THE EFFECT OF VELOCITY AND FLOW DIRECTION AT APPROACH OUTLET ON DISCHARGE COEFFICIENT OF VERTICAL PIPE INTAKE

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The vertical pipe intake (VPI) is used as an intake structure for impoundment from river or reservoir. The vertical pipe intakes (VPI) are often more economical in compare with other hydraulic structures. As a result of installation near the water surface they prevent the entrance of coarse sediments into the system. One of the main problems of the VPI is the creation of strong vortices in VPI entrances, which causes the reduction of system efficiency. Vortices in addition to decrease intake efficiency, they produce some problems such as spins in water, air entrance, vibration in the intake and pipeline and pumps, noise, cavitations and improperly using equipment which reduce effective life of equipment. Therefore, creation of vortices will increase structural costs. The parameters which influence on creation of vortex are the lack of symmetry in the intake structure, its geometry, the lack of submergence, separation of flow, sudden change in flow direction and the velocities more than 0.6 m/sec in approaching flow to intakes [3, 4, and 5].

Recognition of effective parameters on vortices will help the designers and engineers to design a correct and efficient structure. In this research by using a laboratory model the effect of tangential velocity and flow direction on VPI discharge coefficient has been studied and by dimensional analysis it was shown the effective parameters on vortex are the submergence number Froude number and circulation number the final equation is

$$\frac{H}{d} = f_3(N_\Gamma, F_r^{-\frac{1}{2}}) \tag{4-b}$$

Also the discharge coefficient of VIP has an inverse relation with the root square of submergence number as following:

$$C_d = \frac{\mathbf{4}Q}{\pi d^{\mathbf{2}}\sqrt{\mathbf{2}gH}} = \frac{\mathbf{4}Q}{\pi d^{\frac{5}{2}}\sqrt{2g\frac{H}{d}}} \tag{5}$$

The tangential velocity component can be calculated by :

$$V_\theta = \frac{Q}{(c+H)b}\ \sin\alpha \tag{7}$$

To investigate the height of water level as a function of changing in tangential velocity of approaching flow, 216 tests were done.

In Table 3 some results from different tests are given.

From these resuts It was conclude that:

1-increasing the circulation number in a flow with a constant Froude number would lead to decrease in intake dishrag coefficient.

2-with increases Froude number changes in circulation has more influence to created vortex and decrease intake discharge coefficient.

3-reducing angle of approaching flow and the increase of the height of the intake span from the bottom cause the increase of intake discharge coefficients.

4-the same parameter that increases the circulation of approaching flow would also decrease intake efficiency. Therefore, in designing of the intakes for increase the efficiency one should try to minimum the angle of approaching flow verses the intake span and to have the maximum height of intake span from the bottom. This causes that the vortex will be weak and the costs will decrease.

Therefore, considering these ideas in designing of intake to reduce impacts of unfavorable vortices in VIP and increase the efficiency is recommended that circulation of approaching flows must reduces by the following means

1-increase cross section of approaching intake channel so that the velocity of approaching flow decreases. 2-try to lead flow direct and uniformly to intake which it can be done by the installation of blades before the intake.

3-increasing height of intake span from the bottom of basins. To apply this in designing the receiving water intakes can be designed in a way that it would have the lowest height from the bottom of approaching canal.

Table 3. Summary of some tests results

No.	C_d Intake discharge coefficient	Froude Number	N_Γ Circulation number	Γ Spin	V_θ Tangential velocity (m/sec)	H/d Submergence ratio	H Height water on intake span	C(mm) Height of span from bottom	angle of directing blades (α)	Q discharge (l/sec)	d pipe diameter (mm)
1	0.712	1.27	0.734	0.048	0.017	1.588	121	150	15	5	75
2	0.639	1.27	1.281	0.085	0.030	1.969	150	150	30	5	75
3	0.582	1.27	1.642	0.107	0.038	2.375	180	150	45	5	75
4	0.549	1.27	1.886	0.124	0.044	2.664	203	150	60	5	75
5	0.709	2.1	0.342	0.02	0.007	3.701	188	200	15	3	50
6	0.657	2.1	0.612	0.036	0.13	4.311	219	200	30	3	50
7	0.614	2.1	0.804	0.047	0.017	4.291	251	200	45	3	50
8	0.590	2.1	0.940	0.056	0.02	5.354	272	200	60	3	50
9	0.747	2.15	0.323	0.013	0.004	4.147	158	152	15	1.5	38
10	0.704	2.15	0.586	0.023	0.008	4.672	178	152	30	1.5	38

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