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

Water Efficiency Campaign

Water Efficiency Guidance Documents Series

RAISING OF MILKED CATTLE

NACE CODE: 01.41

ANKARA 2023

Ministry of Agriculture and Forestry, General Directorate of Water Management Contractor io Environmental Solutions R&D Ltd. Sti. has been prepared.

Table of contents

Abbreviations

AAT	Wastewater Treatment Plant
EU	European Union
AKM	Suspended Solids
BREF	Best Available Techniques Reference Document
EMS	Environmental Management System
MoEUB	Republic of Turkey Ministry of Environment, Urbanization and Climate Change
DOM	Natural Organic Matter
EMAS	Eco Management and Audit Program Directive
EPA	United States Environmental Protection Agency
IPPC	Industrial Pollution Prevention and Control
ISO	International Organization for Standardization
FLOW	Best Techniques Available
NACE	Statistical Classification of Economic Activities
SYGM	General Directorate of Water Management
CTR	Reverse Osmosis
TOB	Ministry of Agriculture and Forestry of the Republic of Turkey
TurkStat	Turkish Statistical Institute
NF	Nanofiltration
MF	Microfiltration
UF	Ultrafiltration
MOURNING	Groundwater
YUS	Surface Water

1 Introduction

Our country is located in the Mediterranean basin, where the effects of global climate change are felt intensely, and is considered 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 percent in the next hundred years.

For 2022, the annual amount of usable water per capita in our country is 1,313 m³, and it is expected that the annual amount of usable water per capita will fall below 1,000 cubic meters after 2030 due to human pressures and the effects of climate change. It is obvious that if the necessary measures are not taken, 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* "the use of the least amount of water in the production of a product or service". Water efficiency approach; It is based on the rational, sharing, equitable, efficient and effective use of water in all sectors, especially drinking water, agriculture, industry and household uses, taking into account the needs of not only people but also ecosystem sensitivity and all living things by protecting it in terms of quantity and quality.

With the increasing demand for water resources, the change in precipitation and temperature regimes as a result of climate change, the increase in population, urbanization and pollution, it is becoming more and more important to share the usable water resources among the users in a fair and balanced way. For this reason, it has become a necessity to create a roadmap based on efficiency and optimization in order to protect and use limited water resources with sustainable management practices.

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

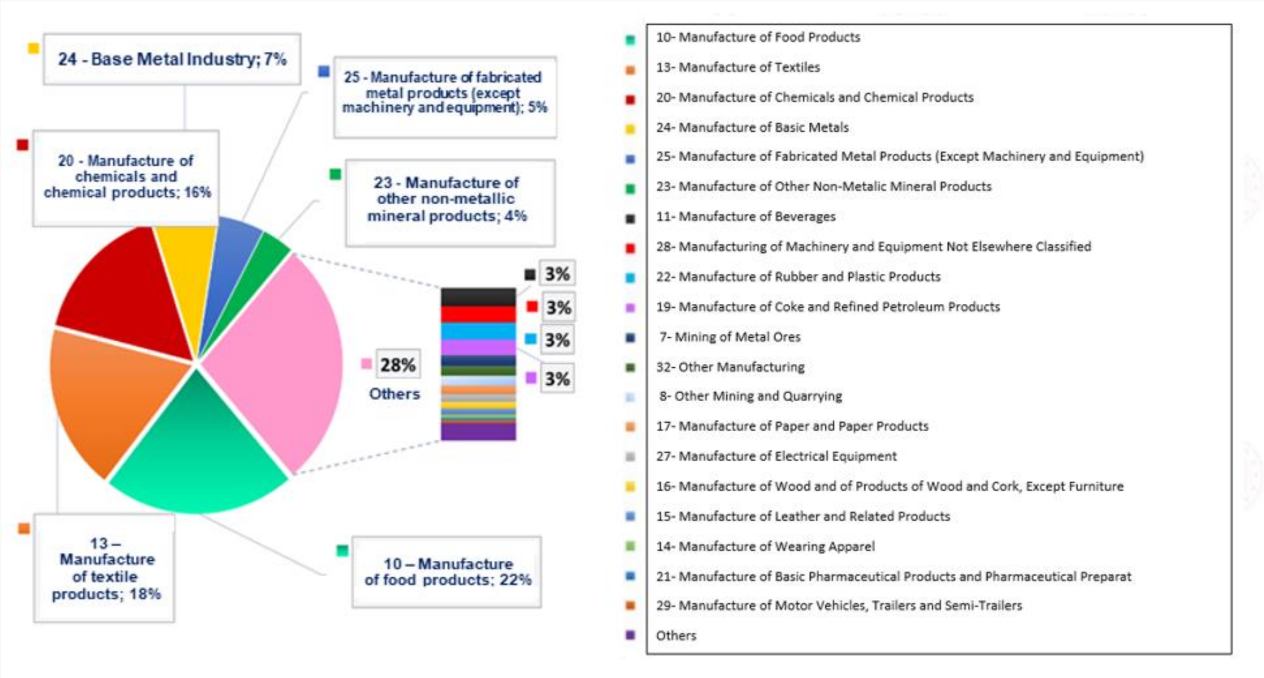
In the European Green Deal Action Plan prepared by our country within the scope of the European Green Deal, where member countries agree on goals such as implementing a clean, circular economy model with the goal of carbon neutrality, expanding the efficient use of resources and reducing environmental impacts, actions emphasizing water and resource efficiency in various fields, especially in industry, production and consumption 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 the measures to be taken to control, prevent or reduce the 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/ MET) are presented in order to systematize the applicability of cleaner production processes and to eliminate the difficulties experienced in practice. Considering the costs and benefits, METs are the most effective implementation techniques for a high level of environmental protection. In accordance with the Directive, Reference Documents (BAT-BREF) have been prepared for each sector, in which the METs are explained in detail. In BREF documents, METs are presented in a general framework such as good management practices, general water efficiency BATs, 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 studies aimed at disseminating efficient practices in urban, agricultural, industrial and individual water use and increasing social awareness. "Water Efficiency Strategy Document and Action Plan within the Framework of Adaptation to the Changing Climate ***(2023-2033)" entered*** into force with the Presidential Circular No. 2023/9Water efficiency action plans addressing all sectors and stakeholders have been prepared. 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 appointed for these actions. Within the scope of the said Action Plan; Carrying out studies to determine specific water usage ranges and quality requirements on the basis of sub-sectors in the industry, organizing technical training programs and workshops on a sectoral basis, and preparing water efficiency guidance documents are defined as the responsibility of the General Directorate of Water Management.

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

As in the world, the sectors with the highest share in water consumption in our country are food, textile, chemistry 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, chemistry, basic metal industry, which will represent production areas of different capacities and diversity within the scope of NACE Codes, which operate in our country and have high water consumption, and provide data on water supply, sectoral water use, wastewater generation and recycling. and the best available techniques (MET) and sectoral reference documents (BREF) published by the European Union, water efficiency, cleaner production, water footprint, etc.



Distribution of water use in industry on a sectoral basis in our country

As a result of the studies, specific water consumption and potential savings rates for the processes of the enterprises were determined for 152 different 4-digit NACE codes with high water consumption, and water efficiency guidance documents were prepared by taking into account the EU best available techniques (MET) and other cleaner production techniques. The guidelines include 500 techniques for water efficiency (MET);
It has been examined under 4 main groups: (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 account during the determination of METs for each sector. In the determination of METs, BREF documents were not limited to the METs, but also different data sources such as current literature data, real case studies, innovative practices, and reports of sector representatives on a global scale were examined in detail and sectoral MET lists were created. In order to evaluate the suitability of the MET lists created for the local industrial infrastructure and capacity of our country, the MET lists prepared specifically for each NACE code were prioritized by the enterprises by scoring them on the criteria of water saving, economic saving, environmental benefit, applicability, cross-media impact, and the final MET lists were determined using the scoring results. Sectoral water efficiency guidelines have been created on the basis of the NACE code based on the water and wastewater data of the facilities visited within the scope of the project and the final MET lists highlighted by the sectoral stakeholders and determined by taking into account the local dynamics specific to our country.

2 Scope of the Study

The guidance documents prepared within the scope of water efficiency measures in the industry include the following main sectors:

- Crop and animal production, hunting and related service activities (including sub-production areas represented by 6 four-digit NACE Codes)
- Fisheries and aquaculture (including 1 sub-production area represented by a four-digit NACE Code)
- Extraction of coal and lignite (including 2 sub-production areas represented by a four-digit NACE Code)
- Service activities in support of mining (including 1 sub-production area represented by a four-digit NACE Code)
- Metal ore mining (including 2 sub-production areas represented by a four-digit NACE Code)
- Other mining and quarrying (including 2 sub-production areas represented by a four-digit NACE Code)
- Manufacture of food products (including 22 sub-production areas represented by a four-digit NACE Code)
- Manufacture of beverages (including 4 sub-production areas represented by a four-digit NACE Code)
- Manufacture of tobacco products (including 1 sub-production area represented by a four-digit NACE Code)
- Manufacture of textiles (including 9 sub-production areas represented by a four-digit NACE Code)
- Manufacture of apparel (including 1 sub-production area represented by a four-digit NACE Code)
- Manufacture of leather and related products (including 3 sub-production areas represented by a four-digit NACE Code)
- Manufacture of wood, wood products and cork products (except furniture); manufacture of articles made by knitting from reeds, straw and similar materials (including 5 sub-production areas represented by a four-digit NACE Code)
- Manufacture of paper and paper products (including 3 sub-production areas represented by a four-digit NACE Code)
- Manufacture of coke and refined petroleum products (including 1 sub-production area represented by a four-digit NACE Code)
- Manufacture of chemicals and chemical products (including 13 sub-production areas represented by a four-digit NACE Code)
- Manufacture of basic pharmaceutical products and pharmaceutical materials (including 1 sub-production area represented by a four-digit NACE Code)
- Manufacture of rubber and plastic products (including 6 sub-production areas represented by a four-digit NACE Code)
- Manufacture of other non-metallic mineral products (including 12 sub-production areas represented by a four-digit NACE Code)
- Base metal industry (including 11 sub-production areas represented by a four-digit NACE Code)
- Manufacture of fabricated metal products (excluding machinery and equipment) (including 12 sub-production areas represented by a four-digit NACE Code)
- Manufacture of computers, electronic and optical products (including sub-production area represented by 2 four-digit NACE Codes)
- Manufacture of electrical equipment (including 7 sub-production areas represented by a four-digit NACE Code)
-

- Manufacture of machinery and equipment, n.e.c. (including 8 sub-production areas represented by a four-digit NACE Code)
- Manufacture of motor vehicles, trailers and semi-trailers (including 3 sub-productions areas represented by a four-digit NACE Code)
- Manufacture of other means of transport (including 2 sub-production areas represented by a four-digit NACE Code)
- Other productions (including 2 sub-production areas represented by a four-digit NACE Code)
- Installation and repair of machinery and equipment (including 2 sub-production areas represented by a four-digit NACE Code)
- Electricity, gas, steam and ventilation system production and distribution (including 2 sub-production areas represented by a four-digit NACE Code)
- Waste collection, remediation and disposal activities; recovery of materials (including 1 sub-production area represented by a four-digit NACE Code)
- Construction of non-building structures (including 1 sub-production area represented by a four-digit NACE Code)
- Storage and supporting activities for transportation (including 1 sub-production area represented by a four-digit NACE Code)
- Accommodation (including 1 sub-production area represented by a four-digit NACE Code)
- Educational Activities (Higher Education Campuses) (including 1 sub-production area represented by a four-digit NACE Code)
- Sports, entertainment and recreational activities (including 1 sub-production area represented by a four-digit NACE Code)

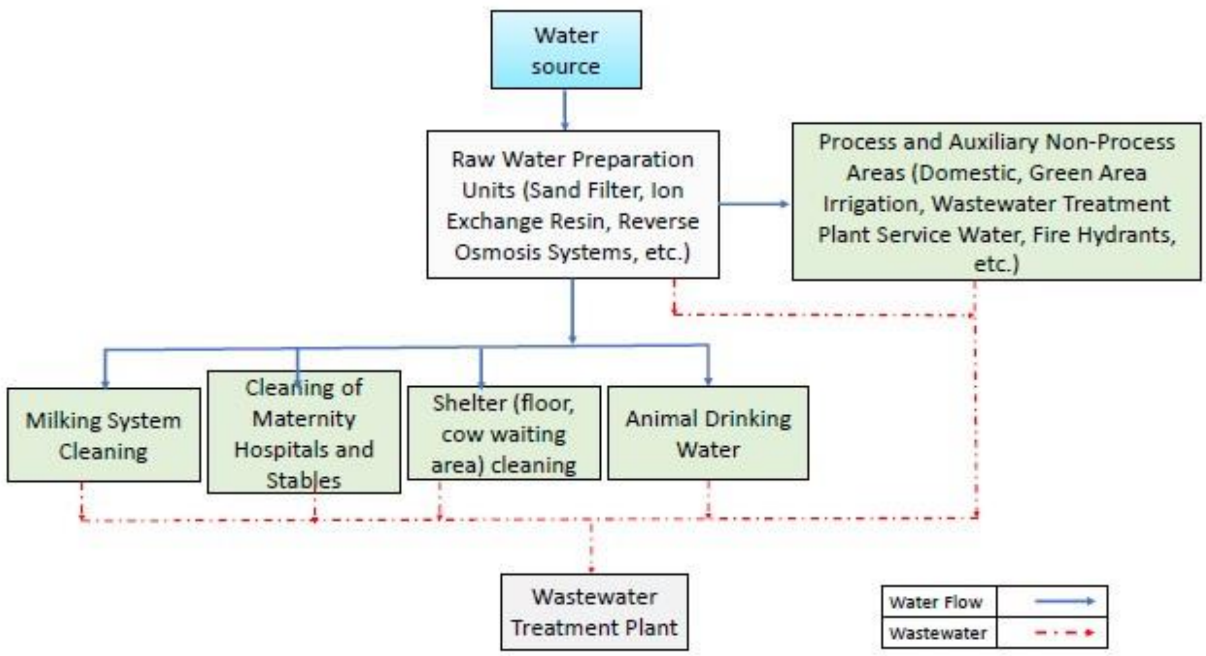
Plant and animal production, hunting and related service activities

Under the sector of plant and animal production, hunting and related service activities, the sub-production branches for which guide documents are prepared are as follows:

01.41 Raising of milking cattle
01.42 Other cattle and buffalo breeding
01.43 Breeding of horses and other horse-like animals
01.45 Sheep and goat breeding
01.47 Poultry farming
01.49 Other livestock breeding

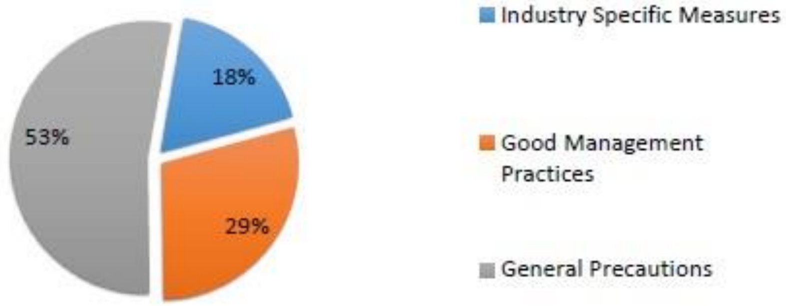
2.1 Milking Cattle Breeding (NACE 01.41)

Milking Cattle Breeding Sector Water Flow Chart



	Minimum	Maximum
Specific Water Consumption of Facilities Visited within the Scope of the Project (L/animal.day)	85	
Reference Specific Water Consumption (L/animal.day)	23	66

Percentage Distribution of Water Efficiency Practices



Feeding is one of the factors affecting productivity and profitability in milked cattle breeding. The nutrients consumed are primarily used in the body to meet the needs of the share of life. The nutrients left over from the survival share are used to meet the needs of growth, milk yield and gestational period. Feed and water consumption should be taken into account due to the age of the animals, their pregnancy status, lactation period, dry periods, climatic conditions of the region, etc.

Since water constitutes a significant part of milk, the water consumption of lactating animals is quite high. Water requirement of dairy cattle; It varies depending on factors such as the physiological state of the animal, dry matter consumption and environmental temperature. Cattle consume approximately 4-6 liters of water for each kg of dry matter consumption. Apart from this, 0.87 liters of water should be calculated for every 1 liter of milk yield in dairy cows. In hot weather in summer, the water consumption of animals increases significantly. Insufficient water consumption in dairy cattle does not change the water ratio in milk , but reduces feed consumption and milk yield. The quality of the water is as important as the quantity. Giving very cold water to animals in winter causes some digestive problems, while giving heated water due to hot weather in summer also reduces water consumption and feed consumption. The optimal drinking water temperature for animals is 10-15 °C. Drinking water should be free of impurities, heavy metals, toxic elements, low nitrate and salt content, and free of pathogenic microorganisms (Filya et al., 2019).

In hot weather, there are heat-insulated shelters so that animals are not adversely affected by weather conditions. Thus, heat stress for animals is reduced. Float systems are used to prevent animal drinking water from overflowing from containers. In order to meet the water needs of the animals, equipment such as spout drinkers, round drinkers, water troughs suitable for the type of animals are used. Water consumption occurs to clean animal shelters and equipment. For this purpose, high-pressure cleaning systems are used. In milking cattle breeding, there is a milking system, cleaning of milking parlors, delivery rooms and barns, and the use of water as animal drinking water. In addition, if there are raw water preparation units such as sand filter, ion exchange resin, reverse osmosis required to produce soft water for use in the facilities, water consumption is realized for filter washing, resin regeneration, etc.

In the milking cattle breeding sector, the reference specific water consumption is in the range of 90 – 198 L/animal.day. The specific water consumption of the production branch analyzed within the scope of the study is in the range of 19 – 134 L/animal.day. With the implementation of sector-specific measures, good management practices and general measures, it is possible to achieve 9-53% water recovery in the sector.

01.41 Milking Cattle Breeding Priority water efficiency implementation techniques recommended under the NACE code are presented in the table below.

NACE code	NACE code explanation		Prioritized Sectoral Water Efficiency Techniques
01.41	Milking large cattle breeding		**Industry-Specific Measures**
		1.	Use of low-salt feeds in cattle/sheep breeding
		2.	Use of high-pressure cleaners to clean animal shelters and equipment
		3.	Reducing the heat stress of animals by using shelters that will protect the animals from hot weather
		4.	It is necessary to ensure that the necessary equipment to meet the water needs of the animals (spout drinker, round drinker, water trough, etc.) To be formed in the appropriate size and posture angle in accordance with the category of animals in the facility
		5.	Monitoring water consumption and water quality with smart detection systems
		6.	Use of float shut-off systems in routine filling operations to prevent overflow in water containers
		7.	Keeping the amount of feed required to obtain the final product to a minimum
			Good Management Practices
		1.	Using an integrated wastewater management and treatment strategy to reduce the amount of wastewater and the pollutant load
		2.	Establishment of an environmental management system
		3.	Preparation of water flow diagrams and mass balances for water
		4.	Preparation of a water efficiency action plan to reduce water use and prevent water pollution
		5.	Providing technical training to personnel for the reduction and optimization of water use
		6.	Good production planning to optimize water consumption
		7.	Setting water efficiency targets
		8.	Water used in production processes and ancillary processes, and Monitoring the wastewater generated in terms of quantity and quality and adapting this information to the environmental management system
			General Water Efficiency BATs s
		1.	Minimization of spills and leaks
		2.	Recovering water from rinsing solutions and reusing the recovered water in processes suitable for its quality will save water at water usage points such as showers/toilets, etc.
		3.	automatic hardware and equipment (sensors, intelligent handwashing systems etc.) Use
		4.	Pressure washing for equipment cleaning, general cleaning, etc. Using systems

NACE code	NACE Code explanations		Prioritized Sectoral Water Efficiency Techniques
01.41	Milking large cattle breeding	5.	Reuse of filter wash water in filtration processes, reuse of relatively clean cleaning water in production processes, and reduction of water consumption by using clean-in-place systems (CIP)
		6.	Avoiding the use of drinking water in production lines
		7.	Detection and reduction of water losses
		8.	Use of automatic check-off valves to optimise water use
		9.	Documentation of production procedures and use by employees to prevent waste of water and energy Transportation of toxic or hazardous chemicals for the aquatic environment
		10.	Closed storage and impermeable waste/scrap yard for prevention To be done
		11.	Substances that pose a risk in the aquatic environment (oils, emulsions, binders) to be stored, stored and prevented from mixing with wastewater after use
		12.	Prevention of mixing of clean water streams with dirty water streams Use of computer-aided control systems in production
		13.	processes
		14.	Reuse of relatively clean wastewater resulting from washing, rinsing and equipment cleaning in production processes without treatment Scope of
		15.	reuse of washing and rinsing water Determination
			Separate collection and treatment of grey water in the plant and high-water quality
		16.	In areas that do not require (green area irrigation, floor, floor washing, etc.) Use
		17.	Implementation of time optimization in production and arrangement of all processes to be completed as soon as possible
		18.	Collecting rainwater and evaluating it as an alternative water source in facility cleaning or in appropriate areas
A total of 33 techniques have been proposed in this sector.			

Milked cattle breeding is for the NACE code;

(i) Sector-Specific Measures,
(ii) Good Management Practices,
(iii) General Water Efficiency BATs
It is given under separate headings.

2.1.1 Industry-Specific Measures

- ***Reducing the heat stress of animals by using shelters to protect animals from hot weather*** Water consumption can be reduced by reducing the heat stress of animals. Shelter use, especially during the warmer seasons, can reduce heat stress of animals (Doreau, Corson, & Wiedemann, 2012).

https://l24.im/6zuOhw

Indoor Animal Shelters and Water Systems

- ***Use of high-pressure cleaners to clean animal shelters and equipment***

  In high-pressure cleaning systems, water usage is significantly reduced due to the mechanical cleaning effect of the water jet. Heavy dirt is removed by the mechanical action of the water jet, resulting in a significant reduction in the use of chemicals, and with the decrease in water volume, the areas where bacteria can grow are also reduced.

- ***Installation of the necessary equipment (spout drinker, round drinker, water trough, etc.) to meet the water needs of the animals in the appropriate size and posture angle in accordance with the animal category in the facility***

  While meeting the water needs, it is necessary to select and use appropriate equipment (e.g. nipple drinkers, round drinkers, water troughs), taking into account factors such as the condition, age, gender, ambient temperature, etc. of the animals (IPPC BREF, 2017a).

https://images.meesho.com/images/products/127767338/ox9s6_512.webp

https://l24.im/A26SX9

Drinking Water Systems in Milking Cattle Farming

Monitoring water consumption and water quality with smart detection systems

Water consumption in livestock activities can be controlled by using monitoring systems. A system that includes motion detectors, cameras, water level sensors, flow meters, Radio Frequency Identification (RFID) systems, and water temperature sensors can provide high throughput (Tang et al., 2021).

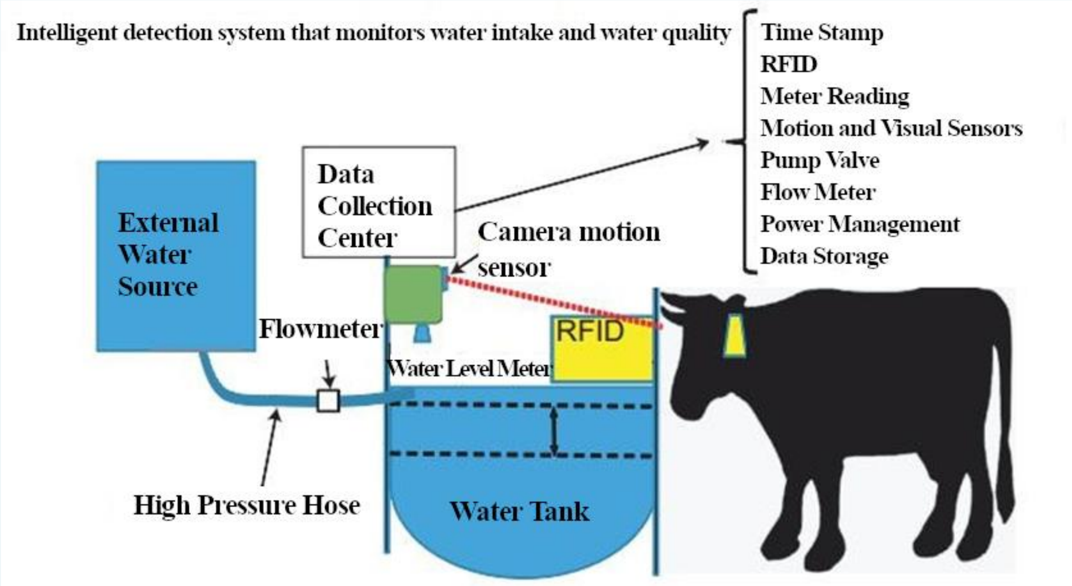
- ***Use of low-salt feeds in cattle/sheep breeding*** Water consumption of animals can be reduced by using low-salt feeds to meet the minerals needed by the animals (Doreau, Corson, & Wiedemann, 2012).

- ***Optimising feed consumption by reducing the amount of unnecessary feed***

  Feeding the amount needed by optimizing the amount of feeding to ensure daily milk production reduces redundant feeding and water consumption (Doreau, Corson, & Wiedemann, 2012).

- ***Use of float shut-off systems in routine filling operations to prevent overflow in water containers***

  Water waste can be prevented by preventing water from overflowing from containers through the use of float closure systems (OMAFRA, 2013).



A Smart Sensing System of Water Quality and Intake Monitoring for Livestock and Wild Animals - (Tang et al.,2021)

Intelligent Sensing System for Monitoring Water Quality and Water Intake for Farm Animals

https://www.arddoors.com.au/images/11185/_thumb2/how-to-use-a-high-pressure-water-cleaner-to-clean-your-garage-barn-or-shed.jpg

High Pressure Cleaning Equipment

2.1.2 Good Management Practices

Establishment of an environmental management system

Environmental Management Systems (EMS) include the organizational structure, responsibilities, procedures and resources required to develop, implement and monitor the environmental policies of industrial organizations. The establishment of the environmental management system improves the decision-making processes of institutions between raw materials, water-wastewater infrastructure, planned production process, and different treatment techniques. Environmental management organizes how to manage resource procurement and waste discharge demands 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 Programme Directive (EMAS) (761/2001). It has been developed for the evaluation, 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 participation is provided voluntarily (TUBITAK MAM, 2016; TOB, 2021). The benefits of establishing and implementing an Environmental Management System are as follows:

- Economic benefits can be achieved by improving business performance (Christopher, 1998).
- International Organization for Standardization (ISO) standards are adopted, resulting in greater compliance with global legal and regulatory requirements (Christopher, 1998).
- While the penalty risks related to environmental responsibilities are minimized, the amount of waste, resource consumption and operating costs are reduced (Delmas, 2009).
- The use of internationally accepted environmental standards eliminates the need for multiple registrations and certifications 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 important to consumers. The implementation of environmental management systems provides a competitive advantage over companies that do not adopt the standard. It also contributes to the better position of institutions in international areas/markets (Potoski & Prakash, 2005).

The benefits listed above depend on numerous factors such as the production process, management practices, resource use, and potential environmental impacts (TOB, 2021). Savings of 3-5% in water consumption can be achieved with applications such as the preparation of annual inventory reports with similar content to the environmental management system and monitoring of inputs and outputs in production processes in terms of quantity and quality (Öztürk, 2014). The total duration of the EMS development and implementation phases is estimated to be 8-12 months (ISO 14001 User Manual, 2015).

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

- ***Using an integrated wastewater management and treatment strategy to reduce the amount of wastewater and the pollutant load***

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

The reuse of treated wastewater in the plant not only improves the quality of water bodies, but also reduces the demand for fresh water. Therefore, it is very important to determine the appropriate treatment strategies for different reuse targets.

In integrated industrial wastewater treatment, different aspects such as the wastewater collection system, the treatment process, and the reuse target are evaluated together (Naghedi et al., 2020). Facilities can determine the integrated wastewater treatment framework by combining methods such as SWOT method (strengths, weaknesses, opportunities and threats), PESTEL method (political, economic, social, technological, environmental and legal factors), decision tree with expert opinions in order to create the most appropriate functional group for industrial wastewater recycling (Naghedi et al., 2020). Integrating the Analytical Hierarchy Process (AHP) and Unified Consensus Solution (CoCoSo) techniques can be used to set priorities for industrial wastewater management processes based on a multitude of criteria (Adar et al., 2021).

With the implementation of integrated wastewater management strategies, reductions of up to 25% in water consumption, wastewater quantities and pollution loads of wastewater can be achieved on average. The potential payback period of the application can range from 1-10 years (TOB, 2021).

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

Industrial Wastewater Treatment Plant

Providing technical training to personnel for the reduction and optimization 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. Due to the fact that the personnel do not have the necessary technical knowledge in industrial facilities, problems may arise with the use of high amounts of water and wastewater formation. For example, it is important that cooling tower operators, who represent a significant proportion of water consumption in industrial operations, are properly trained and have technical knowledge. In applications such as determining water quality requirements in production processes, measuring water and wastewater amounts, etc., it is necessary for the relevant personnel to have sufficient technical knowledge (TOB, 2021). For this reason, it is important to provide training to staff on water use reduction, optimization and water saving policies. Practices such as involving personnel in water conservation studies, creating regular reports on water usage amounts before and after water efficiency initiatives, and sharing these reports with personnel support participation and motivation in the process. The technical, economic and environmental benefits to be obtained through personnel training give 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 are resource uses in industrial facilities, and as a result of resource use,

Inefficiency and environmental problems can be caused by input-output flows. Therefore

It is necessary to monitor the water and wastewater used in production processes and auxiliary processes in terms of their 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 be used to reduce energy consumption by 6-10%, water consumption and wastewater amounts.

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:

- Use of monitoring equipment (such as meters) to monitor consumption of water, energy, etc. on the basis of processes,
- 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, comparatively evaluating and reporting in terms of their quantity and quality,
- Monitoring raw material losses in production processes where raw materials are transformed into products and taking measures against raw material losses (MoEUB, 2020e).

Good production planning to optimize water consumption

In industrial production processes, planning a raw material until it turns into a product by using the least process is an effective practice to reduce labor costs, resource use costs and environmental impacts and to ensure efficiency (TUBITAK MAM, 2016; TOB, 2021). Production planning in industrial facilities by considering the water efficiency factor reduces water consumption and wastewater. Modifying production processes or combining some processes in industrial facilities provides significant benefits in terms of water efficiency and time planning (TOB, 2021).

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

  In terms of water efficiency, it is important to prepare an action plan that includes what to do in the short, medium and long term in order to reduce the amount of water-wastewater in industrial facilities and to prevent water pollution. At this point, water needs should be determined throughout the facility and in production processes, quality requirements should be determined at water usage points, wastewater formation points and wastewater characterization should be done (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 feasibility and to prepare action plans for the short-medium-long term. In this way, water efficiency and sustainable water use are ensured in facilities (TOB, 2021).

- ***Setting water efficiency targets***

  The first step in achieving water efficiency in industrial facilities is to set targets (TOB, 2021). For this, first of all, a detailed water efficiency analysis should be carried out on the basis of processes. Thus, unnecessary water use, water losses, wrong practices affecting water efficiency, process losses, reusable water-wastewater resources with or without treatment can be determined. It is also extremely important to set 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 facilities, creation of water-wastewater balances in production processes and auxiliary processes other than production processes are the basis of many good management practices in general. Creation of process profiles throughout the plant and on the basis of production processes; It facilitates the identification of unnecessary water usage points and high water use points, the evaluation of water recovery opportunities, process modifications and the determination of water losses (TOB, 2021).

2.1.3 General Water Efficiency BATs

- ***Detection and reduction of water losses***

In industrial production processes, water losses occur in equipment, pumps and pipelines. First of all, water losses should be detected and leaks should be prevented by keeping equipment, pumps and pipelines in good condition by performing regular maintenance (IPPC BREF, 2003). Regular maintenance procedures should be established and particular attention should be paid to the following:

- Adding pumps, valves, level switches, pressure and flow regulators to the maintenance checklist,
- Carrying out inspections not only in the water system, but also especially for heat transfer and chemical distribution systems, broken and leaking pipes, barrels, pumps and valves,
- regular cleaning of filters and pipelines,
- Calibrating, routinely checking and monitoring measuring equipment such as chemical measuring and dispensing instruments, 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).

- ***Minimization of spills and leaks***

Both raw material and water losses can be experienced due to spills and leaks in enterprises. In addition, if wet cleaning methods are used to clean the spilled areas, there may be increases in water consumption, wastewater amounts and pollution loads of wastewater (TOB, 2021). In order to reduce raw material and product losses, spillage and splash losses are reduced by using anti-splashes, fins, drip trays, sieves (IPPC BREF, 2019).

- ***Untreated reuse of relatively clean wastewater from washing, rinsing and equipment cleaning in production processes***

In industrial facilities, relatively clean wastewater, especially washing-final rinsing wastewater and filter backwash wastewater, can be recycled without treatment in floor washing and garden irrigation processes that do not require high water quality, saving between 1-5% in raw water consumption. The initial investment costs required for the application consist of the establishment of new pipelines and reserved tanks (Öztürk, 2014).

- ***Prevention of mixing of clean water streams with dirty water streams***

  By determining the wastewater formation points and characterizing the wastewater in industrial facilities, 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 of appropriate quality can be reused with or without treatment. By separating wastewater streams, water pollution is reduced, treatment performances are increased, energy consumption can be reduced in relation to reducing treatment needs, and emissions are reduced by ensuring 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 often require high investment costs, and costs can be reduced when it is possible to recover large amounts of wastewater and energy (IPPC BREF, 2006).

- ***Determination of the scope of reuse of washing and rinsing waters***

  In industrial facilities, relatively clean wastewater such as washing-final rinsing wastewater and filter backwash wastewater can be reused without treatment in floor washing and garden irrigation processes that do not require high water quality (Öztürk, 2014). Thus, it is possible to save between 1-5% in raw water consumption (TOB, 2021).

- ***Use of pressure washers for equipment cleaning, general cleaning, etc.***

  Water nozzles are widely used in equipment plant cleaning. Effective results can be obtained by using correctly placed, appropriate nozzles to reduce water consumption and wastewater pollution loads. The use of active sensors and nozzles where high water consumption occurs and where possible is very important for the efficient use of water. Thanks to the replacement of mechanical equipment with pressurized nozzles, it is possible to achieve significant water savings (TUBITAK MAM, 2016). Reducing water consumption, wastewater generation and wastewater pollution load through the use of water pressure-optimised nozzles in technically feasible processes are the main environmental benefits of the application.

- ***Use of automatic check-off valves to optimise water use***

  Monitoring and controlling water consumption using flow control devices, meters and computer-aided monitoring systems provides significant technical, environmental and economic advantages (Öztürk, 2014). Monitoring the amount of water consumed within the facility and in various processes prevents water losses (TUBITAK MAM, 2016). It is necessary to use flow meters and meters in the facility and production processes, to use automatic shut-off valves and valves in continuously operating machines, to develop monitoring-control mechanisms according to water consumption and some determined quality parameters using computer-aided systems (TUBITAK MAM, 2016). With this application, it is possible to save up to 20-30% in water consumption on a process basis (DEPA, 2002; LCPC, 2010; IPPC BREF, 2003). By monitoring and controlling water consumption on a process basis, 3-5% savings can be achieved in process water consumption (Öztürk, 2014).

- ***Avoiding the use of drinking water in production lines***

  In different sub-sectors of the manufacturing industry, water with different water quality can be used in accordance with production purposes. In industrial facilities, raw water obtained from underground water sources is used in production processes after being treated. However, in some cases, although it is costly in production processes, drinking water can be used directly or raw water is disinfected with chlorinated compounds and evaluated in production processes. These waters, which contain residual chlorine, can react with organic compounds (natural organic substances (DOM)) in the water in the production processes and form disinfectant by-products harmful to living metabolisms (Özdemir & Toröz, 2010; Oğur et al.; TOB, 2021). The use of drinking water containing residual chlorine compounds or raw water disinfected with chlorinated compounds should be avoided as much as possible. In the disinfection of raw water, disinfection methods with high oxidation ability such as ultraviolet (UV), ultrasound (US) or ozone can be used instead of chlorine disinfection. In order to increase the technical, economic and environmental benefits to be provided by the application, determining and using the water quality parameters required in each production process helps to reduce unnecessary water supply and treatment costs. With this application, it is possible to reduce water, energy and chemical costs (TUBITAK MAM, 2016).

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

  In today's world where 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, infiltration into the ground, collection from the surface and filter systems are used. Rainwater collected by 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 (Witness et al., 2015).

  In various examples, 50% water savings were achieved in landscape irrigation by using roof rainwater collected in industrial facilities and using it in buildings and landscaping areas after storing it (Yaman, 2009). Perforated stones and green areas can be preferred in order to increase the permeability of the ground and to ensure that rainwater passes and is absorbed into the soil in the field (Yaman, 2009). Rainwater collected on the roofs of buildings can be used for car washing and garden irrigation. It is possible to reuse the collected water by recovering 95% of it with biological treatment after use (Şahin, 2010).

- ***Recovery of water from rinsing solutions and reuse of recovered water in processes appropriate to its quality***

  Rinsing wastewater in industrial facilities can be reused without treatment in relatively clean wastewater, floor washing and garden irrigation processes that do not require high water quality (Öztürk, 2014). In raw water consumption with the recovery of rinse water Savings of 1-5% can be achieved.

- ***Storage, storage and prevention of substances that pose a risk in the aquatic environment (such as oils, emulsions, binders) and mixing with wastewater after use as much as possible***

  In industrial facilities, dry cleaning techniques can be used to prevent chemicals that pose a risk to the aquatic environment, such as oils, emulsions and binders, from mixing with wastewater streams and leaks can be prevented. In this way, the protection of water resources can be ensured (TUBITAK MAM, 2016).

- ***Construction of closed storage and impermeable waste/scrap yard to prevent the transportation of toxic or hazardous chemicals for the aquatic environment***

  In industrial facilities, closed and impermeable waste/scrap storage areas can be built to prevent the transport of toxic or dangerous chemicals to the receiving environments for the aquatic environment. This practice is already being implemented within the scope of the current environmental regulations in our country. Within the scope of the field studies carried out, a separate collection channel can be built in the toxic or hazardous substance storage areas in industrial facilities to prevent the separate collection of the leachate in question and its mixing with the natural water environments.

- ***Use of computer-aided control systems in production processes***

  Since inefficiency and environmental problems in the use of resources in industrial facilities are directly related to input-output flows, it is necessary to define the process inputs-outputs in the best way for production processes, for their quantity and quality (TUBITAK MAM, 2016). Thus, it is possible to develop proposals to increase resource efficiency, economic and environmental performance. It is possible to develop suggestions for input. Input-output inventories can be arranged at different levels (IPPC BREF, 2003). This is considered a prerequisite for continuous improvement. Such management practices require the participation of technical staff and senior management, and usually pay for themselves in a short time with the work of various experts (IPPC BREF, 2003). It may require the use of measuring equipment on the basis of application processes. In addition, situations may arise where some routine analyzes/measurements are required specific to the processes. In order to obtain the highest level of efficiency from the application, making use of the computerized monitoring systems used today as much as possible will increase the technical, economic and environmental benefits to be obtained (TUBITAK MAM, 2016).

Computer Aided Control System

https://sayachizmet.com/wp-content/uploads/2020/01/SCADA-nedir-1280x720-1.jpg.webp

- ***Reuse of filter wash water in filtration processes, reuse of relatively clean cleaning water in production processes, and reduction of water consumption by using clean-in-place systems (CIP)***

Wastewater from backwashes of activated carbon filters and softening devices often contains only a high percentage of suspended solids (AKM). Backwash water, which is one of the easiest wastewater types to recycle, can be recovered by filtering with ultrafiltration plants. In this way, water savings of up to 15% are achieved (URL - 1, 2021).

Regeneration wastewater formed after the regeneration process is soft water with high salt content and constitutes approximately 5-10% of total water consumption. It is ensured that regeneration wastewater is collected in a separate tank and evaluated in processes with high salt requirements, facility cleaning and domestic use. For this, a reserved tank, plumbing and pump are needed. With the reuse of regeneration wastewater, water consumption, energy consumption, wastewater amounts and salt content of wastewater are approximately
A reduction of 5-10% is achieved (Öztürk, 2014). The payback period varies according to the consumption of regeneration water in production processes, facility cleaning and domestic use. It is estimated that if regeneration water is reused in production processes that require high salt (since both water and salt will be recovered), the potential payback period will be less than one year. It is estimated that the payback period will be over one year for facility and equipment cleaning and domestic uses (TOB, 2021).

In our country, reverse osmosis (CTR) concentrates are combined with other wastewater streams and given to the wastewater treatment plant channel. The concentrates formed in the CTR systems used for additional hardness removal can be used in garden irrigation, in-plant and tank-equipment cleaning (TUBITAK MAM, 2016; TOB, 2021). In addition, with the structuring of raw water quality monitoring, it is possible to re-evaluate CTR concentrates by feeding them back into raw water reservoirs and mixing them (TOB, 2021).

- ***Use of automatic equipment 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 provide the necessary hygiene standards. Water consumption can be achieved in various ways in the production processes of industrial facilities, as well as savings in water consumption by using equipment such as sensor taps and smart hand washing systems in the water usage areas of the personnel. Smart hand washing systems adjust the water, soap and air mixture in the right proportion and provide resource efficiency in addition to water savings.

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

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

- ***Documentation of production procedures and use by employees to prevent waste of water and energy***

  In order to make efficient production in an enterprise, effective procedures should be applied in order to identify and evaluate potential problems and their sources and to control the 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 assurance of reliability and quality in production processes (Ayan, 2010). The presence of documented production procedures in production processes contributes to the development of the ability to develop sudden reflexes for the evaluation of operational performance and the solution of problems (TUBITAK MAM, 2016; TOB, 2021). Effective implementation and monitoring of procedures created specifically for production processes is one of the most effective ways to ensure product quality, to receive feedback and to develop solution proposals (Ayan, 2010). Documenting, effectively implementing and monitoring production procedures is a good management practice and is an effective tool in structuring and ensuring the continuity of the cleaner production approach and environmental management system. In addition to the potential benefits, there may be changes in the cost and economic gains of the application depending on the sector or facility structure (TUBITAK MAM, 2016; TOB, 2021). Although the establishment and monitoring of 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 optimization 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 transformation using the least process is an effective practice to reduce labor costs, resource use costs and environmental impacts and to ensure efficiency. In this context, it may be necessary to review the production processes and revise them to use the least number of process steps (TUBITAK MAM, 2016). In cases where the desired product quality cannot be achieved due to some inadequacies, inefficiency and design errors in basic production processes, production processes may need to be renewed. Therefore, in this case, the use of resources required in the manufacture of the unit amount of product and the amount of waste, emissions and solid waste generated increase. Time optimization in production processes is an effective practice (TUBITAK MAM, 2016).

Bibliography

- 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). Prioritizing of industrial wastewater management processes using an integrated AHP–CoCoSo model: comparative and sensitivity analyses. International Journal of Environmental Science and Technology.
- 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.
- Christopher, S. (1998). ISO 14001 and Beyond Environmental Management Systems in the Real World.
- MoEUB. (2020e). Cleaner Production Practices in Specific Sectors Project. T.R. Ministry of Environment, Urbanization 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.
- DEPA. (2002). Danish Environmental Protection Agency (DEPA). Danish Experience, Best Avaible Techniques-Bat in the Clothing and Textile Industry.
- Doreau, M., Corson, M. S., & Wiedemann, S. G. (2012). Water use by livestock: A global perspective for a regional issue? Animal Frontiers, Volume 2(Issue 2), 9–16p. doi:https://doi.org/10.2527/af.2012-0036
- Filya, İ., Canbolat, Ö., Ak, İ., Alçiçek, A., & Kırkpınar, F. (2019). Animal feeding. Eskisehir: Anadolu University.
- 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. (2017a). Best Available Techniques (BAT) Reference Document for the Intensive Rearing of Poultry or Pigs.
- 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.
- LCPC. (2010). Lebanese Cleaner Production Center. Cleaner Production Guide for Textile Industries.
- 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.
- Oğur, R., Tekbaş, Ö. F., & Hasde, M. (2004). Chlorination Guide: Chlorination of Drinking and Potable Water. Ankara: Gülhane Military Medical Academy, Department of Public Health.
- OMAFRA. (2013). Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) in 'Pig News & Views', Jaydee Smith.
- Özdemir, K., & Toröz, I. (2010). Monitoring of Chlorination By-Products in Drinking Water Sources by Differential UV Spectroscopy Method. Itujournal.
- Ozturk, E. (2014). Integrated Pollution Prevention and Control and Cleaner Production Practices in the Textile Industry. 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 Natural and Applied Sciences, M.Sc. Thesis.
- Tang, W., Biglari, A., Ebarb, R., Pickett, T., Smallidge, S., & Ward, M. (2021). A Smart Sensing System of Water Quality and Intake Monitoring for Livestock and Wild Animals. Sensors 2021, 21, 2885. doi: https://doi.org/ 10.3390/s21082885
- 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 for Economic Analysis and Water Efficiency Studies within the Scope of River Basin Management Plans in 3 Pilot Basins. T.R. Ministry of Agriculture and Forestry.
- TUBITAK MAM. (2016). Determination of Cleaner Production Opportunities and Applicability in Industry (SANVER) Project, Final Report. The Scientific and Technological Research Council of Turkey Marmara Research Center.
- URL - 1st (2021). Recovery of filter backwash water. Retrieved from https://rielli.com/portfolio/filtre- ters-washing-waters-recovery/
- Yaman, C. (2009). Siemens Gebze Facilities Green Building. IX. National Plumbing Engineering Congress.

Resitpasa Mah Katar Cd.
Arı Teknokent 1 2/5, D:12, 34469
Sariyer/Istanbul

(0212) 276 65 48

www.iocevre.com