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CALIBRATION OF 18-INCH VENTURIS

FOR

BINGHAM WILLAMETTE

by

J. Paul Tullis

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Engineering Research Center
Colorado State University
Fort Collins, Colorado

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PROCEDURE

The venturis were calibrated at the Hydro Machinery Laboratory of Colorado State University with a precalibrated 18.8" x 23.5" orifice meter. The installation of the venturi and orifice is shown in Fig. 1. Adequate straight piping was allowed upstream and downstream from the orifice and venturi to make the calibration independent of the piping arrangement.

The calibration of the orifice meter, which is traceable to the United States Bureau of Standards was conducted in a stepwise manner as follows:

1. The 18.8" x 23.5" orifice was calibrated by placing an 11" x 12" orifice in the pipe at the location where the venturis would be installed. These data are listed in Table 1. The discharge of the calibration was from 9390 gpm to 19,143 gpm which was the maximum possible through the 12-in. line. The maximum deviation in the coefficient from the mean value of 5447 was 0.41%.
2. The 11" x 12" orifice was calibrated in a volumetric calibration stand up to 4253 gpm. This meter has been calibrated three times in the past 3 years and the coefficients have not varied more than 0.45% from the mean. The last two calibrations are included as Tables 2 and 3. The coefficient used to calibrate the 18.8" x 23.5" orifice was 2282 which is the average of the highest discharges of the most recent calibration (Table 3). The average coefficient for the three calibrations was 2283.
3. The volumetric tanks were calibrated by weighing out quantities of water with a scale that was calibrated with weights which

were calibrated at the U.S. Bureau of Standards. The water was dumped into the sump and the stage-volume determined.

RESULTS

The calibration data for the two venturis are listed in Tables 4 and 5. The accuracy of the overall calibration procedure is estimated to be 1.0%. The difference between the coefficients for the two venturis was only 0.41% so it is recommended to use the average of the two coefficients for all four meters that will be in the pump loop.

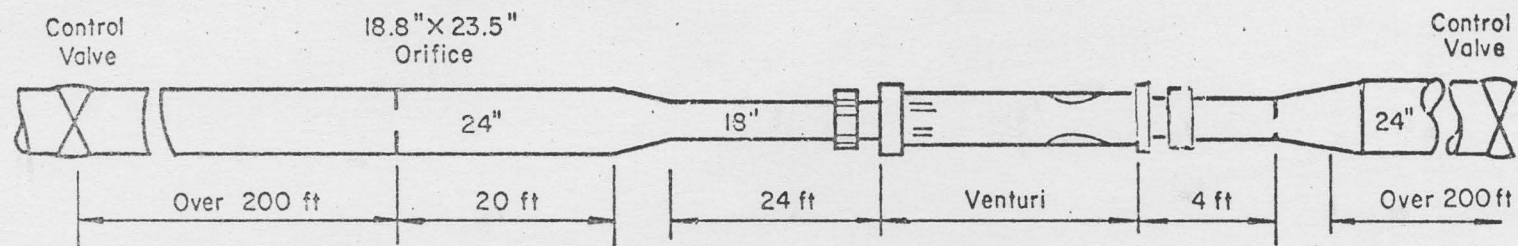


Fig. 1 Venturi Installation

19 Nov. 74

TABLE 1
CALIBRATION FOR BINGHAM WILLAMETTE
VENTURI CALIBRATIONS

11" x 12" Orifice (GPM = 2282 $\sqrt{\Delta H}$ ft water)				18.8" x 23.5" Orifice (GPM = Coef $\sqrt{\Delta H}$ ft water)			
High Mano cm	Low Mano cm	Fluid Conv. to ft Water	Q GPM	High Mano cm	Low Mano cm	Fluid Conv. ft	Coef.
120.45	79.45	.413	9390	23.65	22.75	.064	5449
127.2	72.85	.413	10812	31.1	30.35	.064	5452
137.55	62.75	.413	12684	42.4	42.0	.064	5457
144.7	55.70	.413	13835	50.45	50.10	.064	5454
156.0	44.50	.413	15485	63.20	62.95	.064	5450
168.5	32.2	.413	17121	111.9	87.95	.413	5444
185.8	15.4	.413	19143	115.0	84.85	.413	5425
						Av. =	5447

$$\text{Coef} = \frac{\text{GPM}}{\sqrt{\Delta H \text{ ft H}_2\text{O}}}$$

Test Crew: Tullis
Hooper
Rahmeyer

Water Temp. 40° F

TABLE 2

CALIBRATION FOR Dr. Tullis
METER MFD BY _____
MODEL NO. _____
SERIAL NO. _____
SIZE 11" x 12" FLUID Water

CALIBRATED BY Chuck Copeland
COLORADO STATE UNIVERSITY
ENGINEERING RESEARCH CENTER
FORT COLLINS COLORADO
DATE 9/11/72

[illegible]

CM. OF MERIAM X.0246 = FT H₂O
CM. OF Hg. X.413 = FT H₂O
Water Temp. 70° F

$$C_d = \frac{GPM}{\sqrt{\Delta H \text{ FT H}_2\text{O}}}$$

TABLE 3

CALIBRATION FOR Dr. Tullis
 METER MFD BY _____
 MODEL NO. _____
 SERIAL NO. _____
 SIZE 12" x 11" FLUID Red Meriam

CALIBRATED BY Ramu
 COLORADO STATE UNIVERSITY
 ENGINEERING RESEARCH CENTER
 FORT COLLINS COLORADO
 DATE 8/23/74



RUN NO	P ₁ cm	P ₂ cm	ΔH CM	ΔH FT H ₂ O	√ΔH	TIME MIN. & SEC.	TIME MIN.	INITIAL HOOK	FINAL HOOK	INITIAL VOLUME	FINAL VOLUME	VOLUME GALLONS	Q GPM	Q CFS	C _d	BACK PRESSURE
1	1.40	0.30	1.70	0.1088	0.32985	4:89.00	4.01483	0.429	3.981	70.941	3180.164	3109.223	774.435		2347.8	9 psi
2	2.3	1.1	3.40	0.2176	0.46648	3:00.00	3.00	0.436	4.176	76.853	3351.19	3274.337	1091.446		2339.8	9 psi
3	3.6	2.4	6.00	0.3840	0.61968	2:30.00	2.50	0.557	4.681	180.769	3796.078	3615.309	1446.124		2333.7	9 psi
4	5.2	4.0	9.20	0.5888	0.76733	2: 5.96	2.09933	0.709	4.985	312.879	4064.026	3751.147	1786.831		2328.6	9 psi
5	7.85	6.75	14.60	0.9344	0.96664	1:52.00	1.86667	0.600	5.351	218.145	4386.879	4168.733	2233.246		2310.3	9 psi
6	12.5	11.4	23.9	1.5296	1.23677	1:31.97	1.53283	0.436	5.402	76.85	4432.202	4355.352	2841.38		2297.42	9 psi
7	18.0	16.9	34.9	2.2536	1.49452	1:11.00	1.18333	0.405	5.023	50.672	4097.47	4046.80	3419.839		2288.25	9 psi
8	20.8	19.7	40.5	2.592	1.60997	1:2.00	1.03333	0.537	4.877	163.385	3968.904	3805.52	3682.77		2287.5	9 psi
9	25.2	23.9	49.1	3.1424	1.77268	0:59.02	0.98367	0.570	5.120	192.07	4182.782	3990.712	4056.96		2288.6	9 psi
10	31.5	30.1	61.6	3.9426	1.985	0:56.97	0.91617	0.535	5.200	161.647	4253.25	4091.6	4465.98		2249.8	9 psi
													Av. of runs 6-10 =		2282	

CM. OF MERIAM X.0246 = FT H₂O

CM. OF H₂O X.413 = FT H₂O

Water Temp. 70° F

$$C_d = \frac{GPM}{\sqrt{\Delta H \text{ FT H}_2\text{O}}}$$

TABLE 4
VENTURI CALIBRATION
BINGHAM WILLAMETTE
Venturi A1

Date: 2 November 1974

Calib. Orifice (18.8"x23.5") GPM = 5447 $\sqrt{\Delta H}$ ft water				Venturi A1			
High Mano cm	Low Mano cm	Fluid Conv to ft	Q gpm	High Mano cm	Low Mano cm	Fluid Conv to ft	Coef.
19.32	18.30	0.064	8452	47.65	47.25	0.064	3430
7.75	6.35	0.064	5174	18.40	17.30	0.064	3423
29.30	28.50	0.064	10476	111.30	88.45	0.412	3414
120.10	80.00	0.412	22140	150.85	49.85	0.412	3432
124.0	76.05	0.412	24210	160.30	40.20	0.412	3442
107.8	92.2	0.412	13809	119.90	80.20	0.412	3414
111.05	88.9	0.412	16455	128.05	72.15	0.412	3429
113.80	86.30	0.412	18335	134.80	65.55	0.412	3433
116.80	83.20	0.412	20266	142.35	58.10	0.412	3440
120.00	80.00	0.412	22112	150.55	50.00	0.412	3436
122.00	78.00	0.412	23191	155.30	45.3	0.412	3445
							Av = 3431

$$\text{Coef} = \frac{\text{GPM}}{\sqrt{\Delta H \text{ ft H}_2\text{O}}}$$

Water Temp. 40° F

TABLE 5
VENTURI CALIBRATION
BINGHAM WILLAMETTE
Venturi A2

Date: 4 November 1974

Calib. Orifice (18.8"x23.5") GPM = 5447 $\sqrt{\Delta H}$ ft water				Venturi A2			
High Mano cm	Low Mano cm	Fluid Conv to ft	Q gpm	High Mano cm	Low Mano cm	Fluid Conv to ft	Coef.
10.05	-8.60	0.064	5951	23.95	-22.85	0.064	3438
13.50	-12.1	0.064	6972	33.15	-32.40	0.064	3404
22.20	-21.1	0.064	9068	55.55	-55.1	0.064	3407
31.45	-30.35	0.064	10833	87.7	112.15	0.412	3413
40.00	-39.50	0.064	12287	115.65	84.20	0.412	3413
51.0	-50.5	0.064	13883	120.0	80.00	0.412	3420
109.5	90.3	0.412	15320	124.35	75.6	0.412	3418
110.65	89.15	0.412	16212	127.4	72.7	0.412	3415
113.2	86.6	0.412	18032	133.95	66.3	0.412	3416
116.05	83.7	0.412	19886	141.30	59.05	0.412	3416
120.0	80.0	0.412	22112	150.8	49.8	0.412	3428
							Av = 3417

$$\text{Coef} = \frac{\text{GPM}}{\sqrt{\Delta H} \text{ ft H}_2\text{O}}$$

Water Temp. 40° F

