



## IV Seminário Regional Sobre Gestão de Recursos Hídricos

quantidade e qualidade das águas:  
inovação tecnológica e recursos hídricos



V Fórum do Observatório Ambiental  
Alberto Ribeiro Lamego

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# A água de reuso e a sua importancia para Treinamento de combate a incêndio dos trabalhadores offshore

*To water reuse and its importance for the fire fighting training for offshore workers*

Severino Joaquim Correia Neto\*  
Fernando B. Mainier\*\*  
Marco A.Cruz Moreira\*\*\*

## RESUMO

O consumo de água doce no mundo tem crescido, vertiginosamente, em função do aumento da população nas áreas urbanas, da irrigação no agro-negócio e do uso de água nos processamentos industriais, gerando, conseqüentemente efluentes sanitários e industriais. Isto remete à necessidade precípua de poupar, reduzir, reciclar e desenvolver processos de reuso que não venham na contramão da sociedade, ou seja, estejam baseadas nos princípios da precaução, considerando a possibilidade de ocorrências de contaminações de ordem química e microbiológica presentes nos efluentes. O presente trabalho avaliou numa visão crítica os processos de reuso de uma maneira geral e mais precisamente em Centros de Treinamento de Combate a Incêndio onde o treinamento consome considerado volume de água como agente extintor. As tecnologias simples e criativas desenvolvidas comprovam o sucesso do reuso da água no combate ao desperdício.

**Palavras chaves:** reuso, contaminações, princípio da precaução, treinamento, incêndio.

## ABSTRACT

The consumption of freshwater in the world has grown dramatically, due to the increase of population in urban areas, irrigation of agri-business and the use of water in industrial processes, leading consequently municipal sewage and industrial. This evokes the need for major duty of saving, reduce, recycle and reuse to develop processes that do not come in the opposite direction of society, or are based on the precautionary principle, considering the possibility of contamination of a chemical and microbiological present the effluents. This study evaluated a critical process for reuse in general and more specifically in Training Centers Fire Fighting training which consumes considered volume of water as the extinguishing agent. The technologies developed simple and creative prove the success of water reuse in the fight against waste.

**Key words:** reuse, contamination, the precautionary principle, training of fire

\*M.Sc em Sistema de Gestão Área de Conferencia Recursos Hídricos – UFF. Atualmente e Professor do Instituto Federal Fluminense - Campus Macaé. Atua nas áreas de Engenharia de automação, Gestão do Meio Ambiente e Segurança do Trabalho e Responsabilidade Socio Ambiental.

\*\* D.Sc em Educação área de Conferencia Engenharia de Materiais e Metalúrgica, com ênfase em Corrosão, atuando principalmente nos seguintes temas: corrosão, meio ambiente, ensaios de corrosão, contaminações e inibidor de corrosão. Atualmente é professor titular e Diretor da Escola de Engenharia da UFF

\*\*\* D.Sc em Engenharia Elétrica pela UFRJ. Atualmente é professor do Instituto Federal Fluminense - Campus Macaé. Atua nos curso de Engenharia de Controle e Automação e no Mestrado em Engenharia Ambiental daquela



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### 1. INTRODUÇÃO

#### 1. INTRODUCTION

The opinion of renowned environmental experts is that water will become, along the twenty-first century, such an important and disputed natural resource in the economic, social, environmental and political view, as coal and oil were for global economy over the past 150 years (Machado, 2004).

Earth's hydrological cycle is represented by the interdependence and continuous movement of water in solid, liquid and gas phases. Clearly, the liquid phase is the most interesting one, as it is fundamental to human beings' needs and use, as well as to all other organisms, be it animals or plants.

According to Tundisi (2005), the hydrological cycle components are:

- Precipitation: water added to the Earth's surface from the atmosphere, occurring as liquid (rain) or solid (snow or ice);
- Evaporation: the transformation of water from liquid into gas phase (water vapor). Most of the evaporation occurs from the oceans, as well as from lakes, rivers and dams;
- Transpiration: the process of loss of water vapor by plants, which enters into the atmosphere;
- Infiltration: the process by which water is absorbed by the soil;
- Percolation: the process by which water enters the soil and rock formations until the water table;
- Drainage: water displacement movement on the surfaces, during precipitation.

Until the late '80s, the hydrologic cycle on the planet was believed to be closed, meaning that the total amount of water would always remain the same since the beginning of the Earth. No water would enter planet Earth from outer space, and no water would go out of it. Recent discoveries, however, suggest that "snowballs" of 20 to 40 tons, called by scientists as "small comets", coming from other regions of the solar system, may reach Earth's atmosphere. "Snowball" rains vaporize when they approach the atmosphere and may have added three trillion tons (volume =  $3 \times 10^6$  km<sup>3</sup>) of water in 10,000 years. The speed of the hydrologic cycle varies from one geological era to another, as well as the total sum of marine and freshwaters, in other words, water on the planet is related to life cycles (Tundisi, 2005).

Currently, one third of the world's population faces water scarcity due to failures in the management of sources and the increasing use of water, mainly for agriculture. Water shortage is increasing faster than expected, with agriculture accounting for 80% of the world's consumption (UN, 2006).

Global use of water has increased six times in the last hundred years and will probably double by 2050, mainly due to the culture of irrigation. Of the existing species on Earth, humans are the ones that use more freshwater, reaching about 54% of the total available at the present days; if this current trend goes on, in the next 25 years mankind will absorb 90% of the available freshwater, leaving only 10% to the other inhabitants of our planet. (PLANET ORGANIC, 2006)

According to Liu (2011), new waste water treatment techniques should be developed as to guarantee a minimum quality in the use of reclaimed water for food production. According to Machado (2004), water will become, in effect, a strategic resource for most countries' development and quality of life, especially for Brazil.

In Braga et al. (2007) view, water resources can be used in several ways, serving various industrial, agricultural and social activities developed by man. The growing demands for freshwater is due to population's increase as well as the expansion of irrigated agriculture areas and the use of water in various industrial segments. On the other hand, to this scenario, misuse, waste and contamination of all kinds should also be added, which consequently end up by generating the reduction and gradual



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deterioration of water quality. According to Mainier (1999b), it is common to see some cities where the quality of water is questionable, as there is neither drinking water nor sewage treatments, just as there is no piped water distribution and, consequently, black ditches appear and proliferate everywhere. Aimless, the local population must look for water in shallow wells, streams and weirs that, somehow, end up by receiving pollution charges.

In arid regions, where water is a limiting factor for the development of irrigated agriculture, industrial sectors and urban social activities, reclaimed water becomes an attractive prospect in terms of technical, economic and public policy for sustainability.

Water reuse is already being widely used in industry, especially in cooling towers, boilers, civil construction, green areas irrigation and in some industrial processes in which the use of lower quality water does not cause major problems. Thus, the reuse of water for non-potable (drinking) purposes should be considered as the first option for its reuse (Mierza & Hespanhol, 2002).

An alternative that can be considered for integrating reuse activities is the use of production process wastewater, which requires higher quality water in another process that may use lower quality water. This alternative is environmentally correct; however, it continues incorporating impurities to water receiving bodies.

Melin et al. (2005) developed a technology for wastewater treatment and its reuse as industrial process water through membrane bioreactors (MBRs).

The most interesting alternative is the reuse of water in a closed loop, in other words, by using an adequate treatment process, obtaining water with its initial quality after using it in any activity that results in the incorporation of impurities.

Gomez-Lopez et al. (2009) consider the environmental and social impacts resulting from the wastewater treatment complex, and that different treatments are needed, depending on their future application.

From an environmental perspective, water reuse is a correct choice, since it contributes to reduced uptake and consequent outflow reduction in the discharge of effluents. Nevertheless, in order to be used, the issue of public health should be taken into account. In some countries, there are standards that make the reuse of water for non-potable uses a habitual practice.

Nowadays, in the category of water scarcity areas, 26 countries are home to 262 million people. The aggravating factor is that population is growing faster where water shortage is more acute. In the Middle East, 9 out of 14 countries live in scarcity conditions, six of which will probably double their population within 25 years. There, the excessive withdrawal of water from underground aquifers causes ocean salinity intrusion, which contaminates groundwater.

## 2. METHODOLOGY

This work was developed from a literature search, prepared from the books, journal articles, national and international legislation standards, whose sources include the consultative trusted websites, through national and international organizations, including official bodies, institutions not officers of renowned credibility and businesses, aimed to addressing water reuse programs, national and international experiences on the reuse of urban drinking water, collection of concepts, laws and existing research projects in this area.

Moreover, the evaluation and validation study to the reuse of water were made on the premises of a training center for fire aimed at training personnel to operate in various sectors of onshore and offshore oil units and consequently achieve the following objectives:



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- Call attention of professionals, consultants SMS (Safety, Environment and Health), public and private managers, the need to integrate water reuse to national practice, however, within the principles of precaution in order to preserve the human and environment;
- Study the process of simplified treatment of reused water for training centers to fight the fire that does not involve sophisticated and expensive in maintenance

### 3. DEFINITIONS, CLASSIFICATIONS AND FORMS OF WATER REUSE

The Brazilian Association of Sanitary and Environmental Engineering (ABES, 1992) classified the water reuse in two major categories: drinking and not drinking.

- potable water reuse: direct potable reuse, the reclaimed wastewater, through advanced treatment, is directly reused in the drinking water system. Reuse drinking indirect, in which case the wastewater after treatment is provided in the collection of surface water or groundwater for dilution, natural purification and subsequent capture, processing and finally used as drinking water;
- non potable water reuse: this type of reuse has a potential very large and diverse. By not requiring high levels of treatment, is becoming an economically viable process and, consequently, with rapid development. Because of the diversity of use, can be classified as:
  - non-potable reuse for agricultural purposes: the main objective of this practice is irrigation of food crops such as fruit trees, cereals, among others, non-food plants, pastures, fodder, and is applicable for watering livestock;
  - non-potable reuse for industrial purposes: covering the various industrial uses such as cooling, process water, utilities, and so on;
  - non-potable reuse for recreational purposes: reserved for irrigation of ornamental plants, sports fields, parks and also for filling ornamental ponds recreational and so on;
  - non-potable reuse for maintenance of flows: the maintenance of runoff watercourses promote the use of treated effluent planned, aiming at a proper dilution of any pollutant loads carted them, including diffuse sources, in addition to providing a minimum flow in drought;
  - non-potable reuse for domestic purposes, these cases are considered for water reuse for watering the garden, sanitary discharge that is used in large buildings;
  - non-potable reuse for aquaculture: is the production of fish and aquatic plants in order to obtain food and / or energy, utilizing nutrients present in wastewater;
  - non-potable reuse for aquifer recharge underground: the recharge of aquifers with treated effluent, which can be given directly by injection under pressure, or indirectly using surface water discharges that have received the amount.

In view of Asano et al (2007), reclaimed water is defined as an effluent conveniently treated in a sewage treatment plant for a specific intended reuse of water. Additionally, reuse of water directly requires the existence of a pumping system or other transportation facilities for the supply of water. Indirect reuse is accomplished through the discharge of effluent to body of water for dilution or absorption, that water recycling is normally used for a specific use and in some ways to a defined user. That is, the effluent is again to be captured and redirected back to this system of use. In this context, water recycling, predominantly is practiced in the industry.

In the critical view of Hespagnol (2002) are highlighted three potential applications of non potable water reuse: urban, agricultural and industrial. The non-potable urban uses involve less risk



and should be considered as the first option for reuse in the urban area. However, special care must be taken when there is direct contact with the public water reused. The greatest potential of this process are those based on treated sewage to: Irrigation of landscaped areas in public buildings, homes and industry; aquatic systems such as decorative fountains and fountains; water reserve protection fire fighting; sewage in public restrooms, commercial and industrial buildings; cleaning of streets, trains and public buses.

#### 4. WATER REUSE IN THE TRAINING CENTER FIRE FIGHTING

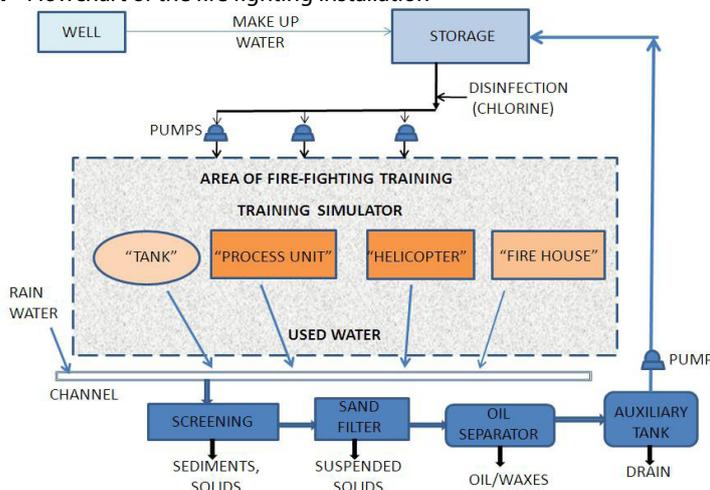
Water reuse assessment was held at the Centro de Treinamento de Combate a Incêndios {Firefighting Training Center} (Sampling Planning SA), located in the municipality of Rio das Ostras (Rio de Janeiro / Brazil), occupying a 17,000 m<sup>2</sup> area. The Center was built to meet the needs of companies in the oil and similar segments, based on the requirements contained in the NBR 14276 (ABNT, 2006), Rule 24 (DPC, 2009) rules and other legislation that recommend the need for the standardization of firefighting training activities through brigades having basic, intermediate and advanced knowledge, skills, and the necessary attitudes to control and prevent a possible accident. Teams should be guided through a training that includes, among other contents, the practice of using smothering, cooling and insulation methods, by means of a water extinguishing agent.

This project, which meets NBR 14.277/05 (ABNT, 2005) provisions, is dimensioned to a 50 (fifty) students / day demand. The main fuel used in the field is LPG (Liquefied Petroleum Gas), and the design of the indoor pipes used for fuel distribution meets the NBR 14750 (ABNT, 2001) provisions. Still about the LPG system, the tank farm should be proportionate, using a P 500 (500 kg capacity) container as a reservoir.

The reuse system consists essentially of the following:

- The water used in firefighting leaks along with the rain water to the gutters;
- From the gutters, the water goes to a rail box, where the coarse solids are retained;
- Next, the water passes through a sand filter, where the solids are retained in suspension.

Figure 1 - Flowchart of the fire fighting installation

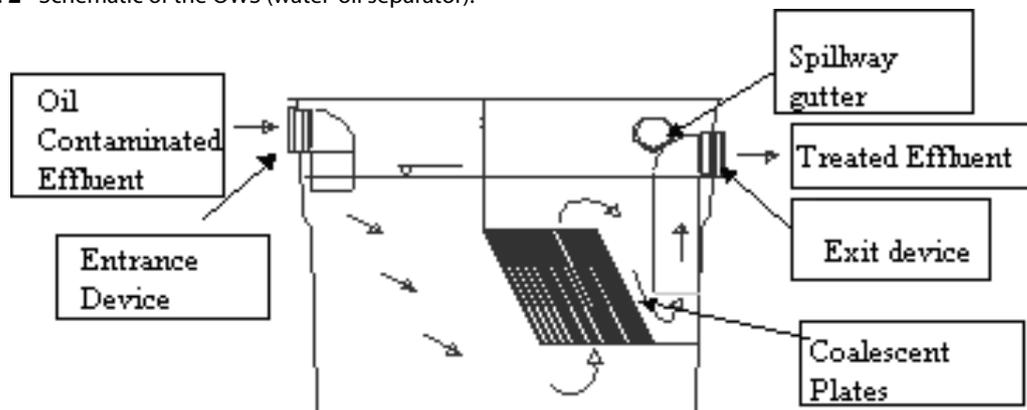


Source: Sampling Planning



The water continually flows into the OWS system (oil-water separator), where much of the oily sludge that is produced between the water- oil interaction is retained. In the OWS, effluents arriving in turbulent regime are sent, in the separator box, to the laminar flow, where with low drainage speed and a longer than 30 minutes retention time, most of the oily products are separated from water. In order to retain the oily particles with a minimum of 10 $\mu$ m diameter, coalescent plates consisting of a bundle of PVC plates (Poly Vinyl Chloride), inclined at a 60 ° angle to obtain an effluent with a maximum concentration of 20 ppm OG (Oil and Greases) are used. The oily matter retained in the separator is concentrated within it by gravity and the coalescence capacity of the plates on the liquid surface of the primary and secondary chambers; there, the oil accumulates and thickens until it is collected by the spillway shaped as a gutter that is located in the secondary chamber of the OWS, sending the already separated oily matter to the oil accumulation tank.

Figure 2 - Schematic of the OWS (water-oil separator).



Source: Sampling Planning

Water, with virtually no oil, flows into the buffer tank (reuse), and then it is pumped to the water tower. The circulated water and the makeup water (from the artesian well) are chlorinated to achieve the recommended values for disinfection. The water reuse is circulated up to its saturation point, in other words, when the amount of microorganisms and odors discourage its use, being then discarded into the sewage treatment plant.

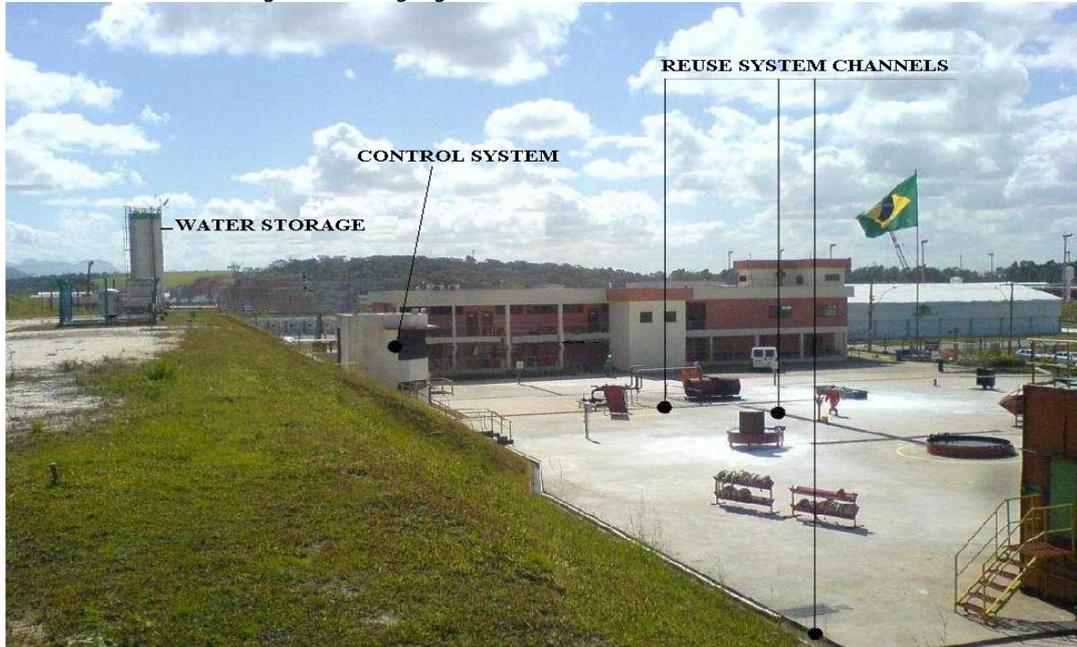
When the water is discarded, or, for any reason, there is loss of volume in the tower, makeup water from the well enters automatically. The oily sludge retained in the OWS is removed by a truck accredited by the environmental agency.

The water used in the system is monitored by the laboratory, where physic-chemical (pH, turbidity, chloride, total iron, alkalinity, sodium, total solids, conductivity and residual chlorine) analyses and bacteriological analysis (total coliforms, Escher coli) are carried out so that the residual chlorine levels are consistent with the disinfection process, i.e., between 0,2 to 0,5 mg Cl<sub>2</sub>/L.

The water used in this center and exercise program is from an artesian well that feeds the water castle, and the rain water that spill into the channels.

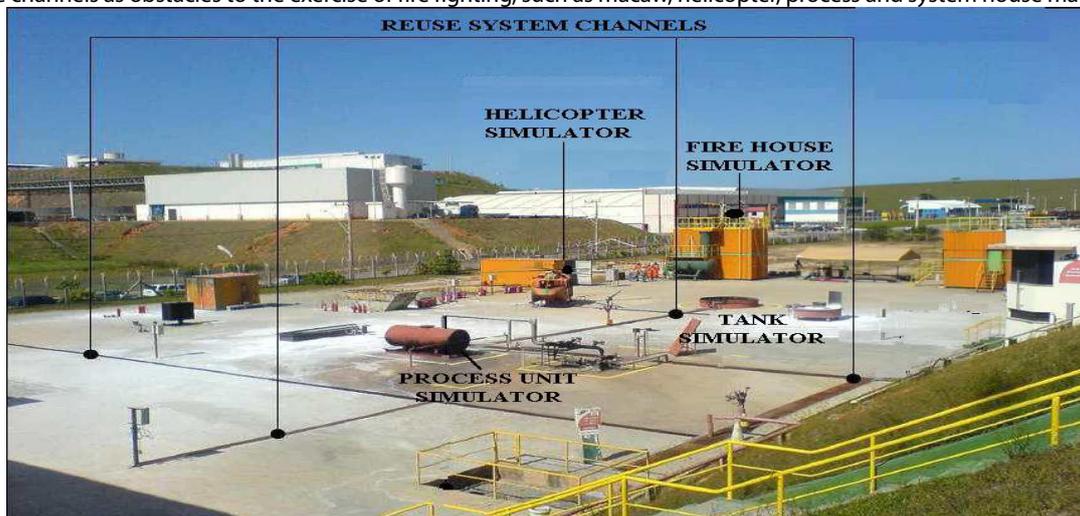


**Figure 3** - Overview of the training center to highlight the castle and water channels for water collection.



Source: Sampling Planning

**Figure 4** - Field aspect of firefighting training where there are practical exercises and identify the water separator and oil (OWS) and the channels as obstacles to the exercise of fire fighting, such as macaw, helicopter, process and system house machine



Source: Sampling Planning

It is estimated that, per year, the amount spent in other units, where there is no reuse system, is 200% to 300% higher. Moreover, the consumption of collected water tends to diminish by using LPG instead of diesel which, when used, adds a lot of oily sludge to the water, highly contaminating it.



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**Table 1:** Water consumption in the training of firefighting and the trainees.

Year	Trainees (number)	Water consumption(m3)
2006	1716	40
2007	7423	120
2008	6912	120
2009	5527	120

## 5. CONCLUSIONS

Based on studies conducted in the Training Center Fire Fighting concludes that:

- Water reuse is an important route to be used in various urban and industrial segments, however, the continuous monitoring of contamination by organic micro-pollutants toxic, pathogenic microorganisms and heavy metals is so important under the view of environmental pollution.
- Water scarcity, especially in large cities, leads to wise use of water reuse come from sewage or industrial effluent.
- The reuse water used in the Training Center of Firefighting is a simple and creative technology option because it reduces the disposal of water used and does not use water from natural springs protected by environmental laws.

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