead to an average reduction of up to 25% in water consumption, wastewater quantity and pollution loads of wastewater. The potential payback period of the implementation varies between 1-10 years (MoAF, 2021).

http://www.asw-eg.com/en/images/products/116567Water-Sewage-Treatment-System-With-Plant-And-Facility.jpg

Industrial Wastewater Treatment Plant

- ***Providing technical trainings to personnel for the reduction and optimisation of water use***

  With this measure, water saving and water recovery can be achieved by increasing the training and awareness of the personnel, and water efficiency can be achieved by reducing water consumption and costs. In industrial facilities, problems related to high water consumption and wastewater generation may arise due to the lack of necessary technical knowledge of the personnel. For example, it is important that cooling tower operators, which represent a significant proportion of water consumption in industrial operations, are properly trained and have technical knowledge. Determination of water quality requirements in production processes, measurement of water and wastewater quantities, etc. It is also necessary for the relevant personnel to have sufficient technical knowledge (TOB, 2021). Therefore, it is important to provide training to staff on water use reduction, optimisation and water saving policies. Practices such as involving the staff in water saving studies, creating regular reports on the amount of water use before and after water efficiency initiatives, and sharing these reports with the staff support participation and motivation in the process. The technical, economic and environmental benefits to be obtained through staff training yield results in the medium or long term (TUBITAK MAM, 2016; TOB, 2021).

- ***Monitoring the water used in production processes and auxiliary processes and the wastewater generated in terms of quantity and quality and adapting this information to the environmental management system*** There is resource utilisation in industrial facilities and there is resource utilisation as a result of resource utilisation.

  Inefficiency and environmental problems may arise from input-output flows. For this reason Water and wastewater used in production processes and auxiliary processes should be monitored in terms of quantity and quality (TUBITAK MAM, 2016; TOB, 2021). Process-based quantity and quality monitoring together with other good management practices (personnel training, establishment of an environmental management system, etc.) can reduce energy consumption by 6-10%, water consumption and wastewater quantities by
  It can provide a reduction of up to 25% (Öztürk, 2014).

  The main stages for monitoring water and wastewater in terms of quantity and quality are as follows

  - Use of monitoring equipment (such as counters) to monitor water, energy, etc. consumption on a process basis,
  - Establishment of monitoring procedures,
  - Determining the use/exit points of all inputs and outputs (raw materials, chemicals, water, products, wastewater, sludge, solid waste, hazardous waste and by-products) related to the production process, monitoring, documenting, comparative evaluation and reporting in terms of quantity and quality,
  - Monitoring raw material losses in production processes where raw materials are transformed into products and taking measures against raw material losses (MoEU, 2020e).

- ***Good production planning to optimise water consumption***

  In industrial production processes, planning by using the least process in the process from raw material to product is an effective practice for reducing labour costs, resource use costs and environmental impacts and ensuring efficiency (TUBITAK MAM, 2016; TOB, 2021). Production planning in industrial plants, taking into account the water efficiency factor, reduces water consumption and wastewater amount. Modification of production processes in industrial plants or combining some processes provides significant benefits in terms of water efficiency and time planning (TOB, 2021).

- ***Preparing a water efficiency action plan to reduce water use and prevent water pollution***

  It is important for water efficiency to prepare an action plan that includes short, medium and long term actions to be taken in order to reduce water-wastewater quantities and prevent water pollution in industrial facilities. At this point, determination of water needs throughout the facility and in production processes, determination of quality requirements at water use points, wastewater generation points and wastewater characterisation should be carried out (TOB, 2021). At the same time, it is necessary to determine the measures to be implemented to reduce water consumption, wastewater generation and pollution loads, to make their feasibility and to prepare action plans for the short-medium-long term. In this way, water efficiency and sustainable water use are ensured in the facilities (TOB, 2021).

- ***Determination of water efficiency targets***

  The first step in achieving water efficiency in industrial facilities is to set targets (TOB, 2021). For this, a detailed water efficiency analysis should be carried out on the basis of processes. In this way, unnecessary water use, water losses, wrong practices affecting water efficiency, process losses, reusable water-wastewater sources with or without treatment, etc. can be determined. It is also extremely important to determine the water saving potential and water efficiency targets for each production process and the plant as a whole (TOB, 2021).

- ***Preparation of water flow diagrams and mass balances for water***

  Determination of water use and wastewater generation points in industrial plants, establishment of water-wastewater balances in production processes and auxiliary processes other than production processes constitute the basis of many good management practices in general. Establishing process profiles throughout the plant and on the basis of production processes facilitates the identification of unnecessary water use points and high water use points, evaluation of water recovery opportunities, process modifications and determination of water losses (TOB, 2021).

2.1.3 General Water Efficiency BATs

- ***Identification and minimisation of water losses***

  Water losses occur in equipment, pumps and pipelines in industrial production processes. Firstly, water losses should be identified and leakages should be prevented by regular maintenance of equipment, pumps and pipelines to keep them in good condition (IPPC BREF, 2003). Regular maintenance procedures should be established, paying particular attention to the following points:

  - Adding pumps, valves, level switches, pressure and flow regulators to the maintenance checklist,
  - Carrying out inspections not only in the water system, but also in particular in the heat transfer and chemical distribution systems, broken and leaking pipes, barrels, pumps and valves,
  - Regular cleaning of filters and pipework,
  - Calibrate, routinely check and monitor measuring equipment such as chemical measuring and dispensing devices, thermometers, etc. (IPPC BREF, 2003).

  With effective maintenance-repair, cleaning and loss control practices, savings ranging from 1-6% in water consumption can be achieved (Öztürk, 2014).

- ***Minimising spillages and leakages***

  Both raw material and water losses can occur due to spills and leaks in enterprises. In addition, if wet cleaning methods are used to clean the areas where spillage occurs, water consumption, wastewater amounts and pollution loads of wastewater may also increase (TOB, 2021). In order to reduce raw material and product losses, spill and splash losses are reduced by using splash guards, flaps, drip trays, sieves (IPPC BREF, 2019).

- ***Prevention of mixing of clean water flows with polluted water flows***

  By determining the wastewater generation points in industrial facilities and characterising the wastewater, wastewater with high pollution load and relatively clean wastewater can be collected in separate lines (TUBITAK MAM, 2016; TOB, 2021). In this way, wastewater streams with appropriate quality can be reused with or without treatment. With the separation of wastewater streams, water pollution is reduced, treatment performances are improved, energy consumption can be reduced in relation to the reduction of treatment needs, and emissions are reduced by providing wastewater recovery and recovery of valuable materials. In addition, heat recovery from separated hot wastewater streams is also possible (TUBITAK MAM, 2016; TOB, 2021). Separation of wastewater streams usually requires high investment costs, and where it is possible to recover large amounts of wastewater and energy, costs can be reduced (IPPC BREF, 2006).

- ***Separate collection and treatment of grey water in the facility and its use in areas that do not require high water quality (green area irrigation, floor washing, etc.)***

  Wastewater generated in industrial facilities is not only industrial wastewater from production processes, but also includes wastewater from showers, sinks, kitchens, etc. Wastewater from shower, sink, kitchen etc. areas is called grey water. Water savings can be achieved by treating these grey waters with various treatment processes and using them in areas that do not require high water quality.

- ***Documented production procedures are kept and used by employees to prevent water and energy wastage***

  In order to ensure efficient production in an enterprise, effective procedures should be implemented to identify and evaluate potential problems and resources and to control production stages (Ayan, 2010). Determining and implementing appropriate procedures in production processes ensures more efficient use of resources (such as raw materials, water, energy, chemicals, personnel and time) and ensures reliability and quality in production processes (Ayan, 2010). The existence of documented production procedures in production processes contributes to the evaluation of business performance and the development of the ability to develop immediate reflexes to solve problems (TUBITAK MAM, 2016; TOB, 2021). Effective implementation and monitoring of the procedures created specifically for production processes is one of the most effective ways to ensure product quality, receive feedback and develop solutions (Ayan, 2010). Documentation, effective implementation and monitoring of production procedures is a good management practice and an effective tool in structuring and ensuring the continuity of the cleaner production approach and environmental management system. In addition to the potential benefits, the cost and economic gains of the application may vary from sector to sector or depending on the facility structure (TUBITAK MAM, 2016; TOB, 2021). Although establishing and monitoring production procedures is not costly, the payback period may be short considering the savings and benefits it will provide (TUBITAK MAM, 2016; TOB, 2021).

- ***Implementation of time optimisation in production and arrangement of all processes to be completed as soon as possible***

  In industrial production processes, planning the process from raw material to product by using the minimum number of processes is an effective practice for reducing labour costs, resource use costs and environmental impacts and ensuring efficiency. In this context, it may be necessary to revise the production processes so that the minimum number of process steps is used (TUBITAK MAM, 2016). In cases where the desired product quality cannot be achieved due to some inefficiencies, inefficiency and design errors in basic production processes, production processes may need to be renewed. Therefore, in this case, the resource utilisation and the amount of waste, emission and solid waste generated in the production of unit amount of product increases. Time optimisation in production processes is an effective application (TUBITAK MAM, 2016).

- ***Use of automatic hardware and equipment (sensors, smart hand washing systems, etc.) that will save water at water usage points such as showers/toilets etc.***

  Water is very important in many sectors of the manufacturing industry, both for production processes and for personnel to meet the necessary hygiene standards. Water consumption in the production processes of industrial facilities can be provided in various ways, as well as water consumption savings can be achieved by using equipment such as sensor faucets and smart hand washing systems in the water usage areas of the personnel. Smart hand washing systems provide resource efficiency in addition to water saving while adjusting the mixture of water, soap and air at the right rate.

- ***Collecting rainwater and utilising it as an alternative water source in facility cleaning or in suitable areas***

  Nowadays, when water resources are decreasing, rainwater harvesting is frequently preferred especially in regions with low rainfall. There are different technologies and systems for rainwater collection and distribution systems. Cistern systems, ground infiltration, surface collection and filter systems are used. Rainwater collected with special drainage systems can be used for production processes, garden irrigation, tank and equipment cleaning, surface cleaning, etc. if it meets the required quality requirements (Tanık et al., 2015).

  In various examples, roof rainwater collected in industrial facilities was stored and then used inside the building and in landscape areas, resulting in 50% water saving in landscape irrigation (Yaman, 2009). Perforated stones and green areas can be preferred in order to increase the permeability of the ground and to allow rainwater to pass and absorb into the soil on the site (Yaman, 2009). Rainwater collected on building roofs can be used for car washing and garden irrigation. It is possible to recover and reuse 95% of the collected water by biological treatment after use (Şahin, 2010).

References

- Abbassi, B., & Al Baz, I. (2008). Integrated Wastewater Management: A Review. https://doi.org/10.1007/978-3-540-74492-4_3.
- Adar, E., Delice, E., & Adar, T. (2021). Prioritising of industrial wastewater management processes using an integrated AHP-CoCoSo model: comparative and sensitivity analyses. International Journal of Environmental Science and Technology, 1-22.
- Ayan, B. (2010). International Certification Systems in Welded Manufacturing Enterprises. Izmir: Dokuz Eylül University, Institute of Social Sciences, Department of Business Administration, Master's Thesis.
- Boyd, C., & Gross, A. (1994). Water use and conservation for inland aquaculture ponds.
- Christopher, S. (1998). ISO 14001 and Beyond Environmental Management Systems in the Real World.
- MoEU. (2020e). Cleaner Production Practices in Certain Sectors Project. Republic of Turkey Ministry of Environment, Urbanisation and Climate Change General Directorate of Environmental Management.
- Delmas, M. (2009). Erratum to "Stakeholders and Competitive Advantage: The Case of ISO 14001. doi:10.1111/j.1937-5956.2004.tb00226.x.
- Günerhan, H. (t.y.). Utilisation of Geothermal Energy in Aquaculture.
- Hutchens Jr., S. (2017). Using ISO 9001 or ISO 14001 to Gain a Competitive Advantage.
- IPPC BREF. (2003). Reference Document on Best Available Techniques for the Textiles Industry. Retrieved from https://eippcb.jrc.ec.europa.eu/reference
- IPPC BREF. (2006). European Commission (EC) Integrated Pollution Prevention and Control Reference Document on Best Available Techniques for the Surface Treatment of Metals and Plastics.
- IPPC BREF. (2019). Best Available Techniques (BAT) Reference Document for the Food, Drink and Milk Industries. https://eippcb.jrc.ec.europa.eu/reference.
- ISO 14001 User Manual. (2015). Generic ISO 14001 EMS Templates User Manual.
- Korkmaz, Ş. (t.y.). Carp Breeding. Ankara University, Faculty of Agriculture, Department of Aquaculture. Retrieved from Ankara University, Faculty of Agriculture, Department of Aquaculture.
- Naghedi, R., Moghaddam, M., & Piadeh, F. (2020). Creating functional group alternatives in integrated industrial wastewater recycling system: A case study of Toos Industrial Park (Iran). Journal of Cleaner Production. doi:https://doi.org/10.1016/j.jclepro.2020.120464.
- Öztürk, E. (2014). Integrated Pollution Prevention and Control and Cleaner Production Practices in Textile Sector. Isparta.
- Potoski, M., & Prakash, A. (2005). Green Clubs and Voluntary Governance: ISO 14001 and Firms' Regulatory Compliance. American Journal of Political Science, 235-248.
- Sahin, N. I. (2010). Water Conservation in Buildings. Istanbul Technical University, Institute of Science and Technology, Master Thesis.
- Tanık, A., Öztürk, İ., & Cüceloğlu, G. (2015). Reuse of Treated Wastewater and Rainwater Harvesting Systems (Handbook). Ankara: Union of Municipalities of Turkey.
- TOB. (2021). Technical Assistance Project for Economic Analyses and Water Efficiency Studies within the Scope of River Basin Management Plans in 3 Pilot Basins. Republic of Turkey Ministry of Agriculture and Forestry.
- TUBİTAK MAM. (2016). Determination of Cleaner Production Opportunities and Applicability in Industry (SANVER) Project, Final Report. Scientific and Technological Research Council of Turkey Marmara Research Centre.
- Yaman, C. (2009). Siemens Gebze Facilities Green Building. IX. National Installation Engineering Congress.

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