EFFECT OF REHABILITATION ON THE DISCHARGE OF A TUBEWELL

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A tubewell in Orangabad, District Sahiwal, which lost 50% of its original production within a period of eight years was investigated. The rehabilitation of this tubewell indicated that screen cleaning with brushes of steel bristles improved the production by 15%. The well treatment with 33.5 L of commercial grade HCl followed by chlorination with supernatant solution of bleaching powder helped to restore the original discharge.

INTRODUCTION

When a properly designed tubewell is put into operation, expected life time of 15-30 years is attained through minimum maintenance. By the passage of time five major problems occur with tubewells resulting in the reduction of the well yield. These include i. chemical encrustation on the well screen and/or the accumulation of materials around the intake portion, ii. plugging of the formation around the well screen by fine particles, iii. sand pumping, iv. structural collapse of the well casing by low pH (Kelly and Kemp, 1974) and v. electrolyte corrosion, particularly in the presence of high carbon dioxide (WASA, 1990).

Baron (1982) formulated calcium carbonate encrustation potential ratio (EPR) and applied it successfully on water test data and well record. He concluded that if the EPR was less than 1, the water would be corrosive and if its value was greater than 1, the water would be encrustant. Iron in the groundwater is found in two states of oxidation divalent (ferrous) and trivalent (ferric). Ferric iron other than in a complex form, is usually found in precipitate, especially when the water is alkaline or weakly acidic (Driscoll, 1987). When groundwater is oxidised, the dissolved ferrous iron changes into insoluble ferric state. Ground water containing iron may provide a favourable condition for the growth of iron bacteria (Lueschoue and Mackenthum, 1962). Normally in the absence of iron bacteria, the rate of precipitation of iron is proportional to the pumped volume from a well (Clark, 1980). Different chemical and other techniques such as hydrochloric acid, sulfamic acid (NH_2SO_3H), sulphuric acid, phosphoric acid and polyphosphates (IRI, 1987) are used to get rid of the encrustant materials. In the present study, hydrochloric acid followed by chlorination technique was used.

MATERIALS AND METHODS

Three water samples from tubewells (Table 1) showing a remarkable reduction in their output. Water samples of these tubewells were analysed in the Research Laboratory, WASA (FDA), Faisalabad for their total dissolved solids (TDS), calcium, magnesium, total hardness (T.H.), carbonate, bicarbonate, chlorides, sulphates, sodium, potassium and iron as recommended by Franson (1985). Tubewell

No. 2 was selected for rehabilitation studies. It's EPR was calculated using Baron's (1982) equation:

$$EPR = \frac{(T.A.\ as\ ppm\ CaCO_3)\ (Calcium\ hardness\ as\ ppm\ CaCO_3)}{10.3^{*}\ 10^{11}\ (H^{+})}$$

where

EPR = Encrustation Potential Ratio and
T.A. = Total Alkalinity

HCl (33.5 L) was introduced in the well and agitated with the help of G.I. pipe. It was left for 16 hours. The screen and blind pipe was cleaned again with brushes of steel bristles for two hours and back washing was done for one hour by turning the tubewell on and off. The discharge of the well was measured again. The supernatant solution of 3 kg bleaching powder (sodium hypochlorite) was introduced in the well and left for 24 hours. Afterward discharges of the well was measured.

Table 1. Preliminary investigations

Parameter	Observation
Depth of ditch	31'
Static water level	35'
Length of blind pipe	20'
Length of filter	90'
Type of pump	Centrifugal
Colour of encrustation material	Reddish brown
EPR calculated	4.32
Material of the housing pipe	PVC
Material of the filter	PVC
Discharge of the well before treatment	0.5 cusec

The discharge of the well was measured using a drum of 55 gallons capacity and a stop watch. Depth of the ditch, static water level, length of blind pipe, length of filter and other informations were obtained (Table 1). The well screen was manually cleaned for two hours with brushes of steel bristles attached to the end of a G.I. pipe. It was done by lifting the brushes about three feet at the rate of 15-20 strokes per minute. The cleaning was done from top to bottom. The back washing of the well was done for one hour by turning the tubewell on and off. The water was clear when discharge was measured. Full strength commercial grade

RESULTS AND DISCUSSION

The chemical analysis of the water samples (Table 2) showed a little variation in the groundwater quality of the area. Preliminary investigations (Table 1) showed a reduction in the well discharge. This may be due to higher $CaCO_3$ encrustation Potential Ratio (4.32) of the tubewell 2. The reddish brown colour of the encrustation material indicates the presence of iron oxide as well. The fromtub contained from (2.1 mg L^{-1}) which would provide favourable conditions for the growth of iron bacteria, like

Table 2. Chemical analysis of groundwater in Orangabad area

Parameter	Tubewell No.		
	1	2	3
Depth (feet)	140	145	100
pH	7.7	7.8	7.9
E.C. (μmhos cm^{-1})	1302	1548	1485
TDS (mg L^{-1})	769	896	798
Calcium (mg L^{-1})	133	142	140
Magnesium (mg L^{-1})	40	39.25	37.5
Total hardness (mg L^{-1})	495	512	500
Carbonate (mg L^{-1})	Nil	Nil	Nil
Bicarbonate (mg L^{-1})	163	169	183
Chloride (mg L^{-1})	67.5	84	72
Hydroxide (mg L^{-1})	Nil	Nil	Nil
Sodium (mg L^{-1})	96.8	120	8.2
Potassium (mg L^{-1})	8.57	12.75	8.2
Sulphate (mg L^{-1})	468.9	513.6	462.2
Iron (mg L^{-1})	1.05	2.1	2.05

Table 3. Treatment vs Discharge

Treatment	Discharge	
	Cusec	gpm
Before treatment	0.5	225
Cleaning (Brush of steel bristles)	0.65	292.5
Cleaning + acid treatment (33.5 L HCl)	0.988	445
Cleaning + acid treatment + chlorination (Bleaching powder)	1.0	450
Original discharge	1.0	450

gpm = gallons per minute.

Carenothrix polyspora, Sphaerotilus natans, Gallionella ferruginea and *Siderocapsia treubii.* Hydrochloric acid readily dissolved $CaCO_3$ and iron oxide whereas bleaching powder removed iron bacteria. The rehabilitation of the tubewell with the help of hydrochloric acid was found to be very successful. Data (Table 3) showed that the output of the tubewell was increased by 15% by only physical rubbing of the screen. However, the original discharge of the well was restored with the help of hydrochloric acid.

The above method of rehabilitation of tubewells can be applied only where the filter and blind pipes are made of PVC or any other material inert to hydrochloric acid. This technique should not be applied to tubewells in which the screens and pipes are made of cellulosic material, cement or iron since these are very much susceptible to acid attack. brushes of steel bristles are found to be very effective because it surges and cleans by rubbing.

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