APPENDIX – II

ERROR ANALYSIS

This appendix gives an estimate of error associated with the experimental data on efficiency (η) and speed ratio (N_r). While carrying out the error analysis, probable uncertainties involved in the measured quantities are taken in to consideration. The method prescribed by Kline and McClintock (1953) has been used to carry out the analysis.

(A) THE METHOD OF ERROR ESTIMATION

The efficiency is calculated using the following equation,

$$\eta = \frac{P_o}{P_{in}}$$

$$P_{in} = \gamma QH$$

$$P_o = \frac{2\pi NT}{60}$$

The speed ratio is calculated using the equation

$$N_r = \frac{N}{60}\frac{1}{\sqrt{2gH}}$$

(i) The uncertainty in η is

$$\left|\frac{\Delta\eta}{\eta}\right| = \left\{\left[\frac{P_o}{P}\right]^2 + \left[\frac{P_{in}}{P}\right]^2\right\}^{\frac{1}{2}}$$

(ii) Uncertainty in P_{out}

$$P_o = \frac{2\pi NT}{60}$$

then

$$\left|\frac{\Delta P_o}{P_o}\right| = \left\{\left|\frac{\Delta N}{N}\right|^2 + \left|\frac{\Delta T}{T}\right|^2\right\}^{\frac{1}{2}}$$

(iii)Uncertainty in P_{in}

$$P_{in} = \gamma QH$$

$$\left|\frac{\Delta P_{in}}{P_{in}}\right| = \left\{\left|\frac{\Delta Q}{Q}\right|^2 + \left|\frac{\Delta H}{H}\right|^2\right\}^{\frac{1}{2}}$$

(iv)Uncertainty in N_r

$$N_r = \frac{N}{60\sqrt{2gH}} = \frac{N}{60\sqrt{2gH}}$$

$$\left|\frac{\Delta N_r}{N_r}\right| = \left\{\left|\frac{\Delta N}{N}\right|^2 + \frac{1}{2}\left|\frac{\Delta H}{H}\right|^2\right\}^{\frac{1}{2}}$$

(B) PROBABLE ERROR IN THE MEASURING INSTRUMENTS USED

Quantity	Instrument	Probable error	Range of parameters encountered
Head (H)	Measuring scale	0.001m	3.0-4.0 m
Discharge (Q)	Magnetic Inductive flow meter	$0.096 \times 10^{-3}\ m^3/s$	20-40 lps
Speed (N)	Inductive type torque transducer	0.01 rpm	75-400 rpm
Torque (T)	Inductive type torque transducer	0.01Nm	4-40Nm
Manometric Head(H_m)	Measuring scale with vernier	0.0001m	0.1 to 0.25 m

(C) Error analysis for η

To calculate the maximum error, the minimum values of the variables were taken.

ie., $H = 3.0$ m $\Delta H = 0.001$ m

$Q = 20 \times 10^{-3} m^3/s$ $\Delta Q = 0.096 \times 10^{-3}\ m^3/s$

N = 75 rpm $\Delta N = 0.01$ rpm

T = 4 Nm $\Delta T = 0.01$ Nm

$$\left|\frac{\Delta P_{in}}{P_{in}}\right| = \left\{\left|\frac{\Delta Q}{Q}\right|^2 + \left|\frac{\Delta H}{H}\right|^2\right\}^{\frac{1}{2}} = \left\{\left|\frac{0.096 \times 10^{-3}}{20x10^{-3}}\right|^2 + \left|\frac{0.001}{3.0}\right|\right\}^{\frac{1}{2}}$$

$$= 4.8116 \times 10^{-3}$$

$$\left|\frac{\Delta P_o}{P_o}\right| = \left\{\left|\frac{\Delta N}{N}\right|^2 + \left|\frac{\Delta T}{T}\right|^2\right\}^{\frac{1}{2}} = \left[\left(\frac{0.01}{75}\right)^2 + \left(\frac{0.01}{4.0}\right)^2\right]^{\frac{1}{2}}$$

$$= 2.833 \times 10^{-3}$$

$$\left|\frac{\Delta \eta}{\eta}\right| = \left\{\left(2.833x10^{-3}\right)^2 + \left(4.8116x10^{-3}\right)^2\right\}^{\frac{1}{2}}$$

$$= 5.584 \times 10^{-3} \approx 0.56\%$$

(D) ERROR ANALYSIS ON N_r

$$\left|\frac{\Delta N_r}{N_r}\right| = \left\{\left(\frac{\Delta N}{N}\right)^2 + \frac{1}{2}\left(\frac{\Delta H}{H}\right)^2\right\}^{\frac{1}{2}} = \left[\left(\frac{0.01}{75}\right)^2 + \frac{1}{2}\left(\frac{0.001}{3.0}\right)\right]^{\frac{1}{2}}$$

$$= 1.354 \times 10^{-3}$$

$$\approx 0.14\%$$

(E) The maximum error

The maximum possible error in the values of efficiency and speed ratio presented in the report are about 0.6 % and 0.15 % respectively.