Q : *Isn't Lower Speed always Better (for Sewage pumps)....?*

1. A popular *(mis)* perception, especially for Sewage pumping - is that ***"The Lower the Speed - the Better it is...!"***

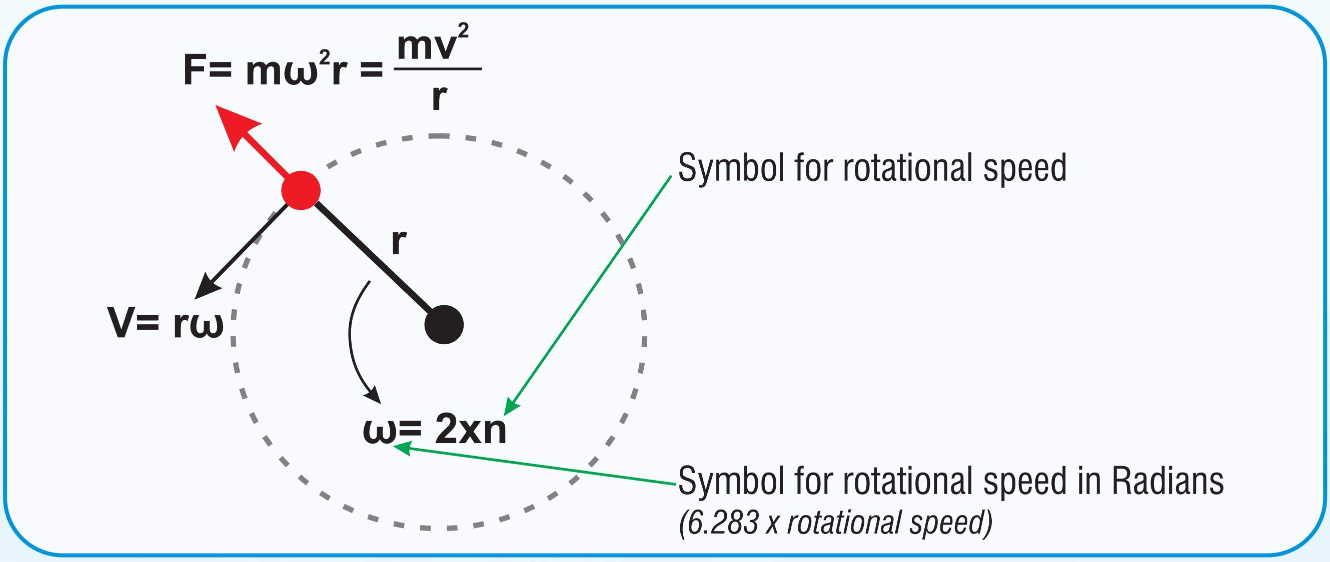
 1.1. While this may be true for some cases - it may also be **Paradoxically False** for a few cases.

 1.1.1. While Lower Speeds may be : **slightly beneficial for Bearings** *(especially if the Pump Manufacturer has used Cheap Bearings or Low Quality Greases)*, **slightly beneficial for Reducing Erosion of Wearing Rings** *(if they are fitted - i.e. for Enclosed Impellers)*.

 1.1.2. **They do not necessarily &** automatically mean **Lower Erosion of the Impeller & Casing.**

2. **Principle of Head Generation:**

 2.1. Any Centrifugal pump, generates Pressure *(or Head)* **by Moving the Liquid Fast** - i.e. **by its High Impeller Tip** *(Outer Diameter)* **Speed** *(Peripheral Velocity)*.



 2.2. Peripheral Velocity is in turn dependent upon **Impeller Diameter x Speed**.

 2.3. **Erosion of :**

 2.3.1. **Impeller** is generally directly Proportional to Peripheral Liquid Velocity - i.e. proportional to Impeller Tip Speed.

 2.3.2. **Pump Casing** is generally directly proportional to the Mean Velocity of Impeller Tip Speed as well as the Volute Discharge Velocity.

 2.4. For Same Head requirement, **a Lower Speed pump would compulsorily require a Larger Diameter of Impeller** to achieve the required Tip Speed *(& hence, the required head)*.

 2.5. Larger Impeller Diameter **leads to Higher Radial Thrusts** onto Impeller & finally onto Shaft & Bearings *(as Radial Thrust is mostly dependent upon the Impeller Diameter)*.

 2.6. Torque required by pump is DIRECTLY proportionate to Power *(bkW)* required and INVERSELY proportionate to the Speed *(RPM)* So, to transmit same Power *(kW)* at a Lower Speed, a Higher Torque has to be transmitted by the Shaft - **hence selecting a Lower speed may also lead to Higher Shear Stress & Premature Shaft Failures**.

3. **The Optimal Choice** of the Pump Speed is best determined by its **Specific Speed** *(Ns)*:

   3.1. Pump Specific Speed ***(Ns)*** is a dimensionless / normalized Index used to describe the hydraulic shape and operating character of a Pump Impeller. In simple terms, it tells you whether a Pump's **Internal Flow Geometry** is fundamentally a Radial-flow, Francis-flow, Mixed-flow or Axial-flow.

   The commonly used USCS expression is : $N_s = \frac{N\sqrt{Q}}{H^{3/4}}$

   Where:

   N = Pump Speed *(rpm)*.

   Q = Discharge *(US gpm)*.

   H = Head *(ft)*.

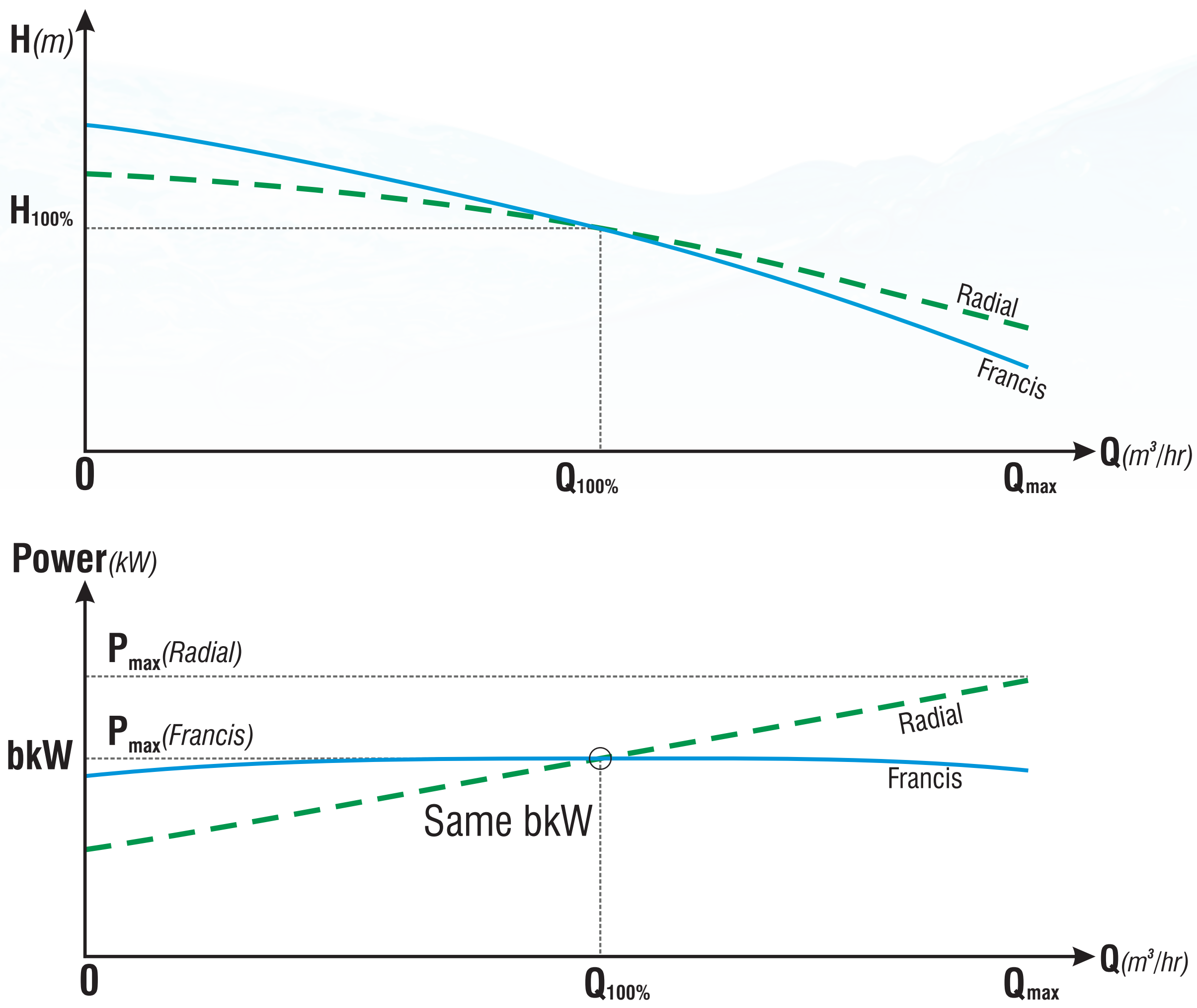
   Ns = Specific Speed.

   3.2. **Ideally**, Specific Speed should be between **2000 to 4500 USCS** *(or in case of Large Flows - up to 6000 or even 7500 for Very Large Flows)*.

4. A Lower Pump Speed will **also result into a Lower Specific Speed**, which in turn will:

   4.1. Generally have **Lower Efficiency**,

   4.2. A **Power Curve Rising Dramatically** towards Full Open Valve / Lower Head conditions - this can lead to Motor Overloading during Monsoons / whenever the Head is lower.



4.3. **Narrow Impeller Internal Passages** making it difficult to Pass Large Solids,

4.4. General *(mis)* perception is that Lower Speed leads to:

a. Larger Impeller Diameter,

b. Bigger Solid Handling Ability &

c. Bigger Pump Nozzle Size.

4.4.1. While Perception **a**. i.e. Impeller Diameter will surely become Larger; *(mis)* perceptions **b.** & **c**. **MAY only be True IF,** the Pump Manufacturer is offering a *(Higher Speed x Larger Output x Larger Sized)* Pump at a Lower Speed to achieve the Low Required Output.

4.4.2. General *(mis)* perception is that slower RPM leads to bigger pump both in terms of Nozzle size and Impeller Opening *(Gap between shrouds)*, hence large solids can pass.

4.4.2.1. But at slower RPM, the Impeller Dia increases larger in proportion than shroud opening *(**Law of similitude**)*.

4.4.2.2. This increased Dia leads to narrow internal passage. And hence difficulty in passing large solids.

4.4.3. Hence contrary to the *(mis)* perception, Lower Speeds can Reduce Solid Passages; especially in Med/High Head pumps.

5. For **Sewage**, it is always **desirable to have a Medium to High** *(& Never a Low to Medium)* Velocity i.e. **Self Flushing Velocities**.

5.1. Hence use of Large Sized Pumps running at Non Optimally Low Speeds are not an Optimal choice.

5.2. While sometimes, due to lack of Adequate Hydraulic Designs; some Pump Manufacturers may offer a *(High Speed x High Output x Larger Sized)* Pump AT Lower Speed to achieve Lower Output & the Purchase Speed Demanded - this will also mean Lower Internal *(within the Pump)* & External *(in Piping)* Flushing Velocities, which can lead to Long Term Settlement/ Sedimentation Build up in the Pump & Piping.

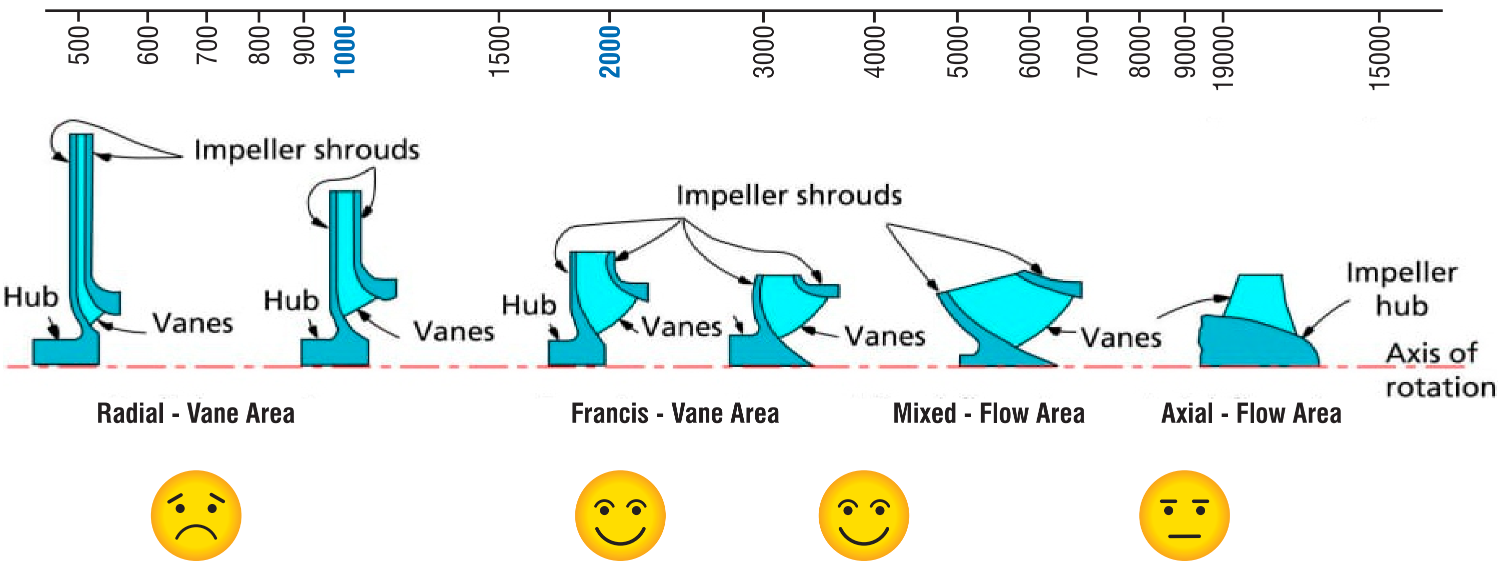
6. **Impact of Speed on Ideal design of a Non Clog Sewage Impeller :**

6.1. Ideally, Each & Every Duty Point *(Head x Discharge)* should have a Dedicated Design with the Duty Point being the same as Best Efficiency Design Point.

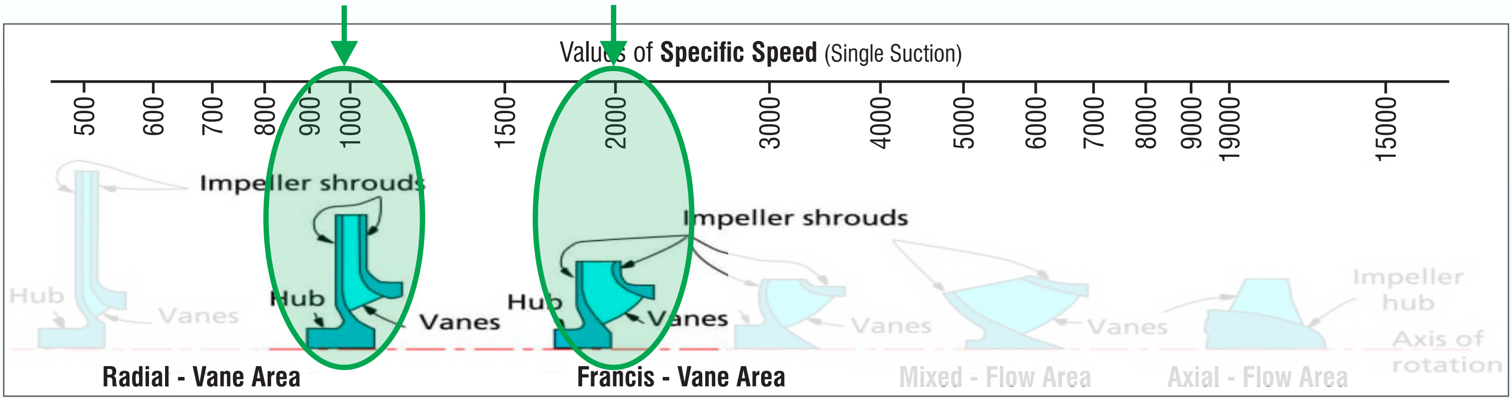
6.2. Pump Design starts with **Calculation of Specific Speed** which varies linearly as the Pump Speed.

6.3. Ideally, Specific Speed should be between 2000 to 4500 USCS *(or in case of Large Flows - up to 6000 or even 7500 for Very Large Flows)* for Optimal Efficiency & Head Discharge Power Characteristics.

Values of **Specific Speed** (Single Suction)

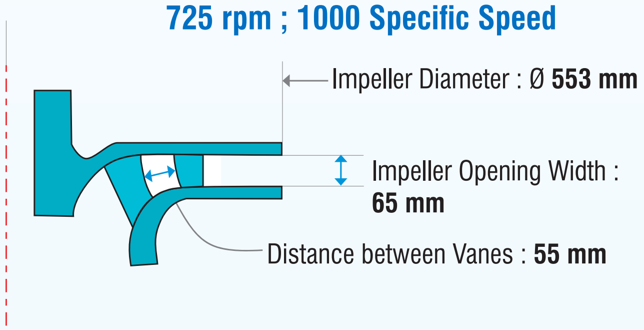


Example : Impact of Speed on Design of a Non Clog Sewage Impeller			
Basis for Selection of Speed	**Units**	**"Low" Speed**	**Optimal Speed**
Head	*m*	20	20
Discharge	*m^3/hr*	230	230
Speed	*rpm*	**725**	**1450**
Resulting Specific Speed	-	**1000**	**2000**
Head Coeff	-	**0.9**	**0.9**
Impeller Diameter	*mm*	**Ø 553**	**Ø 277**
Impeller Opening Width	*mm*	**65**	**80**
Number of Impeller Vanes	*Nos.*	**2**	**2**
Minimum Distance between Two Adjacent Vanes	*mm*	**55**	**80**
Solid Handling Ability	*mm*	55 x 65	80 x 80
Optimal Pump Efficiency *as per Hydraulic Institute Standards* for Non Clog Hydraulics *(as per HI 11.6)*	%	**69.6**	**72.0**
Radial Thrust Generated onto Impeller, Shaft & Bearings	-	High	Low
bhp *(considering 1.05 Sp Gr of Sewage)*	*bhp*	**25.12**	**24.27**
Maximum Power Throughout the UnThrottled HxQ Curve *(Considering 1.05 Sp Gr. of Sewage)*	*hp*	**29.64**	**26.21**
Minimum Motor Rating *(considering Min Motor Reserve Margin of 5% @ Pmax)*	*hp*	31.12	27.52
Minimum Motor Rating *(considering Min Motor Reserve Margin of 15% @ bkW)*	*hp*	28.89	27.91
Minimum **Motor Required**	*hp*	**35**	**30**



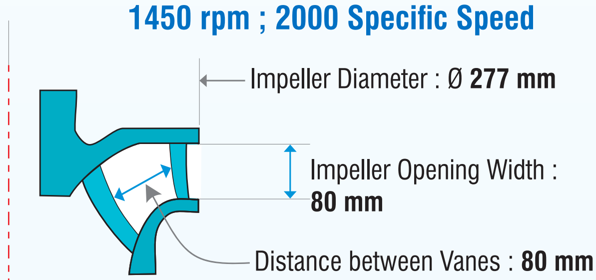
"Low" Speed

725 rpm ; 1000 Specific Speed

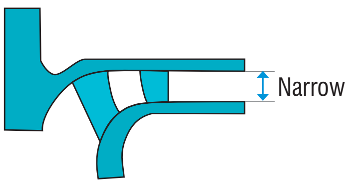
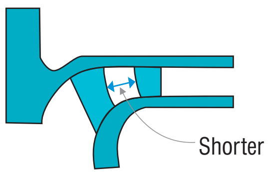
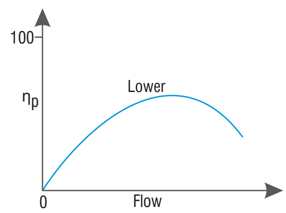
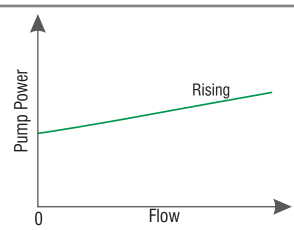
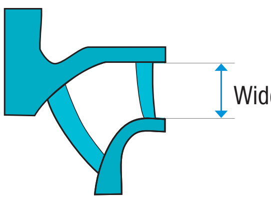
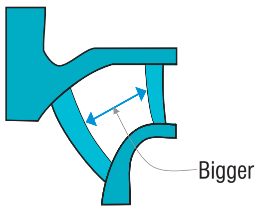
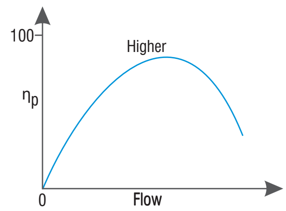
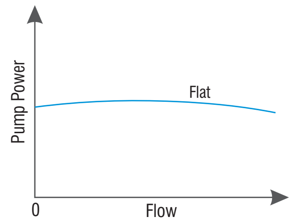


Optimal Speed

1450 rpm ; 2000 Specific Speed



Constructional Aspects

Impeller	Openings	Passages	Efficiency	Power Curve
Radial				
Francis				

Conclusion:

- There is No Rule of Thumb that "Lower the Speed - Better the Reliability".
- It is best to leave the Speed selection based on Optimizing Specific Speed, Solid Passage, Location of Duty Point v/s Best Efficiency Point, etc.
- In case of any clarifications, Aqua *(or any Ethical & Experienced Pump Manufacturer)* can help further.

"Contact Aqua for Further Consultation"

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