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TECHNICAL BRIEF

On-site training for operators of small rural water treatment plants

The lack of capacity of small water treatment plant operators remains one of the main reasons why many of these plants are not functioning adequately. A new illustrative training guide hopes to assist in remedying the situation.

Training needs of small water treatment plant operators

A previous investigation of small water treatment plants across South Africa revealed that a large proportion were not functioning satisfactorily, thereby compromising the safety of treated water and threatening the sustainability of potable water provision to rural communities. Of great concern was the lack of capacity among operators and supervisors of small water treatment plants.

The fact that these capacity constraints could be traced back to a lack of operator training is a clear indication of the critical need in this regard. As a contribution to meeting this need, a mobile system for providing operators with on-site training in the treatment of small rural water supplies has been conceptualised and a series of illustrative training materials developed for this purpose.

The training materials will, firstly, assist trainee operators in acquiring a comprehensive overview and appreciation of drinking water treatment by imparting knowledge on:

- The legal and regulatory aspects of providing safe drinking water to South African consumers;
- The reasons for treating water; and
- Different treatment processes and process combinations and how appropriate treatment options are selected.

Thereafter, the training materials will provide a basis for hands-on instruction in operators associated with conventional water treatment, i.e. the removal of suspended material from raw water, disinfection of the water, and its stabilisation in order to prevent pipeline corrosion.

The legal and regulatory framework for drinking water supply

Institutions that have the legal responsibility for providing water services are water services authorities (WSAs) and water service providers (WSPs). A WSA has executive authority and the responsibility to supply water services in its area of jurisdiction. The role of WSA is usually assigned to a district municipality. A WSP is an organisation (typically, a local municipality or a water board) which is assigned operational responsibility for the provision of water services to consumers. In some cases, WSAs may also act as WSPs.

Each WSA must implement a programme for monitoring the quality of drinking water provided to consumers. If tests on water samples do not comply with compulsory national standards for the quality of provided water as defined in SANS-241, the water is considered to pose a health risk to consumers. Then, both the Director-General of the Department of Water Affairs & Forestry and the head of the relevant Provincial Department of Health as well as affected consumers must be informed immediately and appropriate, timely steps taken to remedy the situation.

SANS-241 requires the monitoring of at least conductivity (or total dissolved solids), pH, turbidity, faecal coliforms (or ***E. coli***) and treatment chemical residuals, but also provides standards for fluoride, nitrate and nitrite, heterotrophic plate counts, iron, manganese and arsenic. It specifies three different classes of water in terms of physical, microbial and chemical quality, namely:

- Class 0: An ideal standard largely based on first world standards.
- Class 1: Water that is known to be acceptable for a whole lifetime of consumption.

- Class 2: Water that is considered to be the minimum allowable quality for short-term consumption (usually not exceeding one year).

In addition to setting standards for drinking water quality, SANS 241 also provides guidelines for frequency of sampling and factors to be taken into consideration in drafting an appropriate sampling plan.

Summary of training material helping trainees to appreciate reasons for treating water

Water must not be allowed to pose a health risk due to either microbiological or chemical contamination. It should also be aesthetically acceptable and not have an economically detrimental effect on either the distribution system of consumers' equipment through corrosion, scaling, hardness or presence of sediments in the water.

Consumption of untreated or inadequately treated raw water can be dangerous. The first treatment priority is to remove suspended or colloidal particles that generally occur in surface water and give water a turbid or murky appearance. These include clay particles, algae, microorganisms, decaying plant material and other organic and inorganic substances.

Microorganisms include bacteria, viruses and other organisms. Most are harmless, but the pathogens among them could, if ingested, result in waterborne diseases (such as cholera and gastroenteritis). Problems associated with the presence of algae may include bad tastes and odours, toxins, filter clogging and corrosion.

Apart from suspended particles, the presence of dissolved substances in water also needs to be considered. Dissolved organic substances normally do not affect the appearance of the water, but may cause the water to have a brackish (salty) taste. If present at excessive concentrations, some substances, e.g. fluoride, may cause the water to be toxic.

High concentrations of calcium and magnesium cause hardness in the water, while iron and manganese cause staining of clothes. Other inorganic substances may cause the water to be corrosive or to cause scale in pipes and kettles.

Dissolved organic substances are frequently present in surface waters. Although most (e.g. humic acids derived from decaying plant matter) are harmless, some harmful substances such as pesticides and herbicides can find their way into water sources. Dissolved organic substances also include so-called disinfection byproducts. Sources of chemical contamination (inorganic as well as organic) are generally spills, discharges, runoff, mine drainage, hazardous waste facilities etc.

Specific treatment needs are revealed by analysing water samples for constituents of concern and identifying those that must be considered for removal because they exceed the recommended standards for domestic use. Constituents that have the potential to affect the health of consumers are the most critical.

Overview of drinking water treatment given to trainees

There are many different water treatment processes that can be used, singly or in combination with one another, to treat water for domestic use:

Clarification processes are used to remove suspended material from water. These processes include coagulation, flocculation, sedimentation, flotation and filtration. **Disinfection processes** include treatment with chlorine and chlorine compounds, the use of ozone and physical processes, such as ultraviolet radiation.

Advanced or specialised processes are employed for the removal of dissolved inorganic or organic substances. **Chemical stabilisation processes** prevent water from corroding pipelines. These processes can be selectively combined in process trains to produce water of the required quality. Process selection depends also on the quality of the raw water, volume of water to be treated, cost/affordability considerations and the acceptable level of sophistication given the expertise and support services available.

Having evaluated alternative processes and process combinations and selected the most appropriate options, treatment plant design is concluded with the preparation of detailed drawings of the different process units, the preparation of specifications of chemicals as well as of pumps and other equipment

and the drafting of instructions for the operation and maintenance of the plant.

Hands-on, on-site training of water treatment plant operators

After providing the trainee operators with a sound, general grounding in conventional water treatment and its competent processes, the focus of the course material shifts to hands-on instruction in all necessary day-to-day treatment plant operations. For this purpose, every treatment plant should be equipped to allow operators to measure at least turbidity, pH, free chlorine, filter run time, flow rate and/or hours of operation.

Process control: For ensuring treatment effectiveness, an appropriate process control system needs to be operated. Such a system specifies:

- The parameters (turbidity, pH etc) to be monitored.
- Procedures and equipment required for measurement, sampling and analysis;
- Treatment stages at which samples are to be collected and the frequency of sampling;
- Acceptable ranges of values for measurements;
- Procedures for adjusting the treatment processes to meet required performance.

Monitoring of critical control parameters

Turbidity is used to assess the efficiency of the coagulation, flocculation, sedimentation and filtration processes. Measurements are required at various points in the treatment plant as well as at the point of delivery to provide an indication of any processes in the distribution system that impact negatively on water quality.

pH is a critical control parameter because it is impacts on the efficiency of the three key processes: coagulation, disinfection and stabilisation. Free chlorine residual is the primary indicator of microbial safety used in process control. Ensuring that there is adequate chlorine residual in the finished water is one of the most important steps in water treatment.

Routine monitoring of chlorine residual throughout the system is thus required to determine the effect of the chlorine dose at the plant on the quality of the water received by consumers at various points in the supply area. Sampling points, sampling frequencies and required ranges and control limits for turbidity, pH and chlorine residual are generally specified and must be strictly adhered to.

Determination of flow and dosing rates

The operating levels, flows into and out all storage tanks and reservoirs in the distribution system and hours of pumping must be recorded. Flow rate measurements are indispensable for dosing rate calculations and are therefore critical for effective water treatment. Operators need to be able to carry out the jar test to select the optimum coagulant dose. Similarly, operators need to be able to calculate the exact flow rate of chlorine to be used in the plant.

Record keeping

It is crucial that records of all measurements, flow rates and dosing rates be kept in a systematic and comprehensive manner.

Conclusion

Course material, urgently needed for the training of operators in small water treatment plants, is now available for use. In preparing the material, every effort has been made to ensure that the course material content is relevant, concise yet comprehensive, and attractively presented, complete with illustrations and worked examples of critical calculations. The course material promises to make a valuable contribution to ensuring the safety of water supplies to small and rural communities.

Further reading:
To obtain the training material, ***On-site Mobile Training of Operators in Small Rural Water Supplies: An Illustrative Guide*** **(Report No: TT 348/08)** contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; E-mail: orders@wrc.org.za; or Visit: www.wrc.org.za