Level Controller Selection Criteria

■ Categories (Reference Information)

Categorized by Fluid Types

Applicable liquids	Electrode	Electrode Holders	Relay Unit
Acid/alkaline solutions	Select electrodes based on corrosion resistance *Table 4.* (Separators are not used.)	Electrodes in BS-IT are outlined in *Table 4*. Separate each electrode with insulation.	Low-sensitivity 61F-□□ND Level Controller (61F-11ND or equivalent, however depending on the cable length, the long-distance 61F-11NL Level Controller may be required.)
Boiler	SUS316 (The materials used make the water alkaline.)	BS-1 (Subject to high temperature and pressure.)	Standard 61F-□□ Level Controller
Tap water	SUS304, SUS316	PS, BF. No other specific requirements.	Standard 61F-□□ Level Controller, but when it is over a long distance, use a long-distance 61F-□□L Level Controller.
Pure water (Ion-exchanged water)	Titanium (Maintains the purity level of water.)	BS-1T Titanium	May require a high-sensitivity Level Controller depending on conductivity 61F- □□NH (61F-11NH) Ultra-high-sensitivity 61F-UHS Level Controller
Bubbles (Detection)	SUS304, SUS316, Titanium (Separators are not used.)	PS, BF	High-sensitivity 61F-GP-NH Level Controller or equivalent
Bubbles (No detection)	As above (Separators are not used.)	As above	Low-sensitivity 61F-□□ND Level Controller
Wastewater	SUS304 (Low salinity) (Separators are not used.)	BF-1 is used with each electrodes separated.	Low-sensitivity 61F-□□ND Level Controller
Oil mixed in water	SUS304	PS, BF use pipes to guard against the oil.	Standard 61F-□□ Level Controller
Steam	SUS316	PS-1, BF-1 If there is enough pressure to be able to separate the electrodes, use the BS-1.	Standard 61F-□□ Level Controller

Categorized by Installation Conditions of Electrodes

Installation Condition	Electrode	Electrode Holder
Confined space	PH underwater electrodes	---
Protect against rainwater	SUS304, SUS316	PS + F03-11 Protective Cover + F03-12 Frame
Objects from wastewater (i.e., clothing) get tangled	SUS304	The BF-1; separates the distance between electrode holders
Wastewater, contaminated water, or areas with clusters of grease	SUS304 or SUS316	As above
Elevated tank	SUS304 or SUS316	PS
Ground tank	SUS304 or SUS316, F03-05 Electrode Band, PH underwater electrodes	PS
Sewer, drains (manhole)	SUS304, SUS316	PS (Place the electrodes in a pipe in areas that accumulate grease, e.g., underground, factory pits)
Septic tank (Flushed matter)	SUS304	BF-1
Measurements at a depth like water wells	PH underwater electrodes	---
Areas where ice forms	PH underwater electrodes	---
High temperature (hot water tank)	SUS316	Temperatures under 50°C, BS-1S2 No model is suitable for temperatures above 250°C (Must be made by the user.)

■ Selection Criteria for 61F Level Controllers

Specific Resistance and Model Selection Criteria

The limit for specific resistance of liquid that can be controlled with a generic Level Controller is 30 kΩ·cm when using a PS-3S Electrode Holder within a submersion depth of 30 mm. For any fluid with specific resistance higher than this value, use a high-sensitivity Level Controller (H type). (See note.)

Table 1 and *Table 2* shown on the right and *Table 3* on the next page show specific resistances for typical liquids. Use these when selecting a model.

Note: 1. The high-sensitivity Level Controllers may suffer from resetting problems when used with certain types of water. In some cases it cannot substitute for the standard Level Controllers or Low-sensitivity Level Controllers. Be sure to select the model appropriate for the application.

2. The circuit configuration of the High-sensitivity 61F-□H Level Controller is designed so that the relay is reset when there is water present between the electrodes. When power supply voltage is applied, the internal relay switches to the NO contact and, when there is conductivity between electrodes E_1 and E_3, the relay is reset to the NC contact. This contact operation is reversed for models other than the high-sensitivity models. Although the internal relay operates (and operation indicator turns ON) simply when the power supply voltage is applied, this operation is normal. (The relay in the 61F-□NH energizes when there is water present between the electrodes.)

Note: For the ultra high-sensitivity variable 61F-HSL Level Switch, malfunction due to electric corrosion may occur in the DC electrode circuit. Be careful not to use the product where current constantly flows between electrodes.

Table 1: Specific Resistance of Water (General Guideline)

Type of water	Specific resistance
Tap water	5 to 10 kΩ·cm
Well water	2 to 5 kΩ·cm
River water	5 to 15 kΩ·cm
Rainwater	15 to 25 kΩ·cm
Seawater	0.03 kΩ·cm
Sewage	0.5 to 2 kΩ·cm
Distilled water	250 to 300 kΩ·cm min.

Table 2: Detectable Specific Resistance (Guideline)

Type of use	Specific resistance (recommended value)
Long distance (4 km)	5 kΩ·cm max.
Long distance (2 km)	10 kΩ·cm max.
Low sensitivity	10 kΩ·cm max.
Two-wire	10 kΩ·cm max.
General-purpose	10 to 30 kΩ·cm
High-temperature	10 to 30 kΩ·cm
High-sensitivity (COMPACT plug-in type)	30 to 200 kΩ·cm
High-sensitivity (base type)	30 to 300 kΩ·cm
Ultra high-sensitivity	100 kΩ to 10 MΩ·cm

Note: The specific resistance of liquids are those that can be controlled using the PS-3S when the submersion depth is 30 mm or less.

Conductance

Conductance is a scale describing how easily current can flow. The relationship of conductance and resistance is defined by the following equation.

$$\text{Conductance} = \frac{1}{\text{Resistance } (\Omega)} \text{ (siemens: S)}$$

Table 1 can be modified to contain the corresponding conductance as shown in *Table 1A*.

Table 1A: Specific Conductance of Water (Guideline)

Type of water	Specific Conductance
Tap water	100 to 200 μS/cm
Well water	200 to 500 μS/cm
River water	67 to 200 μS/cm
Rainwater	40 to 67 μS/cm
Seawater	33,300 μS/cm
Sewage	500 to 2,000 μS/cm
Distilled water	3.3 to 4 μS/cm max.

Table 3: Specific Resistance of Various Liquids

Type of liquid	Temperature (°C)	Concentration (%)	Specific resistance (Ω·cm)
Beer (Company A)	12	---	830.0
Port wine (Company K)	12	---	966.0
Whisky (Company T)	12	---	14,608.0
Sake (Company K First grade quality)	12	---	1,743.0
Silver nitrate $AgNO_3$	18	5.0	39.5
		60.0	4.8
Barium hydroxide $Ba(OH)_2$	18	1.25	40.0
		2.5	20.9
Calcium chloride $CaCl_2$	18	5.0	15.6
		20.0	5.8
		35.0	7.3
Cadmium chloride $CdCl_2$	18	1.0	181.0
		20.0	33.5
		50.0	73.0
Cadmium sulfate $CdSO_4$	18	1.0	240.0
		5.0	68.5
		35.0	23.8
Nitric acid HNO_3	18	5.0	3.9
	15	31.0	1.3
	15	62.0	2.0
Phosphoric acid H_3PO_4	15	10.0	17.7
		60.0	5.5
		87.0	14.1
Sulphuric acid H_2SO_4	18	5.0	4.8
		30.0	1.4
		97.0	12.5
		99.4	117.6
Potassium bromide KBr	15	5.0	14.5
		36.0	2.9
Potassium chloride KCl	18	5.0	14.5
		21.0	3.6
Potassium chlorate $KClO_3$	15	5.0	27.2
Potassium cyanide KCN	15	3.25	19.0
		6.5	9.8
Potassium carbonate K_2CO_3	15	5.0	17.8
		30.0	4.5
		50.0	6.8
Potassium fluoride KF	18	5.0	15.3
		40.0	4.0
Potassium iodide KI	18	5.0	31.4
		55.0	2.4
Potassium nitrate KNO_3	18	5.0	22.1
		22.0	6.2
Potassium hydroxide KOH	15	4.2	6.8
		33.6	1.9
		42.0	2.4
Potassium monosulfide K_2S	18	3.18	11.8
		29.97	2.2
		47.26	3.9
Copper sulfate $CuSO_4$	18	2.5	92.6
		17.5	21.8
Ferrous sulfate $FeSO_4$	18	0.5	65.0
		3.0	21.7
Hydrogen bromide HBr	15	5.0	5.2
		15.0	2.0
Hydrochloric acid HCl	15	5.0	2.5
		20.0	1.3
		40.0	1.9
Hydrogen fluoride HF	18	0.004	4,000.0
		0.015	2,000.0
		0.242	275.0
		29.8	2.9
Mercuric chloride $HgCl_2$	18	0.229	22,727.0
		5.08	2,375.0
Hydrogen iodide HI	15	5.0	7.5
Potassium sulfate K_2SO_4	18	5.0	21.8
		10.0	11.6
Sodium chloride NaCl	18	5.0	14.9
		25.0	5.6
Sodium carbonate Na_2CO_3	18	5.0	22.2
		15.0	12.0
Sodium iodide NaI	18	5.0	33.6
		40.0	4.7
Sodium nitrate $NaNO_3$	18	5.0	22.9
		30.0	6.2
Sodium hydroxide NaOH	15	2.5	9.2
		20.0	2.9
		42.0	8.4
Sodium sulfate Na_2SO_4	18	5.0	24.4
		15.0	11.3
Ammonia NH_3	15	0.1	3,984.0
		4.01	913.0
		3.05	5,181.0
Ammonium chloride NH_4Cl	18	5.0	50.5
		25.0	2.5
Ammonium nitrate NH_4NO_3	15	5.0	16.9
		50.0	2.7
Ammonium sulfate $(NH_4)_2SO_4$	15	5.0	18.1
		31.0	4.3
Zinc chloride $ZnCl_2$	15	2.5	36.2
		30.0	10.8
		60.0	27.1
Zinc sulfate $ZNSO_4$	18	5.0	52.4
		30.0	22.5

■ Selecting Electrode Material According to Resistance against Corrosion

To get the most out of the electrodes, refer to *Table 4* to select the best material.

Table 4: Resistance to Corrosion of Electrode Material

Aqueous Solution			Electrode material				
Type	Concentration (%)	Temperature (°C)	SUS 304	SUS 316	Titanium	HAS B	HAS C
Sulphurous acid H_2SO_3	6	30	E	C	A	B	B
Sulphuric acid H_2SO_4	1	30	A	A	A	A	A
	1	BP	E	D	E	B	C
	3	30	B	A	A	A	A
	3	BP	E	E	E	C	C
	5	30	D	B	D	B	A
	5	BP	E	E	E	D	D
	10	30	E	C	E	A	A
	10	BP	E	E	D	C	E
	20	30	E	E	C	C	B
	20	BP	E	E	D	D	E
	40	30	E	E	D	B	B
	40	BP	E	E	D	E	E
	60	30	E	E	D	B	C
	60	BP	E	E	D	C	D
	70	30	E	E	D	B	B
	70	BP	E	E	D	C	D
	80	30	E	E	D	B	B
	80	BP	E	E	D	D	D
	90	30	E	E	D	B	B
	90	BP	E	E	D	D	D
	95	30	E	D	D	B	B
	95	BP	E	E	D	D	D
Hydrochloric acid HCl	1	30	E	D	B	B	A
	1	BP	E	E	E	D	C
	3	30	E	E	B	B	A
	3	BP	E	E	E	D	C
	5	30	E	E	C	C	A
	5	BP	E	E	E	E	D
	10	30	E	E	E	C	C
	10	BP	E	E	E	E	E
	15	30	E	E	E	C	C
	15	BP	E	E	E	E	E
	20	30	E	E	E	C	D
	20	BP	E	E	E	E	E
	37	30	E	E	E	C	E
	37	BP	E	E	E	E	E
Chromium oxide CrO_3	10	BP	D	C	A	B	C
	20	30	C	B	A	B	B
	36.5	90	E	E	C	C	C
Nitric acid HNO_3	10	30	B	A	A	D	A
	10	BP	B	B	B	D	C
	20	290	B	B	C	D	D
	65	175	C	C	B	E	E
	68	30	C	C	A	D	D
	68	BP	D	D	B	E	E
	90	80	E	E	A	E	E
Hydrogen fluoride HF	5	30	E	E	D	D	C
	100	30	E	D	C	C	C
Phosphoric acid H_3PO_4	10 to 85	RT	B	B	C	B	C

Aqueous Solution			Electrode material				
Type	Concentration (%)	Temperature (°C)	SUS 304	SUS 316	Titanium	HAS B	HAS C
Acetic acid CH_3COOH	5 to 50	RT	A	A	A	A	A
	100	RT	A	A	A	A	A
	100	BP	C	B	A	A	A
Formic acid H·COOH	All	BP	D	D	D	A	A
Acetone $CH_3·CO·CH_3$	All	RT	B	B	A	A	A
Alum	All	RT	E	E	D	B	B
Aluminum sulfate	50	BP	D	C	B	C	A
Ammonium chloride NH_4Cl	5	BP	D	D	A	B	B
Ammonium nitrate NH_4NO_3	All	BP	A	A	A	B	B
Ammonium sulfate $(NH_4)_2SO_4$	5	RT	E	D	B	B	C
	10	BP	E	E	B	B	C
Ammonia NH_3	100	100	C	C	A	B	B
	10	BP	C	B	B	B	C
	28	60	C	B	A	B	B
Potassium hydroxide KOH	25	BP	B	A	C	B	C
Sodium hydroxide NaOH	30	60	A	A	B	A	B
	50	65	B	A	C	A	C
Sodium carbonate Na_2CO_3	25	BP	B	B	B	B	B
Potassium carbonate K_2CO_3	20	BP	B	B	B	B	B
Zinc chloride $ZnCl_2$	50	150	D	C	B	B	C
Calcium chloride $CaCl_2$	25	BP	C	C	A	A	A
Sodium chloride NaCl	25	BP	C	B	A	B	B
Ferric chloride	30	RT	E	E	A	E	B
Copper chloride	30	RT	E	E	A	E	B
Sea water		RT	C	C	A	B	A
Hydrogen peroxide H_2O_2	10	RT	B	B	B	B	B
Sodium sulfite	10	RT	B	B	A	B	B
Citric acid	All	RT	B	A	C	A	A
Oxalic acid $CO_2H·CO_2H$	All	RT	B	A	D	B	B
Sodium hypochlorite	10	RT	E	D	A	C	C
Potassium dichromate	10	BP	C	B	A	B	C
Magnesium chloride	30	RT	C	B	A	A	A
Magnesium sulfate	10	RT	B	B	A	A	A

Note: 1. RT: Room temperature
BP: Boiling point

2. A: Adequate resistance to corrosion
B: Resistive to corrosion, erosion rate is less than 0.8 mm/year
C: Low resistance to corrosion, erosion rate is less than 1.8 mm/year
D: Highly corrosive, not usable
E: No resistance to corrosion, not usable

3. The table above is used for reference when selecting the electrodes. Even if the material has adequate corrosion resistance, it doesn't mean that it is not subject to corrosion. Check regularly once a month to see if corrosion is occurring. If it is, replace the electrodes.

Reference

When selecting an Electrode Holder, make sure that you consider the corrosion resistance of the material of electrode holders as it may be exposed to the liquid inside the water tank.