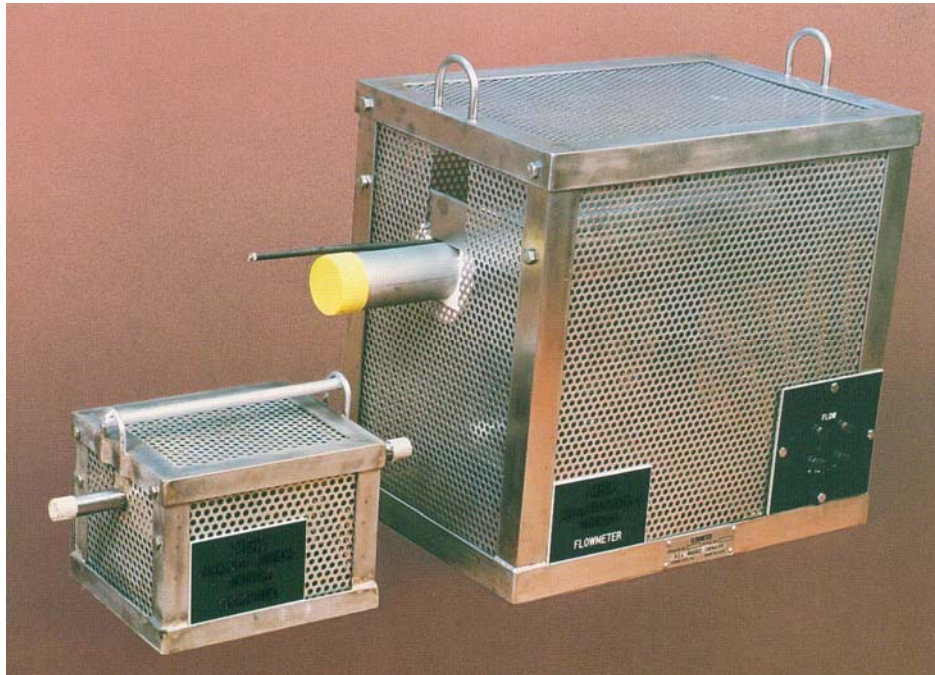




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MAGNETIC FLOWMETERS



CUSTOMER DRIVEN SOLUTIONS

www.CreativeEngineers.com

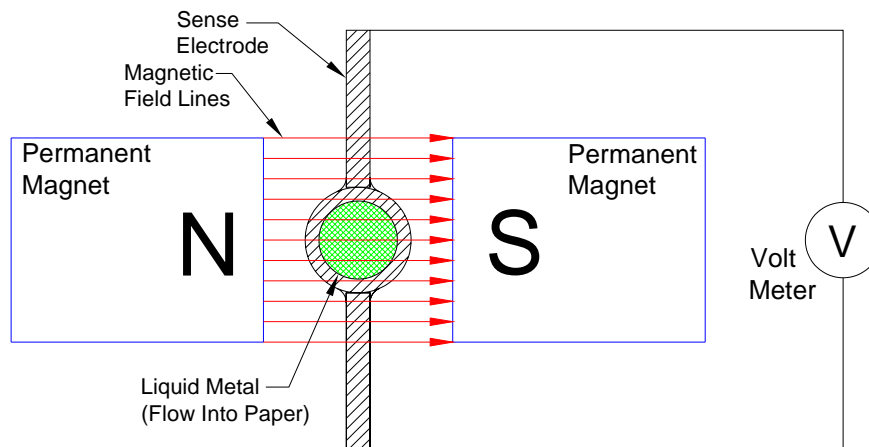
MAGNETIC FLOWMETERS

FEATURES

1. Continuous operation at liquid metal temperatures to 1500 °F (816 °C)
2. No moving parts -- no seals -- no diaphragms -- no leaks
3. Accuracy within +/- 2% measured flow
4. Straight - through flow -- no internal restrictions
5. Low maintenance – reliable to 20 years or more
6. Operable in radiation fields
7. Proven performance since 1950's
8. Can be mounted in any position

PRINCIPLE OF OPERATIONS

Creative Engineers, Inc.'s Magnetic Flowmeter operates on the same principle as electrical generators, Faraday's Law of Magnetic Induction. When a conductor is passed through a magnetic field an electromotive force (emf measured in volts) is created proportional to the change in flux over time. The liquid metal flowing through the tube is a conductor moving through a magnetic field created by a permanent magnet. The voltage is sensed to provide a signal proportional to velocity of flow.



DESCRIPTION

A liquid metal flowmeter is made by placing a nonmagnetic tube, such as stainless steel, between two faces of permanent magnets. The liquid metal acts as a moving conductor through the magnetic field. Electrodes are welded to the tube at right angles to the flow and the magnetic field to maximize the emf sensed. The electrodes are of the same material as the tube to negate any galvanic response.

The generated voltage is proportional to the average velocity of flow. The generated voltage may be read directly by a high impedance input or may be transmitted to an amplifier by a shielded twisted pair cable. The amplifier converts the voltage signal to either an amplified voltage, typically 0-10 VDC, or a 4-20 mA DC signal that can then be used by other instrumentation. Contact Creative Engineers for amplifier and transmitter options.

The flow element is enclosed in a protective cage of stainless steel. This provides mechanical protection for the magnets and electrodes and also allows for free circulation of air.

Thermal insulation around the tube protects the magnets from the heat of the flowing liquid metal. The maximum fluid temperature varies with pipe size and air gap allowed for the magnets. Flowmeters have been successfully operated with fluid temperatures up to 2000 °F (1093 °C).

A curve is furnished with each flowmeter showing flow rate versus output throughout the designed flow range. An optional thermocouple can be provided to monitor magnet temperature. Magnets have been temperature stabilized. If permanent magnets exceed their Curie temperature, the magnets suffer irreparable flux loss and the magnets will be permanently damaged.

MODELS

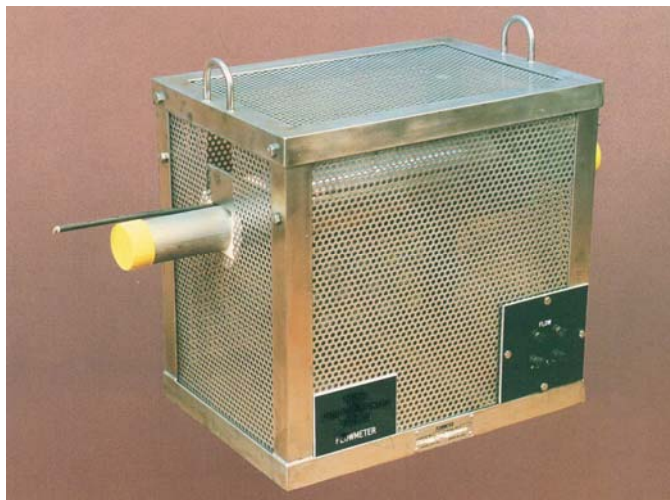
Three magnetic flowmeter designs are available:

- Model FM-1 through FM-5 are designed for temperatures up to 1500°F (816 °C) and large mechanical loads.
- Models FM-6 and FM-8 are open frame designs that must be protected from mechanical shock and vibration and are limited to 1200 °F (649°C).
- Models FM-7, FM-9, and FM-10 are open frame with protect sides and a different geometry for additional structural strength.

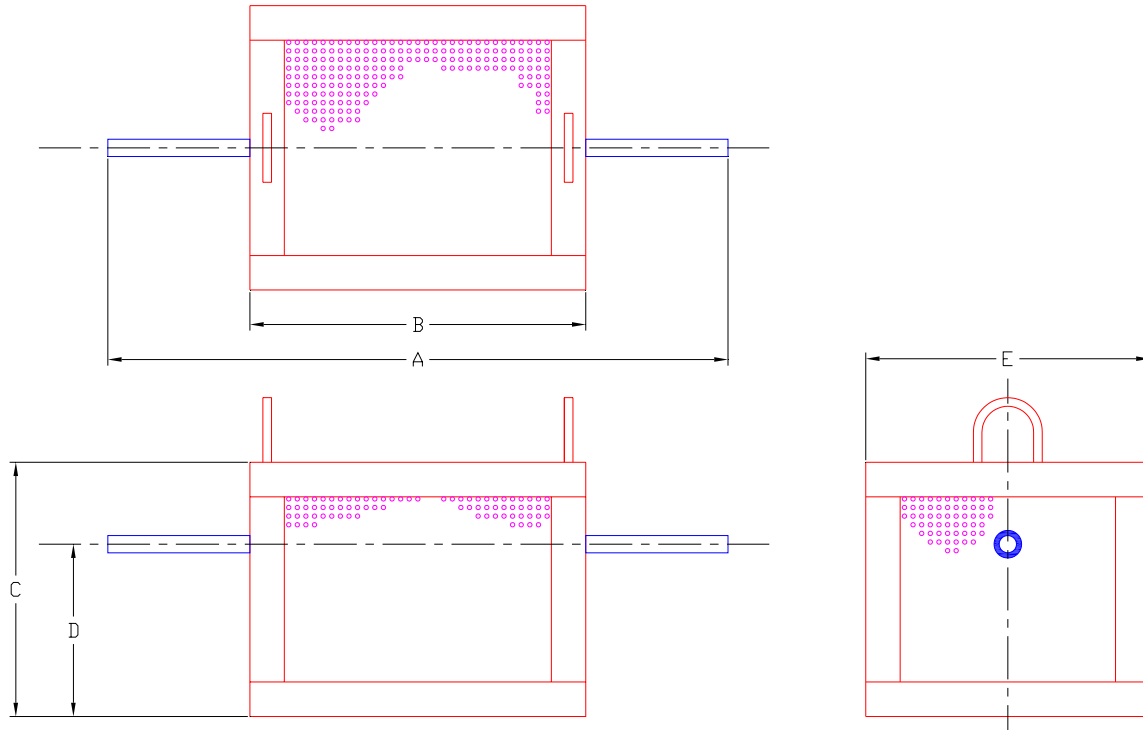
APPLICATION

The magnetic flowmeter may be used to measure the flow of any fluid that has an electrical conductivity near or greater than that of the tube material and which will wet the tube at operating temperatures. The flow tube must be non-magnetic and must not be corroded by the fluid.

To select a flowmeter for an application, select a tube appropriate for the application. Then select the flowmeter with the highest output over the range required. Consult Creative Engineers for sizing assistance.



Flowmeters Type FM-1, FM-2, FM-3, FM-4, FM-5



Model	Tube				Signal Strength		Protective Cage				Weight	
	Length	Size					In (mm)	GPM	Length	Height	Centerline	Width
	A	OD	Wall	Description	B	C			D	E	Net	
	In (mm)	In (mm)	In (mm)		In (mm)	In (mm)			In (mm)	In (mm)	lbs	kg
FM-1	18 (457)	0.250 (6)	0.035 (0.9)	1/4" Tube	0.660	2.50	9.75 (248)	7.38 (187)	5.0 (127)	8.25 (210)	22 (10)	
		0.540 (14)	0.088 (2.2)	1/4" Sch 40	0.293	1.11						
		0.375 (10)	0.049 (1.2)	3/8" Tube	0.480	1.18						
		0.500 (13)	0.049 (1.2)	1/2" Tube	0.317	1.20						
		0.840 (21)	0.109 (2.8)	1/2" Sch 40	0.188	0.715						
FM-2	18 (457)	0.250 (6)	0.035 (0.9)	1/4" Tube	1.060	4.0	10.75 (273)	11.0 (279)	8.56 (217)	14.0 (356)	48 (22)	
		0.540 (14)	0.088 (2.2)	1/4" Sch 40	0.528	2.0						
		0.375 (10)	0.049 (1.2)	3/8" Tube	0.727	2.75						
		0.500 (13)	0.049 (1.2)	1/2" Tube	0.515	1.95						
		0.840 (21)	0.109 (2.8)	1/2" Sch 40	0.293	1.11						
FM-3	30 (762)	1.315 (33)	0.133 (3.4)	1" Sch 40	0.047	0.18	20.0 (508)	19.38 (492)	12.6 (319)	14.0 (356)	220 (100)	
		1.900 (48)	0.145 (3.7)	1 1/2" Sch 40	0.033	0.125						
		2.375 (60)	0.154 (3.9)	2" Sch 40	0.024	0.091						
		3.500 (89)	0.216 (5.5)	3" Sch 40	0.015	0.06						
		4.500 (114)	0.237 (6.0)	4" Sch 40	0.012	0.047						
FM-4	24 (610)	1.050 (27)	0.113 (2.9)	3/4" Sch 40	0.074	0.28	16.5 (419)	15.0 (381)	10.6 (268)	12.5 (318)	115 (52)	
		1.315 (33)	0.133 (3.4)	1" Sch 40	0.061	0.23						
		1.900 (48)	0.145 (3.7)	1 1/2" Sch 40	0.038	0.145						
FM-5	48 (1219)	5.563 (141)	0.258 (6.6)	5" Sch 40	0.0042	0.016	36.0 (914)	24.0 (610)	13.7 (348)	18.0 (457)	420 (191)	
		6.625 (168)	0.280 (7.1)	6" Sch 40	0.0043	0.013						
		8.625 (219)	0.322 (8.2)	8" Sch 40	0.0026	0.0099						

Flowmeters type FM-6, FM-7, FM-8, FM-9, FM-10

Model	Tube				Signal Strength		Protective Cage				Weight (Approx)
	Length	Size					Length	Height	Centerline	Width	
	A	OD	Wall	Description	(Approx) Flow		B	C	D	E	Shipping
	In (mm)	In (mm)	In (mm)		l/min	GPM	In (mm)	In (mm)	In (mm)	In (mm)	lbs (kg)
FM-6 FM-7*	9 (229)	0.250 (6)	0.035 (0.9)	1/4" Tube	1.060	4.00	5.75 (146)	6.0 (152)	4.8 (121)	7.0 (178)	40 (18)
		0.540 (14)	0.088 (2.2)	1/4" Sch 40	0.423	1.60					50 (23)
		0.375 (10)	0.049 (1.2)	3/8" Tube	0.660	2.50					
		0.500 (13)	0.049 (1.2)	1/2" Tube	0.462	1.75					
FM-8 FM-9*	9 (229)	0.250 (6)	0.035 (0.9)	1/4" Tube	0.330	1.3	5.875 (149)	6.0 (152)	3.94 (100)	7.00 (178)	45 (20)
		0.540 (14)	0.088 (2.2)	1/4" Sch 40	0.158	0.6					55 (25)
		0.375 (10)	0.049 (1.2)	3/8" Tube	0.224	0.85					
		0.500 (13)	0.049 (1.2)	1/2" Tube	0.158	0.6					
		0.840 (21)	0.109 (2.8)	1/2" Sch 40	0.099	0.375					
		0.750 (19)	0.065 (1.7)	3/4" Tube	0.099	0.375					
		1.050 (27)	0.113 (2.9)	3/4" Sch 40	0.075	0.285					
		1.000 (25)	0.065 (1.7)	1" Tube	0.074	0.28					
1.315 (33)	0.133 (3.4)	1" Sch 40	0.059	0.225							
FM-10*	30 (762)	1.315 (33)	0.133 (3.4)	1" Sch 40	0.047	0.18	9.0 (229)	16.8 (425)	11.5 (292)	12 (305)	197 (90)
		1.900 (48)	0.145 (3.7)	1 1/2" Sch 40	0.033	0.125					
		2.375 (60)	0.154 (3.9)	2" Sch 40	0.024	0.091					
		3.500 (89)	0.216 (5.5)	3" Sch 40	0.015	0.06					
		4.500 (114)	0.237 (6.0)	4" Sch 40	0.012	0.0474					

* Enclosed with protective cage on all four sides

CALIBRATION

The standard procedure is to supply a calculated curve for liquid metals. This method was adopted after a large number of actual calibrations showed a high degree of correlation with the calculations.

INSTALLATION

Flowmeters models FM-1 through FM-5 are designed to be attached to a hanger or platform supported. Models FM-6 through FM-10 are designed to be base mounted or hung on pipe with the customer responsible for support. Contact Creative Engineers if a hanger is required.

An electrical resistance heater is located along the length of the flow tube to allow pre-heating prior to system filling or operation. The heater should not be operated when flow measurements are being taken.