

Calculating Motor kW Rating

1. Motor Reserve Margin :

1.1 Motor Reserve Margin also needs to be considered for many Unforeseen Condition - for e.g. :

- Seasonal (Suction) Water Level Rise in Monsoon;
- Accidental Starting of Axial Flow Propeller Pump Motor with Delivery Valve Closed &/or it's Partial Closure due to Clogging; etc

1.2 Consider following example : Rated Parameter = 16 m, bkW = 5 kW

1.2.1. During monsoon, when there is huge flow of water; Sump water Level can rise dramatically (say by 9m) & at that time the Head @ the Pump will drop from 16 m to $(16 - 9) = 7\text{m}$; and that will cause Pump to draw 9 kW from motor. So, If we Select Motor Rating Considering **Zero** Reserve Margin throughout the range &/or if there is Low Voltage / Imbalance Voltage at that time; then Motor will get overloaded.

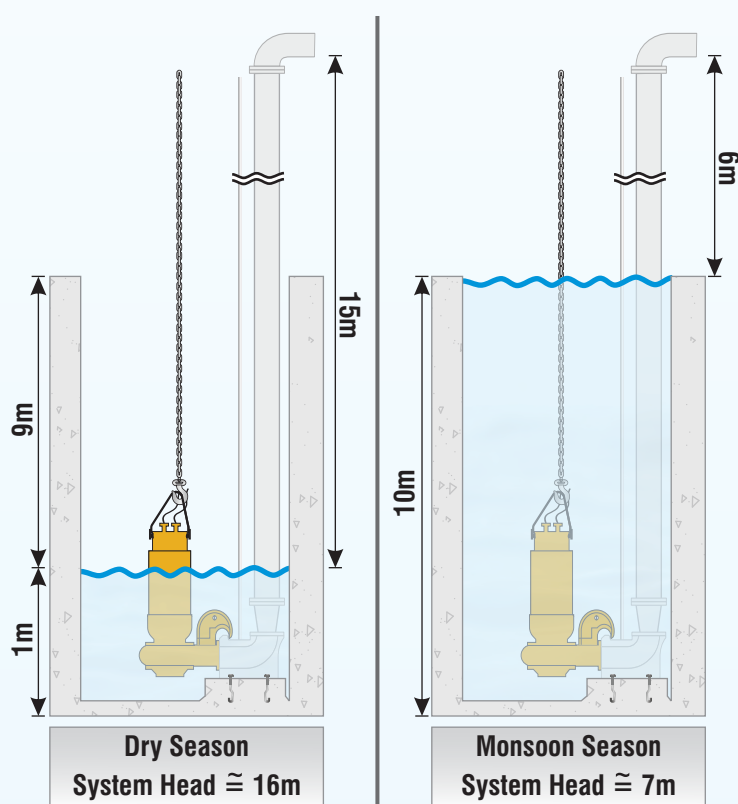
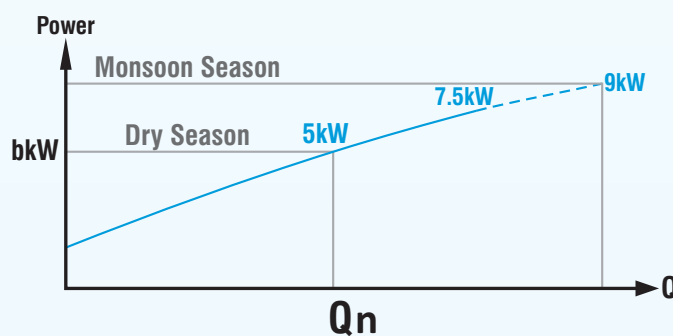
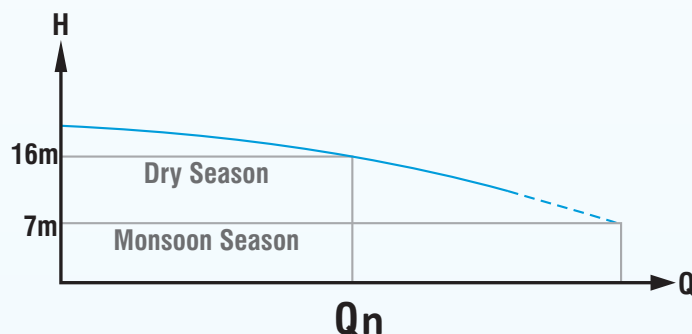


Fig.:A



1.2.2. Even though, motor (Rating = 9kW, i.e. with Zero Reserve Margin) is largely protected at bkW or Duty Point (Dry Season), it has Inadequate Margin @Pmax; i.e. $\sim 7\text{m}$ (Monsoon Season).

1.3. For consistency in Evaluation – It is always recommended to check whether **SIMILAR MOTOR MARGINS** have been considered (*mainly at 2 points*) by all in their offers:

- At the **specified Duty Point**.
- Throughout the Range of the Pump's curve (*i.e. P_{max}*). - To check this, Head x Flow x Power Curve must be considered throughout its natural range without any breaks or curbs, as that may result in **Lower / Partial Pump Power** and hence, **Reduced Motor Rating**.

1.3.1 Please Refer **Example Calculations** for Details :

1.3.1.1 Refer following Example Calculation for Radial Flow & Medium Specific Speed Pumps:

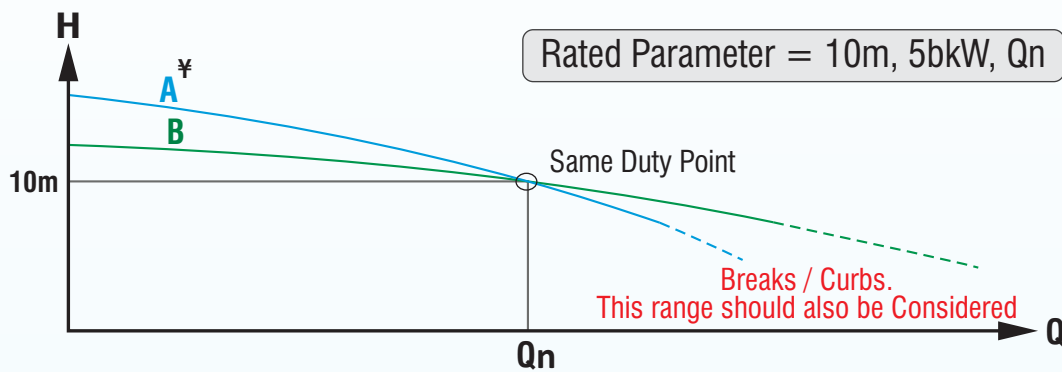


Fig.:D - Q vs H

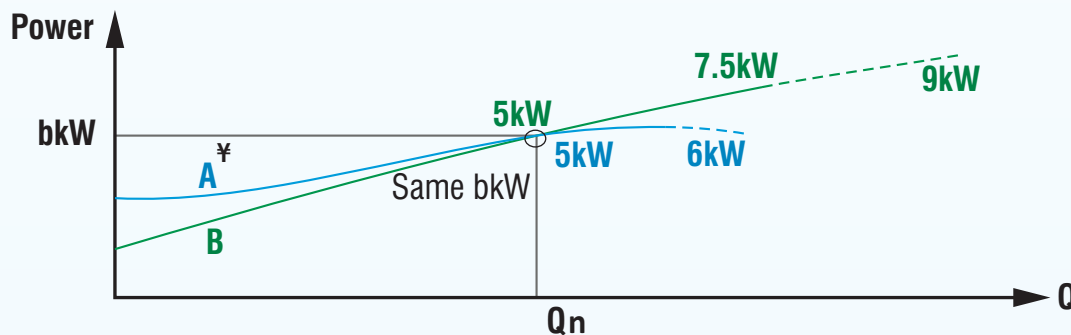


Fig.:E - Q vs Power

1) In the following Scenario; Pump A $\neq$ Pump B; but both Pumps serve the **Same Duty Point & Consume same 5kW as kW if efficiency is same.**

2) $P_{\max}$ of Pump A = 6 kW
 $P_{\max}$ of Pump B = 9 kW } but both Pumps draw Same kW = 5kW @ Duty Point @ Liquid Sp. Gr.

3) Ideal Motor Rating of Pump A
 = 6 kW ($P_{\max}$) $\times$ 1.05 (Reserve Margin) $\geq$ 6.3 kW say 6.7 kW (9 hp)
 Ideal Motor Rating of Pump B
 = 9 kW ($P_{\max}$) $\times$ 1.05 (Reserve Margin) $\geq$ 9.45 kW say 10 kW or 11.2 kW (15 hp)

⚠ Reduced Motor Rating of Pump B based on Partial / reduced P_{max} (due to curb/break)
 = 7.5 kW ($P_{\max}$) $\times$ 1.05 (Reserve Margin) $\geq$ 7.9 kW say 10 kW (12.5hp)

⚠ Thus, Partial H x Q x P Curve[¥] can give Inadequate Motor Rating.

1.3.1.2. Refer following Example Calculation for Axial Flow & High Specific Speed Pumps:

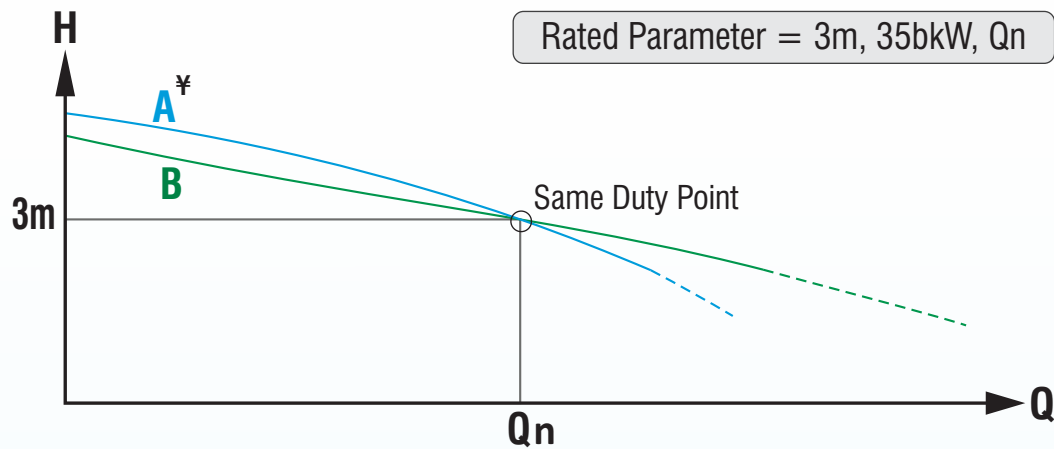


Fig.:F- Q vs H

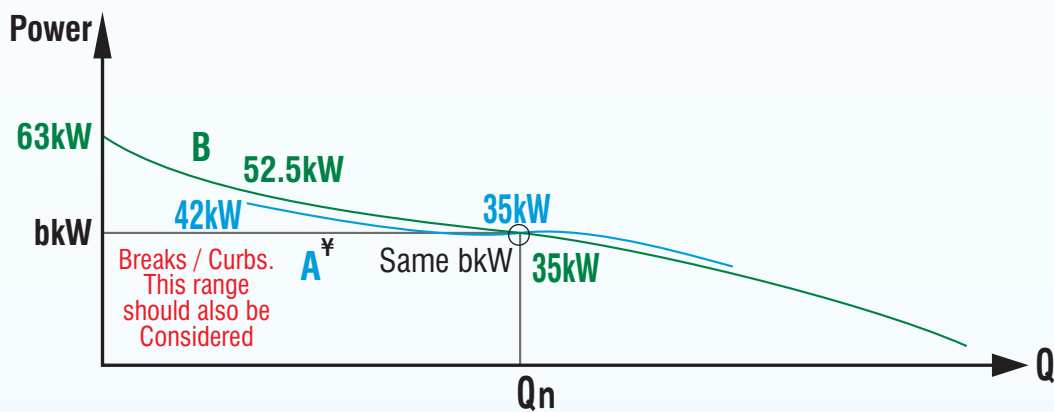


Fig.:G - Q vs Power

Pmax can occur due to Accidental Starting of Axial Flow Propeller Pump Motor with Delivery Valve Closed &/or it's Partial Closure due to Clogging

1) In the following Scenario; Pump A $\neq$ Pump B; but both Pumps serve the **Same Duty Point & draw same 35kW @dp, for Same Efficiency.**

2) P_{max} of Pump A = 42 kW] but both Pumps draw
 P_{max} of Pump B = 63 kW] Same bkW = 35kW @ Duty Point @ Liquid Sp. Gr.

3) Ideal Motor Rating of Pump A

$$= 42 \text{ kW } (P_{max}) \times 1.05 \text{ (Reserve Margin)} \geq 44 \text{ kW say } 45 \text{ kW (60 hp)}$$

Ideal Motor Rating of Pump B

$$= 63 \text{ kW } (P_{max}) \times 1.05 \text{ (Reserve Margin)} \geq 66.1 \text{ kW say } 67 \text{ kW (90 hp)}$$

⚠ **Reduced Motor Rating of Pump B based on Partial / reduced Pmax (due to curb/break)**
 $= 52.5 \text{ kW } (P_{max}) \times 1.05 \text{ (Reserve Margin)} \geq 55.1 \text{ kW say } 55 \text{ kW (75 hp)}$

⚠ Thus, **Partial H x Q x P Curve^{*}** can give **Inadequate Motor Rating.**

Tentative Calculation sheet (Speed & Motor rating of) Submersible Sewage Pumps @

a	b	c	d		e	f	g	h	i	j	k	l	m
Duty Point Flow Rate of Single pump (Q : m ³ /hr)	Typical Pump Delivery Nozzle Outlet Size (mm)	Minimum Vertical Delivery Pipe Size (mm)	Impeller Design	Enclosure Max No of Vanes allowable	Water Power kW $WkW = Q(m^3/hr) \times H(m)/367.2$	$\eta_{P \min}$ Typical Min Pump Efficiency for Cal ⁿ of BkW	Pump Shaft Input at duty Point $bkW = WkW / \eta_{P \min}$	$P_{\max}$ Ratio Typical Max Pump Shaft Input v/s Duty point Input ratio	$P_{\max}$ Ratio Typical Max Pump Shaft Input or Motor Load $P_{\max} = bkW \times P_{\max} \text{ Ratio}$	μ_m Min Motor Reserve Margin over bkW	Calculated min Motor Rating $= bkW \times \mu_m$ or $P_{\max} \times 1.05$ (whichever is higher)	Selected Min Motor Rating higher of j or g round off to the next available size Contractor is to offer this as Minimum Rating irrespective of the Pmax or bkW of his selected Pumpset	Maximum Speed
≤ 25	≤ 50	≤ 65	Vortex / Free Flow / Torque Flow Solids shall not pass from the Impeller Vanes but from Below them to ensure Non Contacting / Non Clogging action	≤ 35		35 %		1.20		25 %		Standard commercially available Motor ratings are :	
$\geq 26 \text{ to } \leq 50$	≤ 80	≤ 80		≤ 50		40 %				20 %			
$\geq 51 \text{ to } \leq 75$	≤ 100	≤ 100	Vortex / Free Flow / Torque Flow Preferred or Semi Open	≤ 65		50 %		1.15		15 %		1.5, 2.2, 3.7, 5.5, 7.5, 9.3, 11, 15, 18.5, 22, 30, 37, 45, 55, 75, 90, 110, 132, 160, 200, 250, 315, 400, 450 kW	
$\geq 76 \text{ to } \leq 150$				≤ 80		60 %				10 %			
$\geq 151 \text{ to } \leq 200$	≤ 100	≤ 150	Semi Open	≤ 100		65 %							
$\geq 201 \text{ to } \leq 300$	≤ 150	≤ 200		≤ 100		70 %							
$\geq 301 \text{ to } \leq 500$	≤ 200	≤ 250	Semi Open or Enclosed 2/3			75 %							
$\geq 501 \text{ to } \leq 1000$	≤ 250	≤ 300											
$\geq 1001 \text{ to } \leq 1200$	≤ 300	≤ 350											
$\geq 1201 \text{ to } \leq 1600$	≤ 350	≤ 400											
$\geq 1601 \text{ to } \leq 2000$	≤ 400	≤ 500											

Caution: This sheet is to facilitate Simple Estimation of kW for Estimation of Electrical System with typical combination of Head x Discharge & it does not consider more exacting details like Specific Speed, Impeller type etc - For exact calculations, please contact nearest Aqua representative.

*The indicated efficiency is purposely kept low for safe motor kW calculations.

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Tentative Calculation sheet (Speed & Motor rating of) Submerged Centrifugal Pumps (for Water Supply) @

a	b	c	d	e	f	g	h	i	j	k	l
Duty Point Flow Rate of Single pump (Q : m ³ /hr)	Typical Pump Delivery Nozzle Outlet Size (mm)	Minimum Vertical Delivery Pipe Size (mm)	Water Power kW $WkW = Q(m^3/hr) \times H(m)/367.2$	$\eta_{p_{min}}^*$ Typical Min Pump Efficiency for Cal ⁿ of BkW	Pump Shaft Input at duty Point $bkW = WkW / \eta_{p_{min}}$	P_{max} Ratio Typical Max Pump Shaft Input v/s Duty point Input ratio Used to calculate typical Maximum Pump Shaft input of pump Throughout the head Range	P_{max} Typical Max Pump Shaft Input or Motor Load $P_{max} = bkW \times P_{max} \text{ Ratio}$	M_m Min Motor Reserve Margin over bkW	Calculated min Motor Rating $M_m \text{ or } P_{max} \times 1.05$ (whichever is higher)	Selected Min Motor Rating higher of j or g round off to the next available size Contractor is to offer this as Minimum Rating irrespective of the Pmax or bkW of his selected Pumpset	Maximum Speed
$\geq 51 \text{ to } \leq 100$	≤ 40	≤ 65		45%		1.40				Standard commercially available Motor ratings are :	Select Speed to achieve Optimal specific speed (efficiency) but strictly restrict the use of 3000 rpm motors upto a maximum motor rating of 175 kW & use 1500/960rpm for larger ratings
$\geq 101 \text{ to } \leq 175$	≤ 65	≤ 100		55%		1.35				1.5, 2.2, 3.7, 5.5, 7.5, 9.3, 11, 15, 18.5,	
$\geq 176 \text{ to } \leq 240$	≤ 80	≤ 125		60%						22, 30, 37,	
$\geq 241 \text{ to } \leq 275$	≤ 100	≤ 150		65%		1.30		15%		45, 55, 75,	
$\geq 276 \text{ to } \leq 400$	≤ 125	≤ 200		70%						90, 110, 132,	
$\geq 401 \text{ to } \leq 650$	≤ 150	≤ 250		75%						160, 200,	
$\geq 700 \text{ to } \leq 1100$	≤ 200	≤ 300		83%						250, 315,	
$\geq 1250 \text{ to } \leq 1500$	≤ 250	≤ 350		85%						400, 450, 500, 550, 600, 700, 800, 1000 kW	

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