

INSTRUMENTATION
IN THE
PROCESSING INDUSTRIES

BÉLA G. LIPTÁK, Editor

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PREFACE

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The two volumes of the Instrument Engineers' Handbook and Supplement provide a complete and up-to-date reference on automation and control in the process industry that is comprehensive and detailed, but which unfortunately does not acquaint the reader with the peculiarities and traditions of the various industries. Therefore it has limited value to the instrument engineer who, for example, may be contemplating a position in the power industry and, although with overall experience in process measurement and control, is unfamiliar with the practices and customs of that industry.

The present work is designed to meet his specific needs and is organized so that—with the exception of Chapter I—each chapter is assigned to a processing industry. The contributing authors in their presentations emphasize the special aspects of the instrumentation in the particular industry. This should contribute to the exchange of experience between members of the various processing industries. The first section in each chapter acquaints the reader with the main processing steps in that industry. The following five sections are devoted to the various categories of instrument hardware from detectors to computers applicable to the industry discussed, the final section discusses the various control systems in the industry.

This format is utilized for the instrumentation practices in all processing industries except the petrochemical—a necessary exception because there are literally hundreds of chemical processes, whereas there are relatively few processing steps shared by all processes. Consequently the chapter devoted to the petrochemical industry is structured around the processing steps so that each section describes the instrumentation aspects of a specific operation, which includes the measurement and control of operating chemical reactors, distillation columns, refrigeration units, boilers, furnaces, dryers, crystallizers, centrifuges, heat exchangers, pumps, compressors, effluent treatment systems, digital blending systems, evaporators and extruders.

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Chapter I

SELECTION GUIDE FOR PROCESS INSTRUMENTS

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What follows is a summary of the instrumentation hardware available to the processing industries. Application and selection guides are tabulated and grouped by function. Therefore the body of data is applicable to all the process industries although, as the later chapters reveal, the same type of application is not necessarily treated in the same manner in all these industries. In many of the tables a reference is given to the corresponding section of the Instrument Engineers' Handbook, in which the particular instrument is discussed in greater detail. Information is also included on the instrument symbols recommended by the Instrument Society of America (ISA).

Table 1.1

ORIENTATION TABLE FOR LEVEL DETECTORS

Section*	Instrument Type	Service	LIQUIDS						SOLIDS	
			Switches		Local Indicators		Self-Contained Local Controller		Transmitters	
			Clean Fluid	Foam	Accounting	Standard	Clean	Hard to Handle	Clean	Hard to Handle
1.1	Float Level Switches		G	—	—	—	—	—	—	—
1.2	Displacer Level Switches		E	—	—	—	—	—	—	—
1.3	Capacitance Probes		G	F-G	P-F	F	—	—	F	P-F
1.4	Vibrating Reed Level Switches		G	P-F	—	—	—	—	—	G
1.5	Ultrasonic Level Detectors		G	P-F	P-F	F	—	—	G	P-F
1.6	Conductivity Probes		F	P	—	—	—	—	—	P-F
1.7	Radiation Gauges		G	G	E	G	—	—	G	E
1.8	Air Bubbler		P-F	—	P-F	P-F	P-F	P-F	P-F	P-F
1.9	Diaphragm Level Sensors		P-F	—	P-F	P-F	P-F	P-F	P-F	P-F
1.10	Thermal Level Sensors		G	P-F	P-F	P-F	—	—	P-F	P-F
1.11	Tape Level Gauges		G	—	E	G	—	—	G	P-F
1.12	Std. & Magnetic Gauge Glasses		F	—	F	E	—	—	—	—
1.13	Slip Tubes		—	—	P-F	P-F	—	—	—	—
1.14	Differential Pressure Level Detectors		G	—	P-F	G	G	P-F	G-E	G-E
1.15	Displacement Level Sensors		F	—	P-F	F-G	G-E	P-F	F	P-F
1.16	Float Level Indicators		—	—	P-F	F	—	—	P-F	P-F
1.17	Rotating Paddle Level Switches		—	—	—	—	—	—	—	G
1.18	Metric Tape Level Devices		—	—	P-F	F	—	—	P-F	P-F
1.19	Level Control Valves		P-F	—	—	—	F	P-F	—	—

E—Excellent G—Good F—Fair P—Poor

*Section numbers are those in Volume 1 of the Instrument Engineers' Handbook, which may be consulted for additional information concerning the selected sensors.

Table 1.2

Category	Section	Type of Design		Features	Applicable Pressure Ranges								
		Ionization	Thermal		mm Hg absolute	"H ₂ O	PSIG						
High Vacuum	2.1	Ionization	Hot Cathode	✓	✓	10 ⁻¹⁴	10 ⁻¹⁶	10 ⁻¹¹	10 ⁻¹³	10 ⁻⁸	10 ⁻⁶		
			Cold Cathode	✓	✓	10 ⁻³	10 ⁻⁵	1	50	200	400	800	
	2.2	Thermal	Radiation Alphanatron	✓	✓	✓	✓	✓	✓	✓	✓	✓	
			Thermocouple	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	2.3	McLeod	Molecular Momentum Capacitance	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Moderate Positive & Vacuum Press.	2.4	Urophragm	Abs. Press. Motion Balance	✓	✓	✓	✓	✓	✓	✓	✓	✓	
			Abs. Press. Force Balance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	2.5	Bellows	Atm. Press. Ref. Motion Bal.	✓	✓	✓	✓	✓	✓	✓	✓	✓	
			Atm. Press. Ref. Force Bal.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
			Press. Repeaters	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓