Since these two varieties are high yielders with other disirable traits like earliness and fertilizer responsiveness, it may be possible to combine resistance with high yield and desirable attributes of the two parents. Hence it will be worthwhile to exploit the hybrid combination TKM 9/IR 50 and its reciprocal to obtain progenies with blast resistance, high yield and other desirable attributes of the above two parents.

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DIMENSIONAL ANALYSIS AN APPROPRIATE METHOD FOR HEAD LOSS DETERMINATION IN FOOT-VALVES

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ABSTRACT

For computing the pressure loss while designing a pump or while selecting a pump, an equation taking into account the area of dome surface, section cross section area, acceleration due to gravity, velocity flow at the foot valve, diameter the suction pipe and strainer opening area was developed.

KEYWORDS : Foot valve, Head loss, Dimensional analysis.

Of the many components of a pump set, foot-valve is an important one. Probably owing to its very nature of being sub-merged under the liquid

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to be pumped and of not being seen to the outside, it has not received its due attention for long. However in the late seventies, many investigators, curiously not the manafacturers, recognised its importance and evinced interest in the development of improved foot valves. In order to develop the improved foot valves, experiments were conducted from October 1984 to December 1985 on different types of foot valves using Dimensional Analysis.

Theoretical Analysis: On the whole, forty sets of experiments were conducted on foot valves with different strainer conditions.

The method of dimensional analysis is employed to arrange the different factors affecting the foot valve pressure loss and also to carry out experiments in a methodical way. The factors identified are the strainer opening area, the strainer surface area, leather opening area, suction pipe cross sectionnal area, viscosity of liquid, roughness factor, weight density of liquid, inclination of the leather flap, velocity of flow, acceleratin due to gravity and diameter of the suction pipe. Checking the dimensions on either side and arranging them in dimensionless form, the pressure loss 'h_f' in the foot valve is obtained as

$$K = f\left(\frac{V}{\sqrt{gd}}, \frac{S}{A}, \frac{O}{a}, \frac{M}{\sqrt{\rho g}^2\, d^{3/2}}, \theta, \frac{\varepsilon}{d}\right) \quad (1)$$

where,

A = area of dome surface (L^2),
a = suction cross section area (L^2),
g = acceleration due to gravity (LT^{-2}),
f = function,
k = coefficient of resistant(-)
V = velocity of flow at the foot valve (LT^{-1}),
d = diameter of the suction pipe (L),
S = strainer opening area (L^2),
O = valve opening area (L^2),
M = dynamic viscosity of pumping fluid ($ML^{-1}T^{-1}$),
O = angle of inclination when the valve is opening upward,
ε = roughness due to projections in the inner side of pipe wall, and
f = weight density of liquid (ML^{-3}).

Though visoosity is a key factor affecting the frictional loss, the effect is merged in the coefficient involved in the dimensionless equation. In as much as it is a constant for the only liquid that has been use namely water, difficulty of estimating the roughness factor 'ε' and the angl of inclination 'O' they could not be considered for analysis. However the ratio of strainer opening area to strainer surface area and the ratio of valve opening area to the suction pipe cross section area could be included in the theoretical equation and their effect quantified. The final non-dimensional equation (1) could be simplified as

$$K = f\left(\frac{V}{\sqrt{gd}}, \frac{S}{A}, \frac{O}{a}\right) \quad (2)$$

This may be also rewritten in the form

$$K = C_2 \left(\frac{V}{\sqrt{gd}}\right)^m \left(\frac{S}{A}\right)^n \left(\frac{O}{a}\right)^P \quad (3)$$

where, C2 = coefficient and
m,n,p = indices

By conducting experiments on different foot valves having various values of (S/A) and (o/a) and observing the pressure loss within them, the coefficient as well as indices can be evaluated from graphs. The resistance coefficient K can be used for prediction purpose. For constant values of o/a, equal to 2.56, 0.99, 0.87 the values of K were plotted against the values of $V/\sqrt{gd}$ for different constant values of S/A. When o/a and S/A are considered with their constant values, equation (3) degenerates as $K = C_o \left(\frac{V}{\sqrt{gd}}\right)^m$. This plots as straight lines on logrithmic sheets. From these figures the values of 'm' computed as the slope of different straight lines taking a full log cycle for $V/\sqrt{gd}$. The intercepts on K axis corresponding to $V/\sqrt{gd}$ equals 1 furnish the values of C_o.

The values of 'm' does not show any systematic variation with respect to either S/A or o/a but they seem to have a constant value of 1.01. However the value of C_o varies with (S/A) varies for any particular value of (o/a). That is, C_o may be of the form

$$C_o = C_1 \left(\frac{S}{A}\right)^n$$

The above equation plots as a stright line in logrithmic sheet for different parametric values of o/a. The slopes of the straight line give the value of 'n' and they are essentially constant having a value of-o.7. The intercept values vary implying that they depend on o/a. In fact C_1 increases with decrease of (o/a). That is, C_1 may be of the form $C_1 = C_2 \,(O/A)^P$. Another graph is plotted connecting c_1 and o/a. The slope of this line is found to be -1.0 with intercept value of 5.3. Estimated values of m,n, C_2 and p are given in Table (1) Feeding back the values of C_2, m, nm, p in equation (3), we get

$$K = 3.5 \left(\frac{V}{\sqrt{gd}}\right)^{-1.01} \left(\frac{S}{A}\right)^{-0.7} \left(\frac{O}{a}\right)^{-1.0} \quad \text{......... (4)}$$

This is the final equation obtained to depict the interrelationship between K, the frictional resistance coefficient on one side, $V/\sqrt{gd}$, the velocity head, S/A the ratio of the strainer opening area to the dome surface area and o/a, the ratio of valve opening area to the suction pipe area. Reynold's num-

Table 1 Estimated values of 'm', 'n', C_2 and P

(O/a)	C_o	(S/A)	m	C_1	n	C_2	P
2.56	1.95	1.0	-0.90				
	2.40	0.63	-0.94				
	3.05	0.43	-1.00				
	3.40	0.40	-1.03	1.85	-0.71	3.5	-1.0
	5.00	0.25	-1.10				
	6.40	0.19	-1.14				
0.99	2.10	1.00	-0.95				
	2.60	0.98	-0.97				
	3.40	0.52	-0.98				
	4.00	0.49	-1.03	2.70	-0.70		
	4.70	0.41	-1.03				
	5.60	0.39	-1.06				
	6.80	0.32	-1.11				
	7.20	0.31	-1.07				
0.87	15.00	0.27	-1.30				
	18.00	0.24	-1.29	6.40	-0.70		

ber apparaently seems to be absent. In a smuch as the Reynold's number also is a function of 'V' for a constant value of μ for water, the only liquid that was experimented with, the Froud number which involved the velocity may be also considered as the substitute. The above equation can be used for estimating the value of 'K' knowing all other variables.

The improved foot valves have the valves of 1.0 to 0.19 for S/A and 2.56 to 0.99 for o/a.

For formulating an empirical equation based on dimensional analysis, the S/A and o/a values were combined to have a systematic permutation and combination.

Finally an equation in the form,

$$K = 3.5 \left(\frac{V}{\sqrt{gd}}\right)^{-1.01} \left(\frac{S}{A}\right)^{-0.7} \left(\frac{O}{a}\right)^{-1.0}$$

has been arrived at. This equation can be advantageously used for computing the pressure loss while designing a pump or while selecting and using a pump.

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CLIMATIC WATER BALANCE AT THE NAGPUR DISTRICT SITUATED IN THE DRY SUBHUMID REGION

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ABSTRACT

Water balance at the Nagpur district was computed from the climatic data. The mean annual precipitation and the potential evapotranspiration values were 124.83 cm and 172.08 cm respectively with the total monthly accumlated water deficit of 97.46 cm being partly met through storage charge and precipitation. Other elements of the water balance viz. water deficit, soil moisture recharge, water surplus etc. were worked out. It was observed that the soil moisture charge (40.45 cm) was useful for the crops during Rabi. Climatic conditions with respect to moisture were favourable during kharif and Rabi seasons but essential during summer irrigations .

KEY WORDS: Water balance, Water deficit, Soil moisture recharge, Dry subhumid region.

An optimum soil moisture is necessary for normal growth of the crop. The knowledge about the gains of water through precipitation and losses of it through run off, percolation and evapotranspiration is essional for determining crop water need, crop-planning, scheduling irrigation and understanding of the ground water movement and is expressed through water balance. Estimation of water balance by actual soil moisture depletion is cumbersome while by lysimeter too costlier and tedius but climatological approach is easy and simple. In the present paper, water budget of the Nagpur district for the first time is investigated.

MATERIALS AND METHODS

Monthly unadjusted values of Potential Evapo Transpiration for Nag-