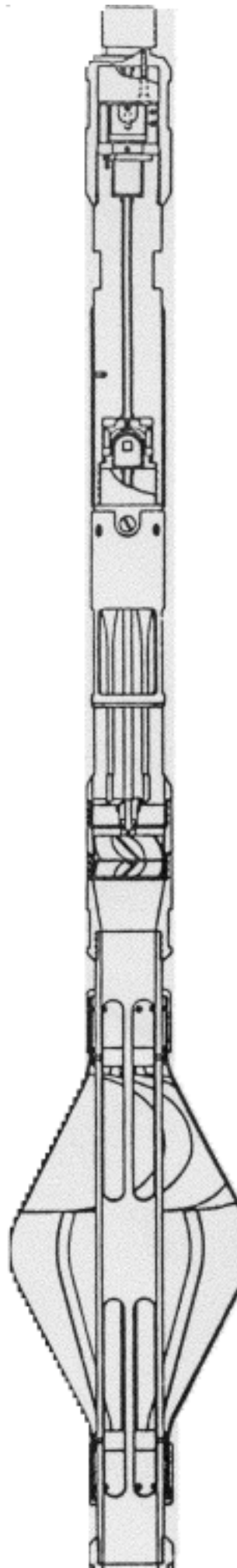


FLOWMETER MK II

SERVICE MANUAL

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SPECIFICATIONS

Diameter	1.75 In.	45 mm
Length	34.5 In	88 cm
-with KPG Recorder	77 In	195 cm
Weight	9 pounds	4 kgm
-with KPG Recorder	14 pounds	6.3 kgm
Maximum Pressure	10,000 psi	703 kg/sqcm
Maximum Temperature	500°F	260°C
Clock	3 hour KPG type	
Charts for Recorder	#10130-1 KPG type	
Flow Rating	681 liter/hour	
-Minimum (threshold)	@ 52.5 mm diameter; 21°C; 1 Atm.. SpG =1	
-Maximum (reported)	7.15x10 ⁸ liter/day @7-5/8 in casing; 180 psi; 165° F; SpG = 1	

PURPOSE

The Kuster Flowmeter Mk II is a mechanical type subsurface recording instrument designed to record accurate, quantitative velocities of producing or injection wells. The recording is mechanical, down-hole, on the Kuster KPG recording device. The Instrument Is lowered into the borehole with conventional solid wire hoisting equipment. It is field proven, rugged and requires little maintenance.

INTRODUCTION

Flowmeter results are Influenced by the physical properties of the fluid; ie., the density, viscosity, temperature, phase and type of flow. An understanding of the Influencing factors is necessary for correct Interpretation of the results.

APPLICATIONS

The continuous type flowmeter is used for the following purposes:

- a. Production from a number of zones is often commingled into a single tubing string. A-flow profile shows which zones are producing and at what relative volumetric rate.
- b. Flowmeter surveys made before and after acidizing or fracturing indicate changes in profile because of the treatment.
- c. Flow profiles made in injection wells can monitor secondary recovery, salt-water and gas storage projects.
- d. Production of unwanted fluids of different physical properties can be detected and located for remedial work.
- e. Flowmeter data together with bottom-hole pressure data can be used to evaluate gas wells.

LIMITATION

The flowmeter will not respond to fluid-instrument differential velocities below a threshold of approximately 5.24 meters per minute (12 fpm). This limitation can be overcome by giving the instrument an initial (contact) velocity with the hoisting equipment.

RESPONSE

The impeller speed is a linear function of the fluid velocity in single phase flow, when the hole diameter and fluid viscosity are constant.

Fluid viscosity has an effect on the flowmeter impeller speed; increasing fluid viscosity at a given flow rate decreases the impeller speed-of rotation.

If the fluid viscosity in the hole is unknown or is not constant, the results of the survey should be questioned. The impeller may be responding more to the variation in viscosity than to flow.

If the results from the flowmeter survey show erratic results opposite perforated intervals, the readings should be taken from the chart between perforated zones.

CALIBRATION

Flowmeters are calibrated at the factory only for threshold (starting) sensitivity. They are not calibrated for various fluid parameters. Field calibration is suggested.

The bore-hole calibration method in the field eliminates many of the difficulties such as bearing friction, machining tolerances, and inaccuracies in the measurement of well fluid viscosity, density, phase, temperature, etc.

In the field, using surface flow measuring equipment at the well site, a calibration stop is made with the instrument about 100 meters below the surface. The surface flow as measured equals 100% and corresponds to the marks on the chart of the recorder at this stop. (Refer to the diagram of the chart herein.)

TO PREPARE FLOWMETER FOR INJECTION SERVICE:

Remove translator housing 16002-1,

Remove upper & lower sleeves 16755-1 & 16755-2.

Slide flowtrap onto the upper housing #16020-1 approximately two inches by compressing flowtrap springs inwardly, insert lower sleeve #16755-2 with the vent openings toward the bottom between the flowtrap springs.

Fit sleeve over the upper housing #16020-1.

Slide it down & insert the upper sleeve through the flowtrap springs & slip it over the upper housing with the screw holes toward the top. Slide the entire flowtrap assembly into position.

Install screws #16755-3 through the upper & lower sleeves and into their respective tapped holes in the upper & lower housing #16020-1 & #16028.

Be sure to align the cut out on the lower sleeve #16755-2 with the flushing screw #16028-3.

Reassemble translator housing 16002-1 to the upper housing 160020-1.

Place stator in position above the impeller by:

- removing nose and extension

- removing stator and impeller

- replace stator above impeller

- replace impeller

- replace nose assembly

PROCEDURE

Select the approximate combination of clock, lead screw assembly, translator driver and orifice.

Install the fluid trap assembly for low flow rates. Please note, the fluid trap is not required at flow rates of about 500 bpd and greater in crude oil. The leaves should be removed in this case. The leaves of the fluid trap will be removed at high fluid velocities whether caused by natural flow or by hoisting velocity.

Assemble the inner housing of the KPG recorder so the stylus base line is near the center of the chart. Draw the base line.

Run the flowmeter in accordance with common practice of subsurface instruments.

OPERATION ABOVE 120°C

Use only 1680-4 High Temperature Flushing Oil Use only 16767-3 Leaves, steel (if required) Note: 16012 Gear Box must be specially prepared for high temperature operation.

Keep a surface log of depth and absolute time.

Make stops at various depths of equal length in time. The stops should be long enough so the marks on the chart number about 10 at each stop.

FLUSH THE IMPELLER SHAFT HOUSING BEFORE AND AFTER EACH RUN.

INTERPRETATION

Refer to the drawing of the chart. Read the chart using a reader with a microscope. From the surface log determine the stops. Count the marks at each stop. Record the data in graphical form.

In the example shown, the flow rate at stop number one and number two is 12 lines/10 minutes and represents 100% flow. Stop number three has 8 lines/10 minutes. This represents 8/12ths or 66% of the flow at stops one and two.

OPERATION

Fluid velocity rotates the Impeller. The Impeller shaft transmits the rotation to a magnet attached to the upper end. The impeller magnet rotates a corresponding gear box magnet across a non-magnetic fluid barrier. The gear box magnet rotates the gear box. The translator parts change the rotary motion of the gear box to small arcs or parts of a circle. The stylus shaft transmits this small motion to the stylus assembly of the recorder.

Each small arc of the stylus shaft marks the recorder chart and represents a certain number of turns of the Impeller. The ratio of turns of the Impeller and chart marks is varied by changes in the translator driver and/or the orifices at the Impeller.

The spacing of the marks on the recorder chart is important. For best resolution the marks should be about .13 mm (.005') apart. The spacing of the marks is varied by the following:

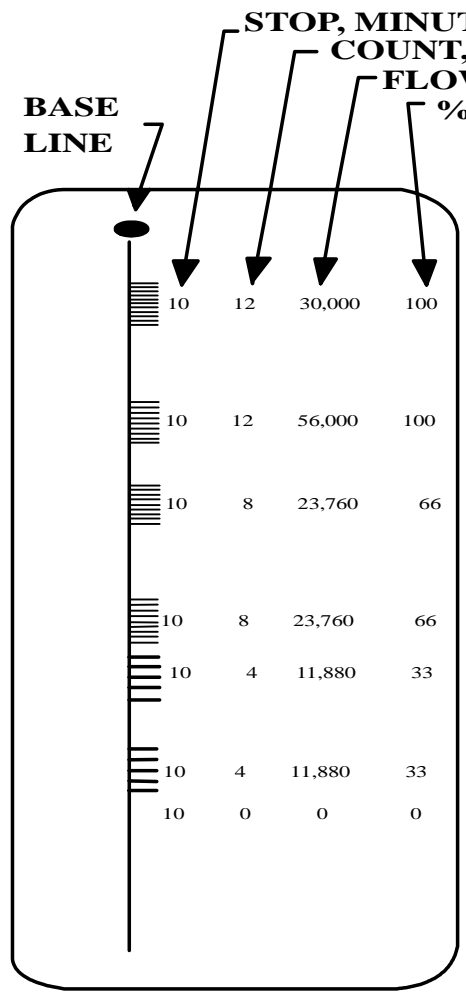
- a) Clock hours of the recorder. Generally a 3 hour clock is used. Other ranges are 2, 8 and 12 hour.
- b) Lead Screw Assembly in the recorder. The standard lead screw makes the run in the clock hours. A fast lead screw assembly makes the run in one-half the clock hours.
- c) The translator driver is furnished with 1, 2 or 4 magnets.

1 magnet equals direct drive	1X
2 magnets equals 2X direct drive	2X
4 magnets equals 4X direct drive	4X

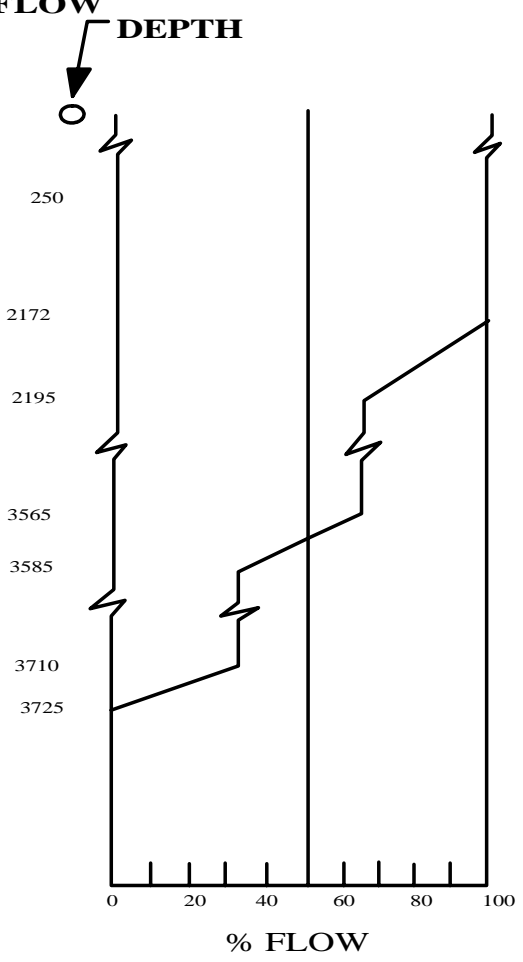
At low fluid velocities the 4X is used.

At high velocities the 1X is used.

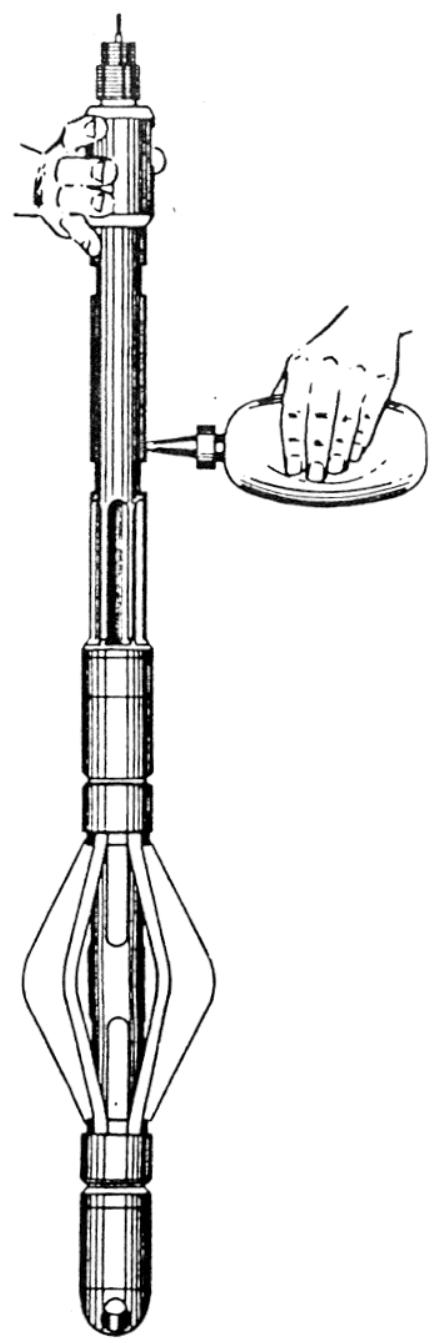
- d) The orifices are used to reduce the fluid velocity and the speed of the Impeller. At high velocities the marks can be spaced a greater distance apart by the use of the orifices.



CHART



% FLOW



FLOWMETER MK 11
Standard Tools and Accessorles 16099-101

Quantity	Part No.	Description
1	132-001	Instruction Manual Flow Meter MK II
10	706-020	O-ring
10	706-025	O-ring
10	706-077	O-ring
1	721-010	Retaining ring 1.433
10	724-002	Retaining ring
6	740-004	Ball bearing
1	901-103	Flushing oil ½ pt. w/spout cap
1	915-001	Thread lube hi-temp.
1	951-005	Hex driver 1/2"
1	958-107	Tube wrench 1 3/4"
1	959-026	End wrench 1 5/8"
1	959-075	End wrench 1.075
1	968-002	Screwdriver 1/8"
1	980-001	Retaining ring installer
1	11232-101	Centralizer 1 1/4"
1	11238-001	Centralizer shipping guard
1	16010-101	Translator driver 1 X
1	16010-102	Translator driver 2X
1	16024-101	Barrier extractor
1	16098-001	Flowtrap shipping guard
2	16767-102	Metal leaf (set of 8)
50	16768-001	Rivet
1	16805-001	Orifice .75, 19mm
1	16807-001	Orifice .50, 12.7mm
1	16830-101	Eyelet pliers

FLOWMETER MK 11
Supplies and Spares for Two Years Operation (optional) 16099-102

Quantity	Part No.	Description
200	706-020	O-ring
200	706-025	O-ring
200	706-077	O-ring
20	715-003	Spring
6	721-010	Retaining ring 1.433
20	724-002	Retaining ring
20	726-027	Spiral pin
10	726-031	Spiral pin
20	726-035	Spiral pin
20	726-047	Roll pin
1	726-055	Roll pin
20	739-006	Ball 1/8"
100	740-004	Ball bearing
6	780-008	Spring washer
20	781-087	Flushing screw
48	783-022	Screw pan head
24	783-044	Screw pan head
20	784-031	Screw fillister head
20	789-060	Cap screw
20	791-033	Set screw 8-32
20	792-004	Set screw 2-56
20	792-008	Set screw 4-40
2	901-102	Flushing oil (1 gal. ea.)
2	901-103	Flushing oil 1/2pt. w/spout cap
8	915-001	Thread tube hi-temp.
1	958-107	Tube wrench 1 3/4"
1	959-026	End wrench
1	959-075	End wrench 1.075
1	980-001	Retaining ring installer
1	16008-001	Stylus shaft
2	16012-004	Gear box
1	16026-001	Impeller shaft
1	16030-101	Stator assembly
1	16032-001	Impeller
2	16767-102	Metal leaf (set of 8)
80	16768-001	Rivet
4	16769-101	Springs (set of 8)
1	16771-001	Collar
1	16772-001	Ring
1	16773-101	Retainer assembly

The Flowmeter MK II is calibrated at the factory only for threshold sensitivity. This calibration is done without an orifice, without a flowtrap and with a one magnet translator driver. The calibration is made with the Flowmeter inside a tube that has an inside diameter of two inches using fresh water with a specific gravity of 1.00. If velocity is used to mean an average velocity at a given crosssectional then:

$$V = Q/A = .9085 \text{ gpm}/d^2$$

where

V = velocity, feet/second

Q = flow in cubic feet/second

A = area, square feet

gpm = flow, gallons/minute

d = inside diameter of pipe

The approximate combination of equipment can be determined using the calculated velocity of the calibration data as compared to the calculated velocity of the well fluids. To calculate the flow area first consider the flow area around the Flowmeter and add the flow area through the Flowmeter.

