Analytical Calculations for The Hydraulic Ram Pump using Average Head Losses

Piyush B. Shende [1] Dr. S. K. Choudhary [2] A. P. Ninawe [3]
[2]Professor [3]Assistant Professor
[1,2,3]Mechanical Engineering Department
[1,2,3]K.D.K.C.E Nagpur, India.

Abstract— This paper presents the analytical calculations for the hydraulic ram pump using the average head losses. The study specifies that head losses includes while doing the sample calculations affects on the output results of the ram. These are based on a systematic study of hydraulic ram pump and testing of on hydraulic ramp pump model. For which we consider literatures reviews & some of them are used for the analytical calculations.

Key words: Hydraulic Ram Pump, Average Head Losses, Output Results

I. INTRODUCTION

Hydraulic ram pumps are water-lifting devices that are powered by falling water. Such pumps work by using the energy of water falling from a small height to lift a small part of that amount of water to a much greater height. The main purpose of hydram is to reduce the use of non-renewable energy. A hydram is a structurally simple unit consisting of two moving parts: the waste valve and delivery (check) valve. The unit also consist an air chamber and an air (snifter) valve. The operation of a hydram is intermittent due to the cyclic opening and closing of the waste and delivery valves. The closure of the waste valve creates a high pressure rise in the drive pipe. An air chamber is necessary to prevent these high intermittent pumped flows into a continuous stream of flow. The air valve allows air into the hydram to replace the air absorbed by the water due to the high pressures and mixing in the air chamber and creating very high pressure. Because of this pressure the water is lifted to very high height. The main and unique advantage of hydraulic ram pumps is that with a continuous flow of water, a hydram pump operates automatically and continuously with no other external energy source - be it electricity or hydrocarbon fuel. It uses a renewable energy source (stream of water) mid hence ensures low running cost. It imparts absolutely no harm to the environment. Hydraulic ram pumps are simple, reliable and require minimal maintenance. It can be used for water supply to countryside and remote areas, domestic and irrigation. Considering average losses we calculated different and related parameters for the hydraulic ram pump.

II. SAMPLE CALCULATION

Nomenclature- Q=supply rate, A= area of pipe, V=supply velocity, Vd= velocity through drive pipe, Ad= area of drive pipe, Dwv= dia. Of waste valve, At=area of T-section, Awv=area of waste valve, Hd=delivery head, Hs= supply head, Qw= rate of water through waste valve.

A. *Supply Rate*

Q = AxV

=π/4xd^2x Cv√ (2*g*Hs)

=π/4x {(0.05)}^2x 0.96√(2*9.81*2)

=11.8 x {10}^(-3) m^3/sec

Q= 11.8 lit/sec

B. *Velocity of supply*

Vd = Q/Ad

= (11.8 x {10} ^ (-3))/ (π/4 x {(0.0508)} ^2

Vd = 6.0136 m/sec

C. *Reynolds Number*

Re=Vd/υ xDwv

Where,

υ= Kinematic viscosity of water

=0.01x {10} ^ (-4)

Re=0.0508X6.0136/ (0.01x {10} ^ (-4))

Re= 290878.63

Re > 4000

Flow is turbulent. Hence selecting the value of friction coefficient as fallows.

For smooth pipe blasins suggest that for turbulent flow

F=0.316/{Re}^0.25

F=0.316/{290878.63}^0.25

=0.0136 friction factor of pipe.

L\D=500

D. *Head Losses*

=FxL/Dx[V^2/2g]

= 0.0136x500x[{6.0136}^2/2X9.81]

Head loss= 2.506 m

Length of drive pipe

Ld =100x0.0508

= 5m

E. *Velocity of fluid flow in T junction*

Vt = Q/At

Let, the waste valve bore diameter =4"=101.6x10-6

Vt = (11.8 x{10}^(-3))/(π/4 x{(0.1016)}^2)

= 1.507m/sec

F. *Losses due to sudden enlargementat T- junction*

Ht=((Vd-Vt))/2g

={ (6.0136-1.507)}^2/2X9.81

= 1.035 m

Other miscellaneous losses

Hl= Kt X {((Vt) ^2)}/2g

= 0.3 X ((1.507)^2))/2X9.81

= 0.0347 m

III. TABLE OF SAMPLE CALCULATIONS

SR	Hs (m)	Hd (m)	Ds (mm)	Dwv (mm)	Q m^3/s	Vd (m/s)	Vt (m/s)	POWER (W)	%	Qd $\boldsymbol{m^3}$ m^3/s	Pwv	Wwv
1	1	3	30	30	3.5310^{-3}	4.99	4.99	103.88	33.33	2.93	12450	8.79
2	1	3	30	40	3.5310^{-3}	4.99	2.80	103.88	33.42	2.92	3920	4.92
3	1	3	30	50	3.5310^{-3}	4.99	1.797	103.88	33.33	2.93	1614.6	3.16
4	2	4	25	70	2.9510^{-3}	6	0.766	11.57	25.04	3.675	293.76	1.12
5	2	4	25	75	2.9510^{-3}	6	0.667	11.57	25.04	3.70	222.44	0.98
6	2	4	25	60	2.910^{-3}	6	1.043	11.57	25.04	3.67	543.92	1.53
7	3	6	30	75	5.210^{-3}	7.36	1.178	306.42	25	6.50	693.56	3.06
8	9	18	50	75	0.025	12.73	5.65	4414.5	25.05	3.11	15961.2	70.47
9	7	15	50	75	0.0220	11.20	4.979	3237.3	26.72	2.55	12395.2	54.73
10	5	12	50	75	0.0186	9.47	4.210	2189.59	29.24	1.99	8862.05	39.13
11	3	7	60	75	0.0208	7.35	4.708	612.14	28.64	2.21	11082.6	48.93
12	3	7	55	75	0.0174	7.32	3.938	4903.03	28.65	1.85	7753.92	34.23
13	3	7	50	75	0.0144	7.33	3.259	988.84	28.67	1.53	5310.54	23.44
14	2	6	60	75	0.0170	6.02	3.848	9810.10	33.43	1.40	7403.55	32.69
15	1	3	60	75	0.0120	4.24	2.714	353.16	33.47	9.91	3688.32	16.28
16	1	3	55	75	0.0101	4.25	2.286	297.24	33.49	8.41	2612.89	11.53
17	2	4	101	152	0.0481	6	2.650	1887.44	25.02	6	3511.25	63.68
18	2	4	101	177	0.0481	6	1.954	1887.44	25.02	6	1909.05	46.94

Table. 1:

IV. GRAPHS

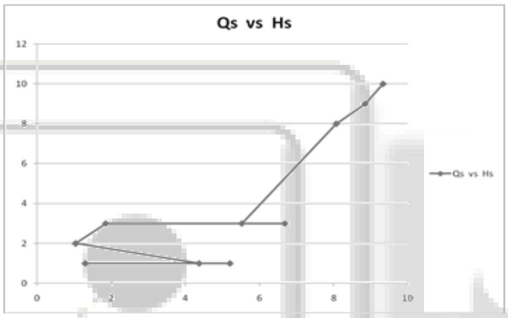

Fig. 1:

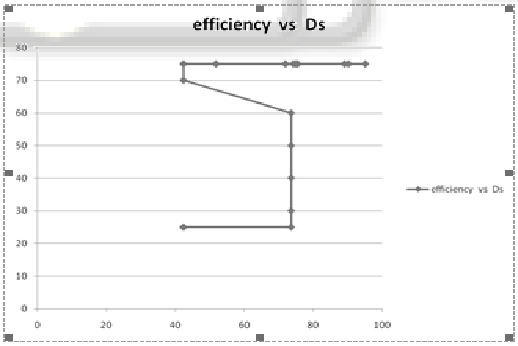

Fig. 2:

V. CONCLUSIONS

Considering average losses it is seen that performance of hydram flow is drastically affected. It will help to predict losses in complete working system. So that we will try to minimize the losses in curve.

REFERENCES

[1] Shuaibu Ndache Moammad, “Design and Construction of a Hydraulic Ram Pump”,Leonardo Electronic Journal of practices and Technologies,ISSN 1583-1078,Issue 11,July-Dec.2007,P.59-70

[2] Ma Chi* and Hu Yinde, “Hydraulic ram,a device lifting water without conventional energy”,Zhejiang University of Technology.

[3] Dr. Abiy Awoke Tessema, “Hydralic Ram Pump System Design and Application”,ESME fifth annualconferenceon manufacturing and process industry,September2000

[4] D. Tulapona,”The Use of Hydra ram for water pumping in Tanzania.”

[5] Oyuko 0. Mbeche, “The Hydralic ram pump in Kenya”

[6] W.T. Weercoon &V.Liyanaj,”Hydralic ram pump technology and practices in Zambia”

[7] E.J. Schiller,”Practical aspects of Hydram operation”

