

# SUBMERSIBLE MULTISTAGE PUMP – 25 HP (21 kW), 120 m HEAD

## FULL TECHNICAL DESIGN :

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### OUR Requirements:

- **Total Head:** 120 m
  - **Motor Power:** 25 HP (21 kW)
  - **Maximum Flow at 120 m:** 65-70 m<sup>3</sup>/h
  - **Fluid:** Water + Mild Copper Mine Slurry
  - **Pump Type:** Submersible, Vertical, 6-Stage, Radial-Flow
  - **Diffuser:** High-Efficiency Vaned Diffuser
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### POWER & HYDRAULIC BALANCE

Hydraulic power available:

$$[P_h = 0.75 \times 21 = 15.75 \text{ kW}]$$

$$\begin{aligned} [Q_{max} &= 15.75 / 1000 \times 9.81 \times 120] \\ &= 0.0133778 \text{~m}^3/\text{s} = 48.16 \text{~m}^3/\text{h}] \end{aligned}$$

This is the **absolute max flow** while maintaining 120 m head with a 21 kW motor.

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### HYDRAULIC DESIGN

#### 1.1 Number of Stages

$$[H(\text{stage}) = 120 / 6 = 20 \text{ m}]$$

**6 stages REQUIRED**

Each designed for **20 m per stage**

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#### 1.2 Impeller Geometry (Per Stage)

| Parameter | Value                     |
|-----------|---------------------------|
| Type:     | <b>Closed,radial flow</b> |
| Material  | SS316L                    |

| Parameter                       | Value                   |
|---------------------------------|-------------------------|
| D <sub>2</sub> (Outer Diameter) | 125 mm                  |
| D <sub>1</sub> (Eye Diameter)   | 38 mm                   |
| b <sub>2</sub> (Outlet Width)   | 8–10 mm                 |
| β <sub>2</sub> (Outlet Angle)   | 24°                     |
| β <sub>1</sub> (Inlet Angle)    | 60°                     |
| Vanes                           | 5                       |
| Tip Clearance                   | 0.20 ± 0.05 mm          |
| Wear Ring Clearance             | 0.16 ± 0.05 mm          |
| Surface Finish                  | R <sub>a</sub> ≤ 0.8 μm |

#### Why this impeller is efficient:

- Backward curved vanes → lower losses
  - Closed design → minimal leakage
  - Tight clearances → high volumetric efficiency
  - SS316L + HVOF → erosion-resistance
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#### Vaned Diffuser Design ( per stage )

| Parameter       | Value                         |
|-----------------|-------------------------------|
| Type:           | Vaned radial diffuser         |
| Expansion Ratio | 1.12–1.18                     |
| Vane Thickness  | 3–4 mm (tip), 10–12 mm (root) |
| Material        | SS316L + HVOF                 |

#### efficiency:

- Eliminates radial thrust

- Superior pressure recovery
  - More efficient than volute by **+4–6%**
  - Stable hydraulic performance at BEP
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## MECHANICAL DESIGN

### a) Shaft Design

| Parameter      | Value                     |
|----------------|---------------------------|
| Material       | EN19 nitrided             |
| Diameter       | 40 mm                     |
| Runout         | <0.03 mm                  |
| Torque         | 278 N·m                   |
| Safety Factor  | ≥2.0                      |
| Critical Speed | $>2.5 \times 1500$<br>rpm |

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## Bearings

- **Top Bearing:** Angular Contact Thrust
  - **Bottom Bearing:** Water-lubricated Radial
  - Expected lifetime: **16,000+ hours**
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## Axial Thrust Management

### Balance Drum

- Gap:  $0.15 \pm 0.05$  mm
  - Residual thrust <3%
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## SEALING SYSTEM

### Double FACES Seal (Oil-Pressurized)

- GFPTFE ( glass filled oil mechanism)

- Oil Chamber Pressure: **+0.5 to +1 bar**

Benefits:

- Protects motor
  - Lowers drag
  - Longer seal life
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## MOTOR

- **Power:** 25 HP (21 kW)
- **Speed:** 1500 rpm
- **Cooling:** Water jacket
- **Cable:** Armoured submersible (<3% voltage drop)

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## MATERIALS

| Component  | Material      | Treatment               |
|------------|---------------|-------------------------|
| Impeller   | SS316L        | HVOF WC-Co              |
| Diffuser   | SS316L        | HVOF                    |
| Wear Rings | SS316L + WC   | Precision lapped        |
| Shaft      | EN19 nitrided | Anti-corrosion          |
| Casing     | SS316L        | Electropolished         |
| Seals      | GFPTFE        | Pressurized oil barrier |

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## TOLERANCES

| Feature   | Tolerance             |
|-----------|-----------------------|
| Wear Ring | $0.16 \pm 0.05$<br>mm |

| Feature          | Tolerance      |
|------------------|----------------|
| Tip Clearance    | 0.20 ± 0.05 mm |
| Balance Drum Gap | 0.15 ± 0.05 mm |
| Surface Finish   | Ra ≤ 0.8 µm    |

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## FULL TECHNICAL DATA SHEET

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| Parameter        | Optimized Design Specification        | Notes  |
|------------------|---------------------------------------|--|
| PUMP TYPE        | 6" Submersible Multistage (Vertical)  | Optimized for DN150 boreholes.                   |
| RATED DUTY POINT | Flow : 48 m³/h<br>Head : 100 m        | Best Efficiency Point (BEP).                     |
| OPERATING RANGE  | Flow: 65 -80 m³/h<br>Head: 140 – 60 m | Wide range enabled by VFD.                       |
| SPEED            | 2900 RPM (Variable 30–55 Hz)          | Corrected from 1500 RPM for hydraulic viability. |
| HYDRAULIC POWER  | 13.1 kW                               | Power actually transferred to water.             |
| SHAFT POWER      | 17.0 kW                               | Requires 18.5 kW motor (92% load factor).        |
| STAGES           | 6 Stages                              | ~16.7m Head per stage.                           |

| Parameter          | Optimized Design Specification | Notes   |
|--------------------|--------------------------------|---|
| IMPELLER DIAMETER  | 128 mm (Trimmed)               | Precision trimmed to 100m duty point.           |
| IMPELLER TYPE      | CLOSED RADIAL                  | High flow capability with good solids handling. |
| EFFICIENCY (HYD)   | 77.5%                          | Enhanced via polishing & gap control.           |
| EFFICIENCY (MOTOR) | 93.5% (IE5 Equivalent)         | Permanent Magnet Synchronous Motor.             |

## • SOLAR PLANT DETAILS (21 kW)

### 3.1 PV Array & Components

| Component       | Specification            | Purpose   |
|-----------------|--------------------------|---|
| PV Array        | 21 kW Mono PERC Half-cut | High efficiency, low temp loss                      |
| Solar Modules   | 550 wp Mono PERC         | Reduced BOS cost                                    |
| Inverter        | 25 kw hybrid inverter    | Solar + grid/diesel support                         |
| Structure       | HDG 90 micron            | To mount the solar panel for high energy efficiency |
| Wiring          | XLPE/DC UV-rated         | Lower losses  |
| Combiner Box    | SPD + DC MCB             | Protection  |
| Derating Factor | 0.85                     | Realistic performance                               |

### 3.2 Solar Efficiency Enhancements

| Feature                                  | Explanation                 | Efficiency / Cost Savings |
|--|-----------------------------|---------------------------|
| AI-based MPPT tuning                     | Tracks panel voltage slope  | +18-30%                   |
| Dust-reduction electrostatic layer       | Reduces manual cleaning     | +10-20%                   |
| Twin-Axis Micro Solar Tracker (Optional) | LDR + MPPT-based            | +30-40%                   |
| DC-DC Boost Optimizer                    | Works under partial shading | +3–5%                     |

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## SECTION 4 — HYBRID BACKUP (GRID/DIESEL)

### 4.1 Backup Source Comparison

| Category      | Grid Backup                | Diesel Backup            |
|---------------|----------------------------|--------------------------|
| Capex         | Low                        | Medium                   |
| Availability  | Good in MP                 | Very high                |
| Reliability   | Medium                     | Very high                |
| Best Use Case | Continuous low-cost top-up | Cloudy day heavy pumping |