Draft

Dhaka Water Supply and Sewerage Authority

Financial and Capacity Building Consultancy
of
Dhaka Water Supply Sector Development Project

OPERATION MANUAL

Volume - 1

Water Pumping Station Details

May 2010

Index

Figure Index

Water Pumping Station

Pump Identity and Specifications

Name of the Water Pump Station	:	....
Reference Number (if any)	:	....
Type of Pump (Turbine/Submersible)	:	....
Well housing diameter (cm)	:	....
Well diameter (cm)	:	....
Well depth (m)	:	....

Data Recording

Following data should be recorded in the pump station log book in Proforma – P1 and initialed by the supervisor after checking.

1) Pump start time
2) Start KWh Reading
3) Start Water Meter Reading
4) Voltage in each phase
5) Current (after start)
6) Water Pressure
7) Chlorine dosing rate
8) Pump stop time
9) Stop KWh Reading
10) Stop Water Meter Reading
11) Pumping hours (from stop time – start time)
12) KWh used (form stop KWh – Stop KWh)
13) Volume of water pumped (from stop water meter reading – start water meter reading)
14) Drums of bleaching powder
15) Cylinder of Chlorine
16) Consumables

Pump Station Log

Pump Station Name :……………………………… Year : ………………………..

Location :……………………………………………

Page – i/ii

Date	Shift	Voltage	Start Water meter Reading	Start KWH Reading	Pump start time	Current	Water Pressure	Chlorine Dosing Rate	Pump stop time	Stop Water meter Reading	Stop KWH Reading	Pumping Hours *(10)-(6)*	Volume of water Pumped *(11)-(4)*	KWH used (12)-(5)
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*	*(13)*	*(14)*	*(15)*
	1													
	2													
	3													
	1													
	2													
	3													
	1													
	2													
	3													
	1													
	2													
	3													
	1													
	2													
	3													
	1													
	2													
	3													
	1													
	2													
	3													

Page – ii/ii (contd.)

Date	Shift	Bleaching Powder Drums	Bleaching Powder used	Chlorine Cylinder (full)	Chlorine Cylinder used	Consu-mables used	Remarks	Signature
	(16)	*(17)*	*(18)*	*(19)*	*(20)*	*(21)*	*(22)*	*(23)*
	1							
	2							
	3							
	1							
	2							
	3							
	1							
	2							
	3							
	1							
	2							
	3							
	1							
	2							
	3							
	1							
	2							
	3							
	1							
	2							
	3							

Signature of Supervisor ……………………………….. Signature Controlling Officer ……………………………….

Date …………………………. Date ………………………….

Deep Tubewell with Turbine or Submersible Pump

Deep tubewell installations with turbine pumps or submersible pumps generally consist of the following:

- Pumphouse building
- Production well or borehole
- Inspection hole (in some installations)
- Observation well (in some installations)
- Deep well turbine pump or submersible pump assembly
- Prelubrication tank with piping (for turbine pump)
- Vertical hollow shaft electric motor (for turbine pump)
- Surface pipework and accessories
- Electric control panel
- Chlorination equipment
- Standby generator

A plan view of a typical deep tubewell pumphouse and pipe arrangement is shown in Figure - 1.

Pumphouse Building

The pumphouse building houses the tubewell, pump, associated control equipment and provides protection to the equipment. The typical DWASA pumphouse is normally a brick structure with an opening in the concrete roof protected by a cover slab. The purpose of the opening is to permit the removal and installation of the pump assembly. In many installations turbine pumps have been replaced with submersible pumps in the old deep tubewell or a submersible pump installed in a new deep tubewell dug outside the pump house. Externally located tubewells usually have a steel gantry beam on a brick or concrete superstructure to facilitate the removal of the pump and riser pipes.

Production Well or Borehole

The function of the production well is to abstract the ground water from the aquifer at a certain depth and provide water for the distribution system through the pump.

Inspection Hole

The inspection hole is provided to check the drawdown or water level of the well. It is frequently made by a short pipe (50 mm diameter) fabricated at an angle to the casing or housing pipe.

Observation Well

The purpose of the observation well is to monitor the performance of the production well. It is normally situated some distance away from the production well but in some cases may be within the production well.

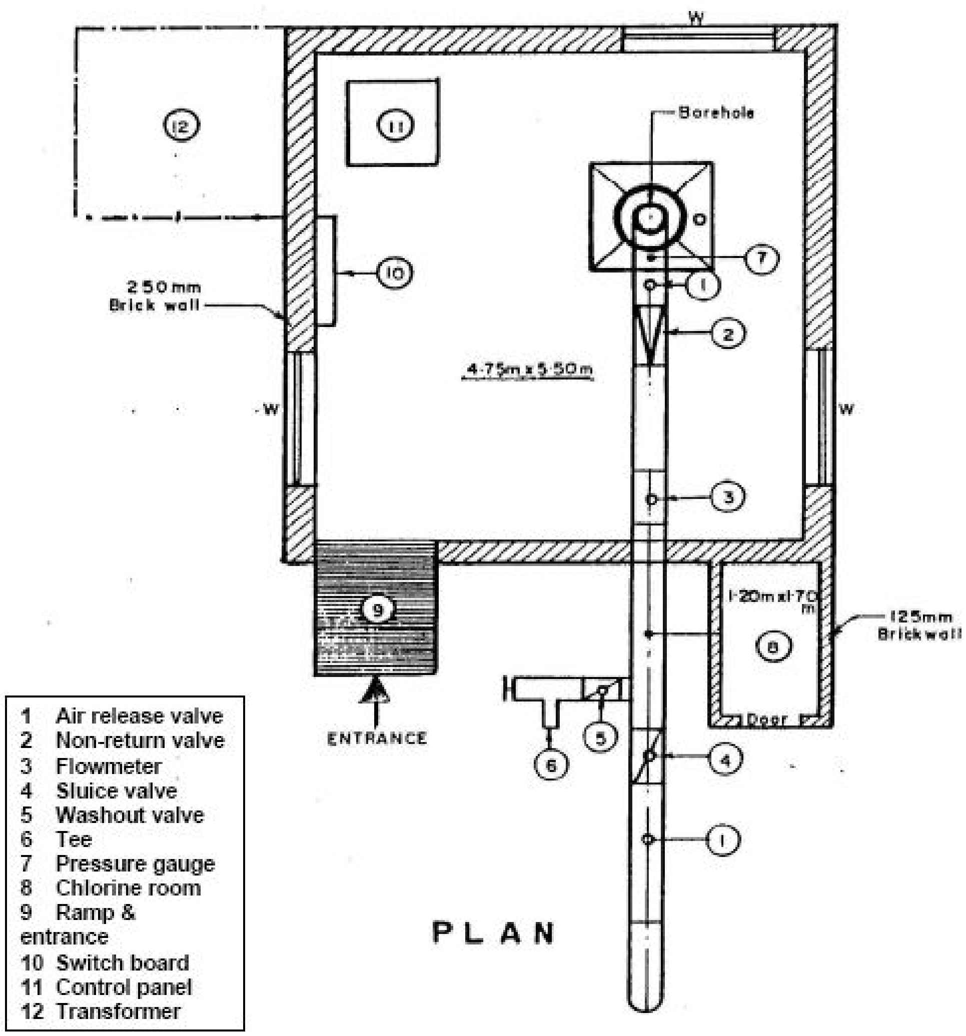

Figure – 1 : Pump House

Turbine Pump Assembly

A deep well turbine pump, also known as a vertical centrifugal turbine pump, generally consists of three main parts:

- Discharge head
- Column pipe assembly
- Pump bowl assembly

The purpose of the discharge head is to support the column pipe and pump bowl assembly in the well, to connect the column pipe with the discharge piping and to transmit power to the drive shaft. The discharge head is securely bolted onto a solid concrete plinth.

The column pipe assembly, comprising the column pipes and the line shaft with water lubricated rubber bearings, serves to hold or support the pump bowl assembly in the well, to transmit power to the pump impellers and to bring the pressurized water to the surface.

The pump bowl assembly contains a number of pump bowls with impellers in series being driven by the same shaft to build up the required head. According to changes in operational conditions, pump bowls may be added or removed from the assembly as required. A sectional drawing of a deep turbine pump is shown in Figure - 2.

Pre-lubrication Tank

The pre-lubrication arrangement is for lubricating the pump shaft rubber bearings and the pump gland packing before starting the pump. It comprises a small elevated tank with connecting pipe work to the pump stuffing box housing in the discharge head. The tank can be filled with fresh water from the distribution system or directly by the lubricating pipe during the running of the pump. The pre-lubrication tank should be covered and not used for any other purpose.

In some installations there is no pre-lubrication tank only a funnel and pipe, into which the lubrication water is poured.

Vertical Hollow Shaft Electric Motor (for turbine pump)

The vertical hollow shaft electric motor is of surface drive type and is mounted on the discharge head casting. The motor is connected to the pump impellers by a long shaft through which the power is transmitted. Vertical alignment of the pump impellers may be adjusted by raising or lowering the line shaft through the hollow motor shaft. The top end of the motor (back end) has a non-reverse ratchet which prevents the motor from rotating in the reverse direction in case after switching it off water from the delivery pipe flows backwards into the column pipe due to leaking non-return valve. Reverse rotation may open the line shaft joints damaging the pump.

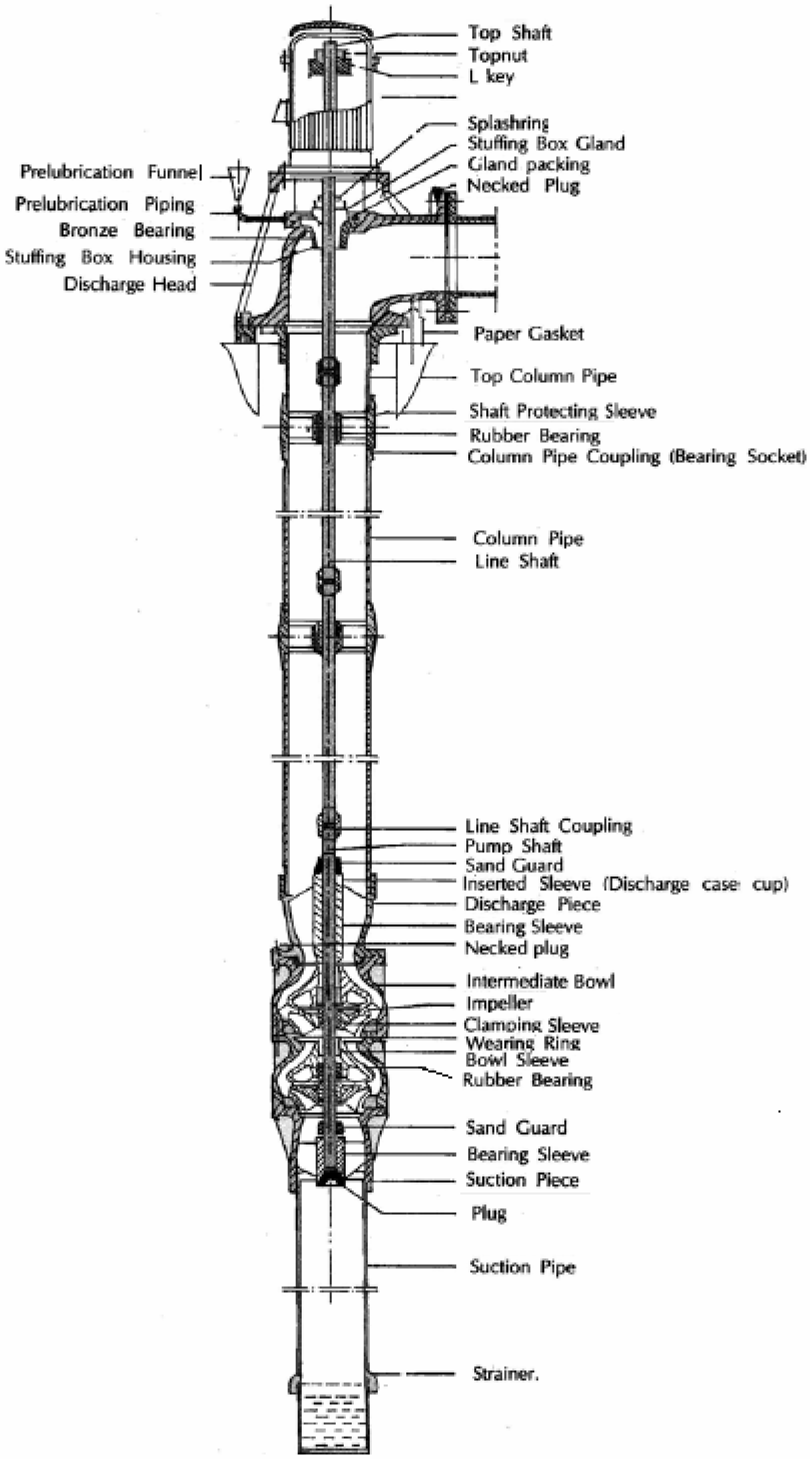

Figure – 2: Turbine Pump

Submersible Pump and Motor Assembly

A submersible pump consists of a centrifugal pump coupled directly with an electrical motor in a common housing. As the name indicates the assembly is designed for submerged operation within the tubewell. The pump assembly has four major parts:

- Motor unit
- Suction strainer
- Bowl type centrifugal pump assembly
- Column or riser pipes

The electric motor is a fixed speed squirrel cage induction motor, normally two-pole, with water cooled winding, operating at 2,900 rpm. The rotor shaft is normally connected to the pump by a mechanical coupling located within the strainer unit.

The suction strainer is located above the motor and below the pump. Its function is to permit the entry of the water into the first stage of the pump, while at the same time preventing any sizeable matter from entering and damaging the impellers.

The pump unit is made up of a series of pump bowls and impellers connected in series on a single shaft. The head (pressure) developed is dependent on the number of stages in the pump. The impeller diameter and design govern the quantity of water pumped.

The outlet of the pump unit is connected to the column pipes or rising main which in turn is connected to the surface pipework. The rising main is usually made of steel or cast iron with flanged or screwed connections. Most DWASA tubewells have 150 mm (6") diameter rising mains.

A sectional drawing of a submersible pump is shown in Figure - 3.

Surface Pipework and Accessories

The discharge pipework is connected to the discharge head by a flanged joint and generally consists of:

- Non-return valve
- Air release valve or vent cock
- Pressure gauge
- Sluice valve
- Flow meter
- Washout branch with sluice valve

(a) Non-Return Valve

The function of the non-return valve is to prevent large amounts of water from flowing down the column pipe in the event of a sudden stoppage of the pump. Flow down the column pipe could damage the pump and motor by causing reverse rotation. The non- return valve will also give some protection against surge pressures which could be generated by the sudden stoppage of the pump or rapid closure of an upstream valve.

The non-return valve normally consists of a flat disc within the pipeline, pivoted so that it is forced open when flow of water is in one direction and forced shut against a seating when flow tries to reverse. The seating is arranged slightly out of perpendicular, when the valve is inserted into a horizontal pipe, so that the flap will close by gravity when there is no flow. Non return valves should shut quickly when flow ceases.

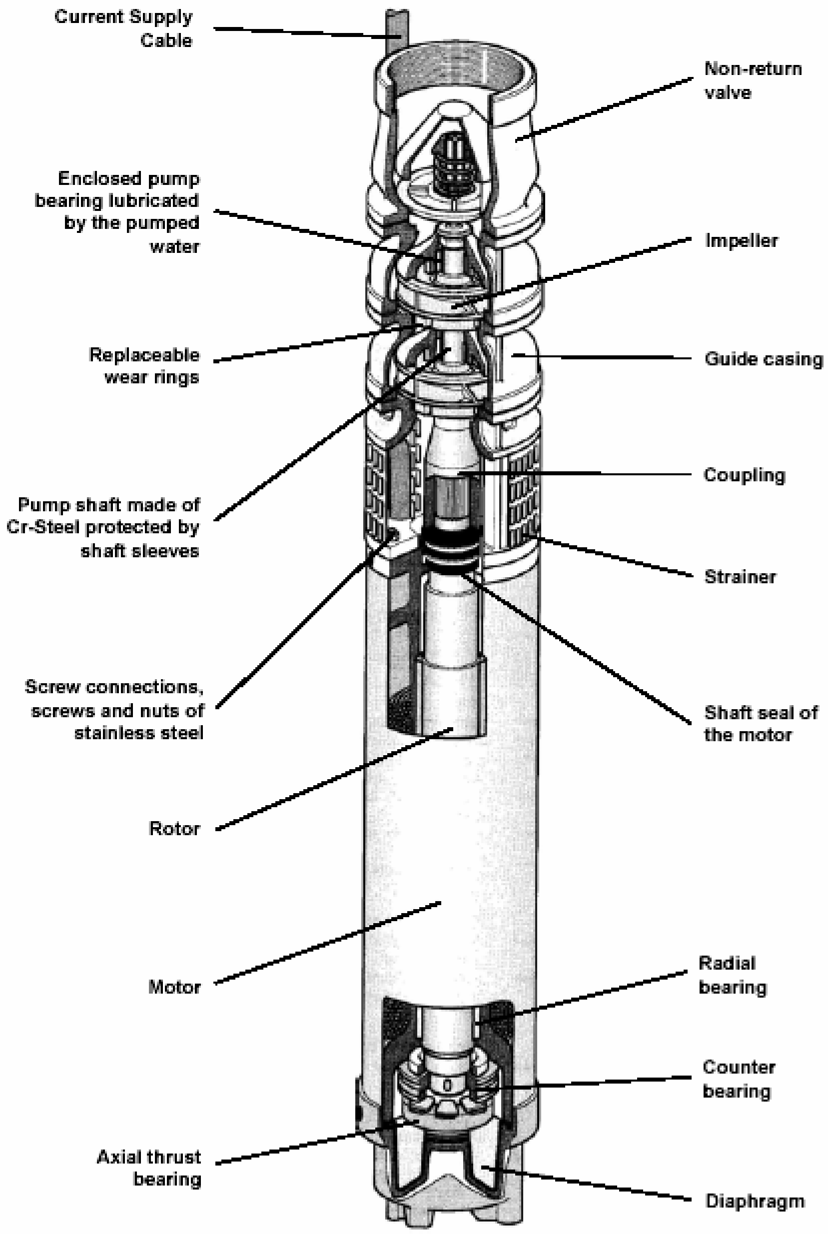

Figure – 3 : Submersible Pump

A counterbalancing weight attached to the spindle can assist quick closing. A diagrammatic sketch of a non-return valve is shown in Figure - 4.

(b) Air Release Valve

The purpose of the air release valve or vent cock is to release both dissolved air coming out of solution and any air trapped in pockets along the pipeline thus avoiding unnecessary pressure surges and reduction in carrying capacity of the pipeline.

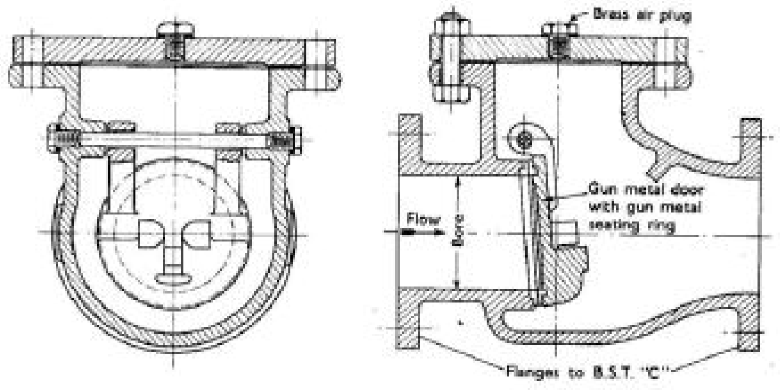

Figure - 4 : Non Return Valve

There are three different types of air valves:

1) Small orifice single air valve
2) Large orifice single air valve
3) Double orifice air valve

Small orifice single air valve which is used for automatically releasing air accumulating in a pipeline under normal working conditions and to prevent accumulation of air interfering with pipeline capacity. Small orifice air valves are normally used in tubewell installations.

Large orifice single air valve is used for automatically exhausting air from a pipeline when it is being filled with water and for automatically ventilating a pipeline when it is being emptied of water.

Double orifice air valve has one large orifice for the release and admission of air when filling and emptying the main and one small orifice for release of air accumulating under normal working conditions.

As an alternative to an automatic air release valve a simple hand operated tap or cock can be used to vent any accumulated air. Obviously the tap would have to be manually opened and closed by the pump operator on a regular basis.

(c) Pressure Gauge

The pressure gauge is installed to enable checking of the pumping pressure. Most meters in Dhaka are calibrated in kg_f/cm^2. Conversion factors are as follows:

1 Kg_f/cm^2 = 0.981 bar = 98.1 Kn/m^2 (kPa) = 14.223 lb_f/in^2 (psi) = 10 meter water head

Pressure gauges are installed at some DWASA tubewells but many are broken.

(d) Sluice Valve

A sluice valve on the delivery line is provided to protect the prime mover (electric motor) against overloading and to isolate the pump during maintenance. Sluice valve on the delivery line should not leak around the gland packing. A handwheel or "Tee-key" is used to operate the valve.

(e) Flow Meter

The flow meter or bulk water meter is provided to measure the discharge from the tubewell. The meters commonly used on tubewell installations are helical vane or Woltmann type meters. There are two important points to consider in the installation of these meters:

- The meter size should be selected on the basis of the expected flow not the diameter of the pipe
- There should be a straight pipe of not less than 5-10 times the diameter before the meter and 5 times the diameter after the meter. (figures vary depending on the particular meter and the pipeline configuration)

Correctly installed Woltmann meters normally have an accuracy of ± 5% over an initial low flow range and ± 2% over the remainder. It is therefore important to size the meter correctly to ensure the normal flow is within the higher accuracy range.

(f) Washout Branch

The washout branch with sluice valve is provided to drain the upstream pipeline during maintenance activities and can also be used to visually check the water to see if the pump is pumping clean or dirty water. Washout valves should not leak especially at the gland packing.

Disinfection

Disinfection is done either by (i) Bleaching powder, or (ii) Chlorine gas. Disinfection of water provides for the destruction, or at least complete inactivation of the harmful micro-organisms. Under normal circumstances the chlorine residual leaving the deep tubewell should be about 0.5 mg/l.

Disinfection by Bleaching Powder

Bleaching powder is a white hygroscopic unstable powder containing between 25 – 35% available chlorine. It is normally delivered in 50kg metal drums. Once opened the bleaching powder loses strength unless kept cool and dry. The powder is mixed with water to form a solution, normally between 1-2% available chlorine (normal maximum 5%). The solution should be allowed to stand for up to 24 hours to allow the insoluble lime to settle out. As some of the available chlorine is lost during the settlement, it is recommended that an additional 10% powder is added to the mixture to compensate.

The chlorine solution is injected into the pumping main by means of a metering or dosing pump. The pump normally consists of an electric motor and a separate dosing unit connected by a "V" belt drive. Where the dosing pump does not have an adjustable stroke, correct dosing rate must be achieved by varying the concentration of the bleaching powder solution. Figure 5 shows a diagrammatic representation of a typical bleaching powder dosing arrangement.

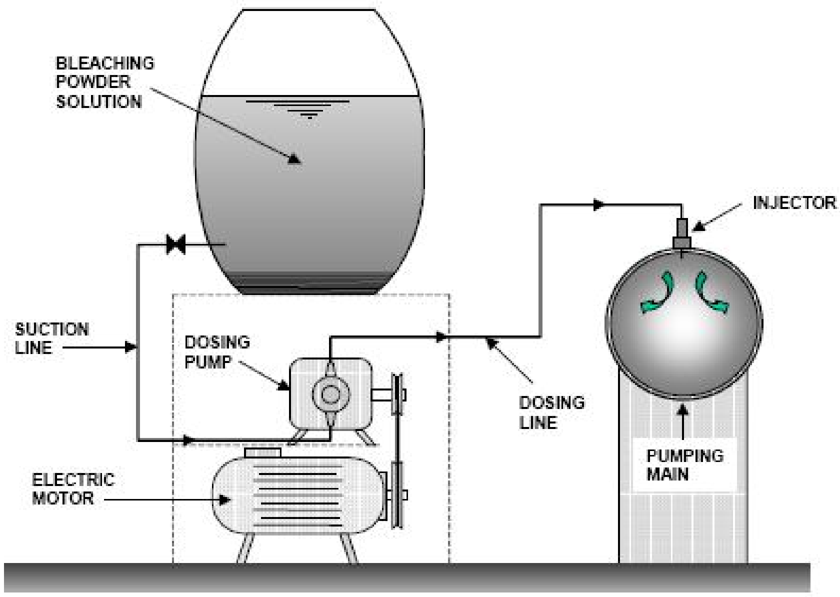

Figure - 5: Bleaching Powder Dosing Arrangement

Disinfection by Chlorine Gas

Chlorine is available as a liquefied gas in pressurized cylinders. The method generally employed involves abstracting the gas from the cylinder by creating a vacuum through a device known as a vacuum regulator. The gas then passes through a flowmeter and control valve before entering the ejector where it is mixed with a controlled pumped supply of water (carrier water). The chlorinated water is then injected into the main raw water pumping main. A typical arrangement is shown schematically in Figure 6.

Most deep tubewell installations are similar to that shown in Figure 6, although weighing machines are seldom present. In some installations the chlorinator is mounted on the wall instead of directly on the cylinder. In other installations two cylinders are provided with an automatic changeover switch, which changes to the second cylinder when the first one is empty.

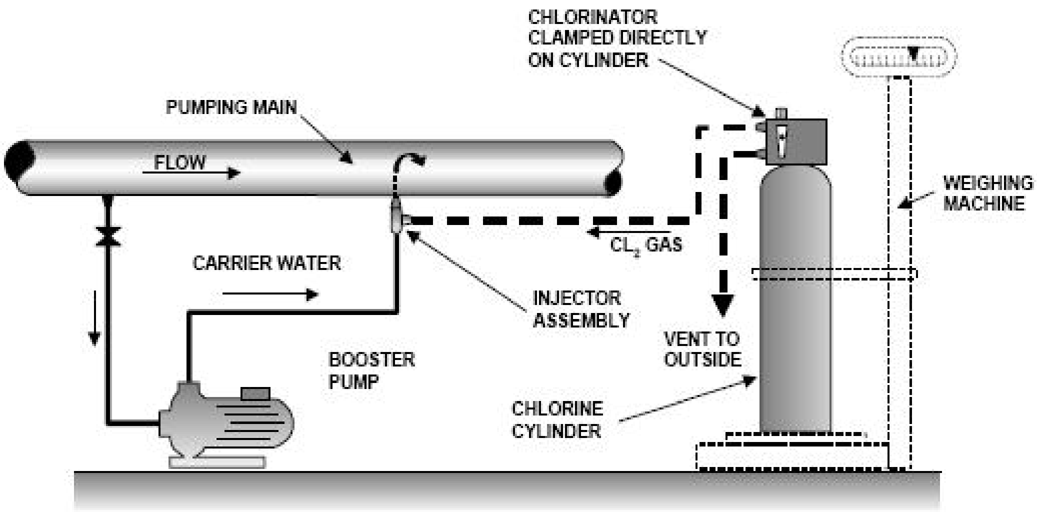

Figure - 6: Gas Chlorination Arrangement