

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

FULL TECHNICAL DESIGN :

OUR Requirements:

- **Total Head:** 120 m
 - **Motor Power:** 25 HP (21 kW)
 - **Maximum Flow at 120 m:** 65-70 m³/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:

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

$$[Q_{\max} = 15.75 / 1000 \times 9.81 \times 120] \\ = 0.0133778 \sim \text{m}^3/\text{s} = 48.16 \sim \text{m}^3/\text{h}]$$

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

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**

1.2 Impeller Geometry (Per Stage)

Parameter	Value
Type:	Closed, radial flow
Material	SS316L

Parameter	Value
D ₂ (Outer Diameter)	125 mm
D ₁ (Eye Diameter)	38 mm
b ₂ (Outlet Width)	8–10 mm
β ₂ (Outlet Angle)	24°
β ₁ (Inlet Angle)	60°
Vanes	5
Tip Clearance	0.20 ± 0.05 mm
Wear Ring Clearance	0.16 ± 0.05 mm
Surface Finish	Ra ≤ 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

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× 1500 rpm

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 ± 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

TOLERANCES

Feature	Tolerance
Wear Ring	0.16 ± 0.05 mm

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

FULL TECHNICAL DATA SHEET

Parameter	Optimized Design Specification	Notes
PUMP TYPE	6" Submersible Multistage (Vertical)	Optimized for DN150 boreholes.
RATED DUTY POINT	Flow : 48 m³/h Head : 100 m	Best Efficiency Point (BEP).
OPERATING RANGE	Flow: 65 -80 m³/h 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	COLSED 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%

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