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D C Sims

Simple operational techniques for waterworks

INTRODUCTION

The Water Decade statistics which are quoted to show what fraction of the world has access to a supply of safe water include all existing waterworks supplies. The figures refer to population served. It is assumed that the quality of water served is satisfactory. This may be so, if the operation of the waterworks is satisfactory. If, however, the treatment plant is not run correctly then an unsatisfactory standard of water will be produced and this will be reflected in the health standards of the community served. The operation of works must therefore be given very careful attention if the full benefit to the people is to be realised.

In this paper the author attempts to discuss some aspects of how water treatment plants can be simply operated, based on experience of some years plant operation in U.K. and observations of operational works in Africa, Asia, the Caribbean and U.S.A.

GENERAL

Good operation of treatment plant depends mainly on good observation of the different parts of the process. This requires patience and training as conditions change relatively slowly. Good observation will detect subtle changes early, so that corrective action can be taken before the situation develops into a more serious incident. For example, if a channel is seen to be accumulating silt it can be cleared before the situation has become so bad that the carrying capacity of the channel is affected. However this presupposes that the observation has been made, recorded, reported, and acted upon, and can only happen if there is a system of proceedure. The basic proceedure is the same in principle for all operations.

TOOLS

No operations can be undertaken without tools. These are few and simple for operators, in contrast to the craftsman's need for many and special tools. Each group of operators should be jointly responsible for their tools on the works. These are usually left at the location where they are needed, as often they are needed quickly and are only used at that location. For example, rakes at the intake ccarse screens. There should be a special place for tools such as a rack or shelf on a convenient wall. They should not be locked away from the place where they need to be used frequently.

Work Schedules or Log Books

Water Treatment Plant operators work on shift systems in order to obtain 24 hour manning. The shifts are often 8 hours continuous work. This work period has to be of a disciplined nature. The supervising staff must ensure that every operator has a schedule of work layed out for him to cover during his shift period. This can be done by a routine plant "walk", which will include visiting and observing each part of the process at set periods of time. It is usual for this period to be one hour. In order to ensure that the operator achieves his schedule a reporting system is necessary. The format for this schedule can vary according to the layout of the works. It will follow the pattern and sequence of the plant walk. It will require the operator to observe the functioning of the individual items making up the process, and to record the operating condition of each. For example a pump observation would include the running volts, and amps readings, the operating pressures and flow, and comments on the general running conditions, such as hot bearings, leaking glands, and noisy or noise damage in motors.

When these work schedules, sometimes referred to as log books, are completed, it is most important that the supervisor should take an active interest in the results. Operators soon become disillusioned if this is not done regularly and effectively.

Work Instructions

The work schedule must be accompanied by instructions to the operator on what he is expected to do and achieve at each section of the plant walk. Examples of these will be given through the individual parts of the plant described.

SOURCE

The operators observations of the source of water, before treatment, is of great importance. In a river this may be the gradual

increase in turbidity over some hours, the sudden appearance of oil pollution on the surface, or floating bodies of dead fish or animals. In all these cases corrective action must be taken, perhaps by the operator himself, or by reference to the supervisor. A much longer term observation may be the siltation or changing course of the river channel. If this is detected,early action can be taken to remove silt, assist in formation of new channels, or excavation of alternative channels to ensure that water arrives at the works from the source. The consequence of delay in taking action early may be the complete closure of the water source.

INTAKES

Siltation is a common difficulty and this is often difficult to observe in the early stages. Operators must be trained to watch out, and supervisors encouraged to take action early, before a major incident developes.

SCREENS

Coarse screens are usually kept clear by the operator raking them. He may need assistance at times of heavy floating debris in the river such as trees, hay bales, sugar cane, and vegetation, to say nothing of dead animals. It is necessary to remove debris from the site after removal from the screens. This can be done by burning, carting away, or sometimes returning to the river below the intake. Fine screens are always very difficult to clean and sometimes an impossible situation involves the screens being removed and taken out of use. Simple strong rakes for operators use are essential for the task and should be stored conveniently near to the screens.

RAW WATER PUMPS

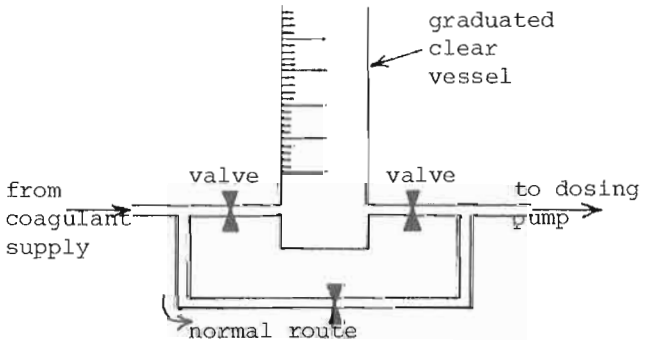
The main operation here is starting and stopping. The operators need to observe the starting of each unit to see if the routine is normal. Any abnormality, including a difference in noise should be noted. The switchgear must also be observed as often arcing on the contacts can be heard or seen long before major replacement is required. The cleanliness of the switchgear can be observed, but it will be a skilled electrician's job to carry out the cleaning task. The non-return valves need to be observed in order to ascertain that they close effectively. The temperature of bearings (by touch), the sealing glands, and running sound also need the operator's attention. Major breakdowns can often be avoided by the skill of the operators in noticing quite small changes in running sounds made by plant with which they are very familiar. They become very skilled at observing changes if they are encouraged by the supervisory staff.

AERATION

There is a small work content in the operation of aerators. Perhaps the main observation to be made is to decide when they become unnecessary and should be by-passed. Weirs, channels, plates, and cascades have to be kept clean of growths by brushing frequently.

CHEMICAL DOSING

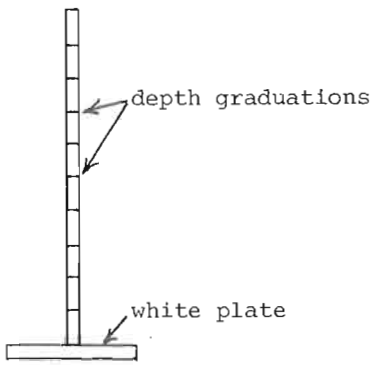
When no resident Chemist is employed the operator has to make the decision on the chemical doses to be applied. This dose may need to be changed during times when the supervisor is not present to carry out the necessary testing and calculations. Therefore the testing and calculations must be made available to be applied in a practical way. The normal jar test for establishing the coagulant dose should be carried out regularly by the operators. The results can be translated into the dosing pump setting by a carefully prepared table. The solution strength also needs to be established by use of an hydrometer. This is easier if a saturated solution is always used, but this may not be possible for smaller doses and flows. Making up these solutions must be carefully carried out in a separate container or tank from the dosing container. If this is not done the dosing container becomes fouled by sludge and in-soluble material from the raw chemicals. Sludge from the tanks must be cleaned out regularly. The dose applied must be checked at regular intervals through the shift, especially if changes are being made. The dosing line should have an open discharge point so that this checking can be done and a "no dose" situation can be seen at a glance. The dose from the pump can be easily checked by the insertion of a small measuring vessel on the suction side of the pump. The sketch shows the system diagrammatically. The



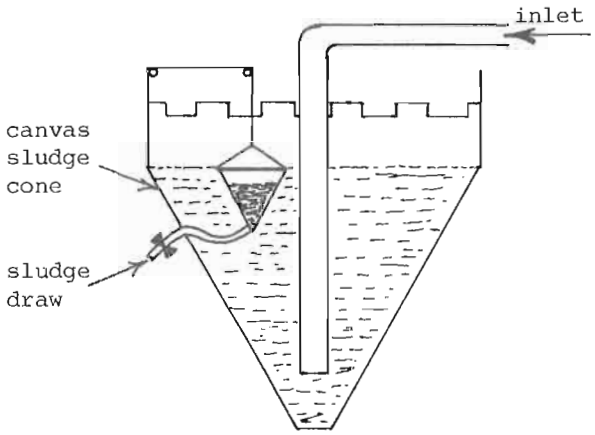
vessel is filled and level noted, then the dosing pump is made to draw from the vessel for a set period of time. The chemical lines must be flushed at intervals with clean water to prevent a build-up or blockage. Care must be taken that the coagulant mixes well with the incoming water, best achieved in a turbulent area such as a weir. Gravity dosing systems with constant head apparatus are simple to operate and easy to check.

SEDIMENTATION

Observation of the flocculation system is a pre-requisite to the sedimentation stage. Often the operator can suggest ways in which flocculators can be improved - sometimes these observations are the first stage in a modification of the installation. The operation of sedimentation tanks is an art. The combination of various water conditions, floc conditions, sludge blanket controls, sludge controls, velocities, and many other variables is a real challenge to the operator. This art is made impossible if the tank design is not correct for the water under treatment. Observation of the tank inlet and outlet are vital. Heavy blanket, wild floc, boiling, overturn, short circuiting, are all terms used by operators to describe the process they are trying to control. The measurement of the depth to the top of the blanket in sime tanks is important. This is done with a simple pole plate instrument.



The pole is dropped vertically into the tank until the plate disappears into the top of the blanket. The depth of water above the blanket can be read off the graduations on the pole. Blanket control is done by use of the sludge controls towards the top of the tank. These controls are connected to hoppers, and cones set at the blanket surface level in the tank. Sludge migration into these hoppers/ cones is a delicate observation and indicator to the operator. Heavy sludge draw-off is carried out from the base of the tank and care must be taken in the operation of these large valves. This should never be done when there is danger of discharging all the blanket material present in the tank. The observation of wild floc at the discharge weir of a tank is a good indicator of the correctness of dose applied. Horizontal flow tanks must be emptied and cleaned at regular intervals and after periods of high turbidity water. High pressure hosepipes are useful but squeegees are still necessary on flat floors. Sometimes a half-clean of a tank is possible between major cleans. Hopper bottomed vertical flow tanks can be improved by the introduction of blanket control cones as illustrated. These cones are positioned near the centre of the tanks and the sludge is drawn from the surface of the blanket.



Solids contact sedimentation tanks are controlled by various positions of the sludge draw-off. The blanket should be formed in a similar way to the vertical flow tank.

Filters (Rapid gravity)

Here the operator has many observations to make, many actions to take, and most hard work to do. The main work is concentrated in the washing proceedure. This is one of the most important operations in any works. It involves disturbing the sand bed in order to loosen the accumulated dirt and mud and then washing this mud out of, and away from, the filter. It is vital that each washing completes the removal of mud or a very gradual accumulation will occur. This starts with small balls of mud on the surface which penetrate the bed as they get larger and heavier until they cannot be removed by air scouring action and have to be dug out of the bed by the operator himself. The main observation to be made is when the filter is running, to observe the quality of the water at the outlet. Many filter outlet chambers are coloured white or white tiled to help this observation with a metre or so of water to look through. If the quality deteriorates then the filter needs to be washed. The loss of lead through the filter is also an important observation. Loss of lead gauges are notoriously inaccurate and frequently do not record at all. The loss of lead can be observed increasing as the level of water in

the filter rises. This will occur even when the outlet controller is working, but is more marked when it is not. Outlet controllers have bad habits of not working and getting set in one position. Providing this position is not closed, the filter will continue to operate but at a variable rate.

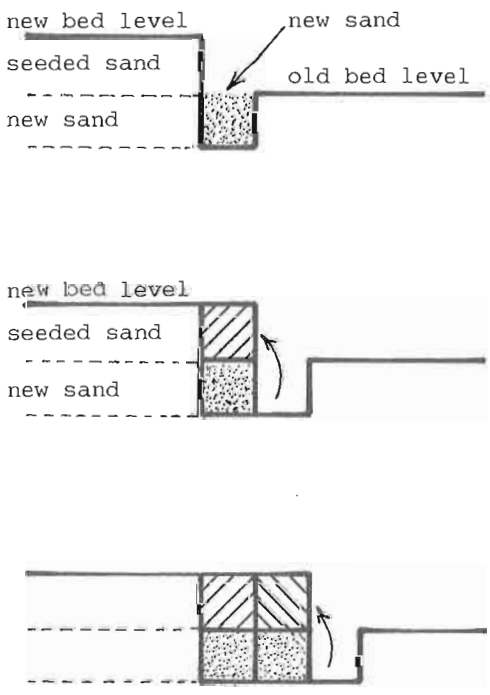
By a combination of these two observations the time for washing is established. More often, however, filters are washed "on time". This means that washing takes place after a set period of use. Often this is 24 hours, or 48 hours, which will mean each filter is washed at a set time every day, every other day, or even longer. This method may mean that filters are washed more frequently than really necessary, but it ensures that a regular pattern of operation is established and better filter cleaning and performance is the end result.

The valve operation for the washing sequence should be written down for reference, but is usually well known by the operators. The time for each operation should be set by the Supervisor, but with some latitude left for operators judgement. This means that if the operator judges that the washing operation has not quite removed the mud, he can prolong the wash. Similarly if he observes the mud on the surface has not been disturbed sufficiently by the air scour, he can extend this time. There should be maximum limits set for both scour and wash. The time of each operation should be carefully recorded.

If for some reason the air scour fails completely, as in the case of breakdown of blowers or compressors, then manual disturbance of the mud may be necessary. The operator walks on the surface and disturbs it with a fork or rake before the washwater is turned on. Some filters are operated in this way with no air scour sequence. There seems to be a reluctance of operators to get into rapid gravity filters. Perhaps this is because a ladder is needed, or because it is an unpleasant muddy job. The method of cleaning filters when they have become badly contaminated so that the air scour will not disturb the sand bed is to manually dig and try to wash out the mud. Sometimes this can be achieved but often the only method is to completely remove the sand and mud, wash it manually, and return it to the bed. The malfunctioning of the underdrain system and nozzles can only be detected by keen observation, and repaired by removal of the whole depth of sand and coarse media. Many filters can be rehabilitated by this method of manual disturbance and constant washing providing the underdrain system is sound. Filter defects can only be detected initially by keen observation of the operators during the washing sequence. The opportunity to pass these observations to the supervisors must be afforded to the operators and their observations should always be treated with great respect, they may be the key to something which is causing a detioration of the filters.

SLOW SAND FILTERS

To operate slow sand filters efficiently is a skilled job. It is important to filter slowly after cleaning to allow a new filter mat "Schmutzdecke" to form. The rate of filtering and the quality at outlets has to be observed diligently. Beds must never be allowed to dry out. At the end of the run the cleaning of the top sand should leave the sand surface level and clean. When new sand is added it should always be seeded by placing existing sand from the bed on top. This is done by trenching across the bed as illustrated.



Care must be taken, when sanding and cleaning, to avoid compacting the sand surface. Barrows must always be run on timber planks. Excessive walking on the surface must be avoided by using walking planks. The finished surface of a bed must be level and of constant thickness throughout.

PRESSURE FILTERS

Observation of the wash water outlet will indicate when the filter is clean after washing. Observation of the filtrate is

rarely possible when the filter is running and washing is carried out on a time basis. Times for air scour and/or agitation should be carefully monitored. Inspection of the sand by emptying the filter and opening the access holes should be carried out at regular intervals. The air scour should be observed with the sand just covered with water to ensure that even distribution is achieved.

DISINFECTION

When chlorine gas is used the drums or cylinders must be stored in a cool, well-ventilated place. The chlorinator should be at a higher ambient temperature than the cylinder and the temperature gradient of the gas feed line should never be reversed since this can cause the chlorine to condense. The feed line should be as short as possible. Cylinders should be secured as a cylinder falling and a pipe fracture can cause a dangerous leak. It is necessary to make joints carefully with the correct washers. These are of lead fabricated with a fibre reinforcing. All empty cylinders should be chalk marked MT. Operators need careful training on the proceedure to bring a cylinder into use. Instructions should be issued in writing such as:

"The proceedure to bring a cylinder into use is:

1. Remove the protecting dome, by unscrewing.
2. Ease gland nut on spindle head to 'finger tightness' taking care that the valve spindle does not turn.
3. Remove cover nut on side of spindle.
4. Attach union connection using washer supplied by manufacturer.
5. Open valve slightly using appropriate spanner (No.4.)
6. Test gland and all pipe connections for leaks using the ammonia bottle. (By holding the open ammonia bottle UNDER all joints. Any leakage will become apparant by the appearance of dense white fumes.)
7. In the event of leakage, tighten gland nut GENTLY.
8. If all satisfactory, 3 complete turns will fully open the valve, do not attempt to open further."

Gas masks are kept near the chlorine installation, (not locked up in the supervisor's cupboard) and operators should wear them for at least five minutes once every three months. This familiarity is necessary in case of emergency and it also indicates when a mask has reached the end of its useful life. Masks are often seen hanging behind doors very dusty and quite useless if required. Operators should understand why icing of cylinders occurs when the draw-off of gas is excessive. When bleaching powder is used it should be mixed in a mixing tank, allowed to settle, and the clear liquid then transferred to the dosing tank. The sludge should be regularly removed from the mixing tank. If powder is mixed in the dosing tank this sludge will clog any taps, pipe or dosing mechanism. Simple dosing apparatus is required. A tap at the bottom of the dosing tank is not satisfactory as the dose will vary with the level in the tank. A constant head device is necessary and can be easily constructed with cheap materials. The point of application should be visible so that it can be checked at a glance if dosing has ceased.

RECORDS

Each shift operator will record the state of operation of the plant during his tour of duty. This record can be in various ways but is usually in a log book. A selection of parameters, observations, and readings are called for at set intervals, often one hourly. It is easier if these are in order of his plant walk. The supervisor will inspect this record at least daily. The local Engineer will always look at it when he visits the works and action will be taken based on the operators remarks and observations.

CONCLUSION

The operators job can be best summed up in a few words.

Objective Observations
Delicate Dosing
Careful Control
Continuous Cleaning
Dedicated Disinfection
Wonderful Water.