



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



Water Efficiency Guidance Documents Series

ELECTRICAL DISTRIBUTION AND CONTROL DEVICES MANUFACTURING

NACE KOD 27.12

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.

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Abbreviations

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

1 Introduction

Our country 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 m³ 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 Türkiye 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, the change in precipitation and temperature regimes as a result of climate change, the increase in population, urbanisation and pollution, the fair and balanced distribution 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.

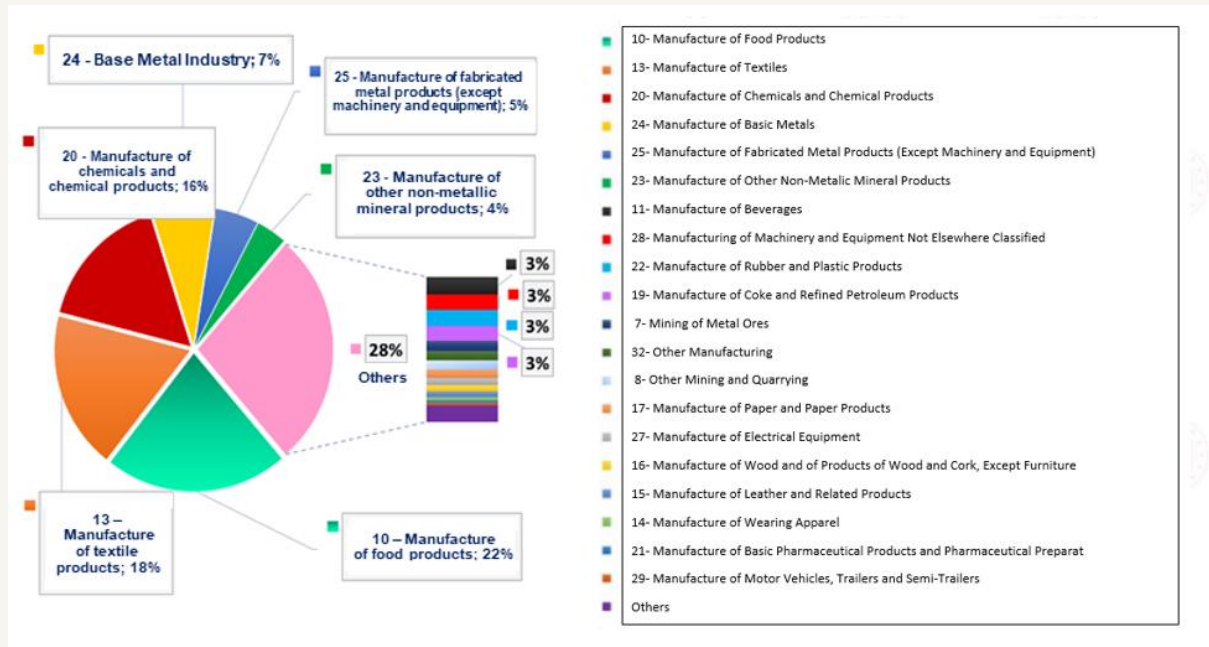
In the European Green Deal Action Plan prepared by our country within the scope of the European Green Deal Action Plan, in which member countries agreed on the objectives such as implementing a clean, circular economy model with a carbon neutral target, expanding the efficient use of resources and reducing 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 ~~one~~ overcome 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 have been 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, sectoral best techniques specific to our country were determined within the scope of the studies for 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 the best available techniques (BAT) and sectoral reference documents (BREF) published by the European Union, water efficiency, clean production, water footprint, etc.



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

Guidance documents prepared within the scope of water efficiency measures in industry cover the following main sectors:

- Crop and animal production and hunting and related service activities (including sub-production area represented by 6 four-digit NACE codes)
- Fisheries and aquaculture (including sub-production area represented by 1 four-digit NACE Code)
- Coal and lignite extraction (including sub-production area represented by 2 four-digit NACE codes)
- Service activities in support of mining (including sub-production area represented by 1 four-digit NACE Code)
- Metal ores mining (including the sub-production area represented by 2 four-digit NACE codes)
- Other mining and quarrying (including the sub-production area represented by 2 four-digit NACE codes)
- Manufacture of food products (including 22 sub-production areas represented by four-digit NACE codes)
- Manufacture of beverages (including the sub-production area represented by 4 four-digit NACE codes)
- Manufacture of tobacco products (including sub-production area represented by 1 four-digit NACE Code)
- Manufacture of textile products (including 9 sub-production areas represented by four-digit NACE codes)
- Manufacture of articles of clothing (including sub-production area represented by 1 four-digit NACE Code)
- Manufacture of leather and related products (including sub-production area represented by 3 four-digit NACE codes)
- Manufacture of wood, wood products and cork products (except furniture); manufacture of articles made of thatch, straw and similar materials (including sub-production area represented by 5 four-digit NACE Codes)
- Manufacture of paper and paper products (including sub-production area represented by 3 four-digit NACE codes)
- Manufacture of coke and refined petroleum products (including sub-production area represented by 1 four-digit NACE Code)
- Manufacture of chemicals and chemical products (including 13 sub-production areas represented by four-digit NACE codes)
- Manufacture of basic pharmaceutical products and pharmaceutical ingredients (including sub-production area represented by 1 four-digit NACE Code)
- Manufacture of rubber and plastic products (including sub-production area represented by 6 four-digit NACE codes)
- Manufacture of other non-metallic mineral products (including 12 sub-production areas represented by four-digit NACE codes)
- Basic metal industry (including 11 sub-production areas represented by four-digit NACE codes)
- Manufacture of fabricated metal products (except machinery and equipment) (including 12 sub-production areas represented by four-digit NACE codes)
- Manufacture of computers, electronic and optical products (including sub-production area represented by 2 four-digit NACE codes)
- Manufacture of electrical equipment (including sub-production area represented by 7 four-digit NACE codes)
- Manufacture of motor vehicles, trailers (semi-trailers) and semi-trailers (semi-trailers) (including sub-production area represented by 3 four-digit NACE codes)

- Manufacture of other transport equipment (including sub-production area represented by 2 four-digit NACE codes)
- Other manufacturing (including 2 sub-production areas represented by four-digit NACE codes)
- Installation and repair of machinery and equipment (including sub-production area represented by 2 four-digit NACE codes)
- Electricity, gas, steam and ventilation system production and distribution (including sub-production area represented by 2 four-digit NACE codes)
- Waste collection, reclamation and disposal activities; recovery of materials (including sub-production area represented by 1 four-digit NACE Code)
- Construction of non-building structures (including sub-production area represented by 1 four-digit NACE Code)
- Warehousing and supporting activities for transport (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)
- Sporting activities, leisure and recreation activities (including sub-production area represented by 1 four-digit NACE Code)

Electrical equipment manufacturing

Under the electrical equipment manufacturing sector, the sub-production branches for which guidance documents have been prepared are as follows:

27.11 Manufacture of electric motors, generators and transformers

27.12 Manufacture of electrical distribution and control equipment

27.20 Accumulator and battery manufacturing

27.31 Manufacture of fibre optic cables

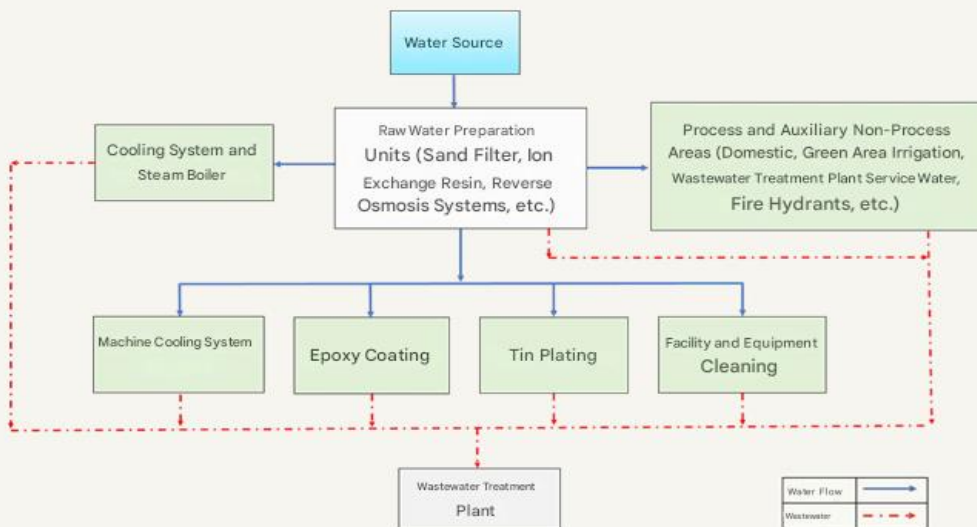
27.32 Manufacture of other electronic and electrical wires and cables

27.40 Manufacture of electrical lighting equipment

27.51 Manufacture of household electrical appliances

2.1 Electricity Distribution and Control Equipment Manufacturing (NACE 27.12)

Water Flow Diagram in the Electrical Distribution and Control Devices Manufacturing Industry



	Minimum	Maximum
Specific Water Consumption of Facilities Visited within the Scope of the Project (L/product)	41	
Reference Specific Water Consumption (L/kg product)	6	42

* A comparison could not be made since the reference specific water consumption value and the specific water consumption units of the facilities visited within the scope of the project were different.

Percentage Distribution of Water Efficiency Practices



27.12 Electrical Distribution and Control Equipment Manufacturing NACE code within the scope of the proposed priority water efficiency implementation techniques are presented in the table below.

Within the scope of electrical distribution and control devices manufacturing, fuse devices, automatic circuit breaker, relay, insulation, circuit and load disconnecter switches, table, console, cabinet for control panel are manufactured. The parts required for the final product are supplied and the assembly process is carried out. The assembled products are subjected to epoxy coating and tin plating processes in order to gain features such as brightness, fullness and resistance to tarnishing.

Water is used in epoxy and tin coating processes in the manufacture of electrical distribution and control devices. Machine and product cooling water is consumed in the plants. The water used in product cooling is used in recirculation and is added as it decreases as a result of evaporation. If there are raw water preparation units such as sand filter, ion exchange resin, reverse osmosis used to produce soft water for use in the sector, water consumption is realised for filter washing, resin regeneration, etc. In addition, water consumption also occurs in auxiliary processes such as cooling system and steam boilers.

The reference specific water consumption in the electrical distribution and control equipment manufacturing sector is in the range of 6 - 42 L/kg. The specific water consumption of the production line analysed within the scope of the study is 41 L/ unit. Comparison could not be made due to the unit difference. With the implementation of good management practices, measures in the form of general measures and measures related to auxiliary processes, it is possible to achieve water savings of 31 - 46% in the sector.

27.12

Manufacture of electrical distribution and
control equipment**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. Monitoring the quantity and quality of water used in production processes and auxiliary processes and the wastewater generated and adapting this information to the environmental management system

General Water Efficiency BATs

1. Minimising spillages and leakages
2. Use of automatic hardware and equipment (sensors, smart hand washing systems, etc.) to save water at water usage points such as showers/toilets etc.
3. Use of pressure washing systems for equipment cleaning, general cleaning, etc.
4. Use of automatic control-close valves to optimise water use
5. Construction of closed storage and impermeable waste/scrap sites to prevent the transport of toxic or hazardous chemicals for the aquatic environment
6. Storage and storage of substances (such as oils, emulsions, binders) that pose a risk in the aquatic environment and prevention of their mixing with wastewater after use
7. Prevention of mixing of clean water flows with polluted water flows
8. Determination of wastewater flows that can be reused with or without treatment by characterising the wastewater quantities and qualities at all wastewater generation points
9. 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.)
10. Collecting rainwater and using it for facility cleaning or in suitable areas utilisation as an alternative water source

NACE Code	NACE Code Descriptio	Prioritised Sectoral Water Efficiency Techniques
27.12	Manufacture of electrical distribution and	<p>Precautions for Auxiliary Processes</p> <ol style="list-style-type: none"> 1. Saving water by reusing steam boiler condensate 2. Water saving by insulation of steam and water lines (hot and cold) 2. Prevention of water and steam losses in pipes, valves and connection points in the lines and monitoring with a computer system Old equipment in the ventilation system should be converted to the reverse osmosis principle 3. replacement with ion exchange resins (systems producing demineralised water) based on ion exchange resins and water reuse 4. Avoiding unnecessary cooling processes by identifying processes that need wet cooling 5. Prevention of flash steam losses due to boiler unloading 6. Collecting the water generated by surface runoff with a separate collection system and using it for purposes such as cooling water, process water, etc. 7. Minimisation of boiler discharge water (blowdown) in steam boilers 8. Re-use of the energy produced from the steam condenser A

total of 24 techniques have been proposed in this sector.

For Electricity Distribution and Control Devices
Manufacturing NACE Code;

- (i) Good Management Practices,
- (ii) General Precautions and
- (iii) Measures for auxiliary processes
are given under separate headings.

2.1.1 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 has been 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).



- ***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).

- ***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).

- ***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).

2.1.2 Measures in the nature of General Measures

- **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 generally requires high investment costs, and where it is possible to recover large amounts of wastewater and energy, costs can be reduced (IPPC BREF, 2006).

- **Determination of wastewater flows that can be reused with or without treatment by characterising wastewater quantities and qualities at all wastewater generation points**

Determination and characterisation of wastewater generation points in industrial facilities
It is possible to reuse various wastewater streams with or without treatment (Öztürk, 2014; TUBITAK MAM, 2016; TOB, 2021). In this context, filter backwash waters, TO concentrates, blowdown waters, condensate waters, relatively clean washing and rinsing waters can be reused without treatment in the same/different processes and in areas that do not require high water quality (such as plant and equipment cleaning). In addition, wastewater streams that cannot be directly reused can be reused in production processes after treatment using appropriate treatment technologies.

Membrane filtration processes are an integral part of many wastewater reuse systems. Nanofiltration (NF) and reverse osmosis (RO) filtration systems are used for industrial wastewater recovery. Microfiltration (MF) and ultrafiltration (UF) are generally used for pre-treatment of water before it goes to NF or TO (Singh et al., 2014).

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

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

- ***Use of automatic control-close valves to optimise water use***

Monitoring and controlling water consumption using flow control devices, meters and computer-aided monitoring systems provide significant technical, environmental and economic advantages (Öztürk, 2014). Monitoring the amount of water consumed in the plant and in various processes prevents water losses (TUBITAK MAM, 2016). It is necessary to use flow meters and counters in the plant in general and in production processes in particular, to use automatic shut-off valves and valves in continuously operating machines, and to develop monitoring-control mechanisms according to water consumption and some determined quality parameters by using computer-aided systems (TUBITAK MAM, 2016). With this application, it is possible to save up to 20-30% of water consumption on 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).

- ***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.

- ***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.

- **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 (Tanik et al., 2015).

In various examples, roof rainwater collected in industrial facilities was stored and 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).

- **Preventing substances that pose a risk to the aquatic environment (such as oils, emulsions, binders) from being stored, stored and mixed with wastewater after use as much as possible** In industrial plants, substances that pose a risk to the aquatic environment such as oils, emulsions and binders dry cleaning techniques to prevent the mixing of chemicals into wastewater streams can be used and leaks can be prevented. In this way, water resources can be protected (TUBITAK MAM, 2016).

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

In industrial facilities, closed and impermeable waste/scrap storage sites can be constructed to prevent the transport of toxic or hazardous chemicals for the aquatic environment to receiving environments. This practice is already being implemented in our country within the scope of existing environmental regulations. Within the scope of the field studies carried out, a separate collection channel can be constructed in the storage areas of toxic or hazardous substances in industrial facilities and the leachate can be collected separately and prevented from mixing into natural water environments.

2.1.3 Precautions for Auxiliary Processes

BATs for steam generation

- **Ensuring water saving by insulation of steam and water lines (hot and cold) and preventing water and steam losses in pipes, valves and connection points in the lines and monitoring them with a computer system** Failure to design steam lines properly in the facilities, routine maintenance and maintenance of steam lines repairs, mechanical problems occurring in the lines and the lines are not properly repaired. If the steam lines and hot surfaces are not fully insulated, steam losses may occur. This situation affects both water consumption and energy consumption of the plant. It is necessary to use control systems with automatic control mechanisms in order to make steam isolation and continuous monitoring of steam consumption. Depending on the reduction of steam losses, similar savings can be achieved in fuel consumption and additional soft water consumption in boilers. Since fuel consumption in steam boilers will decrease, waste gas emissions are expected to decrease at the same rate. Since the use of additional soft water used in steam boilers will decrease with the application, the amount of regeneration water, the amount of salt used in regeneration and reverse osmosis concentrates are also reduced. Full steam isolation application and automatic control mechanisms to minimise steam losses are used in many plants with high steam consumption. With the configuration of the application, fuel savings of 2-4% are achieved in steam boilers.

In order to prevent losses in production processes; adding the most important parts of the equipment such as pumps, valves, control knobs, pressure, flow regulators to the maintenance check list, inspecting not only water systems but also heating and chemical dispensing systems, drums, pumps and valves, regular cleaning of filters and pipelines, regular calibration of measuring equipment (thermometers, chemical scales, dispensing/dosing systems, etc.) and inspection and cleaning of heat treatment units (including chimneys) at routinely determined periods, effective maintenance-repair, cleaning and loss control practices can reduce water consumption by %. Regular calibration of measuring equipment (thermometers, chemical scales, distribution/dosing systems, etc.), routine inspection and cleaning of heat treatment units (including chimneys) in specified periods, effective maintenance-repair, cleaning and loss control practices can save 1-6% in water consumption (Hasanbeigi, 2010; Öztürk, 2014; TOB, 2021).



Industrial Steam Boilers

- ***Saving water by reusing steam boiler condensate***

When steam indirect heating techniques are used to transfer thermal energy in production processes, recovery of condensed steam (condensate) is an effective application in terms of reducing water consumption (IPPC BREF, 2009). An average of 5% reduction in water consumption can be achieved by recovering condensate (Greer et al., 2013). In addition, the potential payback period varies between 4-18 months (considering energy savings) (Öztürk, 2014; TUBİTAK MAM, 2016).

- ***Prevention of flash steam losses due to boiler discharge***

Steam boiler condensate is generally discharged from the system at atmospheric pressure from equipment outlets and steam traps. As the pressure decreases in condensate systems, some of the condensate re-evaporates and cools to the boiling point of water at atmospheric pressure. The re-evaporated condensate, called flash steam, is lost by being thrown into the atmosphere. In condensate return lines, which are usually quite long, cooling and therefore evaporation is inevitable. In order to prevent re-evaporation of condensate, savings can be achieved by keeping it in a flash tank under pressure until it returns to the boiler feed tank. As the pressure decreases in the condensate taken into the tank, the vapour formed is collected on the tank and feeds the low pressure steam system from here. The remaining hot condensate is taken from the bottom of the tank to the boiler.

- ***Minimisation of boiler discharge water (blowdown) in steam boilers***

Boiler blowdown refers to the water wasted from a boiler to prevent the condensation of pollutants during the continuous evaporation of steam. Boiler blowdown can be reduced by 50% with condensate recovery (IPPC BREF, 2009).

In automatic systems, blowdowns in the boilers are continuously monitored and the system is re-analysed with the water taken after the blowdown. In the analysis, data such as dissolved and undissolved particles in the water and water density are processed. If the density for the boiler is above the system limits, the blowdown process is repeated. The system should be automated and the optimum blowdown frequency should be determined. When the blowdown frequency is reduced, the amount of wastewater decreases. Energy and cooling water used for cooling this wastewater is saved (IPPC BREF, 2009). By optimising the steam boiler blowdown process, operating costs are reduced by saving on boiler water consumption, waste costs, treatment and heating.

- ***Re-use of energy generated from the steam condenser***

With a simple modification to the pipework system, the water supplying the water resting/decarbonising unit can be obtained from the outlet of the turbine condenser unit. This water has a sufficient temperature for the resting/decarbonising unit. Therefore, it is not necessary to heat this water by means of the steam produced by the heat exchanger system. Significant vapour recovery can be achieved through this operation. Cooling water consumption can also be reduced (CPRAC, 2021).

- ***Avoiding unnecessary cooling processes by identifying processes that need wet cooling***

The boundaries of the plant site affect design parameters such as cooling tower height. In cases where it is necessary to reduce the tower height, a hybrid cooling system can be applied. Hybrid cooling systems are a combination of evaporative and non-evaporative (wet and dry) cooling systems. Depending on the ambient temperature, the hybrid cooling tower can be operated as a fully wet cooling tower or as a combined wet/dry cooling tower (TUBITAK MAM, 2016). In regions where there is not enough cooling water or where water costs are high, the evaluation of dry cooling systems or hybrid cooling systems can be an effective solution to reduce the amount of cooling booster water (TUBITAK MAM, 2016).

- ***Collecting the water generated by surface runoff with a separate collection system and using it for purposes such as cooling water, process water, etc.***

In most industrial plants, wastewater is generated from process or non-process areas. The wastewater generated can be treated and reused in appropriate places. Savings can be achieved at varying rates in various industrial plants by reusing the wastewater generated in the plant after treatment. Water generated by surface runoff can be collected with a separate collection system and used as cooling water (TOB, 2021).

BATs for ventilation and air conditioning systems

- ***Replacement of old equipment in the aeration system with ion exchange resins based on the principle of reverse osmosis (systems producing demineralised water) and reuse of water***

Conductivity of the final effluent using ion exchange resins in the aeration system is brought to a conductivity level suitable for use in cleaning equipment. Example In a facility in Spain, by replacing the equipment in the aeration system with ion exchange resins, effluent with a conductivity value of approximately 1000 μS is obtained and reused in the system (MedClean, n.d.).

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