

24. Misalignment.
25. Foundations not rigid.
26. Shaft bent.
27. Rotating part rubbing on stationary part.
28. Bearings worn.
29. Wearing rings worn
30. Impeller damaged
31. Casing gasket defective, permitting internal leakage.
32. Shaft or shaft sleeves worn or scored at the packing.
33. Packing improperly installed.
34. Incorrect type of packing for operating conditions.
35. Shaft running off center because worn bearings or misalignment.
36. Rotor out of balance, causing vibration.
37. Gland too tight, resulting in no flow of liquid to lubricate packing.
38. Failure to provide cooling liquid to water cooled stuffing boxes.
39. Excessive clearance at bottom of stuffing box between shaft and casing, causing packing to be forced into pump interior.
40. Dirt or grit in sealing liquid leading to scoring of shaft or shaft sleeve.
41. Excessive thrust caused by a mechanical failure inside the pump or by the failure of the hydraulic balancing device, if any
42. Excessive grease or oil in antifriction bearing housing or lack of cooling, causing excessive bearing temperature.
43. Lack of lubrication.
44. Improper installation of anti-friction bearings (damage during assembly, incorrect assembly of stacked bearings, use of unmatched bearings as a pair, etc.)
45. Dirt in bearings.
46. Rusting of bearings from water in housing.
47. Excessive cooling of water-cooled bearing, resulting in condensation of moisture from the atmosphere in the bearing housing.

**TABLE 11.8**  
**CHECK CHART FOR ROTARY PUMP TROUBLES**

Symptoms	Possible cause of trouble (Each number is defined in the list below)
Pump fails to discharge	1, 2, 3, 4, 5, 6, 8, 9, 16.
Pump is noisy	6, 10, 11, 17, 18, 19
Pump wears rapidly	11, 12, 13, 20, 24.
Pump not up to capacity.	3, 5, 6, 7, 9, 16, 21, 22
Pump starts, then loses suction.	1, 2, 6, 7, 10
Pump takes excessive Power	14, 15, 17, 20, 23

### ***SUCTION TROUBLES***

1. Not properly primed
2. Suction pipe not submerged.
3. Strainer clogged
4. Leaking foot valve
5. Suction lift too high
6. Air leaks in suction.
7. Suction pipe too small

### ***SYSTEM PROBLEMS***

8. Wrong direction of rotation.
9. Low speed.
10. Insufficient liquid supply.
11. Excessive pressure.
12. Grit or dirt in liquid.
13. Pump runs dry.
14. Viscosity higher than specified.
15. Obstruction in discharge line.

### ***MECHANICAL TROUBLES***

16. Pump worn.

17. Bent drive shaft
18. Coupling out of balance or alignment.
19. Relief valve chatter.
20. Pipe strain on pump casing.
21. Air leak at packing.
22. Relief valve improperly seated.
23. Packing too tight.
24. Corrosion.

**TABLE 11.9**  
**CHECK CHART FOR RECIPROCATING PUMP TROUBLES**

Symptoms	Possible cause of trouble (Each number is defined in the list below)
Liquid end noise.	1, 2, 7, 8, 9, 10, 14, 15, 16
Power end noise.	17, 18, 19, 20
Overheated power end :	10, 19, 21, 22, 23, 24.
Water in crankcase.	25
Oil leak from crankcase	26,27
Rapid packing or plunger wear.	11, 12, 28, 29.
Pitted valves or seats	3,11,30
Valves hanging up	31,32
Leak at cylinder-valve hole plugs.	10,13,33,34
Loss of prime.	1,4,5,6

### ***SUCTION TROUBLES***

1. Insufficient suction pressure
2. Partial loss of prime.
3. Cavitation.
4. Lift too high
5. Leaking suction at foot valve
6. Acceleration head requirement too high.

## ***SYSTEM PROBLEMS***

7. System shocks
8. Poorly supported piping, abrupt turns in piping, pipe size too small, piping misaligned.
9. Air in liquid.
10. Overpressure or overspeed.
11. Dirty liquid.
12. Dirty environment.
13. Water hammer

## ***MECHANICAL TROUBLES***

14. Broken or badly worn valves.
15. Packing worn.
16. Obstruction under valve.
17. Loose main bearings.
18. Worn bearings.
19. Low oil level.
20. Plunger loose.
21. Tight main bearings
22. Inadequate ventilation.
23. Belts too tight.
24. Driver misaligned.
25. Condensation
26. Worn seals
27. Oil level too high.
28. Pump not set level and rigid.
29. Loose packing.
30. Corrosion
31. Valve binding.
32. Broken valve spring
33. Loose cylinder plug
34. Damaged O-ring seal

## **11.10 SELECTION OF ELECTRIC MOTORS**

### **11.10.1 GENERAL**

In water supply systems, mainly three types of motors are used.

- ♦ Induction (A.C.) motors.
- ♦ Synchronous (A.C.) motors.
- ♦ D.C. motors.

Amongst these, induction motors are the most common.

Synchronous motors merit consideration when large HP, low speed motors are required. D.C. motors are used occasionally for pumps where only direct current is available as in ships, railways, etc.

### **11.10.2 SELECTION CRITERIA**

Type of motor has to be selected considering various criteria such as the constructional features desired, environment conditions, type of duty, etc.

#### **11.10.2.1 Constructional Features Of Induction Motors**

Squirrel cage motors are most commonly used. Normally the starting torque requirement of centrifugal pumps is quite low and squirrel cage motors are therefore suitable.

Slip ring or wound rotor motors are to be used where required starting torque is high as in positive displacement pumps or for centrifugal pumps handling sludge.

The slip ring motors are also used when the starting current has to be very low, such as 1 time the full load current, such regulatory limits being specified by the Power Supply Authorities.

#### **11.10.2.2 Method Of Starting**

Squirrel cage motors when started direct on line (with DOL starter) draw starting current about 6 times the full load (FL) current. If the starting current has to be within the regulatory limits specified by the Power Supply Authorities, the squirrel cage motors should be provided with the star delta starter or auto-transformer starter.

#### **11.10.2.3 Voltage Ratings**

Table 11.10 would give general guidance on the standard voltages and corresponding range of motor ratings.

For motors of ratings 225 KW and above, where high-tension (HT) voltages of 3.3 KV, 6.6 KV and 11 KV can be chosen, the choice should be made by working out relative economics of investment and running costs, taking into consideration costs of transformer, motor, switchgear, cables etc.

### 11.10.2.4 Type Of Enclosures (Table 11.11)

**TABLE 11.10**  
**SELECTION OF MOTORS BASED ON SUPPLY VOLTAGES**

Supply	Voltage	Range of Motor rating in KW	
		Min.	Max.
Single-phase A.C.	230 V	0.3	2.5
Three-phase A.C.	415 V	-	250
	3.3 KV	225	750
	6.6 KV	400	-
	11KV	600	-
D.C.	230V	-	150

**N.B.** When no minimum is given, very small motors are feasible. When no maximum is given very large motors are feasible.

**TABLE 11.11**  
**TYPES OF ENCLOSURES**

Type	Environment Code as per IS	Where used
screen-protected drip proof (SPDP)	IP.23	Indoor, clean (dust-free) environment.
Totally enclosed fan cooled (TEFC)	IP.44	Indoor, dust-prone areas.
	IP.54	Normal Outdoor
	IP.55	Outdoor at places of Heavy rainfall

### 11.10.2.5 Class Of Duty

- (i) All motors should be suitable for continuous duty i.e. Class SI as specified IS: 325-1978.

- (ii) Additionally, it is recommended that motors should be suitable for minimum 3 equally spaced starts per hour.
- (iii) The motor should also be suitable for atleast one hot restart.

#### 11.10.2.6 Insulation

Class B insulation is generally satisfactory, since it permits temperature rise upto 80° C.

At cool places having ambients upto 30°C, motors with Class E insulation can also be considered.

At hot places having ambients above 40°C, motors with Class F insulation should be considered.

#### 11.10.2.7 Selection Of Motor Rating

Motors are rated as per the output shaft horsepower (Brake kilowatts, BKW). The motor rating should be selected as to provide margins, over the required BKW, calculated for the pump.

### 11.11 STARTERS

#### 11.11.1 TYPES

Starters are of different types, viz. Direct on-line (DOL), Star Delta, auto-transformer and stator rotor. Of these, the last one is used with slip ring motors. The other three are used with squirrel cage motors.

#### 11.11.2 STARTERS FOR SQUIRREL CAGE MOTORS

Starters draw starting current, which is considered as a multiple of the full load current (FLC) of the motor. Different types of starters help control the starting current required. General guidelines are given in Table 11.12.

**TABLE 11.12**  
**GUIDELINES FOR STARTERS FOR SQUIRREL CAGE MOTORS**

Type of Starter	Percentage of voltage reduction	Starting Current	Ratio of starting torque to locked rotor torques, %
DOL	Nil	6 x FLC	100
Star delta	58%	2 x FLC	33
Auto-transformer	Tap 50%	1.68 x FLC	25
	Tap 65%	2.7 x FLC	42
	Tap 80%	4 x FLC	64

**Note :** As per the torque speed characteristics of the motor, the torque of the motor at the chosen percentage of reduced voltage should be adequate to accelerate the pump to the full speed.

#### **11.11.2.1 Selection Of The Tapping Of Auto Transformer Type Starter**

The torque available from the motor is generally much higher than the starting torque required by the pump, as the starting torque required by the pump is also regulated by starting the pump with the delivery valve closed or open, depending upon the nature of the power versus Q characteristics of the pump.

The torque available from the motor being more than the starting torque required by the pump draws an unnecessary excessive current. This can be controlled as the torque available from the motor varies as the square of the applied voltage. For reducing the excessive torque available from the motor, the voltage to be applied to the motor can be reduced by selecting the appropriate percentage tapping on the auto transformer starter. The value of the percentage for the tapping position can be decided by the following formula.

$$Tapping\% = 100 \times \sqrt{\frac{\text{Torque for pump}}{\text{Torque for motor}}}$$

where,

Torque for pump is the torque required by the pump at its rated speed and at its maximum power demand; and

Torque from motor is the torque available from the motor at its full-load capacity at its rated speed at rated voltage.

Based on the above calculation, the nearest higher available position of tapping should be selected.

### **11.12 PANELS**

#### **11.12.1 REGULATIONS**

The regulations, as per I.E. Rules, in respect of space to be provided around the panel are detailed under 11.4.

#### **11.12.2 VARIOUS FUNCTIONS**

The various functions, which the panel has to serve and the corresponding provisions to be made in the panel are detailed below:

1. For receiving the supply - Circuit breaker or switch and fuse units.
2. For distribution - Bus bar, Switch fuse units, circuit breakers.
3. For controls - Starters: level-controls, if needed: Time- delay relays.
4. As protections - Under voltage relay, Over-current relay, Hot fault relay, Single Phasing Preventor.



5. For indications and readings - Phase indicating lamps, voltmeters, Ammeters, Frequency meter, power factor meter, temperature scanners, Indications for state of relays, indications for levels, indications of valve positions, if valves are power actuated.

The scope and extent of provisions to be made on the panel would depend upon the size and importance of the pumping station.

### **11.12.3 IMPROVEMENT OF POWER FACTOR**

For improvement of power factor, appropriate capacitors should be provided. Capacitors may be located in the control panel or separately.

Some useful guidelines regarding the selection, installation, operation and maintenance of the power capacitors are compiled in the following paragraphs.

#### **11.12.3.1 Selection Of Capacitors**

It is generally advisable that capacitors be installed across individual machines. However, in the case of intermittently running machines, it is advisable to select the capacitor of rating appropriate to the average active load for a group of such machines, installing the capacitor across the mains through a fuse switch. A rationalised combination of individual machine-mounting of capacitors and a mains installation of capacitors, for a group of machines running intermittently, can also be made in order to maintain a power factor yielding optimum economy.

To have a flexible arrangement for maintaining the power factor within set limits would require an automatic power factor correction panel, monitoring a bank of capacitors through a power factor sensing relay and appropriate contactors, the recommended capacitor rating for direct connection to induction motors is given in Table 11.13.

#### **11.12.3.2 Installation Of Capacitors**

While installing a capacitor, ensure following :

- (a) A capacitor should be firmly fixed to a base.
- (b) Cable lugs of appropriate size should be used.
- (c) Two spanners should be used to fasten or loosen capacitor terminals. The lower nut should be held by one spanner and the upper nut should be held by the other to avoid damage to or breakage of terminal bushings and leakage of oil.
- (d) To avoid damage to the bushings, a cable gland should always be used and it should be firmly fixed to the cable-entry hole.
- (e) The capacitor should always be earthed appropriately at the earthing terminal to avoid accidental leakage of the charge.
- (f) There should be a clearance of at least 75 mm on all sides for every capacitor unit to enable cooler running and maximum thermal stability. Ensure good ventilation and avoid proximity to any heat source.

**TABLE 11.13**  
**RECOMMENDED CAPACITOR RATING FOR DIRECT CONNECTION TO INDUCTION MOTORS**  
(To improve power factor to 0.95 or better)

Capacitor rating in KVAR when motor speed is											Capacitor rating in KVAR when motor speed is										
Motor H.P.	3000 r.p.m.	1500 r.p.m.	1000 r.p.m.	750 r.p.m.	600 r.p.m.	500 r.p.m.	Motor H.P.	3000 r.p.m.	1500 r.p.m.	1000 r.p.m.	750 r.p.m.	600 r.p.m.	500 r.p.m.								
2.5	1	1	1.5	2	2.5	2.5	105	22	24	27	29	36	41								
5	2	2	2.5	3.5	4	4	110	23	25	28	30	38	43								
7.5	2.5	3	3.5	4.5	5	5.5	115	24	26	29	31	39	44								
10	3	4	4.5	5.5	6	6.5	120	25	27	30	32	40	46								
12.5	3.5	4.5	5	6.5	7.5	8	125	26	28	31	33	41	47								
15	4	5	6	7.5	8.5	9	130	27	29	32	34	43	49								
17.5	4.5	5.5	6.5	8	10	10.5	135	28	30	33	35	44	50								
20	5	6	7	9	11	12	140	29	31	34	36	46	52								
22.5	5.5	6.5	8	10	12	13	145	30	32	35	37	47	54								
25	6	7	9	10.5	13	14.5	150	31	33	36	38	48	55								
27.5	6.5	7.5	9.5	11.5	14	16	155	32	34	37	39	49	56								
30	7	8	10	12	15	17	160	33	35	38	40	50	57								
32.5	7.5	8.5	11	13	16	18	165	34	36	39	41	51	59								

Capacitor rating in KVAR when motor speed is										Capacitor rating in KVAR when motor speed is										
Motor	3000	1500	1000	750	600	500	Motor	3000	1500	1000	750	600	500	Motor	3000	1500	1000	750	600	500
H.P.	r.p.m.	r.p.m.	r.p.m.	r.p.m.	r.p.m.	r.p.m.	H.P.	r.p.m.	r.p.m.	r.p.m.	r.p.m.	r.p.m.	r.p.m.	H.P.	r.p.m.	r.p.m.	r.p.m.	r.p.m.	r.p.m.	r.p.m.
35	8	9	11.5	13.5	17	19	170	35	37	40	42	53	60	170	35	37	40	42	53	60
37.5	8.5	9.5	12	14	18	20	175	36	38	41	43	54	61	175	36	38	41	43	54	61
40	9	10	13	15	19	21	180	37	39	42	44	55	62	180	37	39	42	44	55	62
42.5	9.5	11	14	16	20	22	185	38	40	43	45	56	63	185	38	40	43	45	56	63
45	10	11.5	14.5	16.5	21	23	190	38	40	43	45	58	65	190	38	40	43	45	58	65
47.5	10.5	12	15	17	22	24	195	39	41	44	46	59	66	195	39	41	44	46	59	66
50	11	12.5	16	18	23	25	200	40	42	45	47	60	67	200	40	42	45	47	60	67
55	12	13.5	17	19	24	26	205	41	43	46	48	61	68	205	41	43	46	48	61	68
60	13	14.5	18	20	26	28	210	42	44	47	49	61	69	210	42	44	47	49	61	69
65	14	15.5	19	21	27	29	215	42	44	47	49	62	70	215	42	44	47	49	62	70
70	15	16.5	20	22	28	31	220	43	45	48	50	63	71	220	43	45	48	50	63	71
75	16	17	21	23	29	32	225	44	46	49	51	64	72	225	44	46	49	51	64	72
80	17	19	22	24	30	34	230	45	47	50	52	65	73	230	45	47	50	52	65	73
85	18	20	23	25	31	35	235	46	48	51	53	65	74	235	46	48	51	53	65	74
90	19	21	24	26	33	37	240	46	48	51	53	66	75	240	46	48	51	53	66	75
95	20	22	25	27	34	38	245	47	49	52	54	67	75	245	47	49	52	54	67	75

Capacitor rating in KVAr when motor speed is							Capacitor rating in KVAr when motor speed is						
Motor H.P.	3000	1500	1000	750	600	500	Motor H.P.	3000	1500	1000	750	600	500
	r.p.m.	r.p.m.	r.p.m.	r.p.m.	r.p.m.	r.p.m.		r.p.m.	r.p.m.	r.p.m.	r.p.m.	r.p.m.	r.p.m.
100	21	23	26	28	35	40	250	48	50	53	55	68	76

**Note :** The recommended capacitor rating given in the above table are only for the guidance purpose. (The capacitor rating should correspond approximately to the apparent power of the motor on no-load)

- (g) While making a bank, the bus bar connecting the capacitors should never be mounted directly on the capacitor terminals. It should be indirectly connected through flexible leads so that the capacitor bushings do not get unduly stressed.

This may otherwise result in oil leakage and/or porcelain breakage.

- (h) Ensure that the cables, fuses and switchgear are of adequate rating.

### 11.12.3.3 Operation And Maintenance Of Capacitors

- (a) The supply voltage at the capacitor bus should always be near about the rated voltage and the supply voltage including the allowable fluctuations should not exceed 110% of the rated voltage of the capacitor.
- (b) Frequent switching of the capacitor should be avoided.. There should always be an interval of about 60 seconds between any two switching operations.
- (c) The discharge resistance efficiency should be assessed periodically by sensing, if shorting is required to discharge the capacitor even after one minute of switching off. If the discharge resistance fails to bring down the voltage to 50V in one minute, it needs to be replaced.
- (d) Leakage or breakage should be mended immediately. Care should be taken that no appreciable quantity of impregnant has leaked out.
- (e) Before physically handling the capacitor, short circuit the capacitor terminals one minute after disconnection from the supply to ensure total discharging of the capacitor.

## 11.13 CABLES

Table 11.14 gives guidance of the types of cables to be used for different voltages.

**TABLE 11.14**

### **TYPES OF CABLES FOR DIFFERENT VOLTAGES**

SNo.	Range of Voltage	Type of cable to be used	IS Ref
1.	10-230 V or 30-415 V	PVC insulated, PVC sheathed	IS 1554
2.	Upto 6.6 KV	PVC insulated, PVC sheathed	IS 1554
		Paper insulated, lead sheathed	IS 692
		XLPE, Cross linked, Polyethylene	IS 7098
		Insulated, PVC Sheathed.	
3.	11 KV	Paper insulated, lead sheathed	IS 692

The size of the cable should be so selected that the total drop in voltage, when calculated as the product of current and the resistance of the cable shall not exceed 3%. Values of the resistance of the cable are available from the cable manufacturers.

In selecting the size of the cable the following points should be considered :

- (i) The current carrying capacity should be appropriate for the lowest voltage, the lowest power factor and the worst condition of installation i.e. duct condition.
- (ii) The cable should also be suitable for carrying the short circuit current for the duration of the fault.
- (iii) The duration of the fault should preferably be restricted by 0.1 second by proper relay setting.
- (iv) Appropriate rating factors should be applied when cables are laid in group (parallel) and/ or laid below ground.
- (v) For laying cables, suitable trenches or racks should be provided.

## **11.14 TRANSFORMER SUBSTATION**

### **11.14.1 ESSENTIAL FEATURES**

Normally outdoor substations are provided. However on considerations of public safety and for protection from exposure to environmental pollution, the substations may be indoors.

- (i) Lightning arresters
- (ii) Gang operated disconnectors (GOD) are provided in outdoor substation. In indoor substation, circuit breakers are provided. In case of outdoor substations of capacities 1000 KVA and above, circuit breakers should be provided in addition to GOD.
- (iii) Drop out fuses for small out door substations.
- (iv) overhead bus bars and insulators.
- (v) Transformer.
- (vi) Current transformer and potential transformer for power measurement.
- (vii) Current transformers and potential transformers for protection in substations of capacity above 1000 KVA.
- (viii) Fencing.
- (ix) Earthing.

Earthing should be very comprehensive, covering every item in the substation and in accordance with IS: 3043.

#### **11.14.2 DUPLICATE TRANSFORMER MAY BE PROVIDED, WHERE INSTALLATION SO DEMANDS**

### **11.15 MAINTENANCE AND REPAIRS OF ELECTRICAL EQUIPMENT**

#### **11.15.1 CONSUMABLES**

Adequate stock of lubricating oil and transformer oil should be maintained.

#### **11.15.2 REPLACEMENT SPARES**

To avoid downtime, stock of fast moving spares and of spares likely to be damaged by short circuit should be maintained. A set of recommended spares for two years of trouble free operation should be ordered alongwith the equipments.

#### **11.15.3 TOOLS AND TEST EQUIPMENTS**

Tools such as crimping tools, soldering, brazing and usual electrical tools should be available.

#### **11.15.4 PREVENTIVE MAINTENANCE**

As preventive maintenance, it is advisable to follow a schedule for the maintenance of the equipments. The schedule covers recommendations for checks and remedial actions, to be observed at different periodicities such as daily, monthly, quarterly, semi annually, annually and bi-annually.

##### **11.15.4.1 Daily**

- (i) For Motors
  - (a) Check bearing temperatures.
  - (b) Check for any undue noise or vibration.
- (ii) For panel, circuit-breaker, starter;
  - (a) Check the phase-indicating lamps
  - (b) Note readings of voltage, current, frequency etc.
  - (c) Note energy-meter readings.
- (iii) For transformer substation
  - (a) Note voltage and current readings.

##### **11.15.4.2 Monthly**

- (i) For motor:- nothing special other than the daily checks.
- (ii) For panel, circuit-breaker, starter.
  - (a) Examine contacts of relay and circuit breaker. Clean, if necessary.
  - (b) Check setting of over-current relay, no volt coil and tripping mechanism and oil in the dashpot relay.

(iii) For transformer substation

- (a) Check the level of the transformer oil.
- (b) Check that the operation of the GOD is okay.
- (c) Check contacts of GOD and of over-current (OC) relay.
- (d) Check temperatures of the oil and windings.
- (e) Clean radiators to be free of dust and scales.
- (f) Pour 3 to 4 buckets of water in each earth-pit.

#### 11.15.4.3 Quarterly

(i) For motor:

- (a) Blow away dust and clean any splashing of oil or grease.
- (b) Check wear of slip ring and bushes, smoothen contact-faces or replace, if necessary. Check spring-tension. Check bush-setting for proper contact on the slip-ring.
- (c) Check cable connections and terminals and insulation of the cable near the lugs, clean all contacts, if insulation is damaged by overheating investigate and rectify. All contacts should be fully tight.

(ii) For panel, circuit-breaker, starter, etc.

- (a) Check fixed and moving contacts of the circuit breakers/ switches. Check and smoothen contacts with fine-glass- paper or file.
- (b) Check condition and quantity of oil/liquid in circuit-breaker, auto- transformer starter and rotor-controller.

(iii) For transformer substation;

- (a) Check condition of the H.T. bushing.

Check the condition of the dehydrating breather and replace the silica-gel charge, if necessary. Reactivate old charge for reuse.

#### 11.15.4.4 Semi-Annual

(i) For motor

- (a) Check condition of oil or grease and replace if necessary. While greasing, avoid excessive greasing.
- (b) Test insulation by megger.

(ii) For panel, etc.

Check for corrosion and take remedial measures. Check by megger the insulation-resistance of switches, busbar, starter- terminals, auto-transformer, etc. for phase- tp-earth and phase-tp-phase, resistance.

(iii) For transformer substation.



- (a) Check die-electric strength and acid- test of transformer oil and filter, if necessary.
- (b) Test insulation by megger.
- (c) Check continuity for proper earth connections.

#### **11.15.4.5 Annual**

- (i) For motors;
  - (a) Examine bearings for flaws, clean and replace if necessary.
  - (b) Check end-play of bearings and reset by lock nuts, wherever provided.
- (ii) For panel, etc.;
  - (a) All indicating meters should be calibrated.
- (iii) For transformer substation
  - (a) Check resistance of earth pit/earth electrode.

#### **11.15.4.6 Bi-Annual**

- (i) for motor: Same as annual
- (ii) for panel, etc. same as annual
- (iii) for transformer substation
  - (a) Complete examination including internal connections, core and windings.

### **11.16 TROUBLE SHOOTING FOR ELECTRICAL EQUIPMENT**

Trouble-shooting comprises detecting the trouble, diagnosing the cause and taking remedial action. Detection of the trouble is prompted by noticing the symptoms. The trouble-shooting details are hence outlined hereunder for various symptoms.

#### **11.16.1 MOTOR GETS OVERHEATED**

- (i) Check whether voltage is too high or too low. Change tapping of transformer, if HT supply is availed. Otherwise approach power supply authorities for correction of the supply voltage.
- (ii) Check whether air ventilation passage of motor is blocked. Clean the passage.
- (iii) Check whether the motor bearings are properly lubricated or damaged. Replace the damaged bearings and provide proper lubrication.
- (iv) Check whether the cable terminals at the motor are loose. Tighten the terminals.

#### **11.16.2 MOTOR GETS OVER LOADED: (DRAWING MORE THAN THE RATED CURRENT AT THE RATED VOLTAGE)**

- (i) Check any excessive rubbing in the pump or any clogging of the impeller passages.
- (ii) Check whether characteristics of pump (i.e. the related driven equipment) are of the overloading type.

- (iii) Check for any vortices in the sump.
- (iv) Check that there is no short-circuiting or single-phasing.
- (v) Check whether any foreign matter has entered the air-gap, causing obstruction to the smooth running of the motor.

#### **11.16.3 STARTER/BREAKER TRIPS**

- (i) Check whether the relay is set properly. Correct, the setting, if necessary.
- (ii) Tripping can also occur, if motor is drawing more than the rated current, for which details are mentioned above.
- (iii) Oil in dashpot may be either inadequate or of low viscosity.
- (iv) Check that there are no loose connections.
- (v) Check whether the timer setting of star delta or auto transformer starter is proper.

#### **11.16.4 VIBRATION IN MOTOR**

- (i) Check for structural rigidity of supporting frame and foundation.
- (ii) Check alignment of pump and motor.
- (iii) Check that the nuts on foundation bolts are tight.
- (iv) Check if rotor has an imbalance.
- (v) Check the resonance from supporting structure or foundation or from critical speed of rotor or from vibration of adjoining equipment.

#### **11.16.5 CABLES GET OVER-HEATED**

- (i) Check whether the cable is undersized. Change the cable or provide another cable in parallel.
- (ii) Check for loose termination or joint. Fasten the termination and make proper joint.
- (iii) Check whether only a few strands of the cable are inserted in the lug. Insert all strand using a new lug, if necessary.

## **CHAPTER 12**

# **INSTRUMENTATION AND CONTROLS IN WATER TREATMENT PLANT**

### **12.1 INTRODUCTION**

Instrumentation and control plays an important role in efficient and effective operation of any water treatment plant. In order to monitor the quality and quantity of water produced and to have trouble free operation of water treatment plant, it is desirable to provide proper instrumentation and control system in the plant. The impact of sudden changes in raw water quality, peak demands and seasonal variations require quick responses and proper action. This is possible only if the plant is provided proper instrumentation and control systems.

This chapter covers the general applications of instrumentation and control system in water treatment plant. Water treatment plant equipments are generally of a rugged nature and not prone to much mechanical defects. It may, therefore, not be desirable to go in for complex automatic control systems.

### **12.2 PURPOSE AND OBJECTIVE**

The purpose and objectives of Instrumentation & Control systems in a water treatment plant are:

- (a) To produce water at a lower cost in lesser time.
- (b) To control certain key functions in order to maintain balance in plant processes.
- (c) To obtain plant operating data such as (i) characteristics of raw & treated water, (ii) flow and quantity measurements including the record of consumables.
- (d) To guide the operator by providing all related data for efficient functioning of various units of water treatment plants.

#### **12.2.1 INSTRUMENTS & CONTROL SYSTEMS**

The instruments and control systems when properly applied and used will provide:

- (i) Precision of operation and instantaneous response to changes in important process variables.
- (ii) Indication and recording of key operating data.
- (iii) Means of better utilization of manpower and treatment chemicals and reduction in down time due to disruption in normal operating procedure.

The instruments and control system have been classified in two categories : Essential and optional. Systems which are considered essential from the point of view of safety of chemical dosing, control and operational ease, constitute the essential systems. The essential system should preferably be incorporated in all the plants. Optional items can be considered where the owner intends to use them for data collection and information and are used where skilled manpower is available.

### **12.3 SYSTEMS AVAILABLE**

The most commonly used instrument and control systems in water treatment plants are:

- (i) Mechanical;
- (ii) Pneumatic;
- (iii) Electric;
- (iv) Electropneumatic; and
- (v) Hydropneumatic.

#### **12.3.1 MECHANICAL**

These instruments are locally mounted or connected for the measurement of parameters at the specific point of measurement. These instruments are operated on mechanical principles by use of floats, pulleys and gears. These include pressure gauges, level indicators and flow indicating devices.

#### **12.3.2 PNEUMATIC**

Pneumatically operated instrument and control system uses clean, dry and filtered air for both transmission and power media for activating the control elements. An example is the pneumatically operated valves for filter beds.

#### **12.3.3 ELECTRIC**

The electrically operated system employs electrical signal for transmission as well as control signal to the control element. An example for such a system is the motorised valves for filter beds or for sludge withdrawal from clariflocculator.

#### **12.3.4 ELECTROPNEUMATIC**

This system employs an electric transducer (with integral transmitter), electric receiver, electric set point and electric controller. The controller sends an electric signal to a positioner with a pneumatic four valve to activate a pneumatic operator to final control element. In this system the transmission medium is an electric signal and the power medium is air.

#### **12.3.5 HYDROPNEUMATIC**

This system is basically identical to pneumatic system except that power medium is oil or water. The transmission medium is air.