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EFFECT OF STRAINER OPENING RATIO ON HEAD LOSS CHARACTERISTICS OF FOOT VALVES IN PUMP SETS

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ABSTRACT

Foot valve is an important component of a pump set. For the loss of pressure in a pump, foot valve is responsible for 10 to 15 percent of the loss. However, with improved foot valves, it is possible to reduce this loss considerably and save energy consumption. By experiments and dimensional analysis, it is clearly indicated that the lesser strainer opening ratio increases the head loss and vice-versa.

KEY WORDS: Pump sets, Foot valves. Strainer Opening ratio, Head loss.

Of the many components of a pumpset, foot valve is an important one. Probably owing to its very nature of being submerged under the liquid to be pumped and not being seen outside, it has not received its due attention for long. However, in the late seventies, many investigators recognised its importance and evinced interest in the development of important foot valves. The pressure loss in the conventional foot valve is 1 to 1.5m. By reducing this loss to 0.4 or 0.5 m in about 9 lakh pumpsets operating in the whole of Tamil Nadu, it is possible to save electricity worth of Rs.36 million per annum

Twelve existing foot valves have been reviewed for possible identification of the important parameters that govern the pressure loss of a foot valve. The shape of the foot valve, total area of the dome surface (A), the strainer opening area (S), the valve opening area (O) and the sectional area of the suction pipe (a) are important in affecting the pressure loss. Though most of the existing foot valves are hemispherical in shape, a few are cylindrical, note-worthy of the latter being Sujala foot valves. There are synthetic rubber foot valves also available in the market. They have the advantage of being rust free but suffer from the undesirable feature of causing heavy pressure loss even to the extent of 3 meters of water.

MATERIALS AND METHODS

The study was taken up to analyse the performance of locally available foot valves, to identify areas of deficiency and incorporate any modifications or to fabricate new types of foot valves if necessary. With this view in mind, the locally available foot valves were first tested for their performance. The very commonly used foot valves of size 2½", 3" and 4" were tested in the laboratory.

The ratio of the strainer opening area to strainer surface area (S/A) and the ratio of valve opening area to its suction cross section area (o/a) were computed and pressure loss that took place in the foot valves were observed. The edges of the slot opening of rubber foot valve were very sharp and this led to higher resistance as discussed later. With a view to increase the strainer opening areas as a desirable feature, additional openings were made at the base of the cylindrical foot valves with the help of the drilling machine. A class of cylindrical foot valves were also designed incorporating larger strainer opening areas. However, the leather flap assembly was retained as in the Sujala type. These new cylindrical valves were fabricated with vertically arranged rods welded with circumferentially arranged rods. The base of the valves was of a circular plate with holes on it. In some of the experiments, since the holes were felt to be too large in size, the strainer was covered with different types of wire meshes and coconut leaf sheath to prevent the entry of floating materials into the suction line. This caused a token uneven in the pressure loss.

In some of the experiments, the strainer dome was removed keeping only the foot valve assembly in suction pipe line. In all, the total number of the experiments was forty in number. In the course of the experiments, water was pumped with a five horse power centrifugal pump and recirculated back. The suction pipe line was 3" in diameter and delivery 2½". A pressure tapping had been made in the suction pipe line just above the foot valve and was connected to the limb of manometer with the other end being open to atmosphere. The mano-

Table. Experimental details of foot valves.

Foot valve Number	Name	Size (d) inch	Discharge (Q) m³/sec	Head loss (h_f) m	Co-efficient of Resistance (K)	$\frac{S}{A}$ Ratio
1	Fabricated	3"	0.018	0.51	0.49	
			0.017	0.50	0.54	
			0.015	0.46	0.64	0.98
			0.012	0.37	0.82	
			0.008	0.22	1.10	
2.	Fabricated (Strainer covered with wire mesh)	3"	0.018	0.67	0.65	
			0.017	0.65	0.70	
			0.015	0.57	0.80	0.67
			0.013	0.50	0.94	
			0.010	0.40	1.29	
			0.008	0.32	1.60	
3.	Fabricated (Strainer covered with square mesh)	3"	0.018	0.77	0.74	
			0.015	0.68	0.95	
			0.013	0.60	1.13	0.62
			0.012	0.55	1.22	
			0.010	0.48	1.54	
			0.007	0.35	2.33	
4.	Fabricated (Strainer covered with nylon mesh)	3"	0.017	0.88	0.95	
			0.015	0.81	1.14	
			0.013	0.72	1.35	0.39
			0.012	0.68	1.51	
			0.011	0.64	1.68	
			0.008	0.49	2.45	
5.	Fabricated (strainer covered with coconut leaf sheath)	3"	0.017	1.02	1.10	
			0.015	0.94	1.32	
			0.013	0.86	1.62	0.30
			0.012	0.82	1.82	
			0.010	0.74	2.38	
			0.008	0.64	3.20	
6.	Synthetic	3"	0.018	3.05	2.96	
			0.016	2.83	3.49	
			0.015	2.75	3.87	0.10
			0.013	2.55	4.81	
			0.010	2.27	7.32	
			0.009	2.15	8.60	

metric liquid used was mercury. The discharge pumped out was metered by actually collecting in a tank. The pressure loss in the foot valve was observed on the manometer.

An equation was obtained to work out the pressure loss using the observed data. Considering two points for the purpose, one at the entrance to the foot valve and the other at the outlet of the foot valve and applying Bernoullis theorem, we get

$$Ha + X = Hs + \frac{Vs^2}{2g} + h_f$$

But $Hs = Ha + H - 13.6\ \Delta H - (H-\Delta H) + W' \{h-\Delta H + y + x\}$

That is $Hs = Ha - 13.6\ \Delta H + \Delta H \quad W' = o$

Eliminating Hs and rearranging for h_f, $h = x + 12.6\ \Delta H - \frac{Vs^2}{2g}$

Where h_f = head loss due to foot value (m)

x = Submergence of foot valve tapping (m)

H_s = Suction head (m)

V_s = Suction velocity (m/sec)

W' = Weight density of air

ΔH = differential head in the manometer (m)

In this analysis, the weight of the air column from the manometer to the outlet point of the valve is neglected. Hence head loss can be expressed as

$$K\frac{V^2}{2g} = h = x + 12.6\,\Delta H - \frac{Vs^2}{2g}$$

where K is the resistance coefficient. This resistance coefficient can be determined with the computation of velocity head $\frac{V2}{2g}$ and the observed pressure head 'h_f'.

RESULTS AND DISCUSSION

One of the important factors affecting the pressure loss in the foot valve is the ratio of strainer opening area to that of dome surface area. This value was worked out for the different valves (Table). From the table it is clear that the coefficient of resistance (K) varies inversely with the strainer opening ratio (S/A). In foot valve No.1, the K value varies from 0.49 to 1.1 for the S/A value of 0.98 and in foot valve No.5, it varies from 1.10 to 3.2 for the S/A value of 0.30. In foot valve No.4, K varies from 0.95 to 2.45 for S/A value 0.39 and in foot valve No.3, it varies from 0.74 to 2.33 for S/A value 0.62. From the above results it is clear that the strainer opening ratio plays an important role in the determination of head loss characteristics in foot valves. This is because, the increased strainer opening ratio (S/A) will mean higher strainer opening area (s) for a given strainer surface area (A) and this will facilitate smooth entry of water from sump to the foot valves strainer. The smooth and free entry of water is subjected to loss friction and this leads to lesser coefficient (K). Also the curvilinear path of water particles is altered to straight line path by the larger strainer opening ratio. The straight line path of water particles movement will reduce the frictional resistance. This is in accordance with the elementary rationale that increased opening of the passage should diminish the resistance offered to the flow.

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INFLUENCE OF RHIZOBIAL INOCULATION AND MICRONUTRIENTS APPLICATION ON THE PRODUCTION OF NITROGEN TRANSPORTING COMPOUNDS IN GREENGRAM (*Vigna radiata* L.WILCZEK)

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ABSTRACT

Seed inoculation with rhizobial strains have significantly enhanced the production and accumulation of nitrogen transporting compounds (Ureides)over untreated control in CO 5 greengram. Among the plant parts, maximum ureide production was observed at nodules and was effectively translocated to flowers and pods through root, stem and leaves. Among the strains inoculated better effect was recorded by GG 2 followed by the other two strains. Maximum translocation and accumulation of ureides were recorded in leaves, stem, root and flowers at 45 DAS, whereas in pods it was found to accumulate at 60 DAS. Incorporation of Fe at 0.5 mM and Mo at 0.5 µM enhanced ureide production in the different parts of greengram.

KEY WORDS: Ureides, Allantoin, Rhizobial inoculation, Micronutrients.

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