MODERN CONVENTIONAL WATER TREATMENT TECHNOLOGIES AND CHALLENGES FOR OPTIMAL UTILIZATION IN NIGERIA.

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ABSTRACT

The need to ensure adequate provision of potable water over the years to Nigerians in rural, semi-urban and urban communities had been a challenge in spite of the abundance of water resources. It was observed that most water borne diseases or outbreaks that have occurred in the recent year were caused by the inadequate control of treatment facilities, contamination of untreated supplies, storage tanks, distribution system, interrupted treatment and ceasing attention to maintenance and operating details.

Nigeria as a signatory to Millennium development Goals(MDGs) of recent therefore embarked on the construction of dams and modern water treatment plants towards provision for people access to improved sources of drinking water. This paper discusses methods and processes in modern conventional water treatment plants as its being characterised by a degree of mechanization and automation which requires the engagement of high skill personnel. The paper also highlights the challenges of modern conventional water treatment which lies in the maintenances of electrical/mechanical equipment and other operational facilities, manpower development, power supply, security, political will and continuity etc.

The paper however concludes that well designed and constructed modern conventional water treatment plant does not guarantee regular provision of potable water and safety but proper and timely maintenance plan, regular power supply, adequate security, adequate political will and continuity, skillful and alert plant operation and attention to the sanitary requirements of the source supply and distribution system among others are equally important. All these depends on the readiness of the stakeholders(Government at all levels, private organisation and the general public) to work towards the realisation of the set goals as far as the provision of safe water for drinking is concerned.

Keywords: Automation, Conventional, mechanization, technology, Water, water treatment

1.0 INTRODUCTION

More than a billion of people in the developing World lack access to potable water. Access by households to sufficient and safe water combined with adequate sanitation and hygiene could result in a substantial reduction of the 5million deaths due to diarrhea diseases that occur each year [1]. [2] reported that 88% of the 4 billion annual cases of diarrheal diseases are attributed to unsafe water and inadequate sanitation and hygiene and 1.8million million people die from diarrheal disease each year. When water with any resources is abundant, there is relatively little attention to the rights, but with increasing scarcity and competition for water, there has been growing attention to its conservation and the rights in recent years[3].

Water is both the most abundant and the most important substance which nature provides to sustain life for plants and animals. Its availability is limited while its overall demand per capital has increased considerably due to population explosion and the increasing sophistication of people [4].

[5] remarked that water is an indispensable natural resources and that there is no substitute for it and its uses. Surface water in particular has been grossly inadequate and increasing reliability is being placed on water from aquifers[4]. It was further confirmed that water plays a major role in the overall development of communities[6]. Man requires safe and reliable water for his domestic, agricultural or industrial activity. Most of the food production in Nigeria is carried out by rural dwellers that are subsistent farmers and constitute about two-third of the nation's population[7].

Recent years have experienced steady growth in the need for water purification. This need comes from all categories of users- commercial, industrial, institutional, Municipal and residential. A broad range of applications and requirements for water quality has stimulated the water treatment industries to improve existing methods and to investigate and develop new water purification technologies.

1.1 Water classification by source

The type of treatment depends on the quality of the source of supply and the quality desired in the finished product. The sources of water can be classified into two general categories namely: Ground water sources , principally wells and Surface water sources such as rivers, lakes, and impoundments on rivers and streams.

Ground water: The water emerging from some deep ground water may have falling as rain many decades, hundreds, thousands or in some cases millions of years ago. Soil and rock layer naturally filter the ground water to a high degree of clarity before it is pumped to the treatment plant. Such water may emerge as springs, artesian springs, or may be extracted from boreholes or wells. Deep ground water is generally of very high bacteriological quality (i.e pathogenic

bacteria or pathogenic protozoa are typically absent), but the water typically is rich in dissolved solids, especially carbonates and sulfates of calcium and magnesium.

Surface water: This is typically located in the headwaters of river systems, upland reservoir are usually sited above any human habitation and may be surrounded by a protective zone to restrict the opportunities for contamination. Bacteria and pathogen levels are usually low, but some bacteria, protozoa or algae will be present. Others include rivers, canals and low land reservoirs[8].

1.2 Water Treatment

Water treatment involves process that alter the chemical composition or natural "behaviour of water". Primary water availability include surface or ground water. Most municipal or public water comes from surface water while private water supplies usually consists of ground water pumped from wells or boreholes[9].

Water treatment originally focused on improving the aesthetic qualities of drinking water. Methods to improve the taste and odour of drinking water were recorded as early as 4000B.C. Ancient Sankrit and Greek writings recommended water treatment methods such as filtering through charcoal, exposing to sunlight, boiling and straining. Visible cloudiness (later termed turbidity) was the driving force behind the earliest water treatment, as many source water contained particles that had an objectionable taste and appearance[10]. To clarify water, the Egyptians reportedly used the chemical alum as early as 1500B.C. to cause suspended particles to settle out of water. During the 1700s, filtration was established as an effective means of removing particles from water, although the degree of clarity achieved was not measurable at that time.

During the late nineteenth and early twentieth centuries, concerns regarding drinking water quality continued to focus mostly on disease-causing microbes(pathogens) in public water supplies. Scientists discovered that turbidity was not only an aesthetic problem; particles in source water such as fecal matter, could habour pathogens. As a result, the design of most drinking water treatment systems built during the early 1900s was driven by the need to reduce turbidity, thereby removing microbial contaminants that were causing typhoid, dysentery and cholera epidemics[10].

While filtration was a fairly effective treatment method for reducing turbidity, it was disinfectants like chlorine that played the largest role in reducing the number of waterborne disease outbreaks in the early 1900s. In 1908, chlorine was used for the first time as a primary disinfectant of drinking water in Jersey City, New Jersey. Since the passage of the original Safe Drinking water Act of 1974, the number of water systems applying some type of treatments has

increased. Filtration and chlorination remain effective treatment techniques for protecting water supplies from harmful microbes[10].

According to [11], the three basic objectives of water treatment are production of water safe for human consumption, production of water appealing to the consumer and production of water using facilities reasonable with respect to capital and operating costs.

In the design of water treatment plants, the provision of safe water is the prime goal and anything less is unacceptable. A properly designed plant is not a guarantee of safety. However skillful and plant operation and attention to the sanitary requirements of the source of supply and distribution system are equally important. Water treatment plants have demonstrated the ability to produce safe water under adverse conditions. Most of the outbreaks that have occurred in recent years have been caused by inadequate control of treatment facilities, contamination of untreated supplies, storage tanks and distribution systems. These serve as remainders of the need for uninterrupted treatment and unceasing attention to operating detail.

The second basic objective of water treatment is the production of water appealing to the consumer. Ideally, an appealing water is one that is clear and colourless, pleasant to the taste and cool. It is non-straining, and it is neither corrosive nor scale forming. Engineers, managers and operators are aware of the consumer's growing sensitivity to the quality of water served and of the demand in many places for water of better quality. Experts for those supplies of excellent natural quality, the responsibility for production of an appealing water rests mainly with the treatment plant. In satisfying the demand for an appealing water, the treatment plant must be able to cope with variations in flow and raw water quality to produce a water of uniformly good quality. An additional reason for production of an appealing water is to discourage the consumer from turning to some other unsafe sources of water. The consumer is principally interested in the quality of water delivered to the tap in his home or place of business, as opposed to the quality at the treatment plant. Therefore water utility operations should be such that quality is not impaired as water flows from the treatment plant through the distribution system to the consumer.

The third basic objective is that water treatment be accomplished using facilities that are reasonable with respect to capital and operating costs. This does not mean that a plant's capacity to meet emergency situations or justifiable future condition should be sacrificed for the sake of initial savings. Water of improved quality is the direct return on a community's investment in water treatment facilities.

1.3 Water quality

The treatment of water in order to make it suitable for drinking, domestic or industrial use includes a complex of physical, chemical and biological methods which change the initial composition of water. Water treatment involves not only purification and removal of various

unwanted and harmful impurities, but also improvement of the natural properties of water by adding certain deficient ingredients.

1.4 Water quality parameters

Water quality parameters based on present-day standards and guides are presented to assist in the establishment of water system performance goals for any plant. Quality parameters are expected to change as new information on the nature and behaviour of water is revealed. The trend is toward production of water of higher quality.

The substances in Nigeria standards for drinking water quality are simply divided into physical/organoleptic, chemical organic and inorganic constituents, disinfectants and disinfectants by-products, radionuclide and microbiological parameters[2]

2.0 MODERN CONVENTIONAL WATER TREATMENT METHODS AND PROCESSES

2.1 Methods

Water treatment involves not only purification and removal of various unwanted and harmful impurities, but also improvement on the natural properties of water by adding certain deficient ingredients[12]. All methods of water treatment can be divided into the following main group:

(a) those aimed at improving the organoleptic properties of water (clarification, decolouration, deodorization),
(b) those which ensure epidemiological safety (chlorination, ozonization, ultraviolet irradiation) and
(c) those by which the mineral composition of water is conditioned (fluorination and deflourination, deironing (dererrizatio), demanganisation, softening, desalination).

A particular method of water treatment is chosen upon preliminary examination of the composition and properties of the water source to be used and comparison of these data with the consumers requirements.

2.2 Processes

Treatment plants have been classified according to raw-water quality to assist consulting Engineers, regulatory agencies and others concerned with water treatment. One of the common types which is known as rapid sand filtration plants is being used in this presentation to illustrate water treatment process arrangement. The following are the basic definition of processes involve in the modern conventional water treatment plant.

(i) **Aeration**: As applied to water treatment, aeration may be defined as the process by which a gaseous phase, usually air, and water are brought into intimated contact with each other for the purpose of transferring volatile substances which may include oxygen,

carbondioxide, nitrogen, hydrogen sulfide, methane, and various unidentified organic compounds responsible for taste and odour.

(ii) **Coagulation** : The word coagulation according to water treatment practitioners and chemists is referred to as entire process that included addition of chemicals coagulants,(iron or aluminum salts), such as aluminum sulphate, iron sulphate, iron chloride or polymers to the water. These chemicals are called coagulants, and have a positive charge. The positive charge of the coagulants neutralises the negative charge of dissolved and suspended particles in the water.

(iii) **Flocculation**: The term flocculation refers to water treatment processes that assemble or combine or " coagulate" small particles (Floc particles) which settle out of the water as sediment. Settling or sedimentation occurs naturally as flocculated particles settle out of the water.

(iv) **Sedimentation**: Settling tanks(sedimentation tanks, sedimentation basins, settling basins or clarifier), are used in water treatment to reduce the amount of settleable solids suspended in water. Sedimentation is one of the most widely used processes in the treatment of water, second perhaps to chlorination.

(v) **Filtration** : Water filtration is physical and chemical process for separating suspended and colloidal impurities from water by passage through a porous medium, usually a bed of sand or other granular material. Water fills the pores of the medium and the impurities are left behind in the openings or upon the medium itself.

(vi) **Chlorination and disinfection**: Water disinfection involves specialized treatment for the destruction of harmful and otherwise objectionable organisms. Classically, disinfection has been practiced for the purpose of destroying or inactivating disease producing (pathogenic) organisms more particularly, bacteria, of intestinal origin. Pathogenic organisms other than bacteria that merit attention in connection with water disinfection include a variety of viruses, intestinal protozoa and some few macroorganisms.

Modern complexes for improving the quality of water are complicated enterprises which by right may be called water-purification plants since their capacity in the final product(water of proper quality) amounts to tens or hundreds thousands cubic metres per day. According to [14], the largest municipal water treatment plants in cities such as Moscow, Leningrad, Kiev, Chicago, Tokyo, London, Paris, produces more than 1 million cubic metres per day.

Water treatment plants as a rule, occupy large territories, sometimes of an area of a few tens hectares, which constitute the first belt sanitary zone. The zone is fenced to prevent admission of unauthorized person. Trees and shrubs are planted with decorated flowers and well organized water drainage. The general structural features of modern water treatment plants includes a number of units, departments and shops such as Inlet structure, Raw water chamber, Aerator, mixing and distribution structure, Clarifiers block, Filtration block and electromechanical building, Waste backwash tank and pumping station, Internal conveyance, Treated water reservoir, Treated water pumping station, Treated water measurement chamber and pipelines interconnection, Chemical plant, Chlorine gas plant, Chlorine gas plant, Reagent shop, Repair

shop, Electric substation, standby power station and fuel tank, Laboratory, administrative and control building, Elevated water tank, Gate house etc. These structures sheltered highly sensitive modern equipment that are being used in the control and operation of water treatment processes.

Modern conventional water treatment plants are characterized by a high degree of mechanisation and automation. All principal characteristics of the operation of electrical and mechanical equipment and technological parameters of operation of individual water treatment installations are transmitted by telemetering devices to the central control board and control room. The day to day control and operation of modern conventional water treatment plant for instance in Nigeria is being directed and monitored from the control room through the central control board and Mccs/Control panels located in various structures or building earlier mentioned that are associated with the process units. Instruments such as PH meters, turbidity meters, flow meters etc. are also provided to monitor the water PH level, turbidity and rate of flow.

Also, among the special operation common to modern conventional water treatment plants are automatic deslugging of clarifiers, automatic filter backwash, automatic change over of chlorine drum, automatic operation of drain pumps in basements and waste backwash water pump, automatic operation of the filtered water pumps and chemical dosing pumps and automatic extent of throttling the inlet control valves.

The technology of improvement of water quantity at treatment plants can also be characterised by a large diversity of the methods and processes employed and substantial differences in the design of process structures and equipment as well as in the kinds of reagents used for intensification of various stages of water treatment.

This complex technology, the high requirements to reliability and the high degree of automation and mechanization in the modern convectional water treatment plants is a major concern to the authors as a result of various problem that could truncate the set goals upon which the adoption of modern water treatment technologies in Nigeria is based.

3.0 PROBLEMS OF MODERN CONVENTIONAL WATER TREATMENT TECHNOLOGY

While this paper discusses the existence of an advanced conventional water treatment technologies towards making potable water available to people in both rural and urban communities in Nigeria, It should be noted that as interesting and effective this new technology tends to be, there exist factors or barriers that may pose serious threat to its success. some of these factors include:

(i) **Poor maintenance Culture:** It has been observed that there is poor attitude to maintenance in Nigeria from the parts of the general public and the policy makers. Public properties if not vandalised are being handled carelessly. Also, there is lack of timely and formal maintenance policy which institutionalizes maintenance with financial backing. The policy makers are very much interested in flagging- off new projects while completed ones and some under construction are being abandoned. The abandonment of all water projects in most cases thus leads to early decay and subsequent breakdown of installed / tested equipment.

(ii) **Inadequate Manpower Power:** Insufficient of highly skilled personnel to operate modern equipment and inadequate refresher trainings or courses for the personnel who are familiar with old methods has contributed to the failure of the modern water treatment projects.

(iii) **Erratic power supply:** There is no gain saying that the power supply in Nigeria is erratic. This irregular supply of power has impaired the smooth running of the highly sensitive and automated control panels and other equipment available in modern treatment plants.

(iv) **Inadequate security:** The safety of equipment for modern water treatment of recent is not guaranteed. Also as a result of security challenges, expatriates on modern water treatment technologies are tired of being kidnapped, abducted or attacked while in Nigeria.

(v) **Lack of political will and continuity:** Politician do gives approval and embark on new projects that are not meant to solve immediate problem like water. This they do just to show people that they are working while the on-going/the uncompleted ones approved by their predecessors are abandoned because of political reason(s).

4.0 SUGGESTED WAY OUT

For Nigeria to have her goals of providing portable water for her citizens actualized through conventional water treatment technologies, the following suggestions are proposed.

(i) **Policy Reform on Efficient Maintenance Culture :** Formulation of workable maintenance policies should be put in place upon agreement by all stakeholders. Also, the maintenance activities must well planned and adequately funded so as to prevent early decay and breakdown of equipment. As a matter of fact, adoption of computerized maintenance management will facilitate easy access to operation and technical data in modern conventional water treatment technologies.

(ii) **Adequate Manpower Development:** The technical and professional requirements in modern conventional water treatment demands for highly skilled and knowledgeable personnel. The personnel will also need to update themselves through regular training on the job in other to meet up with future challenges in modern water treatment schemes.

(iii) **Regular power Supply:** Provision of regular power supply is not negotiable in the production of portable water through modern conventional water treatment scheme. To this end, government should mandate and encourage relevant agencies for improvement. Also, the construction of small hydropower will serve as an alternative power source in case of power outages.

(iv) **Adequate Security:** As a matter of facts, the security of both the personnel and imported equipment should be guaranteed if provision of portable water is to be actualised. Loss of any equipment however small, could paralyse the whole scheme.

(v) **Political Will and Continuity:** Politician irrespective of ethnic and political affiliation should see provision of portable water as basic necessity which at every point in time should be

made available to people. All uncompleted and abandoned water projects therefore should be adequately funded for sustainability.

5.0 CONCLUSION

Water scarcity has been a major threat to development and food security in many parts of the World. The need to ensure adequate provision of portable water over the years to Nigerians in rural, semi-urban and urban communities had been a challenge in spite of the abundance of water resources. The non availability of portable water of recent become worrisome that Nigeria government embarked on the construction of dams and modern conventional water treatment plants towards alleviating the suffering of the teeming populace. This paper discusses methods and processes in modern conventional water treatment plants and also highlights existing problems militating against its adoption in Nigeria. Surmounting these problems require the combine efforts of all stakeholders in water resources(Government at all levels, private organization and general public) for mutually satisfying remedy because a well designed and constructed modern conventional water treatment plant does not guarantee regular provision of portable water and safety.

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