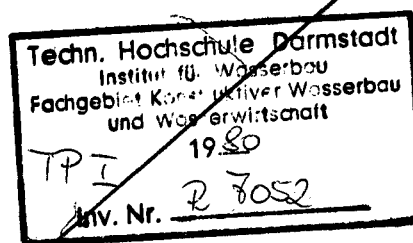


corrosion and encrustation in water wells

a field guide for assessment,
prediction and control

by
frank e. clarke
fao consultant



FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome 1980

Bibliothek Wasser und Umwelt
(TU Darmstadt)



CONTENTS

	<u>Page</u>
Foreword	iii
Contents	v
List of Figures	vii
List of Tables	ix
Glossary	xi

PART I - NATURE, CAUSES AND CONTROL OF WATER WELL DAMAGE

1.	AQUEOUS CORROSION AND DEPOSITION IN METAL SYSTEMS	1
1.1	Pertinent Electrode Reactions	1
1.2	Depolarization Processes	3
1.3	Equilibrium Effects	3
1.4	Other Factors	5
1.5	Interaction of Factors	5
2.	EROSION AND CAVITATION EROSION IN METAL SYSTEMS	6
3.	CORROSION IN WATER WELLS	7
3.1	Water Quality Factors	7
3.2	Wells, Pumps and their Corrosion Problems	7
3.2.1	Filter pipe (well screen)	13
3.2.2	Casing	14
3.2.3	Pump exterior	15
3.2.4	Pump shafts and impellers	15
3.2.5	Pump bowls	15
3.2.6	Column pipe and accessories	16
3.2.7	Lineshaft	18
4.	ENCRUSTATION OF WATER WELLS	19
4.1	Sand and Silt	19
4.2	Carbonate Deposition	19
4.3	Hydrated Iron Oxides	21
4.4	Biological Growths	21
5.	INTERPRETING FIELD OBSERVATIONS	22
5.1	Dissolved Iron	22
5.2	Dissolved Gases	22
5.3	pH and the pH-Eh Relationship	23
5.4	Temperature	23
6.	PREDICTING WELL LIFE AND RELATED PROBLEMS	23
6.1	Predictive Use of Corrosion Tests	24

6.2	Prediction based on Eh	27
6.3	Use of Saturation Index	28
6.4	Use of the Stability Index	31
6.5	Estimation based on Chloride Ions	34
6.6	Use of CO ₂ Data	36
7.	ASSESSMENT OF PROBLEMS IN OPERATING WELLS	37
7.1	Checking Pump Performance	37
7.2	Checking for Well Clogging	37
7.3	Role of Downhole Observations	37
7.4	Other Diagnostic Tests	38
8.	REHABILITATION	39
8.1	Coping with Corrosion Problems	39
8.2	Acidizing Encrusted Wells	41
8.3	Physical Descaling	42
8.4	Removing Inert Materials	42
8.5	Control of Bacteria and Related Deposits	43
9.	EXTENDING WELL LIFE THROUGH MATERIAL SELECTION AND DESIGN	43
PART II - COLLECTION OF WELL WATER DATA		
10.	WATER SAMPLING FOR LABORATORY ANALYSIS AND PREDICTION	49
10.1	Use of Test Wells	49
10.2	Sampling for General Analysis	52
10.3	Sampling for Iron	54
10.4	Sampling for Sulphide	54
10.5	Sampling for Iron Bacteria	54
10.6	Sampling for Sulphate-reducing Bacteria	55
10.7	Sampling for Dissolved Oxygen	55
10.8	Laboratory Procedures	58
11.	FIELD SAMPLING AND TESTING WATER QUALITY	58
11.1	Measuring Temperature	58
11.2	Measuring Specific Conductance	59
11.3	Measuring pH	61
11.4	Measuring Bicarbonate Ion	65
11.5	Measuring Redox Potential	71
11.6	Measuring Dissolved Oxygen	75
11.7	Measuring Ferrous Ion	79
12.	ASSESSING THE CORROSIVITY OF WATER	81
12.1	Massive Specimen Test	81
12.2	Coupon Test	83
12.3	Polarographic Corrosion Meter	83
12.4	Resistance-type Corrosion Meter	86
12.5	Measuring Galvanic Corrosion Potential	90
REFERENCES		94