
INTEROFFICE CORRESPONDENCE

date August 6, 1979

to C. A. Allen

from **D. W. Allman** *DW*

subject CALIBRATION OF ORIFICE PLATES AT RRG-5B AND RRG-6 ON
JUNE 25, 1979 - DWA-22-79

At the request of Reservoir Engineering, in situ calibration tests were undertaken for the orifice plate and associated instrumentation for measuring flow rate. The test consisted of controlling flow at a series of constant flow rates ranging from 650 to 800 gpm using the Fisher control valve at RRG-6. The dead weight calibrated differential pressure (DP) gauge was transferred from site to site. The pertinent data are listed in Table I.

Figure 1 is a plot of the indicated flow rate at RRG-5B versus the indicated flow rate at RRG-6. A linear regression through the data indicates that RRG-5B indicates a flow rate that ranges from 11 to 8 gpm below the values indicated at RRG-6 for flow rates of 650 to 800 gpm, respectively. During the 21-day constant flow rate test, the indicated flow rate at RRG-5B was approximately 13 gpm greater than that indicated at RRG-6. There is a discrepancy of 24 gpm between the predicted value of 618 gpm at RRG-5B when the indicated flow rate at RRG-6 is 630 gpm. The reason for this discrepancy is not apparent.

Because of changes in fluid density as the water temperature declines in the pipeline from RRG-5B to RRG-6, the mass flow rate at each site is the only valid basis of comparison of flow rates. Figure 2 contains plots of indicated and corrected mass flow rates at RRG-5B versus those at RRG-6. The indicated mass flow rate at RRG-6 averages 215.1 lb/min greater than that at RRG-5B. The difference between the mass flow rates at RRG-5 and RRG-6 is only approximately 4.3%. The slope of 1.0426 indicates that the greater the flow rate, the less the difference indicated at the two sites.

A correction factor for each well was calculated by subtracting the temperature corrected flow rate based on the DP gauge data minus the indicated flow rate (Table I). Figures 3 and 4 are graphs of the indicated flow rates at RRG-5B and RRG-6 respectively versus the correction factor to be added to the respective indicated flow rates to obtain the true flow rates. The correction factor for RRG-5B averages 16.63 gpm (Table I) whereas it is only 1.62 gpm for RRG-6. The estimated standard deviations for the RRG-5B and RRG-6 data are 9.85 and 2.75 respectively. The smaller standard deviation and mean correction factor for the data at RRG-6 imply greater accuracy in the flow rate data at RRG-6 than at RRG-5B.

C. A. Allen
August 6, 1979
DWA-22-79
Page 2

The corrected mass flow rate data listed in Table I are plotted in Figure 2. The difference between the corrected mass flow rates at RRGP-5B and RRG-6 is only 97.74 lb/min or 12.5 gpm at 265°F or approximately 1.95%. A corrected mass flow rate data point for the 21-day test from RRGP-5B to RRG-6 is also plotted in Figure 2. There is essentially no difference in the mass flow rate at the two sites during the long-term test.

In conclusion, the data on the flow rates and mass discharges from RRGP-5B and RRG-6 lead to somewhat conflicting results. The corrected mass flow values for the 21-day test indicate essentially the same mass flow at both RRGP-5B and RRG-6. The volumetric flow rate was 639.8 gpm at 265°F at RRGP-5B. In contrast, the flow calibration tests suggest the mass flow at RRGP-5 was less than that at RRG-6. This is not possible since only losses can occur in the mass due to pipeline leakage from RRGP-5B to RRG-6. The flow correction factors were 16.63 and 1.62 gpm at RRGP-5B and RRG-6, respectively. The small flow correction factor ($\approx 0.2\%$) at RRG-6 is negligible. The flow correction factor of 16.63 gpm is $\approx 2.29\%$ of the average flow rate during testing. All of the flow correction factors are within test specifications. Because of the small flow correction factors based on the calibration test data and the data for the 21-day test from RRGP-5B to RRG-6, it is recommended that indicated flow rate values at RRG-6 be used to determine flow rates that occurred at RRGE-2 and RRGP-5B using appropriate temperature correction data.

SW

Attachments:
As stated

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TABLE I
 CALIBRATED DP GAUGE WITH 3.370 IN. ORIFICE AT RRG I-6

Indicated RRGI-6 gpm	Fluid Density		Indicated Flow Rate			Corrected Mass Flow Rate		
	RRGP-5B (lb/ft ³)	RRGI-6 (lb/ft ³)	RRGP-5B (lb/min)	RRGI-6 (lb/min)	Difference (lb/min)	RRGP-5B (lb/min)	RRGI-6 (lb/min)	Difference (lb/min)
	58.40	60.30	4996	5240	244	5126	5253	127
.85	58.40	60.12	5043	5224	181	5173	5237	64
.88	58.40	60.12	5168	5425	257	5298	5438	140
.59	58.40	60.00	5395	5615	220	5524	5628	104
	58.40	59.88	5395	5604	209	5524	5616	92
	58.40	59.88	5566	5803	237	5696	5816	120
	58.40	59.88	5613	5803	190	5743	5816	73
	58.40	59.88	5566	5803	237	5696	5816	120
	58.40	59.72	5715	5988	273	5845	6001	156
	58.40	59.72	5730	5988	258	5860	6001	141
1.03	58.40	59.72	5715	5988	273	5845	6001	156
4.56	58.40	59.72	6285	6387	102	6414	6400	-14
	58.40	59.72	6136	6387	251	6266	6400	134
	58.40	59.63	6027	6178	151	6157	6191	34
	58.40	59.63	6043	6178	144	6172	6191	19
1.62					215.1			97.74

Indicated Flow Rate at RRGP-5B ($Q_{RRGP-5B}$) (gpm)

Fig. 1 Indicated flow rate at RRGP-5B vs indicated flow rate at RRGI-6.

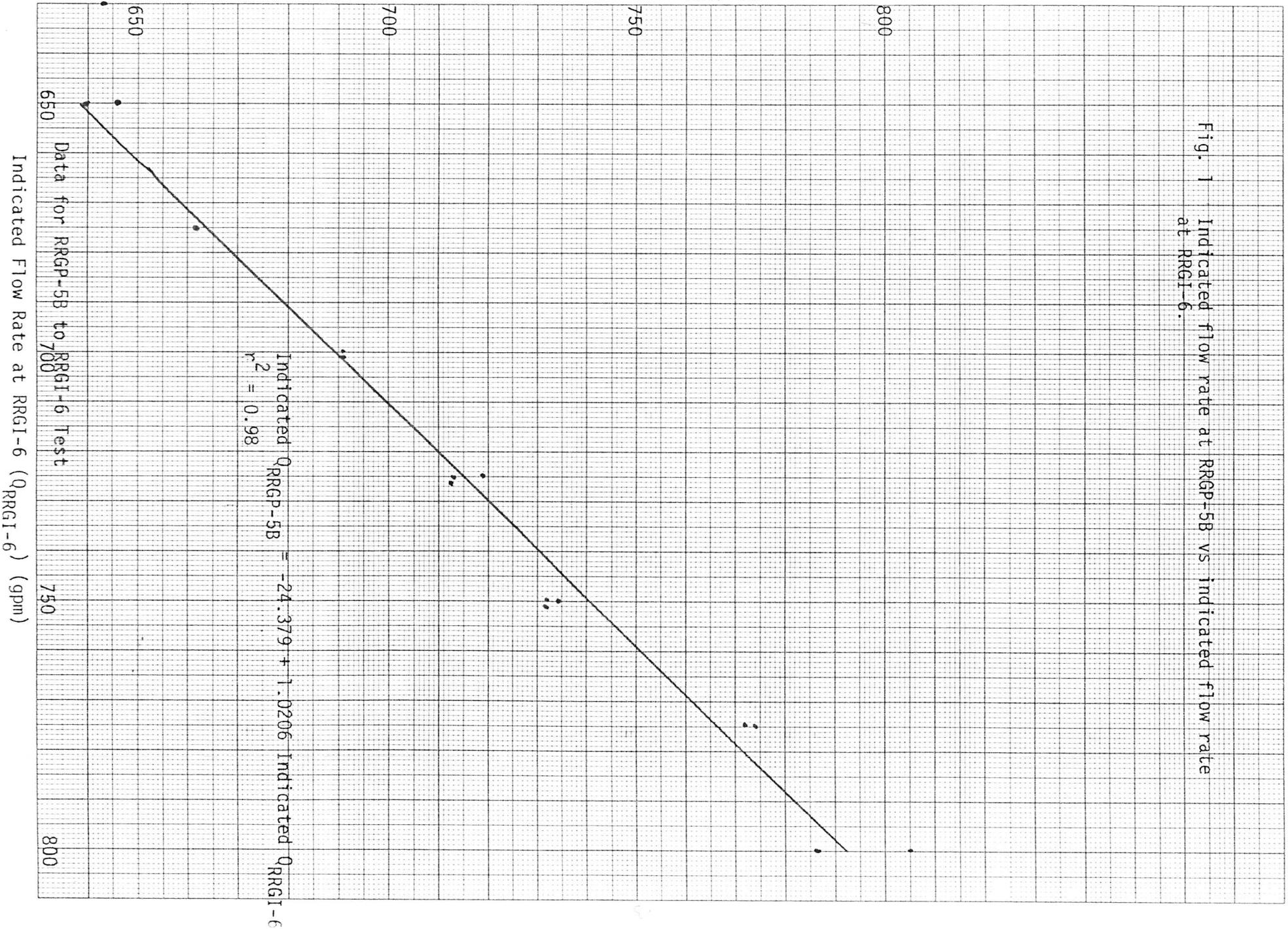


Fig. 2 Mass flow rate at RRGP-5B vs mass flow rate at RRG1-6.

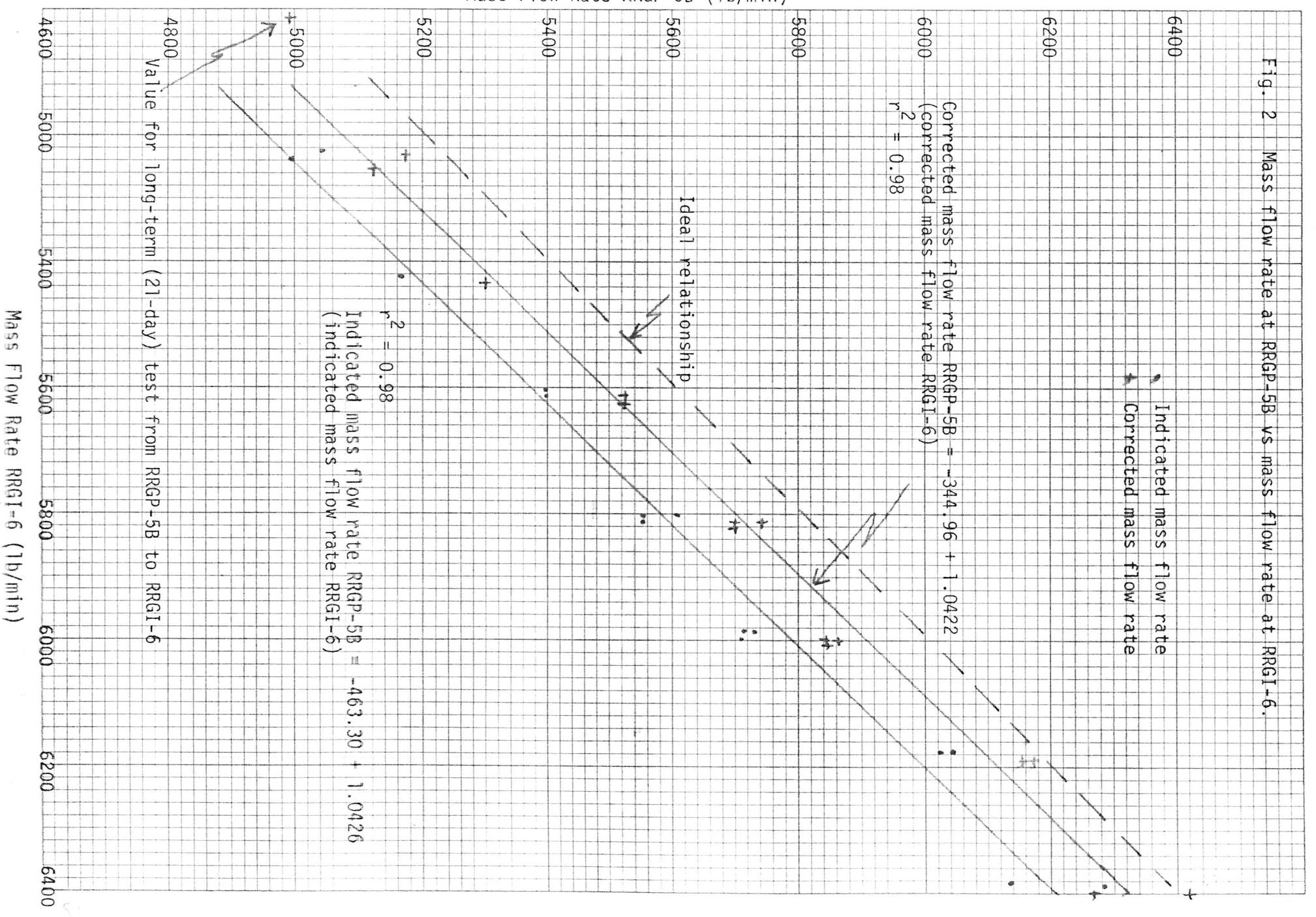


Fig. 3 Indicated flow rate at RRGP-5B versus the correction factor to be added to indicated flow rate to obtain true flow rate.

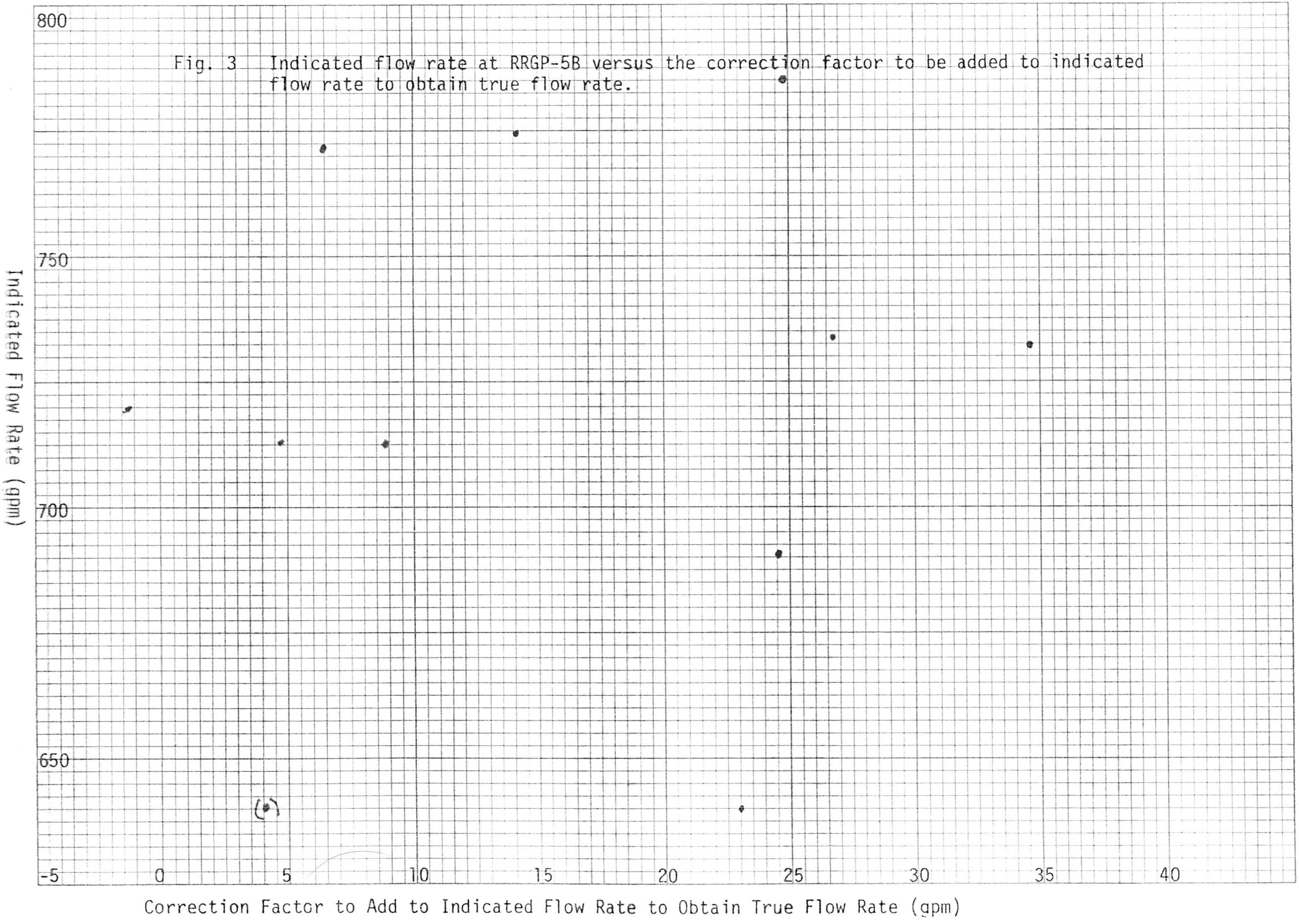
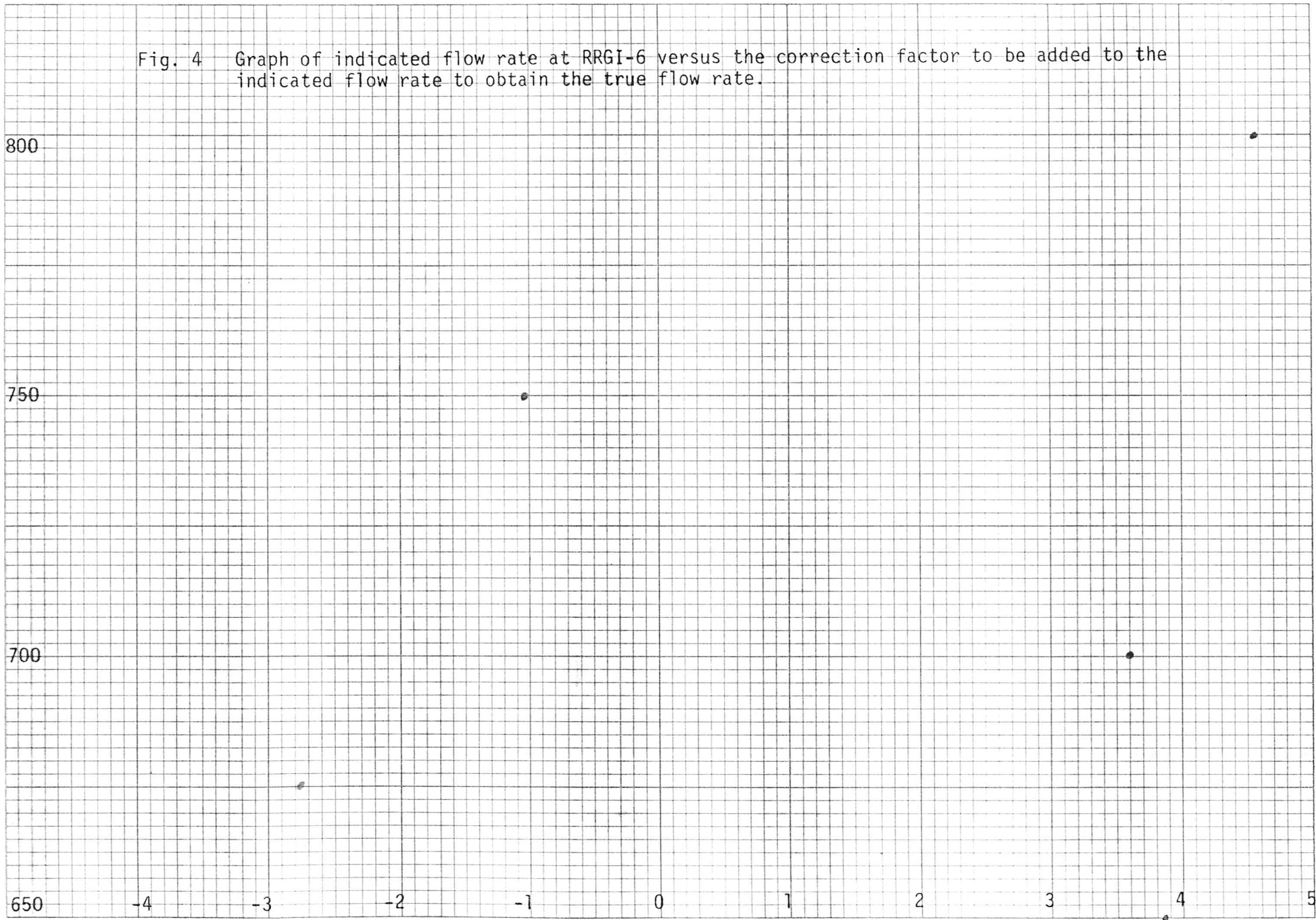


Fig. 4 Graph of indicated flow rate at RRG1-6 versus the correction factor to be added to the indicated flow rate to obtain the true flow rate.

Indicated Flow Rate at RRG1-6 (Q_{RRG1-6}) (qpm)



Correction Factor to Add to Indicated Flow Rate to Obtain True Flow Rate (qpm)