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This paper presents the results of an experimental investigation on the inception of cavitation in a Quadrant-Edge Orifice meter. The relationship between Reynolds' Number, contraction ratio, and cavitation parameter has been demonstrated under constant back-pressure conditions. Further a graphical method has been suggested for locating exactly the onset of cavitation in a Quadrant-Edge Orifice meter, substantiated with experimental results. This method could as well be applied to other similar pressure differential meters. Values of limiting incipient Reynolds' Numbers are also furnished.

INTRODUCTION: Very few investigators have touched upon the effects of cavitation on metering devices and very little information is available regarding the inception of cavitation in such meters. Hence an attempt has been made to study these art this paper mainly deals with the inception of cavitation in Quadrant-Edge Crifice meter.

So far, there is no universally accepted simple method for judging the onset of cavitation. The method that is commonly adopted is visual examination of low pressure zones. This is likely to introduce personal errors. Recently, optical, accoustical and electrical methods have been suggested. These methods generally involve the measurements of the effects of cavitation, which are naturally after inception, and the use of very expensive instruments and hence are not encouraging. Further accoustical methods fail sometimes because of the vibration noise and other noises of the power machines used in the system.

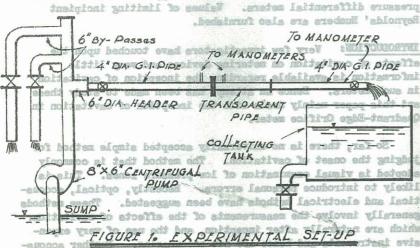
SPECIFICATION OF THE METERS USED: The Quadrant-Edge Orifice plates used in the present investigation have the following specifications:

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| - | β ratio | r Manometer tapping |
| 1. | 0.225 | 0.100 D-D/2 tappings |
| 2. | 0.400 | O.1140 obtained of |
| 3. | 0.500 | Indian, Institute difficure, |
| 4. | 0.600 | ai0.210 St emilered |
| 5. | 0.630 | 0.380 ,, |

*Notations are explained at the end of this paper

EXPERIMENTAL SET-UP: The set up is shown in figure 1.A centrifugal pump of capacity 900 gallons per minute at a head of 120 feet was used to supply the water for the system. Two by-passes of 6" dia. each were used to by-pass the surplus water. The test section consisted of 20 ft. upstream section with 4" dia. G.I. pipe and about 25 ft. downstream section with 4" dia. pipe out of which 4 feet was made of transparent perspex sheet and the rest of G.I. The water was collected in a calibrated collecting tank of capacity of 150 cubic feet.

The downstream end was fitted with a gate valve and a mercury-water differential manometer was used to register the pressure at a point 4" upstream of this gate valve.



the sethods fail sometimes because of the vibration noise and other noises of the power machines used in the system.

EXPERIMENTAL PROCEDURE AND DATA COLLECTION: Pressures p, and p₂ and p₃ were measured for various discharges keeping p₃ as a constant value. This procedure is repeated for various constant p₃ enter enter values (Refer Fig. 2) its tives rebut reduct abloaves surrive to the point of th

The onset of cavitation was determined by hearing the distance characteristic noise as well as by visual observation for checking the walidity of the method suggested garage characteristic noise as well as by visual observation for checking

ANALYSIS OF THE PROBLEM: The problem is solved under the principle of simple hydrodynemic aspect of the flow system. Instance Referring to Figure 2, the dynamic equilibrium between p, p, p, and V, completely characterises the flow picture across and downstream of the orifice plate. The combination of p, p, and V, shows up in the discharge coefficient C and so in pipe way and V, shows up in the discharge coefficient C and so in pipe way and V, if p, is kept as a constant quantity of in the analysis. Further in order to represent the cavitation of conditions, p, and V, may be combined with p, the saturated way our pressure to form a cavitation parameter,

points scatter below the point obtained by the above mentioned graphical solution. This method cowed to graphical to other metering de less as well; since the protestate mede to non-dimensional axes.

Hence a plot of pipe Reynolds' Number against completely depicts the flow conditions across and downstream of the orifice plate, provided, the back pressure pg is kept constant. Since cavitation entails always in loss of energy, there would be an extra loss of energy in the downstream section under cavitating and conditions than under noncavitating, other conditions being similar. For a particular Reynolds' Number, therefore, pg will make the similar of the state of of the sta

Figure 11 shows a plot of auch critical Reynolds' humbers for values and sold and provided manufacturing and contact and conta

FIGURE 2. DEFINITION SKETCH

100 m at 2

A PLOT OF O VA. RA/B

be reduced under cavitating conditions, since p_ is kept constant. The effect of this reduction in p, would be to reduce a staw the value of or an So one can expect a deviation in the plot . eulav of o versus Reynolds' Number under cavitating conditions!) soulsv Figs. 3, 4, 5 and 6 show a plot of \(\sigma \) against R_\(\beta \), under constant back pressures of O (atmospheric), 5, 10 and 15 feet respectively. The division of R by 5° is only to get all barsho the data with a single graph for a constant p. .. It seems then cavitation parameter holds more or less the same functional relationship with R irrespective of the P ratio, if p is kept NAMA constant. Since no significant deviation can be detected from ning figures 3, 4, 5 and 6, the same data have been plotted in Log-Tieles Log scale in figures 7, 8, 9 and 10. It can be seen that the a slopes of the straight lines are different under cavitating and mob noncavitating conditions, with a steeper slope for the latter V box as per the arguments given above. Obviously the point at which wen the break occurs represents the conditions at the onset of cavitation. The inception points obtained by visual examination of me and by hearing the noise are also plotted in the inset block tibnoo diagrams in each of the figures. It may be noted that these approx points scatter below the point obtained by the above mentioned graphical solution. This method could be applied to other metering devices as well, since the plots are made to non-pipe dimensional axes of the sale of the berspex sheet and the rest of C.I. The exter was collected in a calibrated

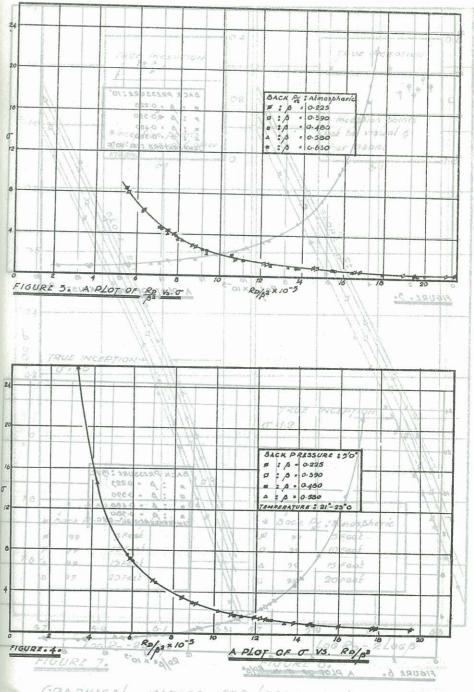
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epilino ent to maerianwob bas accors annitibano woll ent stolceb The study has been made for various back-pressures and the minimum back-pressure that may be expected in any metering installation is atmospheric and hence, the Reynolds' Number at which the inception of cavitation takes place with free discharge conditions represents the minimum value below which cavitation cannot be expected to occur. This value is different for differ-8 ratio and may be different for other metering devices. Figure 11 shows a plot of such critical Reynolds' Numbers for various & ratios of the Quadrant-Edge Orifice meters. All the points fall in a straight line and thus enabling one to separate and designate the portion to the left as "Non-cavitating Zone" and to the right as "Cavitating Zone". But cavitation could be eliminated at Reynold's Numbers to the right of this straight line by suitably increasing the back pressure to increase the system pressure.

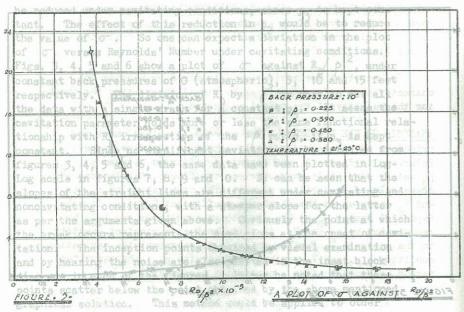
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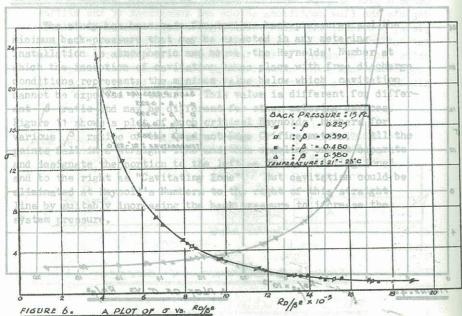


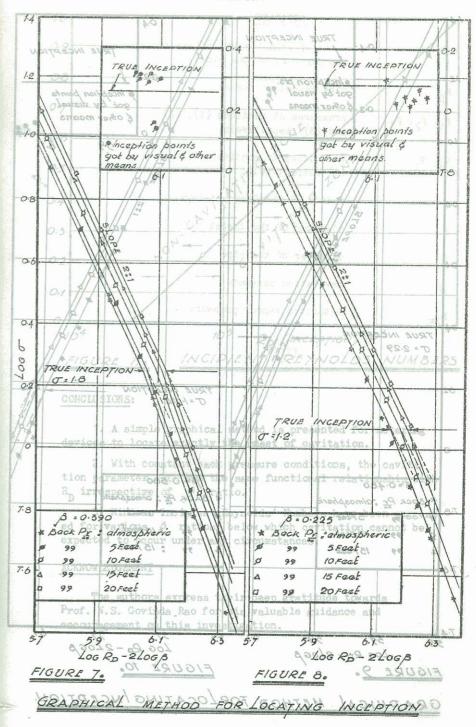
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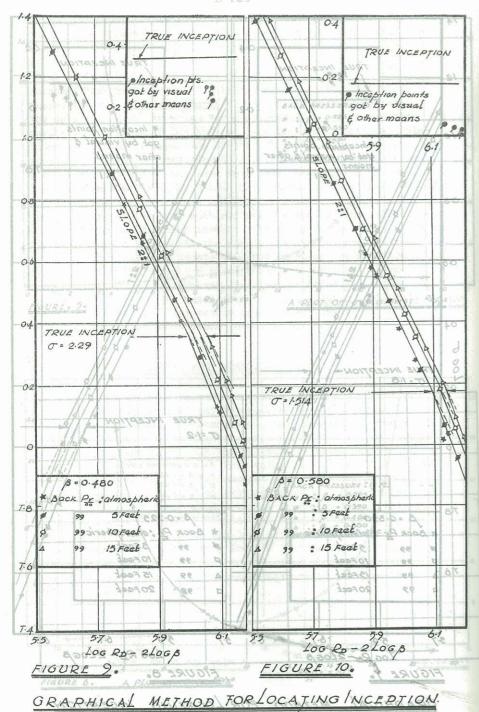


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CONCLUSIONS:

- 1. A simple graphical method is presented for metering devices to locate exactly the onset of cavitation.
- 2. With constant back pressure conditions, the cavitation parameter σ has the same functional relationship with $R_{\rm D}$ irrespective of β ratio.
- 3. Minimum incipient Reynolds' Numbers have been suggested for various β ratios, below which cavitation cannot be expected to occur under any circumstances.

ACKNOWLEDGEMENT

The authors express their deep gratitude towards Prof. N.S. Govinda Rao for his valuable guidance and encouragement on this investigation.

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FLOW BELOW A SUBMERGED SLUICE GATE AS A WALL JET PROBLEM

by N. Rajaratnam

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bstract:

This paper presents a study of the submerged flow below a sluice gate as the case of a plane turbulent wall jet under almost zero pressure gradient with a backward flow planes over it. Experiments have been conducted for four supercritical Proude Mambers from 3.01 to 6.44 with the submergence factor varying from 1.00 to 2.24. The velocity distribution in the fully severaged region follows closely the curve for the classical wall jet with a slight difference only in the scale factors. The boundary shear stress has been measured with a Preston tube. The flow entrainment and the energy fall have also been considered. The appendix presents some calculations for the classical wall jet.

introduction:

The wall jet is defined as a jet of fluid, impinging tangentially (or at an angle) on a boundary, surrounded by stationary (or moving) Fluid. The case of the classical wall jet, i.e. the plane turbulent wall jet issuing into the same stationary fluid of semi-infinite extent, on a smooth boundary, is shown in Fig. 1, in which y is the depth of the slot and U; is the velocity which is assumed to be uniform for the entire depth of the slot. A very full discussion of the wall jet problem with an account of the other investigations has been given by Rmjarstnam (1,2).

For the classical wall jet, the velocity distribution has been found to be fully developed and similar for $x/y \ge 15$, where x is the longitudinal distance from the slot. The length scale at any function is the normal distance from the boundary at which the velocity is equal to half the maximum velocity u, and the velocity gradient u/dy is negative. The velocity scale is the maximum velocity u/m at that section. This velocity distribution curve has been finalised by the theory and Cosart (3) and Rajaratnam (1) using the available experimental information. The nondimensional distance y/δ_1 is represented u/m and the corresponding nondimensional velocity u/u/m by $f(\eta)$.

For the classical wall jet, Sigalia (4) found that

$$8_1/y_1 = 0.5 + 0.065 \times /y_1$$
 (1)

$$u_{\alpha}/U_{1} = 3.45 (x/y_{1})^{-0.50}$$
 (2)

is the boundary shear stress at any section, written as

$$C_0 = c_4 e^{u^2/2}$$
 (3)

cf Ts the coefficient of skin friction and P is the mass density