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Review of the pollution of surface water by effluents from the textile finishing industry

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During the present review, we have tried to define the different types of water resources, namely; Surface waters including waters of dams, lakes, rivers, wades, seas and oceans and groundwater, including groundwater, wells and springs. We also mentioned the different sources of groundwater pollution, including the type of pollution from physical, chemical and biological sources, and accidental, domestic, urban, agricultural and industrial pollution. The pollution of supplementary waters by the discharges of the textile finishing industries and the state of their treatment has been well monitored at the end of this present review.

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Introduction

The world has experienced remarkable demographic, technological, tourist, agricultural and industrial development over a long period head-on the overexploitation of raw water whether it is superficial or underground. This development has contributed in one way or another to the pollution of the environment, including water, in particular through human activities and sometimes by natural disasters (volcanoes, earthquakes and floods). This has depleted natural water resources and has even rendered their quality more deteriorated over time because of various liquid, urban, domestic and industrial effluents [1-4] evacuated directly and indirectly in different natural environments (lakes, wadis, rivers and seas) without any prior treatment.

Industrial units are generally generators of effluents whose characteristics are extremely varied and sometimes toxic, among which are recognized as polluting, in this case the agro-food industries (IAA), the chemical and parachemical industries (ICP), the mechanical, metallurgical and (IMME) and the textile and leather industries (ITC). These industries are responsible for a large proportion of industrially polluted waters [5, 6], such as they generate a very large volume of wastewater loaded with organic materials such as solvents, additives, phenolic derivatives, fats, oils, dyes [7-9] and inorganic materials, namely heavy metals such as copper, nickel, chromium, zinc, cobalt, manganese, arsenic and the most carcinogenic ones, namely mercury, cadmium and lead [9-13]. There are also organometallic compounds [9, 14, 15] which have adverse effects on aquatic flora and fauna, and consequently on the environment and man in particular [16]. As a result, regulations require their reduction by requiring their disposal according to industrial wastewater treatment standards before being released to aquatic environments [16, 17].

The aim of this research is to present a bibliographical review of the various water resources and sources of pollution, focusing in particular on the pollution of water by effluents from the textile finishing industries.

1. Natural waters

1.1. Groundwater

Are all waters below the surface of the soil, in the saturation zone and in direct contact with the soil or subsoil. From a

hydrogeological point of view, the aquifer layers are divided into [18]:

- ✓ **Groundwater**: are shallow and directly fed by rainfall and water flows below, they traditionally feed wells and drinking water resources. This type of groundwater is poorly exploited because of its low productivity and unfavorable chemical quality due to its exposure to pollution resulting from direct contact with the soil surface [19].
- ✓ **Free cloths**: are the set of perched, permanent or temporary webs formed in a non-saturated zone that surmounts a free web of larger extensions.
- ✓ **Captive cloths**: are deeper than those that are phreatic and free. They are separated from the surface by an impermeable layer, such that their feeding is ensured by infiltration on their edges.

The nature of the ground under which groundwater is found is an essential determinant of their chemical composition [20, 21]; however, they are also called clean waters because they generally meet drinking water standards. However, this type of water is less sensitive to accidental pollution and in the case of contamination by micropollutants [22-24], they lose their original purity completely.

Where groundwater contains concentrations of certain minerals exceeding those specified in the potability standards, they have therapeutic properties [25, 26]. This requires a well-defined treatment of this type of water, and then they are sometimes distributed in bottles and marketed in the form of mineral waters.

1.2. Surface water

They are also called surface waters and consist of all circulating, stagnant or stored, soft and brackish waters that are in contact with the atmosphere. The surface waters are basically river waters, wadis, lakes, basins, dams, runoffs, seas and oceans.

The chemical composition of surface waters depends mainly on the nature of the lands traversed by them during their journey across watersheds [27]. Most often, these waters are the site of the development of a microbial life because of the waste discharged into it and the large surface of contact with the external environment [27-29], which makes their quality more deteriorated.

1.3. Seawater of seas and oceans

They cover more than 70% of the earth's surface by constituting enormous reservoirs of water and representing about 97% of the total volume of water currently existing on our planet [30-33], the rest is the share of inland waters (groundwater and surface water).

Seawater and ocean waters are characterized by high salinity and acidity [30, 34], also known as brackish water, making their use difficult in many cases because of their high cost for desalination by distillation techniques and reverse osmosis [30, 31]. In addition to marine pollution resulting from natural disasters, shipwreck accidents and oil leaks, a considerable amount of waste and polluted wastewater is evacuated to marine environments [35].

2. Water consumption

These are waters intended for industrial, administrative and domestic consumption. They have grown enormously as a result of demographic development and improved living conditions. Tap water, conditioned water (spring water, natural mineral water and drinking water by treatment) and private well water used for drinking are all water intended for public consumption [36].

Domestic water consumption ranges from a few liters per day in countries without public supply and low household comfort to several hundred liters in developed countries. Even if only a small amount is going to be drunk, these waters are never distributed until after adequate treatment. They must therefore be treated according to the regulatory requirements for the quality of drinking water at any point in the network in order to be able to be consumed by humans without any danger. The treatment of water intended for public consumption is related to the following three important factors:

- ✓ **The quantity**: such that the source of water must cover the demand in all circumstances.
- ✓ **The quality**: it must be compatible with the legislation in force.
- ✓ **The economy**: the investment and operating cost of the treatment processes relative to available resources is an important determinant.

3. Wastewater

They constitute very complex and altered environments either by anthropogenic activities following agricultural, industrial, artisanal, domestic and other uses, or by natural causes such as volcanoes, thunderstorms, earthquakes, floods, earthquakes earth...

Wastewater is also referred to as polluted water which must be treated before any reuse or disposal in natural receptive environments [37, 38].

Based on a few references, the term pollution has taken several definitions, among which we quote the definitions below according to:

3.1. Larousse dictionary

Pollution is a degradation of the environment by substances (natural, chemical or radioactive), waste (domestic or industrial) or various nuisances (noise, light, thermal, biological, etc.) [39].

3.2. World Health Organization (WHO)

Pollution of aquatic environments is defined as any change in physical, chemical or biological properties by the release of liquid, gaseous or solid substances into the water in such a way as to create a nuisance or render it harmful or detrimental

Public health, safety and welfare, or its uses for domestic, commercial, industrial, agricultural, recreational and other purposes, or wild and aquatic fauna [40-42].

3.3. Report of the scientific committee of the White House

According to the report of the White House Advisory and Scientific Committee in November 1965 on the quality of the environment, pollution is an unfavorable modification of the natural environment, which appears in whole or in part as a by-product of human action, Through direct or indirect effects that alter the criteria for the distribution of energy flows, radiation levels, the physicochemical constitution of the natural environment and the abundance of living species. These changes can affect humans directly or through agricultural resources in water and other biological products [43]. They can also affect it by altering the physical objects it possesses, the recreational possibilities of the environment or by disfiguring nature [44, 45].

3.4. Moroccan water law N° 10-95

Polluted water is water that has undergone, as a result of human activity, directly or indirectly, or under the action of a biological or geological effect, a change in its composition or condition which has the effect of rendering it unsuitable for use for which it is intended [46].

It should be noted that multiple identifiable substances and contaminants in urban, artisanal, industrial and agricultural discharges reach the aquatic environment causing different types of pollution depending on their nature and origin. These substances can be suspended solids, organic, inorganic and organometallic materials, pathogenic micro pollutants, bacteria, viruses ... having multiple effects affecting both public health and aquatic organisms.

4. Wastewaters classification

The classification of wastewater is based either on the origin or nature of the pollutants or on the nature of the nuisance created or on other more general criteria. For our part, we will content ourselves with the classification according to the nature of the pollutants and their origin.

4.1. Classification according to the nature of the pollutant

Based on the nature of the pollutant, the term pollution can be classified into three categories: physical, chemical and biological pollution.

4.1.1. Physical pollution

Physical pollution is defined as any medium modified in its physical structure by various factors. It includes mechanical pollution (solid effluents), thermal pollution (water heating by factories) and atomic pollution (fallout from radioactive elements resulting from nuclear explosions, atomic factor residues and nuclear accidents) [47].

4.1.2. Chemical pollution

It results from the dumping of various domestic, agricultural and industrial waste, loaded with large quantities of chemicals namely polycyclic aromatic hydrocarbons (PAHs), pesticides, insecticides, humic acid, ammonium nitrates, etc. some of which are non-degradable and can affect many aquatic animals and amphibian species [48, 49].

4.1.3. Biological pollution

It is pollution by pathogenic micro-organisms linked to anthropogenic activities, such as bacteria, viruses, parasites, fungi, planktonic efflorescence, etc. The presence of these microorganisms in aquatic environments can cause the risk of water depreciation and hence the impact on human health [27, 47, 50].

4.2. Classification according to the origin of the pollutant

Depending on the origin of the pollutant, there are five categories of polluted water due to accidental, agricultural, urban, domestic and industrial pollution [47-55]. Domestic, industrial and rainwater waste water is the largest category of wastewater [48, 49].

4.2.1. Accidental pollution

It is an important concern for users of water resources, including drinking water producers. The increase in sea and road traffic and the transport of hazardous materials expose water resources to the risk of pollution and consequently the appearance of polluted waters through oil and gas spill incidents. Other products recognized as hazardous in the marine environment, constituting serious ecological and environmental damage to the marine environment and human health [51]. As well as disturbing the living conditions of fish and other aquatic living beings [52].

4.2.2. Agricultural pollution

It is due to agricultural activities such as agriculture, livestock, aquaculture and poultry farming, which are responsible for the release of many organic and inorganic pollutants into surface and underground waters. The problem of diffuse pollution arises mainly in irrigated agricultural areas where the combination of several factors (climate, soil type, depth of groundwater, irrigation water quality and intensity of fertilizer use and of plant protection products), contributes to the degradation of the quality of different types of water, and to the intensification of the phenomenon of eutrophication in certain reservoirs of dams used for the production of drinking water [56].

Pollutants can be sediments from the erosion of agricultural land, phosphate and nitrogen compounds from animal wastes, fertilizers and commercial pesticides [57]. It should be noted that in Morocco, agricultural pollution is of greater concern because of the over-fertilization of soils and the overexploitation of pesticides in agriculture, as well as the absence of their biodegradability [57].

4.2.3. Urban pollution

It is generated by large urban concentrations, through the evacuation of domestic and industrial waste [58]. Urban waste is summarized in all products disposed of by residents of a built-up area, including domestic waste, sewage, waste oil, expired medicines, faeces, packaging products, etc. [58, 59]. The spill flow is related to the size of the agglomeration, its activity and its standard of living. Considering that the large volume of industrial discharges consists mainly of wash water and solid waste, which vary according to industrial nature and activity.

4.2.4. Domestic pollution

It is due to domestic discharges that are biodegradable waste, pharmaceuticals, hazardous and toxic chemical pollutants such as detergents, dyes, paints, pesticides, solvents, etc. and personal care products that individuals release into sewers [60, 61]. All of these products constitute a form of substantial and hazardous pollution that sewage facilities are unable to eliminate [62].

Domestic waters are divided into household and gray waters (bathrooms and kitchens), usually loaded with detergents, greases, solvents and organic debris, and in sewage (toilets) characterized by a high load of various organic nitrogenous materials and in fecal and pathogenic germs [53, 63].

The increase in pollutant loads generated by domestic pollution flows has negative impacts on the quality of water resources, the aquatic ecosystem and the health of populations [62-65].

4.2.5. Industrial pollution

The accelerated development of modern industrial techniques has led to a massive and intensive load of various wastes and effluents from different industrial units [66], which are mainly installed at the shoreline both to dispose of waste and to save transport [67]. These industrial units use a very large quantity of water which, while remaining necessary for their proper functioning, is only really consumed in a very small part and the rest is rejected.

The main industrial activities responsible for surface water degradation include food industries, olive oil mills, sugar factories, refineries, paints, galvanization's, chemicals, petrochemicals, paper mills, tanneries, leather and textiles [37, 66-69]. Given the extreme diversity of these industries, it is evident that waste dumped and effluent discharged without appropriate treatment will result in undesirable changes in receiving environments and, hence, adverse effects on aquatic living organisms [70].

In Morocco, if no measures are taken to reduce the flow of pollutants, it is estimated that by 2020, the pollution carried by liquid industrial discharges will be on the order of 220 000 tons of oxidizable matter, nitrogen, 1,200 tons of chromium and 600 tons of phosphorus [36, 47, 71].

The sector of the textile, clothing and leather industries occupies a very important place in Morocco, constituting industrial and economic activities with strong potentialities. It represents a fairly large position estimated by 31% of all industries at the national level [47]. This type of industry is characterized by its diversity, both in terms of the raw materials used or the processes used in textile manufacturing. As the process of textile finishing is the most important step in textile industry processes, involving procedures in which several and various chemicals are used with a very large volume of water [72-79], resulting in a large amount of liquid effluents charged with the residues of these chemicals.

4.2.5.1. Liquid effluents from the textile finishing industry

Bleaching, dyeing, printing and finishing procedures are all the most important steps that mainly characterize the textile finishing industry. These procedures play an important role in the production of wastewater loaded with dyes, pigments, adjuvants, detergents, wetting agents and other auxiliary chemicals [80].

According to data from the Moroccan Textile and Clothing Industry Association (AMITH) and the Moroccan Center for Cleaner Production (CMPP) in 2000, the textile finishing industries are major users of water and of chemicals that are found in liquid effluents downstream of manufacturing processes. Indeed, water is supplied from public distribution networks, with a total of 5 680 000 m^3/year and private wells or drilling with a total of 4 420 000 m^3 year [81, 82].

At the same time, bleaching, dyeing, printing and finishing operations consume an important proportion of dyes and pigments (2,250 - 2,500 tones/year) annually, auxiliary chemicals by way of example, humectants and surfactants (2,300 tones/year), inorganic salts (20,000 tones/year), halogenated solvents (very small amount) [82] and other chemicals used in this type of industry [83-85]. This will result in a very high volume of liquid effluents characterized by high coloring, high temperature, high fluctuating pH, high chemical oxygen demand (COD), high biological oxygen demand (BOD), and high biotoxine and of high suspended solids (TSS) [86-89].

Note that textile finishing dyes are designed in such a way that they are chemically stable; they are generally poorly biodegradable or non-biodegradable [90]. The presence of these dyes in aquatic environments without any preliminary treatment impairs the functioning of the aquatic ecosystem [81]. This requires the industrial units concerned to ensure adequate treatment of their effluents in accordance with current legislation and regulations on the protection of water resources and the preservation of the environment [81] on the one hand, and Interest in research on techniques for reducing water consumption through the reused of textile washing water and the recycling of certain residues from dye baths on the other hand.

4.2.5.2. State of purification of liquid effluents from textile finishing industry

The presence of dyes, pigments and other chemicals in liquid effluents from the textile finishing industries is a serious

problem in several countries, including Morocco. The direct discharge of these effluents into the receiving environment causes an excessive demand for oxygen, an intensification of the phenomenon of eutrophication and, consequently, an imbalance of the aquatic environment [91].

According to the CMPP report in the textile sector from June 2000 to September 2001, the annual generation of liquid effluents containing not only dye stuffs but other toxic substances which are residuals from textile finishing industries, about 5% of enterprises in the textile sub-sectors have their own wastewater treatment plant, treating about a total of 825 000 m^3/year, 35% have a sort of pretreatment station that allows the settling of wastewater, a volume of 2 340 000 m^3/year of wastewater before the latter is discharged directly into the environment and 60% of these industries whose estimated volume by 5 500 000 m^3/year of wastewater does not are addressed [82].

Conclusions

In the light of this review, it shows that despite the diversity of water resources, overexploitation of water, dyes, pigments and other chemicals by the textile finishing industries, as well as the lack of treatment of the liquid effluents discharged directly into the receiving media cause the multiplication and aggravation of the states of deficiency with regard to the preservation of the environment and more particularly the quality of the surface water. This requires increased efforts by state institutions, industrial units and interested researchers throughout the world to put an end to this danger that threatens the living conditions of aquatic living beings as well as man. For this reason, research on new techniques have been carried out, namely; biological, chemical, physical and physicochemical, and processes hybridized methods, namely; coagulation/ultrafiltration, adsorption/ultrafiltration, coagulation-flocculation/ultrafiltration, etc.

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