ThermalDrive™ TECHNOLOGY-

Direct Use of Geothermal Energy in Oil & Gas Fields

GEOTEK ENERGY

Presented by
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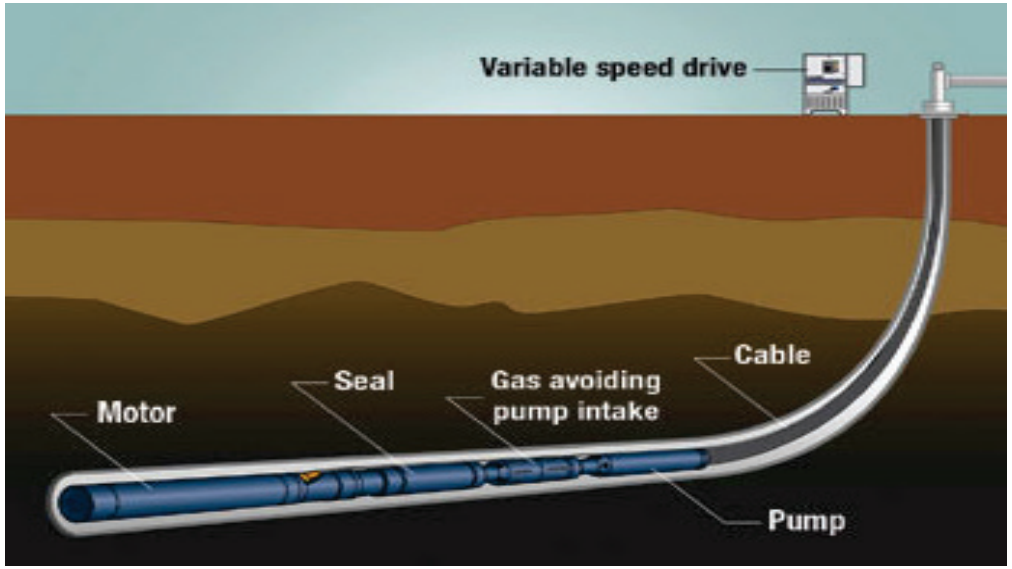
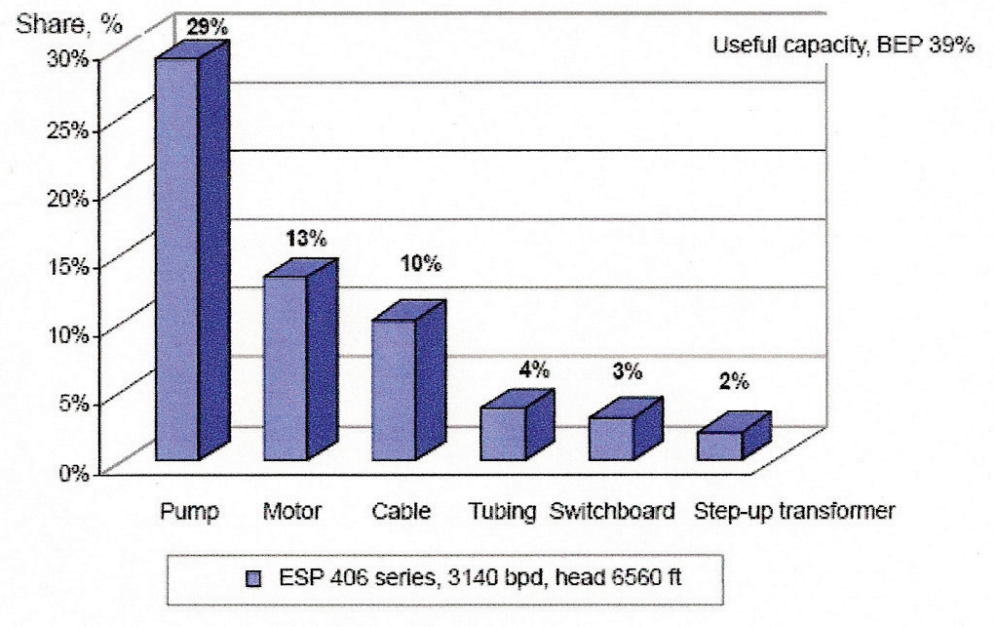
ANATOMY OF AN ELECTRICAL SUBMERSIBLE PUMP (ESP)

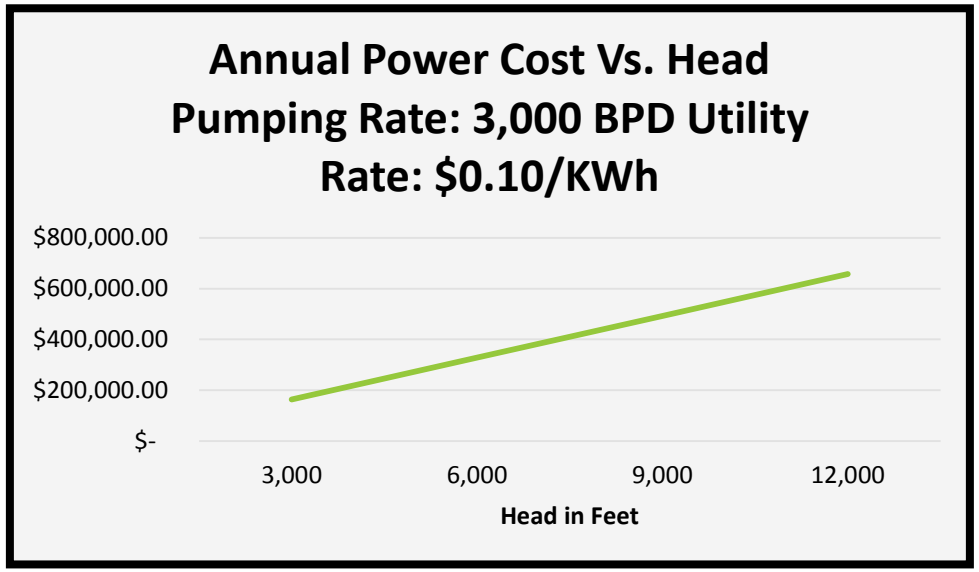
- ESPs pump almost 60% of global oil production annually
- However they have a system efficiency of only 35% to 60%

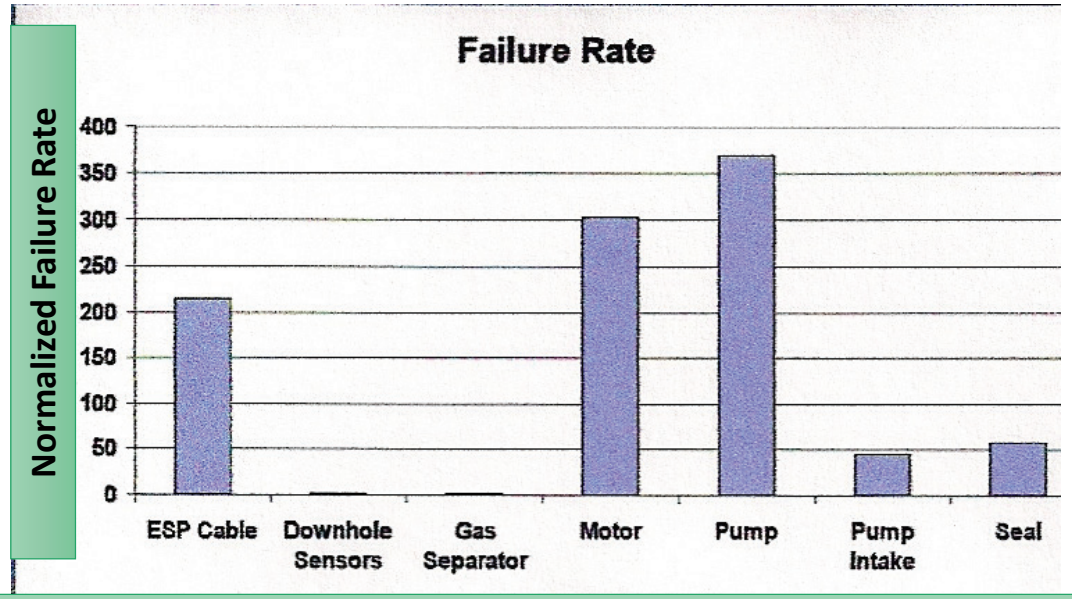




ELECTRICAL COMPONENTS CONTRIBUTE 46% OF ESP LOSSES

ANATOMY OF AN ESP Continued





- $400,000 annual power cost at 3,000 BPD & 7,500 ft. head ($0.10/kwh)
- Short average service cycle of 1.5 to 2.5 years
- Limited capability in high temperature environments

* DOWNHOLE ELECTRICAL COMPONENTS ARE HIGHEST CONTRIBUTOR TO ESP SYSTEM FAILURES

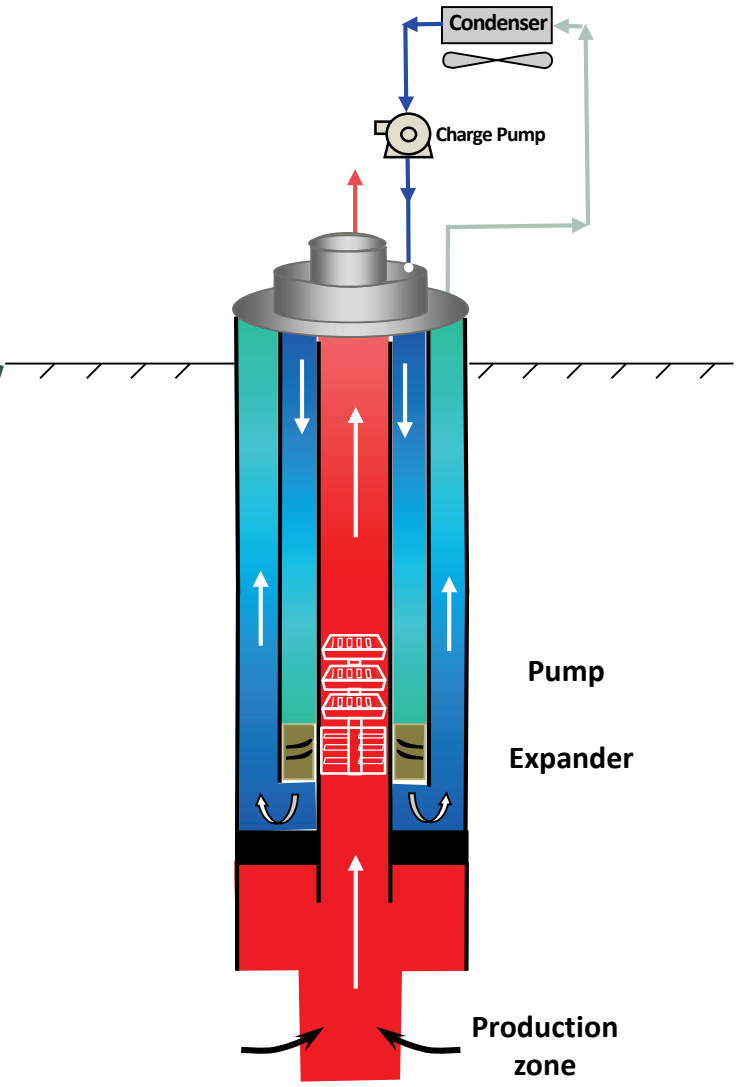
* Source: 2008 RIFTS Database

ThermalDrive™ - a Downhole Thermal Motor to Drive a Submersible Pump

- Originally developed for geothermal power market
- Eliminates high failure rate down-hole electric motor, cable and seal
- Eliminates costly medium voltage VFD and switchgear
- Offers dramatic reduction in power consumption
- Thrives in high temperature environment

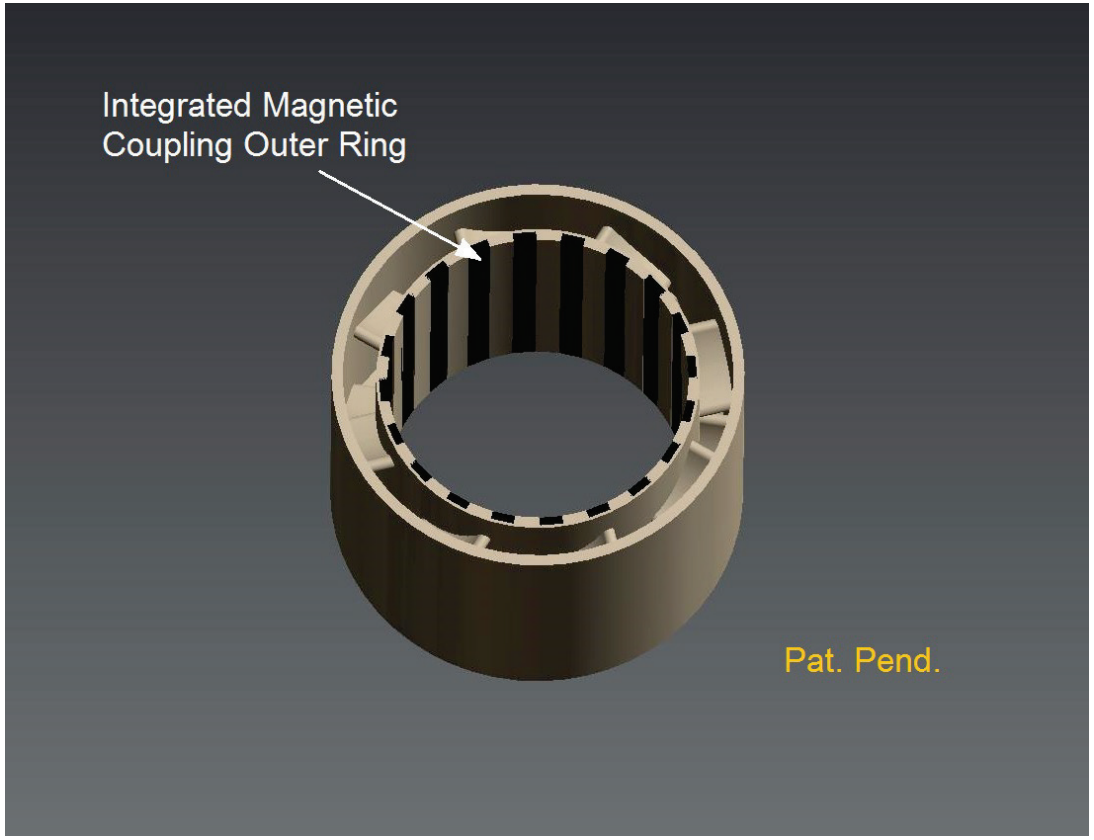
ThermalDrive

- Turbo-expander driven by supercritical working fluid
- Working fluid builds high pressure and temperature by
  - Gravity head from tall liquid column
  - Heat transfer from produced fluid
- Thermo-syphon loop driven by
  - High pressure vapor rising through the well annulus
  - Vapor being condensed at the surface creating a pressure drop
- Pump shaft is magnetically coupled to turbo-expander for
  - Separation of production and working fluids
  - Allowing wireline retrieval of the pump

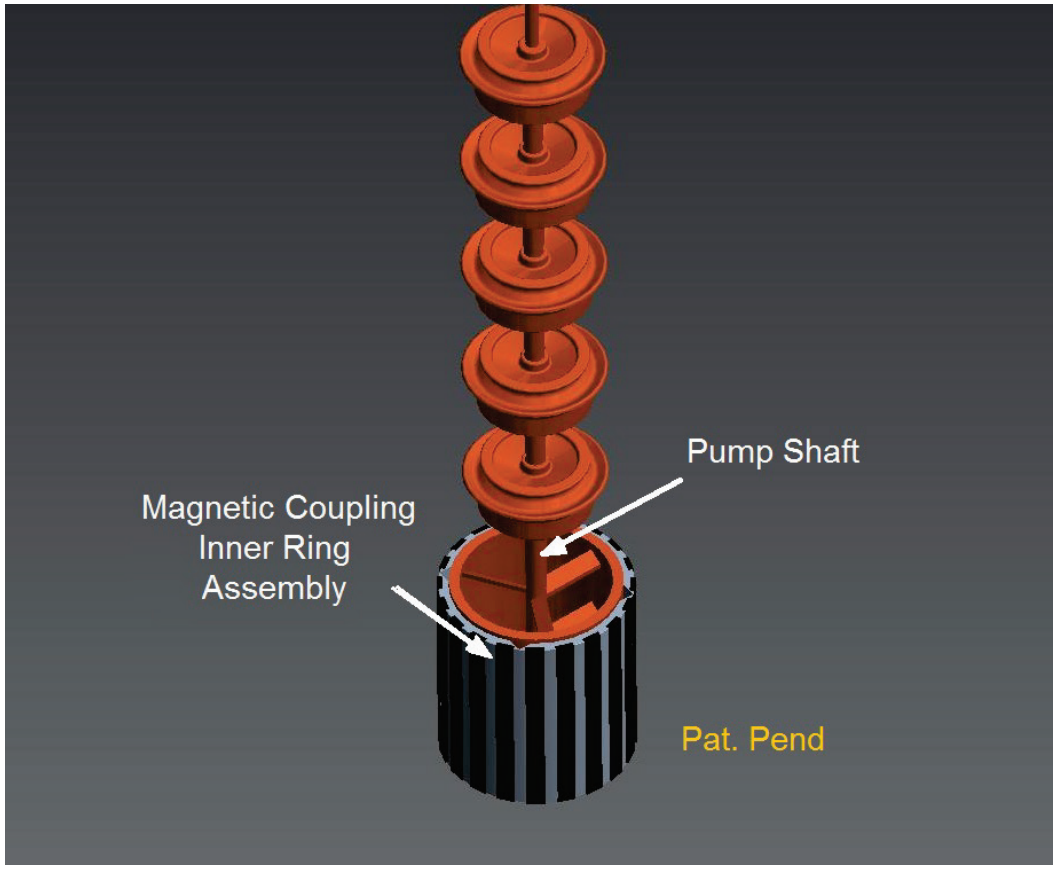


ThermalDrive

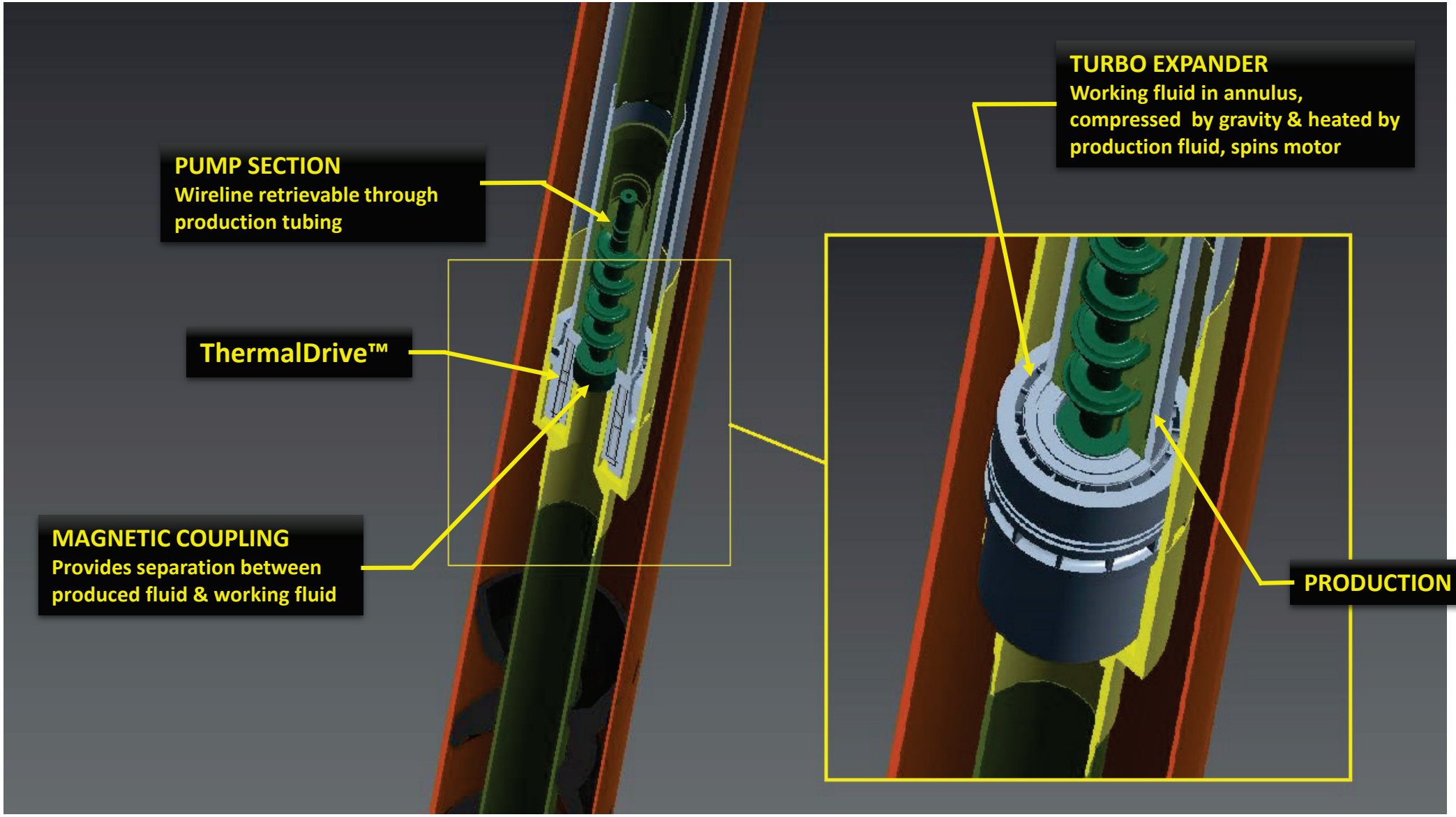
Turbo Expander Rotor



Pump Shaft with Coupling

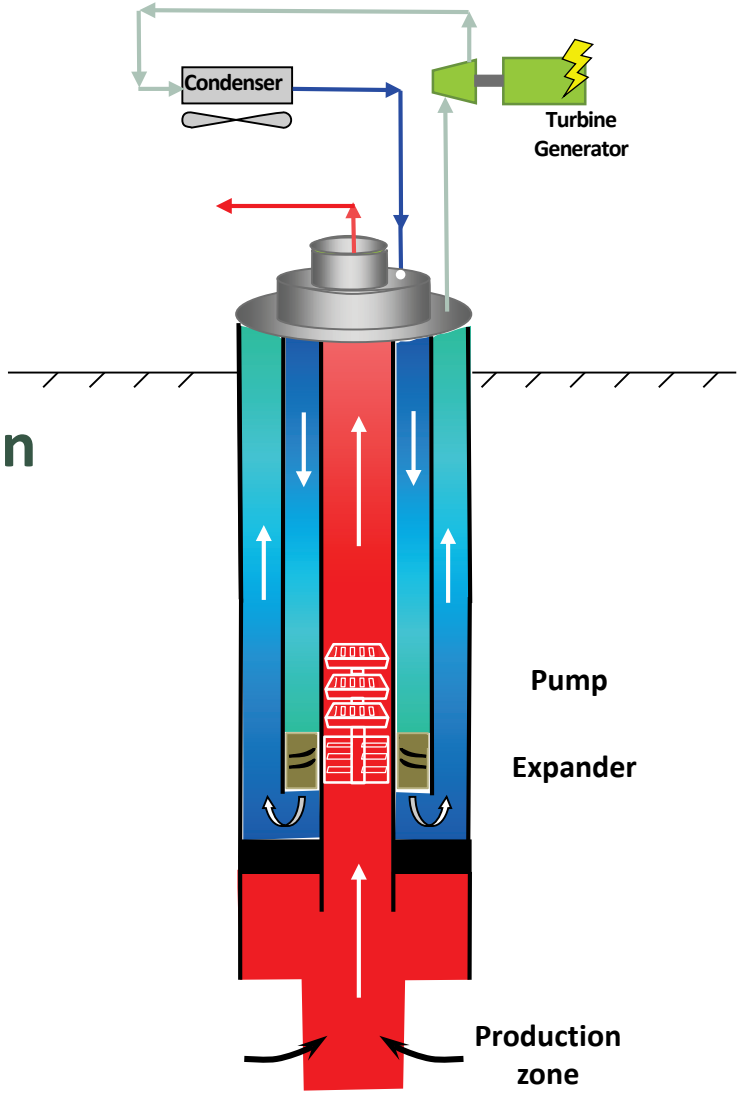


ThermalDrive



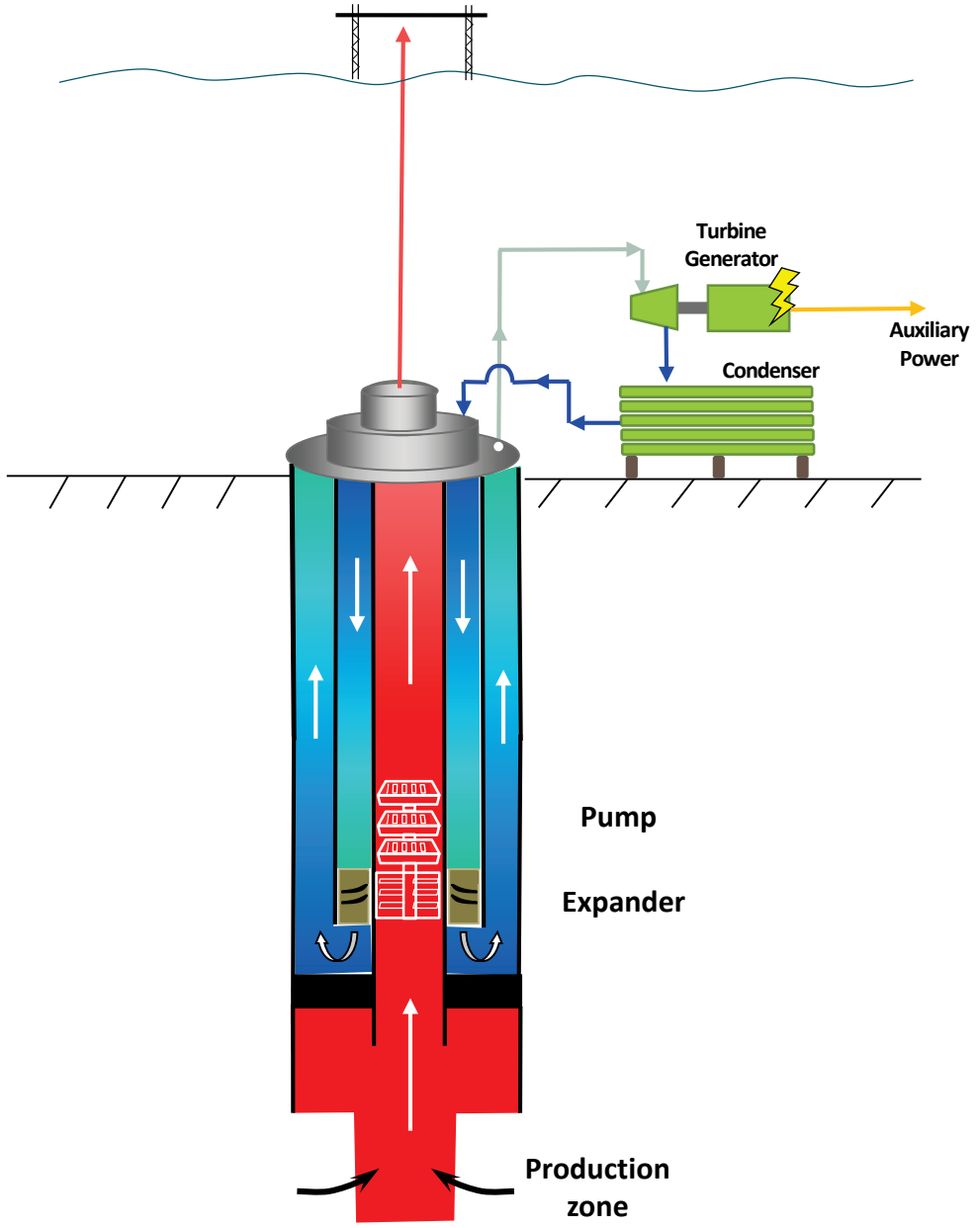
ThermalDrive Plus

- Power generation becomes an option when produced fluid has sufficient heat.
- High energy working fluid vapor exits wellhead and runs a turbine generator
- Provides auxiliary oilfield power or renewable energy to the grid



ThermalDrive Offshore

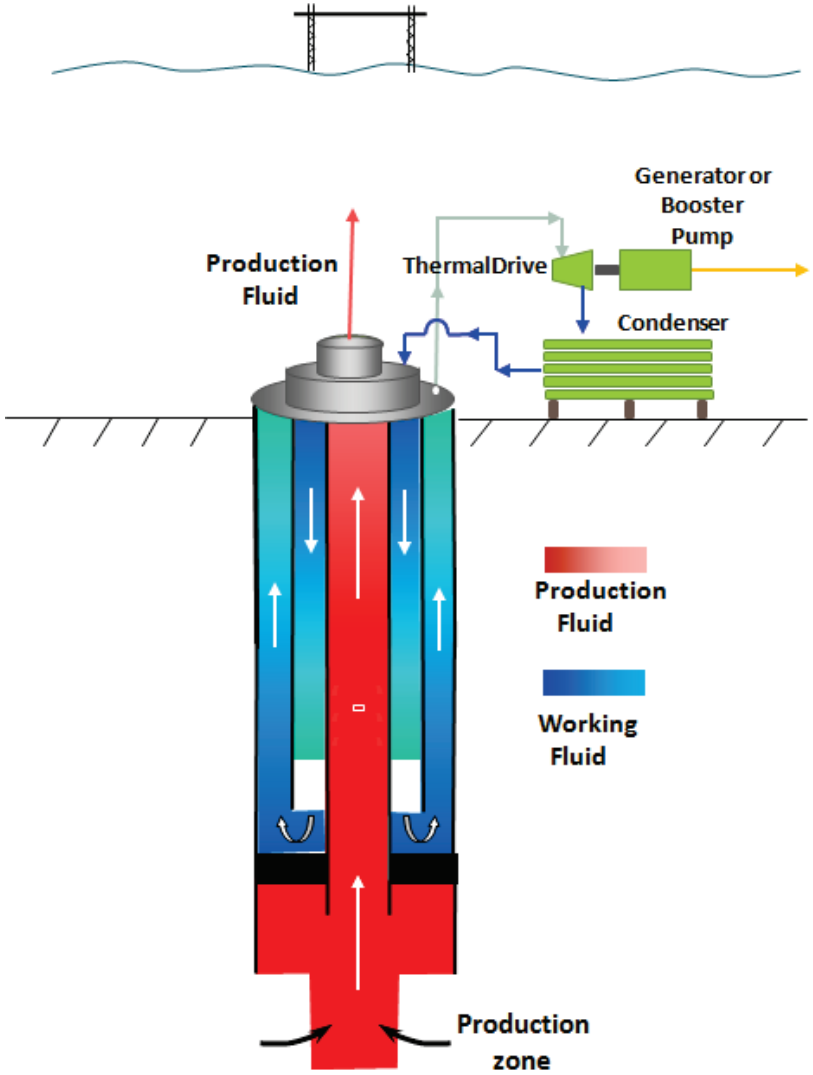
- Offshore co-production of power
- Consistent sea-floor temperature provides optimal thermal cycle potential for power generation (ΔT)
- Substantially reduces cost of offshore power consumption



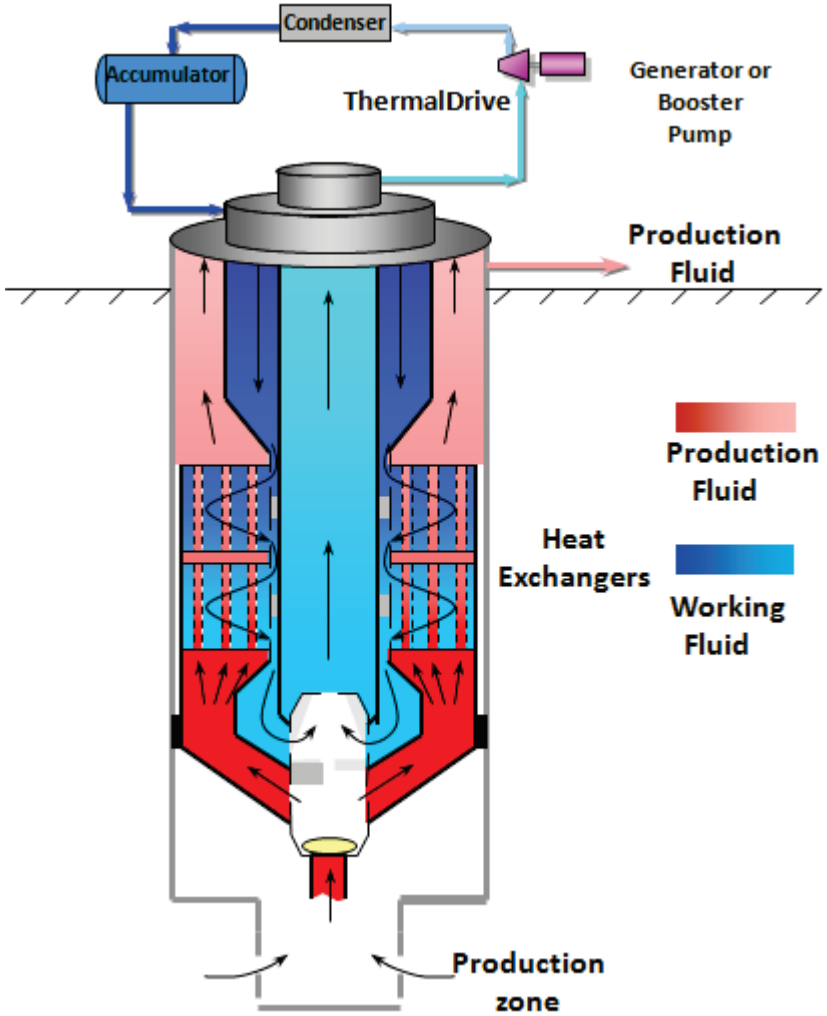
ThermalDrive
SEABED PUMPING/POWER GENERATION (1 of 2)

- For free flowing or gas lift production wells
- Extracting thermal heat from subsea wellbore to drive seabed pumping or power generation
- Consistent sea-floor temperature provides optimal thermal cycle potential (ΔT)

PATENTED PIPE WITHIN A PIPE WELLBORE HEAT EXCHANGER TECHNOLOGY



ThermalDrive
SEABED PUMPING/POWER GENERATION (2 of 2)



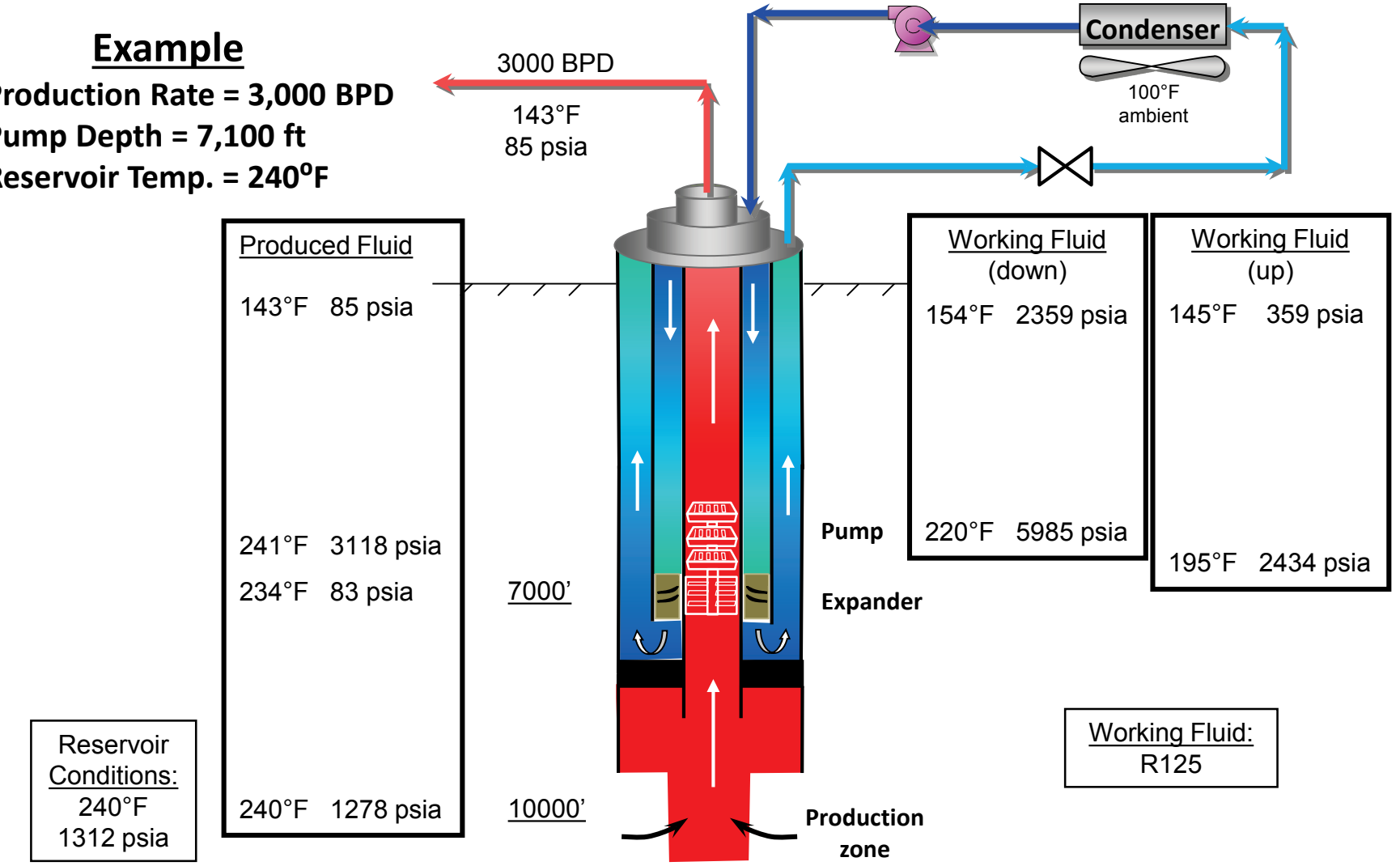
PATENTED WELLBORE MULTI-TUBE HEAT EXCHANGER TECHNOLOGY

- High efficiency heat exchanger for medium to high power applications
- Requires larger diameter wellbore vs. pipe in pipe heat exchanger

THYMO™ (Thermal Hydraulic Model)

Example

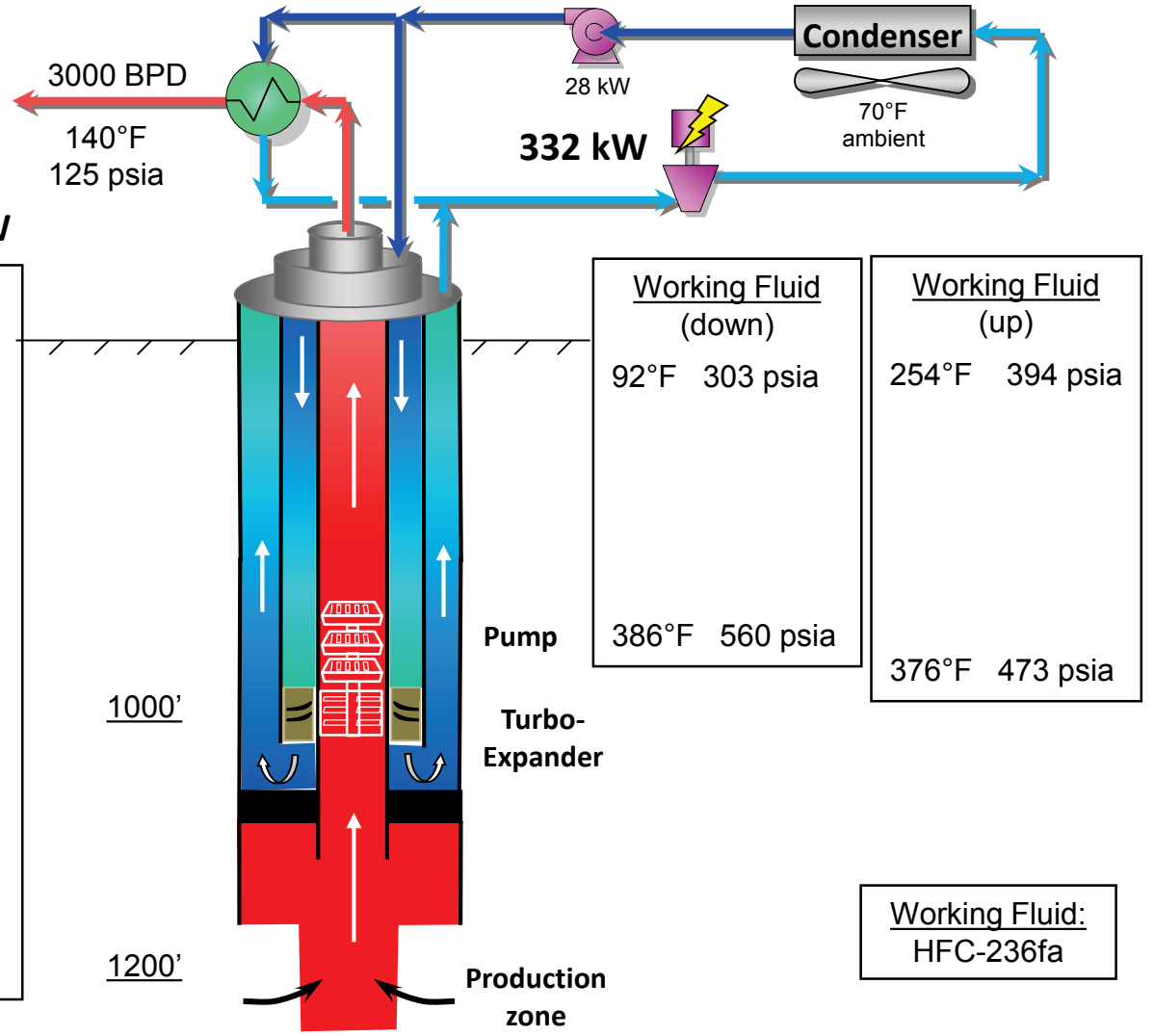
- **Production Rate = 3,000 BPD**
- **Pump Depth = 7,100 ft**
- **Reservoir Temp. = 240°F**



THYMO SAGD Example

Example

- **Production Rate = 3,000 BPD**
- **Pump Depth = 1,000 ft**
- **Reservoir Temp. = 400°F**
- **Electricity Generation ≈ 300 kW**



Reservoir Conditions:
400°F
400 psia

Working Fluid:
HFC-236fa

State of Technology

- THYMO™ - Thermal Hydraulic Model well performance evaluation software
  - Blade Energy Partners – developed original version for geothermal market
  - Ortloff Engineers – adapted software model to oil well applications
- Turbo Expander – at technology readiness level (TRL) 5
  - Concepts NREC – developed design for turbo expander
- Seeking partner for in-well testing